Global Production Networks and Policy Reforms with Imperfect Competition*

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Abstract

How do global production networks shape the gains from trade and competition policy? We show that import prices in Chile and France are lower with more Chinese suppliers; suppliers price discriminate across buyers; and diversified buyers pay lower prices. These facts motivate a model of network formation with two-sided firm heterogeneity, matching frictions, and imperfect competition. More productive buyers match with more suppliers, spurring tougher supplier competition, lower input costs, and higher profits. Causal evidence confirms that larger French and Chilean firms import higher quantities at lower prices as more Chinese suppliers enter, and suppliers charge diversified buyers lower markups. Counterfactuals reveal that entry upstream benefits high-productivity buyers, while lower trade or matching costs favor mid-productivity buyers. Packaging tariff liberalization with trade facilitation or competition promotion amplifies welfare gains, whereas fixed networks or markups dampen gains.

Keywords: production networks, global value chains, matching frictions, imperfect competition, gains from trade.

JEL codes: D24, F10, F12, F14, L11, L22

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1 Introduction

Global value chains (GVCs) have transformed economic activity as firms today transact with upstream suppliers, downstream producers, and final consumers worldwide (e.g., Antràs et al., 2017; Bernard and Moxnes, 2018). These network linkages challenge policy making with their potential to alter the domestic and international effects of both trade agreements and behind-the-border reforms (e.g., Antràs and Staiger, 2012; Grossman et al., 2023, 2024; Antràs et al., 2024). In practice, the growth of GVCs has been accompanied by policy polarization: On the one hand, trade disintegration (e.g., Brexit, China-US trade war) and industrial policy acting as protectionism (Juhász et al., 2024). On the other hand, deeper integration with modern trade agreements that combine tariff cuts with regulatory harmonization, trade promotion, and competition or industrial policy, to facilitate firm entry and buyer-supplier transactions (Maggi and Ossa, 2021).[1] While both market structure and network formation costs have been independently shown to affect firm performance and the gains from trade, understanding their interaction is essential for current policy design and impact evaluation.

We examine the welfare effects of trade and competition reforms with global production networks and imperfect competition. Using French, Chilean, and Chinese customs data, we show that import prices are lower with more Chinese suppliers; suppliers price discriminate across buyers; and diversified buyers pay lower prices. These facts motivate a model of network formation with two-sided firm heterogeneity, matching frictions, and oligopolistic competition upstream. More productive buyers match with more suppliers, spurring tougher supplier competition, lower input costs, and higher profits. Causal evidence confirms that French and Chilean firms (especially large ones) import higher quantities at lower prices as more Chinese suppliers enter, and suppliers charge diversified buyers lower markups. Finally, model quantification and counterfactuals reveal that entry upstream benefits high-productivity buyers, while lower trade or matching costs favor mid-productivity buyers. Packaging tariff liberalization with trade facilitation that lowers matching costs or competition policy that promotes entry amplifies welfare gains. Moreover, fixing trade networks or input markups dampens or nullifies policy gains.

First, we establish three facts about production networks in customs data for China, Chile, and France over 2000-2006. The network of upstream Chinese suppliers and downstream Chilean and French producers exhibits familiar sparsity, with skewed connectivity and pervasive concentration in input markets despite significant entry over time. Fact 1 documents that inputs sold by more suppliers trade at lower average prices. Fact 2 reveals that suppliers

[1] Competition policy is the most frequent provision in modern Preferential Trade Agreements (PTAs) according to the World Bank Deep Trade Agreements database (Hofmann et al., 2017). It is closely followed by policy coordination that lowers firm matching and transaction costs, such as policies on investment, capital and labor mobility, and intellectual property and environmental standards.

with more buyers vary prices significantly more across buyers within products. Lastly, Fact 3 uncovers that firms with more suppliers pay systematically lower input prices within products.[2]

Second, we develop a new general-equilibrium model of global production networks with three key ingredients motivated by the facts above: (i) two-sided firm heterogeneity, (ii) matching frictions, and (iii) imperfect competition. In the model, heterogeneous buyers transact with heterogeneous suppliers in the presence of trade costs, match-specific cost shocks, oligopolistic competition upstream, and monopolistic competition downstream. At a higher fixed cost, a firm can meet more suppliers, which enables a better match for each input and lowers input markups due to tougher competition among suppliers.

The combination of endogenous network formation and imperfect competition upstream generates two-sided market power and a new channel through which production networks amplify firm heterogeneity. More productive firms optimally source from more suppliers, and therefore enjoy lower input costs and markups and higher sales, even though their marginal supplier is less productive. Respectively, more productive suppliers sell more to more buyers and earn higher revenues, with each supplier charging its less productive, less diversified marginal buyers higher markups. Thus buyers' and suppliers' market power varies across matches.

The model highlights novel distributional effects of local industrial policies and multilateral trade reforms. Industrial policy that triggers entry upstream in one country benefits sufficiently productive final manufacturers worldwide: Above a threshold, more productive firms expand their supplier set more aggressively and lower their input costs and markups by more. By contrast, tariff liberalization and trade promotion that reduce iceberg and matching costs, respectively, enable mid-productivity buyers that do not yet source from all suppliers to tap more suppliers. While lower trade costs raise profits for all buyers, those that add suppliers gain more.

Third, we provide causal evidence for the model in comprehensive production and customs data for France, Chile, and China in 2000-2006. We assess how the dramatic, exogenous expansion in firm entry and trade activity in China affected downstream producers in Chile and France, two economies of different size, development, and GVC position. For Chile, we exploit rich data on firm import transactions that identify the supplier, HS 6-digit product, value, price, and quantity, matched to indicators for firm size bins. For France, we access analogous data without supplier identities, matched to detailed firm balance sheets. Finally, for China, we use matched data on firms' export transactions and balance sheets to characterize the set of Chinese suppliers to France, Chile, and the rest of the world (ROW) by HS-6 product.

Guided by the model, we proxy the set of potential Chinese suppliers by product and year using the number of Chinese exporters to ROW. We provide robust evidence using instead

[2] As we discuss in Section 2, Facts 1-3 are consistent with related empirical patterns presented in Atkeson and Burstein (2008), Mayer et al. (2014), Edmond et al. (2015), Fontaine et al. (2020), and Burstein et al. (2024).

the actual number of Chinese exporters to Chile or France, which is arguably exogenous to atomistic buyers. We also instrument the latter with the number of Chinese exporters to ROW or to a comparable market (Pacific Alliance countries for Chile, USA for France). Given the importance of Chinese inputs to Chilean and French firms and the insignificance of the Chilean and French markets to China, our identification strategies permit causal interpretation.

We empirically establish that market structure upstream and buyer heterogeneity downstream shape global production networks in line with the model's predictions. On the buyer side, French and Chilean firms import greater values and quantities of Chinese inputs at lower unit prices as more Chinese suppliers enter over time. Moreover, bigger buyers adjust their sourcing strategy to a greater extent. These results condition on firm, product, and year fixed effects, as well as product-specific time trends. They are not driven by other supply conditions upstream, such as the distribution of supplier productivity and quality, the use of intermediated or processing trade, and the presence of multi-product and multinational suppliers. The patterns hold controlling for import tariffs and various aspects of the market structure downstream.

On the seller side, Chinese suppliers systematically vary prices across Chilean buyers in a way consistent with oligopolistic competition. Suppliers offer lower prices for the same product to producers that source that product from more Chinese providers. This result obtains in stringent specifications that account for suppliers' marginal cost and quality with supplier-product fixed effects and for downstream demand with buyer-product fixed effects.

Finally, we estimate the model to perform policy counterfactuals and assess the role of key model ingredients. We develop a novel estimation method for computationally demanding, high-dimensional models as ours, which tackles both the combinatorial multinomial discrete-choice problem of buyers' sourcing strategy and suppliers' buyer-specific pricing game. In particular, we build on techniques from the prior literature (Jia, 2008; Antràs et al., 2017; Arkolakis et al., 2023a) to accommodate endogenous network formation and imperfect competition. We first directly estimate elasticity parameters and firm cost distributions, and then estimate aggregate demand and matching costs by simulated method of moments.

We consider (a) behind-the-border industrial or competition policy that supports firm entry upstream; (b) tariff liberalization that lowers iceberg trade costs; and (c) trade promotion and facilitation (or, equivalently, relaxation of non-tariff measures (NTMs)) that reduces fixed matching costs. We conduct the analysis for Chile and 5 regions that capture the geo-economic mix of its main trade partners: Latin America, USA, Europe, China, and ROW. We benchmark shock magnitudes to the actual expansion in Chinese suppliers to Chile over the 2000-2006 sample period and the Chile-China PTA signed in 2006. We simulate policy packages motivated by the objectives of enhanced competition and lower firm networking costs in both the

Chile-China PTA and the CPTPP that includes Chile.[3]

We show that (a) unilateral entry upstream, (b) lower bilateral trade costs, and (c) lower bilateral matching costs can each reduce buyers' input costs and either raise or lower total matching costs, with nuanced effects on sales and profits. This reflects how firms adjust their global sourcing due to input complementarities across regions. On net, (a) benefits only highly productive buyers that expand their supplier portfolio, while (b) and (c) favor mid-productivity buyers that do so. Welfare gains are sizable with (a) and (b), but minimal with (c).

We also compare shallow integration (b) to deep integration (b+c) and package trade and industrial reforms (b+a). Both relaxing matching costs and facilitating entry upstream amplify the welfare gains from tariff liberalization in the baseline with endogenous markups and networks.

To illustrate how endogenous networks and imperfect competition interact, we finally contrast the baseline to scenarios with fixed production linkages or constant markups. Fixing the production network implies no effects of (a) or (c) on downstream firm sales and consumer prices and lower welfare gains from all other policy scenarios, as buyers can no longer re-optimize their suppliers. Similarly, fixing input markups significantly dampens gains from all interventions except (b) on its own, since firms reap no pro-competitive cost savings from adding suppliers, and all reforms except (b) feature important supplier-margin responses.

We contribute to the burgeoning literature on the determinants and consequences of global production networks. Early studies have emphasized the benefits of foreign input sourcing for downstream firms' productivity, product quality, innovation, and profitability, while abstracting away from the identity or outcomes of upstream suppliers (Amiti and Konings, 2007; Goldberg et al., 2010; Halpern et al., 2015; Bøler et al., 2015; Manova et al., 2015; Blaum et al., 2018; Antràs et al., 2017). Subsequent work has examined how heterogeneous buyers and suppliers interact to shape firms' production costs and sales, progressing from exogenous networks through random matching to endogenous links with matching costs (Bernard and Moxnes, 2018; Chaney, 2014; Lim, 2018; Oberfield, 2018; Bernard et al., 2019; Panigrahi, 2021; Demir et al., 2024a; Fontaine et al., 2023). For example, Bernard et al. (2022) find that two-sided firm heterogeneity and match-specific shifters are focal to firm size dispersion in the domestic production network in Belgium, while Bernard et al. (2018b), Eaton et al. (2022), and Kramarz et al. (2022) explore exporter-importer linkages for Norway, US-Colombia, and France, respectively.

We advance two frontier developments in this literature. One recent line of work departs from monopolistically competitive markets to consider imperfect competition upstream, downstream or both in *fixed* production networks (Morlacco, 2020; Dhyne et al., 2022; Alviarez

[3]The Chile-China PTA includes a declaration of interest in the harmonization of SPS measures, firm dispute resolution, and trade promotion and facilitation for SMEs. Viewed as an archetype of modern trade agreements and deep integration (Maggi and Ossa, 2021), the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) explicitly includes chapters on competition policy and state-owned enterprises.

et al., 2023; Burstein et al., 2024). This generates markup dispersion in the network and welfare costs to consumers. A key take-away is that bargaining power and rent sharing in buyer-seller matches depend on firms' share in their partners' total sales or input purchases, i.e. the intensive margin of firm-to-firm transactions. In comparison, we develop a model of imperfect competition in which *endogenous* network formation under matching frictions gives rise to two-sided market power regulated by the extensive margin of firm connections.

The second emerging stream of research explores the welfare implications of global production networks.[4] For example, Arkolakis et al. (2023b) and Dhyne et al. (2023) characterize the gains from international trade when domestic production networks can adjust, while Demir et al. (2024b) evaluate the income effect of local digital infrastructure investments mediated through lower firm matching costs. We complement this body of work by considering three different policy levers—trade costs, matching costs, and market competition—in a unified framework that permits the analysis of both stand-alone and package reforms.

Our contribution to these two frontier avenues is to show that the interaction of (i) two-sided firm heterogeneity, (ii) endogenous network formation, and (iii) imperfect competition is necessary and sufficient to generate novel policy effects and rationalize key data patterns that other frameworks cannot. On necessity, models without (i) or (ii) cannot account for the variation in network activity across firms, across suppliers within buyers, and across buyers within suppliers. Models that feature (i) and (ii) but omit (iii) counterfactually rule out price discrimination across buyers within suppliers. They also imply no differential effects of entry upstream across downstream firms. In turn, models that combine (i) and (iii) without (ii) permit match-specific markups. However, fixed network links entail no cross-border spillovers of competition policy and no augmented effects of deep integration with trade facilitation relative to shallow integration without. On sufficiency, ours is the first within a potential class of data-consistent models that can accommodate the complexity of (i), (ii) and (iii), yet remain tractable and parsimonious.

More broadly, we speak to how micro features of production networks shape macro outcomes. Prior work indicates that the characteristics of firms' input suppliers contribute to the large and growing firm size dispersion (Sutton, 2007; Bernard et al., 2022). We show that the combination of endogenous match formation and imperfect competition is an additional amplification force for firm heterogeneity. Separately, asymmetric production networks have been found to enhance long-run growth and generate aggregate swings from idiosyncratic shocks (Acemoglu et al., 2012; Magerman et al., 2016; Baqaee, 2018; Baqaee and Farhi, 2019; Acemoglu and Azar, 2020; Taschereau-Dumouchel, 2020; Acemoglu and Tahbaz-Salehi, 2024), while production linkages mediate shock propagation and business cycle co-movement across

[4]This builds on canonical computable general equilibrium or quantitative trade models that evaluate trade policy with no production networks, firm granularity, or market power (Costinot and Rodríguez-Clare, 2014).

countries (Lim, 2018; Boehm et al., 2019; Carvalho et al., 2021; Dhyne et al., 2021; Di Giovanni et al., 2024; Huo et al., 2025). Our analysis suggests that imperfect competition in global sourcing can strengthen these transmission mechanisms with two-sided firm heterogeneity.

The paper is organized as follows. Section 2 establishes stylized facts about pricing in buyer-supplier production networks. Section 3 presents the model of global sourcing with two-sided firm heterogeneity, endogenous network formation, and oligopolistic competition upstream. Section 4 introduces the data for France, Chile, and China, and provides causal empirical evidence for the model's predictions. Section 5 develops and implements the model estimation strategy, and performs counterfactual analyses. The last section concludes.

2 Stylized Facts

We establish three stylized facts about price dispersion in buyer-supplier networks, using rich transaction-level customs data for China, Chile, and France. We first briefly introduce the data and key features of the production networks between upstream Chinese suppliers and downstream Chilean and French buyers.

The raw data contains information about the universe of Chinese exports by firm, HS 6-digit product and destination; the universe of French imports by firm, HS-6 product and origin; and the universe of Chilean imports by firm, HS-6 product, origin, and supplier. Since the main empirical analysis in Section 4 identifies the impact of upstream entry in China on downstream sourcing activity in Chile and France, here we present systematic cross-sectional patterns in China-France and China-Chile trade relations for the year 2000, the first year in our panel.[5]

The network of upstream Chinese suppliers and downstream Chilean and French producers is sparse with a minority of highly connected firms, consistent with prior evidence for other countries (see Bernard and Zi, 2022). Appendix Figure A1 illustrates the skewed distribution of buyer-supplier matches across firms. The median and modal Chilean importer uses a single Chinese supplier per HS 6-digit input, with a long thin tail of wider sourcing. The median and modal Chinese supplier likewise serves a single Chilean buyer within a product. Similar patterns hold for the distribution of trade transactions between China and France.

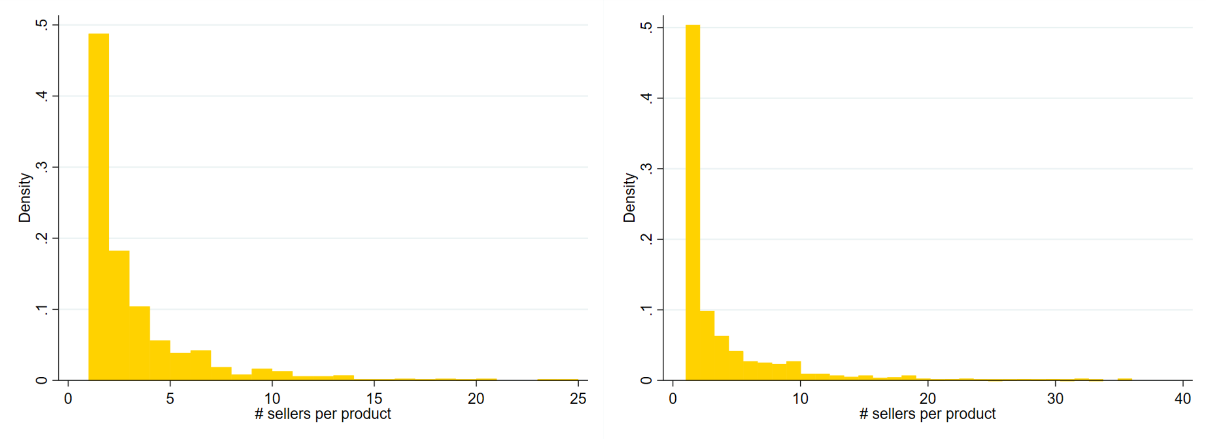
This sparse production network is accompanied by pervasive concentration in input markets. Figure 1 displays the distribution of the number of Chinese exporters of a given HS-6 product to Chile and France. Approximately 80% of all inputs Chile imports from China are provided by fewer than 5 Chinese suppliers. This number stands at roughly 65% in the case of France.[6]

[5]Note China joined the World Trade Organization (WTO) in 2001. All facts hold for other years in our 2000-2006 panel.

[6]These patterns mirror similar findings for the US and several European countries (Mayer and Ottaviano, 2008; Bernard et al., 2018a).

Figure 1: Concentration Upstream

(a) Chinese suppliers to Chile per product (b) Chinese suppliers to France per product



Note: Histograms of the number of Chinese suppliers (a) to Chile and (b) to France per HS6 product.

We now present three stylized facts about price dispersion in buyer-supplier networks, exploiting the Chilean customs data with trade partner identities. These facts point to a role for imperfect competition under two-sided firm heterogeneity and matching frictions, and motivate a novel model of global production networks with these three key ingredients.

Fact 1 (Average Input Prices and Competition): *Inputs sold by more suppliers trade at lower average prices.*

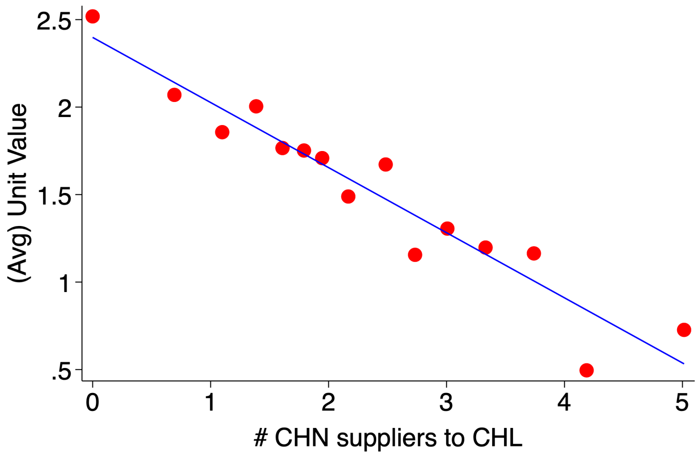
We present Fact 1 with a bin-scatter plot of the mean import price of an HS-6 product exported by Chinese firms to Chile in Figure 2. We group products into 20 bins by number of suppliers, and compute the simple average unit value across all import transactions. There is a tight negative relationship, with slope coefficient of -0.39 for the fitted line.

Thus the first empirical pattern we highlight is that inputs sold by more suppliers generally trade at lower average prices. This pattern is consistent with more concentrated upstream markets featuring higher input prices for downstream manufacturers. It also aligns with prior research that documents how market structure shapes international trade prices (e.g., Atkeson and Burstein, 2008; Mayer et al., 2014; Edmond et al., 2015).

Fact 2 (Supplier Price Dispersion): *Suppliers with more buyers vary prices more across buyers within products.*

We demonstrate Fact 2 with the bin-scatter plot in Figure 3a, where each dot corresponds to a representative supplier in one of 20 bins. We first measure price dispersion within a Chinese exporter and HS-6 product pair across Chilean buyers with the standard deviation of transaction unit values, and demean by product. We then group exporter-product pairs into 20 bins based

Figure 2: Average Input Price



Note: Binscatter of the average log unit value for Chinese products exported to Chile (HS 6-digit), grouped into 20 bins sorted by the log number of Chinese exporters selling each product to Chile. Note that the bottom products all have 1 supplier, so the figure displays 15 bins.

on their product-demeaned number of Chilean partners. For each bin, we finally construct a representative Chinese exporter with the bin-specific average price dispersion and number of Chilean buyers.

The second empirical fact we document is that Chinese suppliers with more Chilean buyers vary prices significantly more across their buyers. This variation suggests that suppliers may be able to price discriminate across their customers, consistent with evidence for French exporters in Fontaine et al. (2020). In particular, it is neither mechanical, nor consistent with models of constant markups across buyers within suppliers, which would imply a flat, rather than an upward-sloping relationship.[7]

Fact 3 (Buyer Pro-competitive Diversification): *Buyers with more suppliers enjoy lower average input prices within products.*

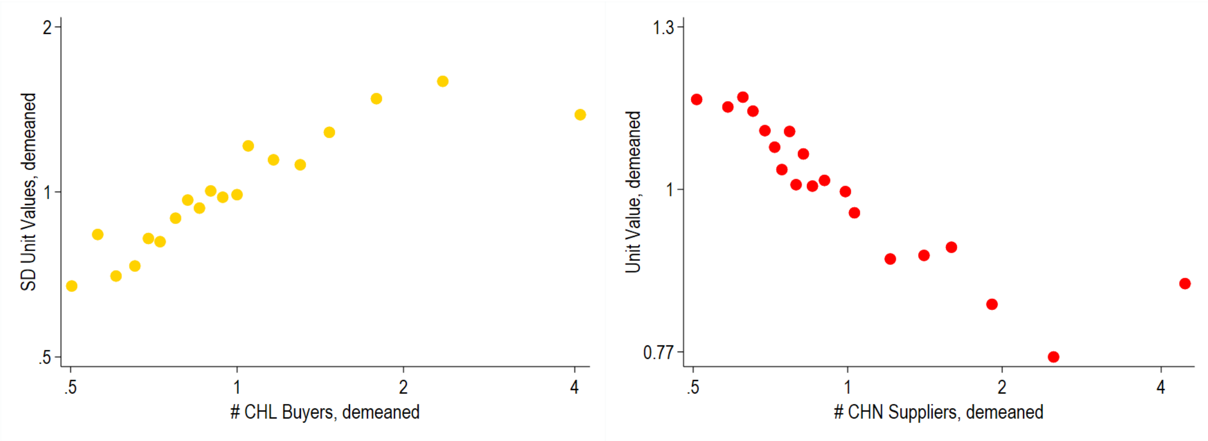
We illustrate Fact 3 with the bin-scatter plot in Figure 3b, where each dot represents a typical buyer in one of 20 bins. We first calculate the average unit value each Chilean importer pays for a given HS-6 product across its Chinese suppliers, and demean by product. We then group importer-product pairs into 20 bins based on their product-demeaned number of Chinese partners. For each bin, we construct a representative Chilean importer with the bin-specific average demeaned unit value and number of Chinese suppliers.

The third empirical regularity we establish is that Chilean buyers with more Chinese sup-

[7]Since the HS 6-digit product classification is somewhat coarse, the price dispersion we measure may under- or overstate the true variation (e.g., Fontaine et al., 2020; Burstein et al., 2024). This is irrelevant for Facts 2 and 3 to the extent that such measurement error is orthogonal to the number of buyers.

Figure 3: Network Price Dispersion

(a) Price dispersion across buyers within suppliers (b) Average input price across buyers



Note: (a) Binscatter of the standard deviation of log unit values within Chinese suppliers across Chilean buyers, for 20 bins of Chinese exporters by number of Chilean buyers. (b) Binscatter of average log unit value of Chinese imports, for 20 bins of Chilean importers by number of Chinese suppliers. All values demeaned by HS-6 product.

pliers pay systematically lower average input prices.[8] This indicates that buyers may enjoy pro-competitive gains from diversifying their supplier portfolio.[9] Once again, this pattern is not mechanical, and is inconsistent with models with no supplier heterogeneity that imply a flat relationship. It is also inconsistent with models of endogenous networks with two-sided heterogeneity and constant markups, which predict the opposite relationship: In these models, negative degree assortativity implies that more diversified buyers source from increasingly less productive, higher-cost suppliers, and pay higher average input prices.[10]

3 Theoretical Framework

We develop a quantifiable general equilibrium model of global sourcing in which heterogeneous buyers match with heterogeneous suppliers in the presence of trade and matching costs. We examine the impact of matching frictions and oligopolistic competition upstream on the sourcing behavior of monopolistically competitive firms downstream. We characterize the endogenous

[8] Our findings are consistent with the evidence in (e.g., Burstein et al., 2024) of substantial variation across Chilean firms in the prices they pay for domestic inputs. We instead focus on imported inputs and explicitly link input price variation to the number of suppliers.

[9] We emphasize how the extensive margin of sourcing from more suppliers correlates with inputs prices, which we later attribute to oligopolistic competition among suppliers in setting buyer-specific markups. This is distinct from, and complements prior evidence that the intensive margin of a supplier's input cost share shapes bargaining power and thereby match-specific markups (e.g., Fontaine et al., 2020; Dhyne et al., 2022; Alviarez et al., 2023).

[10] This interpretation would be more nuanced with quality heterogeneity across suppliers. We explicitly control for average supplier quality in the empirical analysis in Section 4.

formation of the global production network and key outcomes at the firm- and firm-to-firm transaction levels. Detailed proofs are relegated to Appendix A.

3.1 Final Demand

Consumers in J countries have Cobb-Douglas preferences over homogeneous and differentiated goods. In each country i, wages w_i are pinned down by a sector that produces a freely tradable and homogeneous good produced under constant returns to scale. Consumers exhibit CES preferences for available varieties $\omega \in \Omega_i$ of the non-tradable differentiated final good:

$$U_i = Q_0^{1-\alpha} \left[\int_{\omega \in \Omega_i} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\alpha\sigma}{\sigma-1}}, \; \sigma > 1,$$

where Q_0 is consumption of the homogeneous good, α is the expenditure share on differentiated goods, and σ is the elasticity of substitution across varieties. Given aggregate expenditure E_i and price index P_i for differentiated goods, demand for variety ω with price $p_i(\omega)$ is:

$$q_i(\omega) = E_i P_i^{\sigma-1} p_i(\omega)^{-\sigma}. \tag{1}$$

3.2 Downstream Production

In each country, a continuum of monopolistically competitive downstream firms assemble domestic and imported inputs into differentiated goods. Given the CES demand (1), firms optimally set a constant markup above their marginal production cost $c_i(\omega)$ to maximize profits:

$$p_i(\omega) = \frac{\sigma}{\sigma-1} c_i(\omega). \tag{2}$$

Upon paying an entry cost of $w_i f_i$, downstream firms draw core productivity φ from distribution $G_i(\varphi)$ with support $[\overline{\varphi}_i, \infty)$. They combine a unit measure of input varieties $v \in [0, 1]$, produced by upstream suppliers in countries $j \in \mathcal{J} = \{1, ..., J\}$ and sectors $k \in \mathcal{K} = \{1, ..., K\}$. The elasticities of substitution across input varieties from the same country-sector and across country-sectors are $\lambda > 1$ and $\eta > 1$, respectively. The marginal cost of downstream firm φ is thus given by:

$$c_i(\varphi) = \frac{1}{\varphi} \left(\sum_{j=1}^{J} \sum_{k=1}^{K} I_{ijk}(\varphi) c_{ijk}(\varphi)^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{3}$$

Here $I_{ijk}(\varphi)$ is an indicator equal to 1 if the firm sources sector k inputs from country j, and

$c_{ijk}(\varphi)$ is the composite cost index of jk inputs:

$$c_{ijk}(\varphi) = \left(\int_0^1 z_{ijk} \left(\varphi, v\right)^{1-\lambda} dv \right)^{\frac{1}{1-\lambda}}, \tag{4}$$

which aggregates the costs of upstream input varieties v to producer φ, $z_{ijk}\left(\varphi, v\right)$. Note that input costs can vary across producers due to their endogenous choice of suppliers $\mathcal{S}_{ijk}(\varphi)$ and suppliers' endogenous choice of buyer-specific markups.

Buyer φ receives a match-specific cost shock $\xi_{ijks}(\varphi, v)$ for variety v after matching with supplier s and observing that supplier's price, $p_{ijks}(\varphi)$. This shock can be seen as the cost of adapting an input to the firm's production process or the cost equivalent of a quality defect. Conditional on sourcing inputs from a given country-sector, the buyer optimally purchases variety v from the lowest-cost upstream supplier within the set of suppliers it has matched with:

$$z_{ijk}(\varphi, v) = \min_{s \in \mathcal{S}_{ijk}(\varphi)} \left\{ \tau_{ijk} \cdot p_{ijks}(\varphi) \cdot \xi_{ijks}(\varphi, v) \right\}, \tag{5}$$

where τ_{ijk} is an iceberg trade cost of shipping sector-k inputs from country j to i. The presence of match-specific cost shocks implies that equally productive buyers matched with the same set of suppliers may choose different suppliers for the same input variety. Following Antràs et al. (2017), we assume that $1/\xi_{ijks}(\varphi, v)$ is Fréchet distributed: $\Pr(\xi_{ijks}(\varphi, v) \geq t) = e^{-t^{\theta}}$. A larger shape parameter θ corresponds to a wider dispersion of shocks and a higher elasticity of substitution across suppliers within country-sector.

3.3 Upstream Production

A discrete number of upstream suppliers S_{jk} produce differentiated inputs in country j and sector k, and each supplier can produce all varieties in a given sector. In order to sell to downstream buyers in country i, they have to pay $w_j f^U_{ijk}$ (U denotes upstream), which can be thought of as the registration fee to attend a trade fair in a convention center. This fixed cost will imply that only the most productive suppliers select into exporting.

Suppliers matched to a downstream buyer compete oligopolistically among themselves, and set optimal match-specific prices to maximize profits $\pi^U_{ijks}(\varphi)$ separately for each relationship:[11]

$$\max_{p_{ijks}(\varphi)} \pi^U_{ijks}(\varphi) = Q_{ijks}(\varphi)(p_{ijks}(\varphi) - c_{jks}), \tag{6}$$

where c_{jks} is the constant marginal cost of jk input supplier s, and $Q_{ijks}(\varphi)$ is the expected

[11] In the spirit of Neary (2016), the suppliers are large for an individual buyer, but small for the downstream sector as a whole. Consequently, they take downstream aggregate variables as given when setting prices.

residual demand of buyers with productivity φ.

3.4 Buyer-Supplier Matching

Let S_{ijk} suppliers in country-sector jk be productive enough to export to country i. We assume that there are many rooms in a convention center that runs trade fairs where buyers and suppliers can meet and form trading relationships. Each room can be equipped with seats for up to S_{ijk} suppliers. A buyer from country i can use a room with S seats to hold a bidding game among S suppliers, but it has to pay a higher fixed cost $w_i f^D_{ijk}(S)$ to use a bigger room, i.e. $f^D_{ijk}(S_{ijk}) > f^D_{ijk}(S_{ijk}-1) > \cdots > f^D_{ijk}(1) > 0$ (D denotes downstream). These matching costs can be thought of as combining a flat registration fee with room rental fees and labor costs for a team of sourcing managers, accountants and lawyers that scale up with the number of suppliers.

We assume that upstream firms enter each bidding room sequentially in increasing order of marginal cost. This will ensure a unique matching equilibrium and grant significant tractability: Instead of facing a high-dimensional choice over $2^{S_{ijk}}$ possible sets of suppliers in country-sector jk, the buyer has to consider only $S_{ijk}+1$ options.[12] At the cost of $w_i f^D_{ijk}(S')$, a buyer can therefore match with the 'top' $S' \in S_{ijk}$ suppliers.

3.5 Sourcing Problem

Downstream firms optimize their global sourcing strategy in two steps. First, they select the optimal set of countries and sectors from which to purchase inputs, $\mathbb{I}_i(\varphi) = \{\mathcal{J} \otimes \mathcal{K} : I_{ijk}(\varphi) = 1\}$, and the optimal set of input suppliers from each origin country-sector, $\mathbb{S}_i(\varphi) = \{\mathcal{J} \otimes \mathcal{K} : S_{ijk}(\varphi) \in \{0, 1, ..., S_{ijk}\}\}$. Second, they determine their optimal sourcing intensity across suppliers given $\mathbb{I}_i(\varphi)$ and $\mathbb{S}_i(\varphi)$. We characterize these problems in reverse order.

3.5.1 Sourcing Conditional on Supplier Set

Buyers solve the optimal sourcing problem (5) to identify the cheapest provider of each variety in country-sector jk. The probability that supplier s is the lowest-cost supplier is:

$$\chi_{ijks}(\varphi) = \frac{p_{ijks}(\varphi)^{-\theta}}{\sum_{s'=1}^{S_{ijk}(\varphi)} p_{ijks'}(\varphi)^{-\theta}}. \tag{7}$$

[12] The hierarchical pattern that emerges from this assumption is consistent with empirical evidence in, for instance, Bernard et al. (2019). This assumption also underlies the solution concept in Atkeson and Burstein (2008), Eaton et al. (2012) and Gaubert and Itskhoki (2021). It can, for example, be rationalized as the equilibrium of a matching game in which suppliers pay a higher room-specific fixed cost to meet with more buyers.

With a continuum of varieties and i.i.d. cost shocks across matches, $\chi_{ijks}(\varphi)$ is also the share of supplier s in the buyer's expenditure on jk inputs.

A buyer's composite cost index for jk inputs is therefore:

$$c_{ijk}(\varphi) = \gamma\tau_{ijk}\left[\sum\nolimits_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(\varphi)^{-\theta}\right]^{-1/\theta}, \tag{8}$$

where $\gamma = \left[\Gamma(\frac{\theta+1-\lambda}{\theta})\right]^{\frac{1}{\lambda-1}}$ is a constant given by the gamma function $\Gamma(\cdot)$.[13] A downstream firm's total input costs, $C_i(\varphi)$, and demand for jk inputs, $Q_{ijk}(\varphi)$, can be expressed as:

$$C_i(\varphi) = q_i(\varphi)c_i(\varphi) = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} E_i P_i^{\sigma-1} c_i(\varphi)^{1-\sigma}, \tag{9}$$

$$Q_{ijk}(\varphi) = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} E_i P_i^{\sigma-1} \varphi^{\eta-1} c_i(\varphi)^{\eta-\sigma} c_{ijk}(\varphi)^{-\eta}. \tag{10}$$

From the perspective of upstream supplier s, the expected residual demand by buyer φ is $Q_{ijks}(\varphi) = Q_{ijk}(\varphi)\chi_{ijks}(\varphi)$, so that the supplier's problem (6) is:

$$\max_{p_{ijks}(\varphi)} \pi^U_{ijks}(\varphi) = Q_{ijk}(\varphi)\chi_{ijks}(\varphi)(p_{ijks}(\varphi) - c_{jks}), \;\; s = 1, ..., S_{ijk}(\varphi). \tag{11}$$

While a higher price boosts a supplier's profit margin, $p_{ijks}(\varphi) - c_{jks}$, it reduces its market share $\chi_{ijks}(\varphi)$ and residual demand $Q_{ijk}(\varphi)$ by raising the buyer's marginal cost $c_i(\varphi)$.

Proposition 1 summarizes the optimal pricing strategy of the suppliers.

Proposition 1 *There exists a unique Nash Equilibrium with supplier s prices*

$$p_{ijks}(\varphi) = \frac{\varepsilon_{ijks}(\varphi)}{\varepsilon_{ijks}(\varphi) - 1} c_{jks}, \tag{12}$$

where $\varepsilon_{ijks}(\varphi) = [\sigma\delta_{ijk}(\varphi) + \eta\,(1 - \delta_{ijk}(\varphi))]\,\chi_{ijks}(\varphi) + \theta\,[1 - \chi_{ijks}(\varphi)]$ is the elasticity of residual demand, and $\delta_{ijk}(\varphi)$ is the share of country-sector jk in buyer φ's input purchases.

Proof. *See Appendix A.1.*

Suppliers can price discriminate, and optimally charge buyer-specific markups, $\mu_{ijks}(\varphi) = \frac{\varepsilon_{ijks}(\varphi)}{\varepsilon_{ijks}(\varphi)-1}$. Suppliers set higher markups when they have a larger market share in the buyer's input basket, provided that $\rho_{ijk}(\varphi) \equiv \theta - \eta + (\eta - \sigma)\delta_{ijk}(\varphi) > 0$. We assume that this condition holds in light of the prior literature (Amiti et al., 2019; Dhyne et al., 2022).[14] This implies

[13] As in Eaton and Kortum (2002), we need $\lambda < \theta + 1$ for the price index to be well defined.

[14] As shown in Appendix B, $\partial\mu_{ijks}(\varphi)/\partial\chi_{ijks}(\varphi) = \rho_{ijk}(\varphi)/(\varepsilon_{ijks}(\varphi) - 1)^2$. We also show that $\rho_{ijk}(\varphi) > 0$ implies strategic complementarity in pricing among upstream firms (Amiti et al., 2019).

that downstream firms with more diversified sourcing and lower average $\chi_{ijks}(\varphi)$ enjoy lower input markups. Suppliers have less market power and charge lower markups when buyers face more elastic final demand (higher σ), and when inputs are more substitutable across and within countries and sectors (higher η and θ).[15]

Proposition 2 describes the benefits associated with sourcing from more suppliers.

Proposition 2 *An increase in the number of country-sector jk suppliers to a buyer $S_{ijk}(\varphi)$:*
(a) reduces the market shares $\chi_{ijks}(\varphi)$, markups $\mu_{ijks}(\varphi)$, and prices $p_{ijks}(\varphi)$ of all infra-marginal jk suppliers to the buyer;
(b) lowers the buyer's input cost index across jk inputs $c_{ijk}(\varphi)$.

Proof. *See Appendix A.2.*

These results reflect several forces that operate through sourcing interdependence conditional on the set of input origins. Along the extensive margin, higher $S_{ijk}(\varphi)$ increases the probability that the buyer finds a better-matched and therefore lower-cost supplier for any input variety. Along the intensive margin, higher $S_{ijk}(\varphi)$ intensifies competition among matched suppliers, and lowers the markup on each incumbent variety. These beneficial effects outweigh a counteracting one on the extensive margin: Given sequential supplier entry in bidding rooms, expanding the supplier set means adding progressively less productive suppliers.[16]

Proposition 2 indicates that buyers can effectively exert market power in the input market by endogenously choosing their supplier set. Endogenous network formation can thus be seen as providing micro-foundations for endogenous two-sided market power in buyer-supplier transactions, even when there is oligopolistic competition only upstream. Moreover, both buyers and suppliers can have heterogeneous market power, and their market power can vary across their matches. We will see that more productive buyers and suppliers will enjoy greater market power, the former due to their bigger supplier portfolio, and the latter due to their bigger share in buyers' input purchases.

[15] With no match-specific shocks and $\theta \to \infty$, the model collapses to classic Bertrand competition with $p_{jks}(\varphi) = c_{jks}$. With a continuum of suppliers and no matching frictions, the model instead collapses to monopolistic competition with ubiquitous sourcing: As $S_{ijk}(\varphi) \to \infty$, we have $\chi_{ijks}(\varphi) \to 0$ and $\mu_{ijks}(\varphi) \to \frac{\theta}{\theta-1}$.

[16] All these effects operate within an origin-sector. When a buyer adds its first supplier from a new country-sector, they reap additional gains due to this extensive margin.

3.5.2 Optimal Supplier Set

Downstream firms optimally choose their set of country-sector origins $\mathbb{I}_i(\varphi)$ and suppliers $\mathbb{S}_i(\varphi)$ by maximizing total profits, given the final demand shifter $B_i = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} E_i P_i^{\sigma-1}$:

$$\max_{\substack{I_{ijk}(\varphi)\in\{0,1\}_{j=1,k=1}^{J,K} \\ S_{ijk}(\varphi)\in\{0,1,2,\ldots,S_{ijk}\}_{j=1,k=1}^{J,K}}} \pi_i^D(\varphi) = B_i c_i(\varphi)^{1-\sigma} - \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi) w_i f_{ijk}^D(S_{ijk}(\varphi)). \tag{13}$$

Note that the firm's marginal cost $c_i(\varphi)$ decreases with its *sourcing capability* $\Theta_i(\varphi)$ since $\eta > 1$, where $\Theta_i(\varphi)$ is akin to an endogenous input cost index and thus captures the firm's ability to source inputs from low-cost suppliers:

$$c_i(\varphi) = \frac{\gamma}{\varphi}\Theta_i(\varphi)^{\frac{1}{1-\eta}}, \qquad \Theta_i(\varphi) \equiv \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi)\tau_{ijk}^{1-\eta}\left[\sum_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(\varphi)^{-\theta}\right]^{-\frac{1-\eta}{\theta}}.$$

While there is no closed-form solution to the combinatorial multinomial discrete choice problem (13), we can characterize key properties of the optimal sourcing strategy:

Proposition 3 *Downstream buyers' optimal sourcing strategy is such that:*
(a) the set of input suppliers is non-contracting in φ if $\sigma > \eta$ and $\rho_{ijk}(\varphi) > 0$, i.e., $I_{ijk}(\varphi_H) \geq I_{ijk}(\varphi_L)$ and $S_{ijk}(\varphi_H) \geq S_{ijk}(\varphi_L)$ for $\varphi_H \geq \varphi_L$;
(b) buyer sourcing capability $\Theta_i(\varphi)$ is non-decreasing in φ.

Proof. *See Appendix A.3.*

Result (a) implies that downstream firms observe a pecking order of input sourcing across country-sectors and across suppliers. This holds as long as final goods are closer substitutes in consumption than intermediate inputs in production, $\sigma > \eta$, and upstream suppliers' pricing features strategic complementarity, $\rho_{ijk}(\varphi) > 0$. When these two parameter restrictions hold, we say there is *sourcing complementarity* for downstream buyers.

The model thus delivers negative degree assortativity among buyers and suppliers on the extensive margin, in line with prior evidence (Bernard and Moxnes, 2018; Bernard et al., 2022). More productive buyers purchase inputs from more countries in more sectors. They also transact with more suppliers within each country-sector, and include less productive suppliers on the margin. Analogously, more productive suppliers serve a wider range of progressively less productive buyers, compared to their less productive competitors.

Taken together with Proposition 2, Proposition 3 implies that more productive buyers have endogenously greater market power in input markets, because they choose to transact with more suppliers and thereby obtain their inputs at lower markups and prices. Endogenous production networks thus amplify the inherent advantage of more efficient downstream firms. This prediction is consistent with the prior literature on the contribution of production networks to the firm size dispersion (Bernard et al., 2022).

3.6 Trade Flows

Despite the presence of endogenous network formation and imperfect competition, the model delivers gravity relationships for trade flows at the firm-to-firm, firm, and sector levels. Total imports by buyer φ in country i across suppliers s of country-sector jk inputs are:

$$\begin{aligned} X_{ijk}(\varphi) &= \sum_{s=1}^{S_{ijk}(\varphi)} X_{ijks}(\varphi) \\ &= \gamma^{\eta-\sigma-\theta}(\sigma-1)B_i\varphi^{\sigma-1}\Theta_i(\varphi)^{\frac{\sigma-\eta}{\eta-1}}\tau_{ijk}^{-\theta}c_{ijk}(\varphi)^{\theta+1-\eta}\sum_{s=1}^{S_{ijk}(\varphi)}\mu_{ijks}(\varphi)^{-\theta}c_{jks}^{-\theta}, \end{aligned} \tag{14}$$

Firm purchases of jk inputs thus increase with aggregate final demand B_i and with the firm's productivity φ and sourcing capability $\Theta_i(\varphi)$, and decrease with iceberg trade costs τ_{ijk}. Note that $X_{ijk}(\varphi)$ increases with the endogenous choice of suppliers $S_{ijk}(\varphi)$ both directly and indirectly through lower supplier markups $\mu_{ijks}(\varphi)$.

The model can accommodate positive assortativity among buyers and suppliers on the intensive margin, consistent with prior work (Benguria, 2021; Bernard and Moxnes, 2018; Sugita et al., 2023). Firm-to-firm sales $X_{ijks}(\varphi)$ rise with supplier productivity, as a lower marginal cost c_{jks} increases a supplier's market share in a buyer's input purchases, and also drives up the buyer's overall input demand. How firm-to-firm sales vary with buyer productivity depends on the net effect of two opposing forces. On the one hand, more productive buyers face higher output demand and need more intermediates. This scale effect is amplified by their endogenously higher sourcing capability. On the other hand, more productive buyers source from more suppliers, and this competition effect reduces input demand per supplier.

Aggregating across firms, imports by country i of jk inputs are $X_{ijk} = \int_{\overline{\varphi}_{ijk}}^{\infty} X_{ijk}(\varphi)dG_i(\varphi)$, where $\overline{\varphi}_{ijk}$ is the least productive downstream buyer in i that sources jk inputs.

3.7 Equilibrium

We close the model with entry and market clearing conditions. Downstream, free entry implies that expected profits from entry must equal the fixed cost of entry, $\int_{\overline{\varphi}_i}^{\infty} \pi_i^D(\varphi)dG_i(\varphi) = w_i f_i$. Thus only buyers above a threshold productivity $\overline{\varphi}_i$ produce, and their equilibrium mass Δ_i

scales with population L_i. Upstream, input suppliers below a marginal cost cut-off will be able to sell to downstream buyers. This selection results from the combination of fixed export costs per destination and sequential entry into bidding rooms. The number of suppliers from j to i in sector k, S_{ijk}, is determined by the marginal supplier $\overline{s}$ that earns non-negative net profits:

$$\Pi^U_{ijk\overline{s}}(S_{ijk}) = \Delta_i \int_{\overline{\varphi}_{ijk\overline{s}}}^{\infty} \pi^U_{ijk\overline{s}}(\varphi) dG_i(\varphi), \ \Pi^U_{ijk\overline{s}}(S_{ijk}) \geq w_j f^U_{ijk}, \ \Pi^U_{ijk\overline{s}}(S_{ijk}+1) < w_j f^U_{ijk}, \quad (15)$$

where $\overline{\varphi}_{ijk\overline{s}}$ is the marginal downstream buyer in country i that buys jk inputs from $\overline{s}$.

3.8 Comparative Statics

We now characterize the impact of supplier entry upstream, tariff reduction, and lower matching costs on firms' sourcing strategy. First, consider an increase in the number of potential suppliers from S_{ijk} to $S_{ijk}{}'$, for example, due to a lower fixed cost of entry f^U_{ijk} in upstream country-sector jk. Exogenous deregulation that lowers barriers to entry into production or exporting would, for instance, enable a new margin of suppliers from the left of the productivity distribution. From Proposition 2, sourcing from more suppliers $S_{ijk}(\varphi)$ reduces buyer φ's input cost index $c_{ijk}(\varphi)$. Not all buyers find it profitable to transact with the new suppliers, however, as they face a trade-off between lower marginal costs and higher matching costs: from Proposition 3, more productive buyers are more likely to expand their pool of suppliers.

Figure 4: Firm Productivity and # Suppliers: Comparative Statics

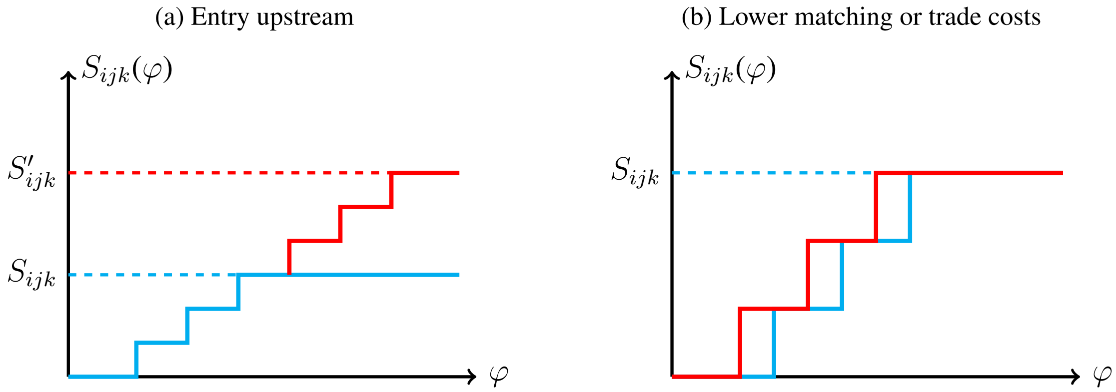


Figure 4a visualizes the impact of the upstream market structure in origin j on downstream firms' sourcing from j, where the optimal supplier set is a step function of buyer productivity. Low-productivity firms will not adjust their sourcing strategy. Sufficiently productive buyers will, however, choose to climb higher as the stairs get taller with entry upstream, and will thereby enjoy lower marginal costs and higher revenues and profits (at somewhat higher matching costs). As we show in Section 5, sourcing complementarity will imply that upstream entry in one origin may induce some buyers to also expand suppliers from other origins and further magnify their gains. Overall, upstream entry therefore amplifies performance dispersion between high- and low-productivity firms. Proposition 4 summarizes these insights:

Proposition 4 *Under sourcing complementarity and fixed market demand B_i, a rise in the number of potential suppliers S_{ijk} due to lower upstream entry costs:*
(a) weakly increases buyers' number of jk suppliers $S_{ijk}(\varphi)$;
(b) weakly reduces buyers' input price index $c_{ijk}(\varphi)$ and weakly increases its input quantities $Q_{ijk}(\varphi)$ and purchases $X_{ijk}(\varphi)$ of jk inputs;
(c) exerts larger effects on marginal costs, revenues, and profits on more productive buyers.

Proof. *See Appendix A.4.*

Next, we evaluate the impact of trade liberalization that reduces bilateral iceberg trade costs τ_{ijk}. The productivity cut-off that buyers in i need to clear to warrant any set of suppliers from j falls, as illustrated by a leftwards shift in the sourcing strategy stairs in Figure 4b. Assuming that the most productive buyers had already tapped all potential suppliers, it is buyers in the middle of the productivity distribution that may be induced to expand their supplier portfolio.[17] The least productive final producers would still not find it optimal to buy intermediates from j.

Trade liberalization thus cuts downstream firms' marginal costs through two channels: lower import duties on the intensive margin for all firms already sourcing from abroad, and greater input variety and pro-competitively lower input markups on the extensive margin for those that grow their supplier roster. Reductions in marginal costs in turn boost revenues and profits.

Lastly, we study the effects of lower buyer-supplier matching costs, for example due to technological change that facilitates partner search and transactions. Whether bilateral or global for all country-sectors, this reduction in matching costs shifts sourcing productivity cut-offs much as trade liberalization does in Figure 4b, with sourcing complementarity across origins acting as an amplification force. Mid-productivity firms once again enlarge their supplier sets. While all globally sourcing firms will see their profits rise due to lower fixed matching costs, those that initiate new supplier relationships will enjoy additional profit gains due to lower inputs costs and higher sales. Proposition 5 formalizes these comparative statics.

Proposition 5 *Under sourcing complementarity and fixed market demand B_i, a reduction in iceberg trade costs τ_{ijk} or matching costs $f^D_{ijk}(S_{ijk})$:*
(a) weakly expands buyers' sourcing strategy $\mathbb{I}_i(\varphi)$ and $\mathbb{S}_i(\varphi)$;

[17] Sourcing productivity cut-offs for other origins may also fall due to sourcing complementarity across origins.

(b) weakly reduces buyers' input price index $c_{ijk}(\varphi)$ and weakly increases their input quantities $Q_{ijk}(\varphi)$ and purchases $X_{ijk}(\varphi)$ of jk inputs;
(c) exerts bigger effects on marginal costs, revenues and profits on mid-productivity buyers.

Proof. *See Appendix A.5.*

4 Causal Evidence

4.1 Institutional Context

We evaluate the empirical relevance of the model by examining the relationship between the upstream market structure in China and the downstream sourcing behavior in Chile and France over the 2000-2006 period. All three countries trade intensively and occupy different segments of the global value chain, with China known as factory of the world providing inputs and assembly to manufacturers in both developed and developing economies. In turn, Chile and France exemplify economies of very different market sizes, economic development, institutional strength, and economic geography. Finding consistent evidence across both can thus reveal the ubiquity and significance of the mechanisms of interest.

China experienced dramatic export growth after joining the World Trade Organization (WTO) in 2001, gradually relaxing various barriers to entry, developing trade-oriented special economic zones, and shoring up physical and institutional infrastructure to support trade activity. This made China an important input supplier to French and Chilean firms, with its share of total imports roughly doubling from 3.2% to 5.7% for France and from 5.6% to 9.9% for Chile between 2000 and 2006. By contrast, France and Chile are not key export markets for Chinese producers, with their respective market shares stable at around 1.4-1.5% and 0.2-0.3%. This makes China-France and China-Chile trade relations ideal contexts for identifying the role of upstream entry on downstream sourcing.

4.2 Identification Strategy

Proposition 4 delivers sharp predictions for the impact of the upstream market structure in China on the sourcing of Chinese inputs by downstream French and Chilean firms. We evaluate these predictions for the value, quantity and unit price of imports from China by firm f of HS-6 product p in year t with variants of the following specification:

$$\{\ln X_{fpt}, \ln Q_{fpt}, \ln p_{fpt}\} = \beta \ln S_{CHN\to ROW,pt} + \Gamma\Omega_{CHN,pt} + \delta_f + \delta_p + t\delta_p + \delta_t + \varepsilon_{fpt}. \quad (16)$$

We proxy unit prices with the average unit value across all input purchases from China at the fpt level. We also present robust results for model-consistent CES import price indices that weight import transactions by value, scaled by Broda-Weinstein elasticities of substitution.

Proposition 4 indicates that the observed number of Chinese exporters of product p to Chile or France in year t, $S_{CHN\to CHL,pt}$ or $S_{CHN\to FRA,pt}$ respectively, is the metric of Chinese upstream market structure relevant to Chilean or French buyer f. Even if $S_{CHN\to CHL,pt}$ or $S_{CHN\to FRA,pt}$ endogenously responded to aggregate import demand downstream, this would be consistent with our general-equilibrium model of global sourcing and not invalidate causal interpretations at the level of individual firms. However, $S_{CHN\to CHL,pt}$ and $S_{CHN\to FRA,pt}$ may fail to capture the set of prospective upstream suppliers, or their correlation with downstream sourcing outcomes may in principle be driven by forces outside our model.

To alleviate such concerns, our baseline proxy for the number of potential Chinese suppliers to Chile (to France) is the number of Chinese exporters to the rest of the world excluding Chile (France), by product p and year t—labeled $S_{CHN\to ROW,pt}$ for both Chile and France for convenience. Guided by the model, we provide consistent evidence using the actual number of Chinese exporters to Chile $S_{CHN\to CHL,pt}$ (to France $S_{CHN\to FRA,pt}$), which is arguably exogenous from the perspective of atomistic buyers. We also instrument the latter either with $S_{CHN\to ROW,pt}$ or with the number of Chinese exporters to a larger yet comparable market: the Pacific Alliance countries (Colombia, Mexico, Peru) for Chile, and the USA for France.

We condition on a full set of firm, product, and year fixed effects, as well as on product-specific time trends, δ_f, δ_p, δ_t, and $t\delta_p$. We therefore identify coefficient β purely from the impact of changes in the Chinese market structure within downstream firms over time. We also guard against omitted variable bias by including product-year specific controls, $\Omega_{CHN,pt}$, which ensure that the market structure indicators do not capture trade costs or other supply conditions in China, as discussed below. We cluster standard errors by product-year (the level of the main variable of interest) to account for common supply and demand shocks across firms.

The theoretical model also characterizes the variation in trade activity across buyers from the perspective of suppliers. Proposition 1 implies that a Chinese supplier will price discriminate across its customers depending on their number of Chinese suppliers of the same product. We confront this prediction with data using variants of the following regression:

$$\ln p_{sfpt} = \beta \ln S_{CHN\to fpt} + \delta_{sp} + \delta_{fp} + \delta_{pt} + \varepsilon_{sfpt}, \tag{17}$$

where $\ln p_{sfpt}$ is the log unit value Chinese supplier s charges when selling HS-6 product p to downstream firm f, and $\ln S_{CHN\to fpt}$ is the log number of Chinese suppliers of input p to f, both at time t. We estimate this specification on the Chilean transaction-level data, which identifies foreign suppliers (unlike the French customs registry). We condition on supplier-product pair fixed effects to account for variation in marginal costs and quality at that level. Coefficient β thus captures the variation in markups across buyers within a supplier-product, on the assumption of minimal product customization across partners. In progressively more stringent specifications, we further add year fixed effects, or both product-year and buyer-product fixed effects. We conservatively cluster standard errors ε_{sfpt} at the product-year level.

4.3 Data and Key Trends

We exploit rich production and trade data for the near universe of Chilean, French and Chinese firms. For Chile and France, we obtain the value, quantity and price (unit value) of all import transactions at the firm - origin country - HS 6-digit product level from their respective customs agency. In the case of Chile, these records report the identity of the foreign supplier, which makes it possible to trace the bi-partite network of supplier-buyer matches. For France, we use detailed accounting statements and the main industry of activity for all firms from FICUS, and match these to the customs declarations based on unique firm identifiers. From the Chilean tax authority, we observe the primary output industry of each firm, as well as information on the size category it belongs to (13 tiers based on sales).

For China, we use comprehensive information on the universe of export transactions at the firm - destination country - HS 8-digit product level from the Chinese Customs Trade Statistics (CCTS), which we aggregate up to HS-6 products. CCTS reports additional information that we employ in robustness checks. It identifies firm ownership type (private domestic, state-owned, joint venture, or foreign multinational affiliate), and permits the classification of trade intermediaries from firm names and a standard word filter. At the transaction level, CCTS distinguishes between processing and ordinary trade, where the former entails exports produced on behalf of a foreign party using imported inputs. We match CCTS to accounting statements from the Chinese Annual Survey of Industrial Enterprises (ASIE) using a standard algorithm based on firm names, zip code, and phone number.

Since import transactions are recorded inclusive of cost, insurance and freight, we are careful to consider changes in trade duties over time. For Chile, MFN import tariffs on Chinese products remained unchanged throughout the 2000-2006 sample. These will therefore be subsumed by product fixed effects in the analysis.[18] For France, China was subject to the EU's GSP program, and hence faced zero or very low tariffs for most of its goods, with little variation over time. We nevertheless account for any gradual relaxation of import barriers with time-varying EU tariffs on China from UN WITS. We use applied ad-valorem tariffs at the HS-6 level, and take the maximum value if there are multiple tariff lines within a product code,

[18] Chile and China enforced a Preferential Trade Agreement in October 2006, towards the end of our sample.

$lmaxtariff_{pt} = \ln(1 + max\_rate/100)$; all results are robust to simple averages instead.

Panel A in Appendix Table A1 overviews the variation in Chinese market structure across traded products, and illustrates the dramatic trend in entry over time. In 2000, China exported 2,139 HS 6-digit products to France. The average number of suppliers per product was 16.9, with a median of 5 and standard deviation of 38.3. By 2006, China shipped 2,954 distinct products to France, from 37.7 suppliers on average, with a median of 8 and standard deviation of 92.3. A similar expansion is observed in China's exports to Chile over this period. The total number of products shipped grew from 1,431 to 2,388, while the average number of exporters per product jumped from 12.4 (standard deviation 23.5) to 21.4 (standard deviation 43.8).

Panel B demonstrates that rapid firm entry changed the composition of Chinese exporters in several respects. We locate each Chinese exporter of an HS-6 product p in ASIE, obtain relevant firm attributes, and report statistics at the product level by aggregating across all firms exporting p. China experienced secular productivity growth, with a steady increase in average value added per worker and measured average TFP, along with a rise in productivity dispersion. Average product quality remained stable, as proxied by firms' imported-input price index constructed from import transactions in CCTS. Also relatively stable were the shares of Chinese exports performed by trade intermediaries, multinational affiliates, or multi-product exporters. Effectively applied EU tariffs on Chinese products fell from 3.9% to 2.8% on average, while the overall share of processing trade declined from 36% to 26%.

Panel C summarizes the extent of downstream firm heterogeneity in Chile and France. Between 2000 and 2006, the number of producers sourcing inputs from China more than doubled in both France (from 12,571 to 25,737) and Chile (from 2,525 to 6,519). Worldwide firm imports also increased on average, and this partly reflects China's growing share in their import portfolio. Consistent with both less productive firms beginning to import on the extensive margin and growth in firm-level imports on the intensive margin, the median sales per worker across firms importing from China remained stable as the number of importers grew.

Panel D summarizes the bipartite network of Chinese supplier-Chilean buyer links. Between 2000 and 2006, the average number of Chilean buyers per product remained stable for Chinese suppliers. Similarly, the average number of Chinese suppliers per product shows little variation for Chilean producers. This is consistent with the significant entry by Chinese suppliers upstream, coupled with the sharp increase in the number of Chilean producers sourcing from China in Panel A. Of note, there was a rise in the dispersion of trade values and unit prices both across Chilean buyers within Chinese suppliers, and vice versa, in line with negative degree assortativity and price discrimination in the network.

4.4 Upstream Market Structure and Downstream Sourcing

Table 1 presents baseline results for the impact of the upstream market structure in China on the sourcing behavior of downstream firms in Chile (Columns 1-2) and in France (Columns 3-4), based on Proposition 4 and estimating equation (16). Panel A examines how the log number of Chinese exporters of an HS-6 product to the rest of the world in a given year, $\ln S_{CHN\rightarrow ROW,pt}$, affects the log value of imports from China by a Chilean or French firm for that product and year, $\ln X_{fpt}$. Panels B and C decompose $\ln X_{fpt}$ to repeat the analysis for the log quantity and log unit value of imports from China by downstream firm-product-year. Trade quantities are systematically recorded in kilograms for all products in the French customs data and in natural units of accounting that vary across products in the Chilean records. Any such heterogeneity is absorbed by product fixed effects.

Table 1: Baseline Results

	Chile		**France**	
	(1)	(2)	(3)	(4)
Panel A. (log) Import Value$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.028**	0.095**	0.085***	0.222***
	(0.014)	(0.039)	(0.010)	(0.029)
R2	0.003	0.553	0.008	0.585
Panel B. (log) Import Quantity$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.209***	0.232***	0.140***	0.285***
	(0.021)	(0.066)	(0.013)	(0.032)
R2	0.011	0.558	0.006	0.605
Panel C. (log) Import Unit Value$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	-0.181***	-0.137***	-0.055***	-0.063***
	(0.017)	(0.053)	(0.010)	(0.015)
R2	0.037	0.727	0.005	0.714
N	306,857	306,857	897,091	897,091
Year FE	YES	YES	YES	YES
HS-6 Product FE		YES		YES
HS-6 Product Trend		YES		YES
Firm FE		YES		YES
Product $\times$ Year Controls		YES		YES

Note: This table examines the effect of the market structure upstream on sourcing activity downstream. The dependent variable is the log value, quantity, or unit value of imports from China by Chilean or French firm, HS-6 product, and year. Upstream market structure is measured by the log # Chinese exporters to ROW by product and year. Product×year controls: log # Chilean or French importers from ROW; EU ad-valorem import tariffs on China (Columns 3, 4); mean and variance of Chinese exporters' productivity; mean input quality of Chinese exporters; value shares of Chinese processing and intermediated exports; shares of state owned, foreign-owned and multi-product Chinese exporters. Singletons dropped and standard errors clustered by HS-6 product × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We consistently find that more competition upstream induces downstream buyers in both Chile and France to expand their input expenditure and purchase higher input quantities, while enjoying lower input prices. Through the lens of the model, the pro-competitive effect of upstream competition on input prices lowers downstream firms' marginal production costs, which raises final demand for their output and in turn boosts their input demand. Together, these pro-competitive and scale effects result in higher import values. This evidence is consistent with tougher competition incentivizing Chinese suppliers to lower markups and cut prices.

These findings obtain both when we adopt a flexible specification with year fixed effects only (Columns 1, 3), and when we consider the most stringent variant of specification (16) with a full set of buyer firm, year and product fixed effects, along with product-specific time trends and additional controls (Columns 2, 4). The results can thus not be attributed to time-invariant buyer characteristics, global shocks, or persistent or trending product features. They also do not reflect the role of other product-year specific supply conditions in China, as we control for the average and the variance of the productivity of Chinese exporters (based on log value added per worker in the matched ASIE-CCTS data) and a proxy for the average output quality of Chinese exporters (based on the average unit value of each exporter's imported inputs). We also include the log number of Chilean or French importers of the same HS-6 product from the rest of the world to capture potentially relevant differences in downstream demand and market structure. We further condition on five value shares of Chinese exports conducted respectively by trade intermediaries, under the processing trade regime, by foreign-owned exporters, by state-owned enterprises, and by multi-product exporters. Finally, the regression for France controls for changes in the ad-valorem EU import tariff on Chinese goods.

Quantitatively, we estimate economically significant effects of the upstream market structure on downstream outcomes. For illustration, suppose the (log) number of potential upstream suppliers in China increased by 1 standard deviation (SD). Our results imply that French firms' import values would increase by 11.8% of a SD, total quantity would grow by 13.3% of a SD, and prices would fall by 6.4% of a SD. The corresponding numbers for Chilean buyers are 4.9%, 10.3% and -8.9%. Alternatively, take the actual rise in the number of Chinese exporters to ROW over the sample period. It can account for French firms' adjusting import values, quantities and prices by 22%, 28.1% and -6.1%, respectively, with analogous changes of 10.9%, 26.8% and -15.9% for Chilean producers.

Table 2 confirms that these baseline results survive a series of robustness checks. We first explore different sub-samples of firms. In Column 1, we drop upstream suppliers identified as wholesalers. This lowers all point estimates and makes the results for French import prices weakly insignificant, suggesting that large wholesalers play an important role in the context of imperfect competition upstream. In Column 2, we remove instead wholesale buyers downstream. If anything, this increases coefficient magnitudes in the case of Chile and slightly dampens those for France. Together, these results are consistent with interdependent price setting across suppliers within a buyer but not across buyers within a supplier. Ignoring important suppliers can thus underestimate the impact of upstream competition, while omitting individual buyers does not, with the caveat that the model predicts bigger effects on larger, more productive downstream firms, which we evaluate below.

Table 2: Robustness

Reported Regressor:	No Wholesalers		CES	Regressor: CHN→CHL/FRA Exporters		
(log) # CHN→ROW Exporters$_{pt}$	Upstream	Downstream	Import Price Index	OLS	IV: # CHN→ROW Exporters	IV: # CHN→PA/US Exporters
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Chile						
(log) Import Value$_{fpt}$	0.063**	0.160***		0.055***	0.071	0.101
(log) Import Quantity$_{fpt}$	0.133***	0.315***	0.274***	0.069***	0.256**	0.425***
(log) Import Unit Value$_{fpt}$	-0.070*	-0.155**	-0.189***	-0.014	-0.185*	-0.324***
N	306,857	154,226	306,762	296,957		
KP-Stat					130	162
Panel B. France						
(log) Import Value$_{fpt}$	0.129***	0.136**		0.116***	0.268***	0.124***
(log) Import Quantity$_{fpt}$	0.124***	0.186***	0.296***	0.150***	0.359***	0.219***
(log) Import Unit Value$_{fpt}$	0.005	-0.050*	-0.082***	-0.034***	-0.091***	-0.095***
N	897,091	134,482	897,091	887,062	887,062	879,879
KP-Stat					606	350
Firm, Year, HS-6 Product FE	YES	YES	YES	YES	YES	YES
HS-6 Product Trend	YES	YES	YES	YES	YES	YES
Product × Year Controls	YES	YES	YES	YES	YES	YES

Note: This table examines the robustness of the baseline effect of the market structure upstream on sourcing activity downstream in Table 2. Columns 1 and 2 excludes respectively wholesale exporters and wholesale importers. Column 3 uses CES import price indices and quantities instead of simple averages. Columns 4-6 measure the upstream market structure with the actual number of Chinese exporters to Chile or France, instrumented with the number of Chinese suppliers to ROW in Column 5 and to the Pacific Alliance or the USA in Column 6. Singletons dropped and standard errors clustered by HS-6 product × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In Column 3, we consider alternative measures of import prices and quantities. We construct CES indices—instead of simple averages—of unit values and quantities at the firm-product-year level from the underlying transaction-level data, using product-specific elasticities of substitution from Broda and Weinstein (2006). These model-consistent measures can in principle more accurately capture the impact of the upstream market structure, as they recognize that downstream firms can reallocate expenditure shares across inputs due to input price changes. Indeed, using these CES indicators produces highly significant estimates of higher magnitude than the baseline. We have confirmed that all other robustness checks likewise deliver stronger results with CES price and quantity measures. Since CES metrics require additional parametric assumptions, however, we have opted for conservative simple averages in the baseline.

In Columns 4-6, we explore alternative proxies for the upstream market structure in China.

From the perspective of individual buyers in Chile or France, the overall number of Chinese exporters to their country can be considered exogenous. Moreover, it may better reflect the set of potential suppliers to their market, given differences in market size, proximity and institutional context that drive the export decisions of Chinese suppliers. Column 4 establishes that $\ln S_{CHN \to CHL,pt}$ and $\ln S_{CHN \to FRA,pt}$ indeed generate robust results in line with the baseline estimates. Column 5 provides additional corroborative evidence when instrumenting the actual number of Chinese exporters to Chile or France with the baseline number of Chinese exporters to ROW, excluding Chile or France respectively. Column 6 applies a more fine-tuned instrument that is meant to reflect Chinese export entry into markets similar to Chile and France rather than all of ROW. We consider Chile's neighbors and co-signatories to the Pacific Alliance organization, and use the USA as a benchmark for France. The results remain qualitatively unchanged.

Finally, we present several additional specification checks in Appendix Table A2. First, in Column 1, we restrict the sample to a balanced set of Chilean or French firms that are active in every period in the 2000-2006 panel. This reduces the number of observations significantly, but the estimates remain stable. Second, in Column 2, we define quantities and unit values in the French data based on supplementary information on different units of accounting (instead of kilograms), available for a subset of products. This exercise does not apply to the Chilean data, which enters with the natural unit of accounting already in the baseline.

Third, although we control for the number of Chilean or French importers in any HS-6 downstream industry throughout, this may not fully rule out other potential effects of the downstream market structure. We therefore include output industry-year fixed effects in Column 3. In Columns 4-5, we ensure instead that changes in upstream competition in other products that a firm sources do not confound our estimates: We control alternatively for the log (import-value weighted) average number of Chinese suppliers in a buyer's products other than p, or for the log number of Chinese exporters in the HS 4-digit category p belongs to.

Finally, in Column 6 we restrict the French sample to importers who do not source from Eastern Europe throughout our sample period. The findings confirm that we have not falsely assigned the effects of structural changes in Eastern Europe that took place during our sample period to increased competition in China.

4.5 Downstream Firm Heterogeneity

Table 3 demonstrates that bigger downstream buyers adjust their sourcing behavior more in response to greater competition upstream, in line with Proposition 4. We group buyers into three size terciles, using either total sales or total imports to proxy size. We then add to specification (16) interactions of indicators for buyers in the middle and top tercile with the measure of market competition upstream.[19] The main effect of $\ln S_{CHN \to ROW,pt}$ now identifies the impact on the bottom tercile, while the interaction terms pick up differential effects on mid-size and large buyers. We report results for both simple averages and CES price and quantity indices.

Table 3: Downstream Heterogeneity

	Chile				**France**			
Importer Size Measure	Sales		Total Imports		Sales		Total Imports	
	Baseline	CES Index	Baseline	CES Index	Baseline	CES Index	Baseline	CES Index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. (log) Import Value$_{fpt}$								
(log) # CHN→ROW Exporters$_{pt}$	0.088**		-0.040		0.196***		0.122***	
	(0.039)		(0.039)		(0.030)		(0.029)	
× 2nd Down Size Tercile Dummy	0.007**		0.088***		0.019***		0.027***	
	(0.003)		(0.002)		(0.005)		(0.007)	
× 3rd Down Size Tercile Dummy	0.007		0.153***		0.049***		0.105***	
	(0.005)		(0.003)		(0.006)		(0.008)	
R2	0.553		0.557		0.588		0.590	
Panel B. (log) Import Quantity$_{fpt}$								
(log) # CHN→ROW Exporters$_{pt}$	0.215***	0.255***	0.090	0.104	0.268***	0.271***	0.172***	0.168***
	(0.066)	(0.069)	(0.065)	(0.069)	(0.033)	(0.034)	(0.033)	(0.033)
× 2nd Down Size Tercile Dummy	0.016***	0.018***	0.096***	0.114***	0.015***	0.021***	0.036***	0.044***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.005)	(0.006)	(0.007)	(0.007)
× 3rd Down Size Tercile Dummy	0.021***	0.023***	0.161***	0.193***	0.048***	0.059***	0.119***	0.138***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.007)	(0.008)	(0.008)	(0.009)
R2	0.558	0.527	0.561	0.531	0.607	0.598	0.609	0.601
Panel C. (log) Import Unit Value$_{fpt}$								
(log) # CHN→ROW Exporters$_{pt}$	-0.128**	-0.175***	-0.130**	-0.144**	-0.071***	-0.079***	-0.050***	-0.047***
	(0.053)	(0.057)	(0.053)	(0.057)	(0.015)	(0.016)	(0.015)	(0.016)
× 2nd Down Size Tercile Dummy	-0.009***	-0.011***	-0.009***	-0.032***	0.003	-0.004	-0.009***	-0.020***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
× 3rd Down Size Tercile Dummy	-0.013***	-0.018***	-0.008***	-0.050***	0.001	-0.014***	-0.014***	-0.041***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
R2	0.727	0.688	0.727	0.688	0.713	0.693	0.714	0.694
N	306,857	306,762	306,857	306,762	836,678	836,678	893,300	893,300
Firm, Year, HS-6 Product FE	YES	YES	YES	YES	YES	YES	YES	YES
HS-6 Product Trend	YES	YES	YES	YES	YES	YES	YES	YES
Product × Year Controls	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table examines the heterogeneity of the effect of the market structure upstream on sourcing activity downstream across buyer size terciles. Firm size terciles are based on total sales or total imports as indicated in the column headings. Odd (even) columns use simple average (CES) input price indices. Singletons dropped and standard errors clustered by HS-6 product × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The evidence indicates that bigger downstream buyers benefit more from tougher competition upstream than their smaller peers: They enjoy even lower input prices, source even higher input quantities, and have even higher imported input purchases overall. Through the lens of the model, these patterns are consistent with bigger buyers incurring higher matching costs to transact with more suppliers, and reaping pro-competitive gains from lower markups.

The results are economically and statistically more significant when using worldwide im-

[19] We categorize firms on a yearly basis to maximize the number of observations in the regressions. Firms rarely switch across tercile groups, and the results are similar for a balanced sample with a fixed assignment in 2000.

ports to measure buyers' size, compared to using firm sales. This is consistent with the drivers of suppliers' price setting in the model: A buyer's total input purchases determine the supplier's expected profits from the relationship and therefore the optimal input price. The buyer's output sales are only relevant to the extent that they are monotonic in firm productivity and thereby in total input purchases. This raises the possibility that global sourcing decisions may vary across firms for reasons outside our model that are not fully captured by total sales. The total amount of imported inputs may thus more accurately reflect firms' ability to match with more suppliers that is relevant to the competition forces in our model.

4.6 Upstream Price Discrimination

The findings above establish the impact of the upstream market structure on sourcing outcomes downstream. We complement this analysis with direct evidence on the pricing strategy of Chinese exporters across Chilean buyers. The results strongly support Proposition 1, namely that suppliers charge more diversified buyers lower markups and prices, even within finely disaggregated product categories. This is in line with suppliers engaging in price discrimination across buyers depending on the extent of competition they face from other suppliers to that buyer.

Table 4: Upstream Price Discrimination

	Chile			
	(log) UV$_{sfpt}$ (1)	(log) UV$_{sfpt}$ (2)	(log) UV$_{sfpt}$ (3)	(log) UV$_{sfpt}$ (4)
(log) # CHN Suppliers$_{fpt}$	-0.033*** (0.003)	-0.029*** (0.003)	-0.017*** (0.004)	-0.019*** (0.004)
R2	0.860	0.892	0.928	0.928
N	330,381	326,594	285,335	285,335
Year FE	YES			
Supplier × HS-6 Product FE	YES	YES	YES	YES
HS-6 Product × Year FE		YES	YES	YES
Buyer × HS-6 Product FE			YES	YES
ROW Suppliers Control				YES

Note: This table examines price discrimination upstream and the pro-competitive effects of diversified sourcing. The dependent variable is the log unit value a Chinese supplier charges a Chilean importer for a given HS-6 product and year. The level of Chinese competition faced by the Chinese supplier is measured by the log number of Chinese suppliers of the same product to that buyer in that year. Column 4 controls for the log number of ROW suppliers of the same product to that buyer in that year. Singletons dropped and standard errors clustered by HS-6 product × year.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4 presents results from estimating specification (17) at the most granular level of Chinese supplier - Chilean buyer - HS-6 product - year transactions. Column 1 includes supplier-product and year fixed effects, such that the impact of the buyer's supply portfolio is identified from the variation within a supplier across buyers of the same product. Column 2 replaces the year fixed effects with product-year fixed effects that more flexibly control for product-specific changes in supply and demand conditions. Column 3 further adds a stringent set of buyer-product fixed effects, such that the main coefficient of interest is now identified from changes in sourcing strategy within buyer-product input lines over time. Finally, Column 4 additionally controls for the buyer's log number of non-Chinese suppliers of the relevant product. This implicitly accounts for changes in supply conditions in ROW, as well as for potential strategic interactions among suppliers from different origins outside our model.

The evidence consistently points to upstream Chinese suppliers offering lower prices to downstream buyers that source from more Chinese suppliers, product by product. This lends strong empirical support to the role of imperfect competition upstream in the model and the resultant pro-competitive effects that upstream entry can exert on sourcing outcomes downstream.

5 Model Quantification

Our theoretical framework permits the assessment of several topical policy interventions. We conclude by quantifying the effects of market entry upstream, matching cost reductions, and lower trade barriers on firm performance and consumer welfare. We interpret upstream entry as the result of behind-the-border industrial or competition policy that supports firm entry in supplier countries. We view reductions in matching costs as arising from unilateral or bilateral trade promotion and facilitation, or equivalently the relaxation of NTMs. Finally, we see lower trade barriers as standard tariff liberalization. To guide the counterfactual magnitudes, we use the actual expansion in Chinese suppliers to Chile during the 2000-2006 sample period, as well as the Chile-China PTA signed in 2006.

Importantly, we consider these policies as both stand-alone and *package* reforms to illustrate how policies interact and how sourcing complementarity generates cross-country spillovers. We also analyze the mediating roles of firm heterogeneity, endogenous network formation, and endogenous markups: We compare the baseline model to alternatives with a different productivity dispersion downstream, fixed buyer-supplier links, or constant markups for intermediates.

We estimate a single-sector version of the model for 1 home country (Chile), 5 upstream origin regions (the United States (USA), Europe (EUR), Latin America (LATAM), China (CHN), and ROW), and 4 or 5 suppliers per region (set to the regional mean in the data). This setup balances policy relevance with computational tractability, and reflects the geo-economic mix of Chile's main trade partners.

5.1 Estimation

The quantification proceeds in three steps. First, we estimate price elasticity parameters by exploiting the pricing equation for upstream suppliers. Next, we calibrate the supplier cost distribution for each region using the estimated elasticities and observed price distributions. Finally, we estimate the aggregate demand shifter and fixed matching costs to match the observed sourcing patterns of Chilean buyers.

Elasticities We start with the elasticities of substitution across final goods and input varieties, σ and η, and the Fréchet parameter governing match-specific cost shocks, θ. Consider supplier s from country c selling product p to buyer b. We log-linearize the supplier's pricing equation (12), and estimate it with supplier-product fixed effects to absorb marginal costs c_{scp}:

$$\ln p_{scpb} = \ln c_{scp} + \ln \frac{\varepsilon_{scpb}}{\varepsilon_{scpb} - 1}. \tag{18}$$

The markup $\frac{\varepsilon_{scpb}}{\varepsilon_{scpb}-1}$ depends on the residual demand elasticity faced by supplier s, $\varepsilon_{scpb} = [\sigma\delta_{cpb} + \eta(1-\delta_{cpb})]\chi_{scpb} + \theta[1-\chi_{scpb}]$. We take $\hat{\sigma} = 5$ as a center value from the literature (Burstein et al., 2020; Gaubert and Itskhoki, 2021). Given σ and the residuals from regression (18), we can estimate θ and η by non-linear least squares using observed input expenditure shares δ_{cpb} and χ_{scpb}. We construct $\chi_{scpb} = \frac{m_{scpb}}{m_{cpb}}$ as the share of supplier s in buyer b's imports m_{cpb} of input p from country c. In the absence of data on domestic inputs, we proxy the share of cp inputs in the buyer's input basket with the share of imports m_{cpb} in buyer b's total imports m_b, $\delta_{cpb} = \frac{m_{cpb}}{m_b}$.

Estimating (18) on the Chilean import data for the last year in our sample, 2006, we obtain $\hat{\eta} = 1.4$ and $\hat{\theta} = 3.9$, consistent with the theoretical assumption of sourcing complementarity $\sigma > \eta$ (i.e., inputs are more complementary in production than outputs in consumption).[20] Moreover, these estimates imply that the condition $\rho_{cpb} = \theta - \eta + (\eta - \sigma)\delta_{cpb} > 0$ is empirically satisfied for the vast majority of origin-product-buyer triplets in the data, as it is equivalent to $\delta_{cpb} < \frac{\theta-\eta}{\sigma-\eta} \approx 0.694$. This ensures that markups rise with the supplier's share in a buyer's purchases, and firms' sourcing decisions are strategic complements across countries and suppliers.

Cost Distributions We assume that suppliers in origin region j draw marginal costs $c \in (0, c_{M_j}]$ from region-specific discrete Pareto distributions $G(c) = (c/c_{M_j})^{k_j}$, where c_{M_j} is the upper bound and k_j the shape parameter (Eaton et al., 2012; Gaubert and Itskhoki, 2021). We exploit properties of the Pareto distribution for the 1^{st} and 10^{th} percentiles, $c_{1,j}$ and $c_{10,j}$: $(c_{1,j}/c_{M_j})^{k_j} = 1/100$, $(c_{10,j}/c_{M_j})^{k_j} = 1/10$, and hence $(c_{10,j}/c_{1,j})^{k_j} = 10$. We estimate the

[20] The estimated $\hat{\eta} = 1.4$ is close to Antràs et al. (2017)'s estimate of 1.8. The estimated firm-to-firm trade elasticity $\hat{\theta} = 3.9$ is close to the aggregate trade elasticity in the literature (e.g., Simonovska and Waugh, 2014).

Pareto shape parameters as $\widehat{k}_j = \frac{\ln 10}{\ln c_{10,j} - \ln c_{1,j}}$ and the upper bounds as $\widehat{c}_{M_j} = 100^{1/\widehat{k}_j} c_{1,j}$, where the suppliers' marginal costs are proxied with the fixed effects estimated in (18).

Panel A of Table 5 shows that the estimated Pareto shapes are around 1, in line with the prior literature. For example, we compute 1.27 for Chinese exports to Chile in 2006, close to the 1.367 estimate in Head et al. (2014) for Chinese exports to Japan in 2000. The Pareto upper bounds for Europe and USA significantly exceed those for China and Latin America, consistent with the former having higher production costs. Since we do not observe domestic input sourcing from Chilean suppliers, we assume that Chile shares a common Pareto distribution with other Latin American countries, and discount the upper bound by the headline iceberg trade cost estimate of 2.70 in Anderson and Van Wincoop (2004).

For Chilean downstream firms, we assume a Pareto productivity distribution with shape parameter 1.5 and scale parameter 1. Later, we vary the shape parameter in the counterfactual analysis to explore the implications of buyer heterogeneity.

Table 5: Estimated Parameters

Panel A. Supplier cost distributions			**Panel B. Demand shifter and matching costs**		
Region	Pareto shape $\hat{k}_i$	Pareto upper bound $\hat{c}_{M_i}$	Variable	Parameter	Estimate
Chile	1.25	1.19	Demand shifter	B_{Chile}	1.351
LATAM	1.25	3.23	Base cost	β_0	1.652
USA	0.93	38.76	Distance	β_1	4.908
EUR	1.09	17.03	Common language	β_2	0.961
CHN	1.27	4.69	Control of corruption	β_3	-2.082
ROW	1.20	7.38	# Suppliers	β_4	3.959

Note: This table reports the estimated parameters for the quantification: Pareto parameters for supplier marginal costs by region, the demand shifter for Chile, and the parameters of the matching cost function in equation (19).

Demand Shifter and Matching Costs Lastly, we estimate aggregate Chilean demand B_{Chile} and the matching costs of Chilean buyers b. Following Antràs et al. (2017), we parameterize the fixed cost of buying inputs from region j as a function of exogenous shipping, communication, and contracting costs, proxied respectively by bilateral distance $dist_j$, common language $comlang_j$, and control of corruption as an index of institutional strength, $ControlCorrupt_j$. Importantly, we depart from prior work to further allow this fixed sourcing cost to increase with the endogenous number of suppliers $S_b \geq 1$:

$$\ln(f_j(S_b)) = \ln(\beta_0) + \beta_1 \ln dist_j + \ln \beta_2 comlang_j + \beta_3 ControlCorrupt_j + \beta_4 \ln(S_b). \quad (19)$$

We impose that fixed sourcing costs drop to zero if b has no suppliers.[21] Gravity variables by region are constructed as weighted averages of country measures from CEPII (Conte et al., 2022) and World Bank Open Data.

We estimate the vector of 6 parameters $\Phi = \{B_{Chile}, \beta_0, \beta_1, \beta_2, \beta_3, \beta_4\}$ with the Simulated Method of Moments (SMM) applied to a set of informative target moments. We first generate 3,000 samples of buyers and suppliers.[22] For a guess Φ', we solve for buyers' optimal global sourcing strategy for each supplier cost draw, compute the implied model moments, and iterate until a solution $\hat{\Phi}$ produces model moments that closely match the corresponding data moments.

We identify the 6 parameters in Φ using 7 empirical moments that capture key features of Chilean firms' import behavior. First, origin-specific gravity components in matching costs shape firms' incentives to source from different regions. To help identify $\{\beta_1, \beta_2, \beta_3\}$, we therefore target the share of Chilean firms that import from each of the 5 foreign regions (Moments I). Second, within each region, transacting with a larger set of suppliers is more costly and profitable only for buyers above a higher productivity threshold. Since the Pareto productivity distribution implies that ever fewer firms source from a larger number of suppliers, we target the linear slope of the share of Chilean firms with respect to the (log) number of regional suppliers (=1, 2, 3, 4+) to help identify β_4 (Moment II).[23] Lastly, the final demand shifter B_{Chile} and the baseline fixed matching cost β_0 are common across buyers and key to whether sourcing inputs from abroad can ever be profitable. We thus use the share of Chilean firms that import any inputs as the final target moment (Moment III).

We face two computational challenges in implementing the SMM. First, sourcing complementarity creates choice interdependence across origins and suppliers, which leads to exponentially increasing complexity. For example, a setting with 6 regions and 5 suppliers per region implies $6^6 = 46,656$ possible sourcing strategies, since buyers choose to source from 0, 1, ..., 5 suppliers per region. This dwarfs the dimensionality of standard multinomial choice models with independent alternatives (Anderson et al., 1992). Second, input prices are determined in strategic games played by a buyers' matched suppliers. Evaluating a firm's sourcing strategies thus requires repeatedly solving such pricing games, which further adds to the computational burden. This contrasts with frameworks where input prices are fixed or uniform across buyers in the absence of upstream market power or price discrimination (Antràs et al., 2017).

[21] Our choice of functional form and gravity variables follows Antràs et al. (2017), but our firm-specific component is deterministic and dependends on S_b, while theirs is a random draw independent of S_b.

[22] Following (Antràs et al., 2017), we use stratified random sampling of Chilean buyers with 12 intervals, 10 draws per interval, and more draws in the right tail. We sample supplier marginal costs from 25 random draws. To reduce the computational burden, we do not estimate the Pareto shape for Chilean buyers, but conduct sensitivity analysis in Section 5.2.

[23] The relationship between supplier numbers and firm shares is very similar across origin regions and well approximated by a linear functional form, in line with Pareto distributed firm productivity.

We develop methods to address the above two challenges, which can be used to solve other similar high-dimensional discrete-choice problems. To tackle the first challenge of combinatorial complexity, we extend the bounding algorithm in Jia (2008), Antràs et al. (2017) and Arkolakis et al. (2023a) for binary discrete-choice problems to *multinomial* discrete-choice problems. This algorithm eliminates sub-optimal choices from the overall choice set by exploiting single-crossing properties of common profit functions. Arkolakis et al. (2023a) show that when these properties hold, it is sufficient to examine the profitability of tapping a given supplier to rule out sub-optimal strategies, without having to evaluate and compare each sourcing profile with brute force. Starting from the smallest and largest possible supplier sets, one can therefore compute whether adding or removing a supplier raises buyer profits, and iteratively "squeeze" the set of potentially optimal choices. In Appendix C, we establish this approach for a multinomial choice problem without first transforming it into a series of binary choices that span all possible pairs of choices within the multinominal set.

To overcome the second challenge of solving pricing games, we decouple this step from the SMM estimation. From Proposition 1, the outcome of any pricing game depends only on the relevant set of suppliers, but not on the demand shifter, matching costs, or buyer identity per se. We therefore solve the pricing game only once for each possible supplier set and use the result for all buyers, rather than repeatedly for every buyer considering that same supplier set.

Together, these two techniques yield an efficient algorithm for computationally feasible SMM estimation of large-scale sourcing models with oligopolistic competition. We estimate Φ by solving the following problem with this algorithm in Appendix D:

$$\min_{\Phi} y_t = (\widetilde{\mathrm{m}}(\Phi) - m)\mathrm{W}(\widetilde{\mathrm{m}}(\Phi) - m)', \tag{20}$$

where $\widetilde{\mathrm{m}}(\Phi)$ are the model moments, and W is the weighting matrix.[24]

Table 6 demonstrates that our SMM algorithm delivers an effective model fit to the data. The estimated model matches very well Moment I (the progressive selection of fewer and fewer buyers into wider supplier portfolios within origins; slope -1.56 in the data and -1.75 in the model) and Moment III (the share of Chilean firms that import inputs; 7.6% in the data and 7.65% in the model). The model also captures well several aspects of Moment II across origins: the similar share of firms sourcing from Latin America, USA and Europe; the similar share of importers from China and ROW; and the fact that the former exceeds the latter. We surmise that the model slightly overpredicts the former and slightly underpredicts the latter due to the low cap of 4 or 5 potential suppliers from each region.

The estimated parameters of the matching cost function in Panel B of Table 5 are econom-

[24] We use the identity matrix $W = I$ as in Antràs et al. (2017). The resulting estimates are consistent but might not be efficient. Following Jalali et al. (2015), we therefore normalize each moment by its mean.

Table 6: Target Moments and Model Fit

Moments		Data	Model
Regional importer share	LATAM	3.14%	7.65%
	USA	3.42%	7.65%
	EUR	3.11%	7.54%
	CHN	2.62%	1.36%
	ROW	2.98%	1.65%
Slope of importer share wrt # suppliers		-1.56	-1.75
Aggregate importer share		7.60%	7.65%

Note: This table reports model fit by targeted moment. The final moment is based on a regression of the share of importers with a given number of suppliers on the log number of suppliers.

ically meaningful, and illustrate the role of granularity upstream. The matching cost rises with bilateral distance; falls with strong control of corruption at the origin; and is 4% lower when partners share a language (1-$\widehat{\beta_2} \approx 0.04$). Notably, the matching cost increases quickly with the number of suppliers, jumping $2^{\widehat{\beta_4}} = 2^{3.959} \approx 15.5$ times every time a buyer doubles its supplier count. This is key to rationalizing sparse production networks: The share of Chilean importers with 1 supplier per country-product (80%) is over 4 times the share with 2 suppliers and 30-40 times the share with 3 suppliers.

5.2 Counterfactual Analysis

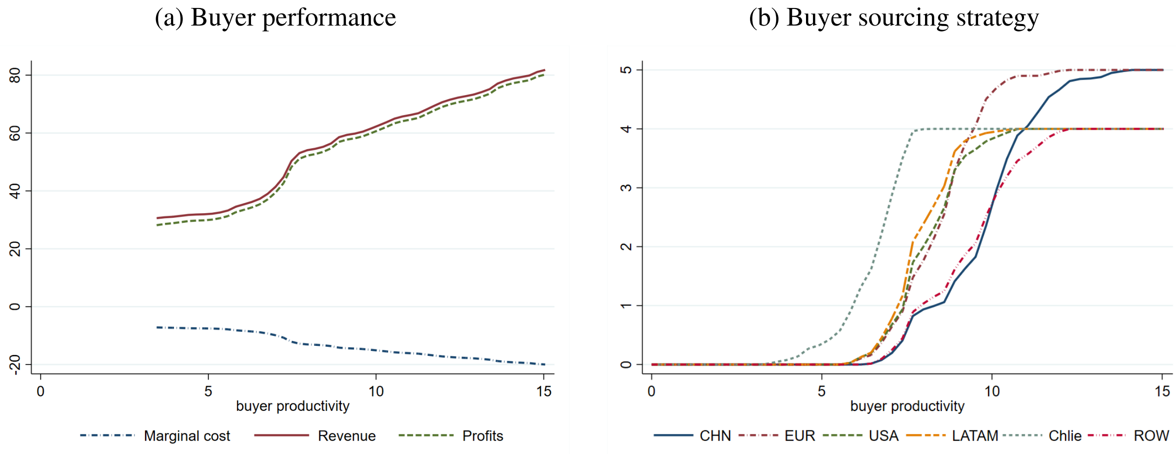
Having structurally estimated the model, we perform counterfactual analyses for Chile to assess the impact of different industrial and trade policies on firm performance and the consumer price index (CPI), which corresponds to welfare given normalized wages.

Baseline Economy We construct a baseline economy by simulating the model 20 times for 1,500 buyers, and report average firm outcomes across simulations in Figure 5.[25] Figure 5a confirms that more productive buyers have lower marginal costs, higher revenues, and greater profits. Figure 5b in turn demonstrates the selection of more productive buyers into sourcing from more regions and more suppliers within each region, with the granularity in matches corresponding to kinks in the cost, revenue, and profit curves.[26] Endogenous network formation thus amplifies the underlying buyer heterogeneity. The simulations also reveal a pecking order

[25] We fix the demand shifter in Chile, consistent with wages being set in an outside sector, and abstract from buyer and supplier entry as in Chaney (2008).

[26] Note that averaging across model simulations smooths kinks in these graphs.

Figure 5: Baseline Model Economy



Note: This figure plots the simulated baseline economy, averaged across simulation samples.

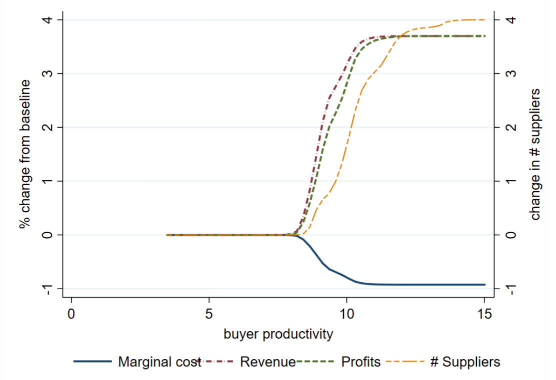
of productivity cut-offs for sourcing across regions in line with the regional variation in distance and average supplier cost: Chilean buyers find it most beneficial to source domestically, followed by nearby Latin America and the USA, distant Europe with strong institutions and familial languages, and finally physically and linguistically distant China and ROW.

Stand-alone Policy Reforms We first consider a counterfactual rise in the number of potential suppliers in China from 1 to 5, to illustrate the pro-competitive gains downstream from entry and tougher competition upstream. Consistent with Proposition 4, we see in Figure 6a that Chilean buyers above a certain productivity threshold opt to pay higher fixed matching costs to expand their supplier portfolio. The most productive among them add 4 more suppliers, to enjoy almost 1% lower marginal costs and more than 3.5% higher revenues and profits. Sourcing complementarity induces some buyers that match with new Chinese suppliers to also expand their sourcing network in other regions where they had not previously tapped all potential suppliers (Appendix Figure A2). Lower marginal costs for final producers in turn imply lower prices for consumers: As Column 1 in Panel A of Table 7 indicates, the CPI falls by 0.92%.

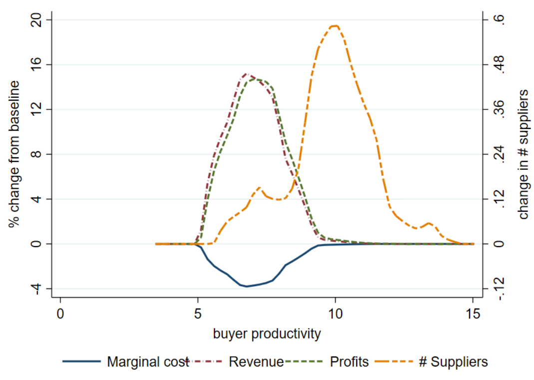
We next assess the impact of lower bilateral matching costs by reducing parameters β_0 and β_4 in the matching cost function (19) for Chilean buyers sourcing from China by 25%. In line with Proposition 5, Figure 6b illustrates that this boosts the performance of mid-productivity firms the most, by incentivizing them to expand their supplier portfolio and thereby enjoy marginal cost cuts and greater sales. More precisely, the buyer productivity cut-offs for sourcing from any given number of Chinese suppliers fall, as do cut-offs for other origin regions due to sourcing complementarity. While all buyers benefit from lower matching costs on inframarginal suppliers, the most productive buyers already trade with all suppliers and only mid-

Figure 6: Counterfactual Scenarios: Firm Response

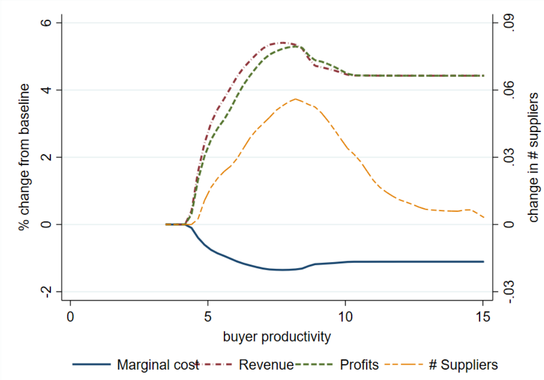
(a) 1 → 5 Chinese suppliers



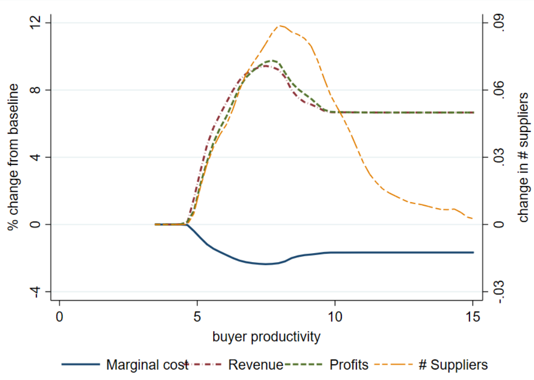
(b) ↓ 25% China matching cost



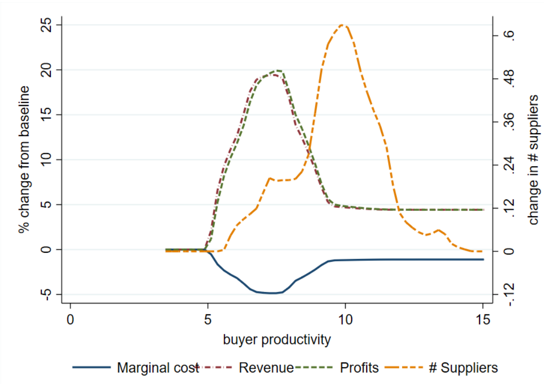
(c) Chile-China PTA (↓ 6% tariff)



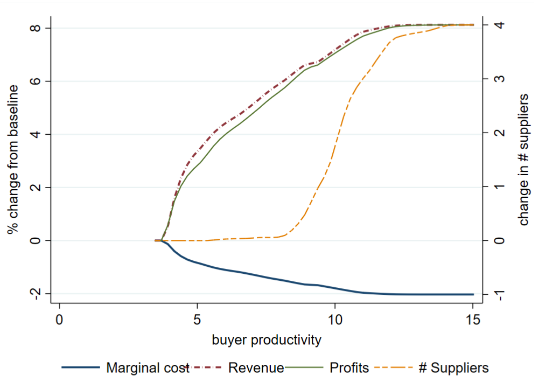
(d) Chile-China & Chile-USA PTAs



(e) Chile-China PTA & ↓ 25% China matching cost



(f) Chile-China PTA & 1→5 Chinese suppliers



Note: This figure reports the average counterfactual percentage change in buyers' marginal cost, revenue and profits (left axis) and the absolute change in buyers' number of suppliers worldwide (right axis) in response to: (a) entry upstream: number Chinese suppliers rises from 1 to 5; (b): lower matching costs: 25% reduction in β_0 and β_4 with China; (c): Chile-China Preferential Trade Agreement (PTA): 6% lower tariffs; (d): Chile-China and Chile-USA PTA: 6% lower tariffs; (e) policy package (b)+(c); (f) policy package (a)+(c).

productivity buyers can profitably add suppliers. Since these firms have small market shares in consumer spending, the associated welfare gains are minimal (Column 2 in Panel A of Table 7).

Finally, we study the impact of a 6% bilateral tariff reduction on trade between Chile and China in Figure 6c. This corresponds to the average tariff cut in the PTA these countries introduced in October 2006. Consistent with Proposition 5, lower variable trade costs reduce marginal costs and increase revenues and profits for all firms that use foreign inputs. On the one hand, these cost savings are larger for more productive buyers who already source more intensively. On the other hand, sourcing complementarity induces mid-productivity buyers to further expand their supplier set despite higher fixed matching costs. These two forces account for the hump-shaped curve for the percentage change in profits. Overall, there is a sizable gain in Chile's welfare of 1.10% (Column 3 in Panel A of Table 7).

Package Policy Reforms We now turn to package deals that build on the Chile-China PTA. Chile signed an independent PTA with the USA in 2003 that also brought about an average tariff reduction of 6%. We consider the impact of these two simultaneous trade reforms in Figure 6d. While the driving mechanisms and overall patterns remain the same, sourcing complementarity roughly doubles the impact on firm performance in terms of costs, revenues, and profits across the firm size distribution. This can be attributed to an approximate tripling of the expansion in the supplier margin. As a result, consumer prices decline by 1.65% in Chile, or about 50% more than with a single reform (Column 4 in Panel A of Table 7).[27]

We also compare shallow and deep bilateral trade agreements, where we conceptualize the latter as a reduction in both tariffs and fixed matching costs on trade between Chile and China. Figure 6e illustrates that facilitating buyer-supplier matches amplifies the gains from lower iceberg costs most dramatically for mid-productivity buyers who widen their supply network. This adds little to the total PTA welfare gains, however, as these firms once again make only a modest contribution to the consumption basket (Column 6 in Panel A of Table 7).

Lastly, we study the combination of bilateral tariff cuts between Chile and China (by 6%) and entry upstream in China (from 1 to 5 suppliers). This can be interpreted as another form of deep integration that relaxes export barriers in China, or alternatively as a standard shallow PTA at a time of industrial policy in China after it joined the WTO in 2001. Figure 6f reveals large amplification effects of this reform package, with a significant profit uplift across the buyer productivity distribution. More productive firms grow their supplier base more aggressively, and add suppliers globally due to sourcing complementarity across regions (Appendix Figure A2f). This results in a welfare gain of 2.01%, the highest across all scenarios we have examined (Column 5 in Panel A of Table 7).

[27] We have also simulated a Chile-USA PTA on its own. Its effect on the CPI is about -0.56%.

Table 7: Chile-China Counterfactual Scenarios: Consumer Price Index

Scenario	(1) Upstream market entry in CHN	(2) Lower matching costs with CHN	(3) China PTA: Baseline	(4) China PTA: +USA PTA	(5) China PTA: +upstream market entry in CHN	(6) China PTA: +lower matching costs with CHN
Panel A. Buyer Pareto shape parameter = 1.5						
Δ CPI	-0.92%	-0.00%	-1.10%	-1.65%	-2.01%	-1.10%
Panel B. Buyer Pareto shape parameter = 2.5						
Δ CPI	-0.27%	-0.23%	-1.13%	-1.70%	-1.40%	-1.36%
Panel C. Buyer Pareto shape parameter = 2.5, Fixed Production Network						
Δ CPI	-0.00%	-0.00%	-1.09%	-1.64%	-1.08%	-1.09%
Panel D. Buyer Pareto shape parameter = 2.5, Constant Markup						
Δ CPI	-0.09%	-0.16%	-1.13%	-1.69%	-1.22%	-1.30%

Note: This table presents changes in consumer welfare measured in terms of consumer price index. Buyers are sampled from Pareto distributions with shape parameter 1.5 in Panel A and 2.5 in Panel B-D. Same as the baseline economy, Panels A and B conduct simulations under endogenous production network and variable markup. Panel C conducts simulations after fixing buyer firms' sourcing strategies to baseline economy ones. Panel D conducts simulations assuming supplier firms charge a constant markup of $\theta/(\theta-1)$.

Firm Heterogeneity, Production Networks, and Markups We conclude the counterfactual analysis by assessing the role of buyer heterogeneity, endogenous production networks, and endogenous markups due to imperfect competition.

First, since policy shocks exert differential effects across buyers, their aggregate welfare effect depends on the distribution of buyer productivity. In Panel B of Table 7, we increase the Pareto shape parameter from the baseline of 1.5 to 2.5, tilting the distribution of final producers towards the low-productivity end, and lowering average productivity. This amplifies the welfare gains from reforms that disproportionately benefit low- and mid-productivity firms, and conversely dampens gains from reforms that favor high-productivity firms. In particular, the CPI drop afforded by upstream entry alone or in combination with a PTA is significantly reduced, from 0.92% to 0.27% in Column 1 and from 2.01% to 1.40% in Column 5, respectively. By contrast, the CPI falls considerably more after a cut in matching costs, from around zero to 0.23% in Column 2, and from 1.10% to 1.36% when combined with a PTA in Column 6.

To highlight the role of endogenous production networks, in Panel C of Table 7 we repeat the counterfactual exercises with a buyer Pareto shape parameter of 2.5, but fix each buyer's supplier set at its baseline. Welfare gains from all policy counterfactuals are significantly lower when firms cannot re-optimize their supplier portfolio. By construction, entry upstream or lower matching costs now have no effects on downstream firms or consumers, as shown in Columns

1 and 2. Moreover, there are also no amplification effects when trade policy is coupled with upstream entry or lower matching costs in Columns 5 and 6, as firms reap no pro-competitive cost savings from expanding their supplier portfolio.

As a final exercise, we examine the role of oligopolistic competition and endogenous markups. In Panel D of Table 7, we re-run the counterfactuals for buyer Pareto shape parameter of 2.5, assuming that suppliers charge a constant markup of $\theta/(\theta-1)$ as under monopolistic competition. Since sourcing from more suppliers no longer brings gains from tougher competition among them, buyers have less incentives to adjust their supply network. The welfare effects of upstream entry and lower matching costs are thus substantially diminished in Columns 1 and 2. At the same time, variable markups appear to play a secondary role in the transmission of trade policy changes into consumer prices (Columns 3 and 4), unless trade reforms are coupled with upstream entry or lower matching costs (Columns 5 and 6). Intuitively, tariff reductions affect primarily the intensive margin of sourcing through lower variable costs, while upstream entry and matching costs move primarily the extensive margin of suppliers, and this latter margin brings smaller CPI reductions under constant markups.

6 Conclusion

This paper examines the role of firm heterogeneity and imperfect competition for the formation of global production networks and the gains from trade. We develop a quantifiable trade model with (i) two-sided firm heterogeneity, (ii) matching frictions, and (iii) oligopolistic competition upstream. Combining highly disaggregated data on firms' production and trade transactions for China, Chile, and France, we present empirical evidence in line with the model that cannot be rationalized without features (i)-(iii). Downstream French and Chilean buyers import higher volumes and quantities at lower prices when upstream Chinese markets become more competitive. These effects are stronger for larger, more productive buyers. Moreover, Chinese suppliers price discriminate across buyers, charging more diversified downstream producers lower input markups and prices.

Our analysis indicates that global production networks amplify the gains from trade liberalization, and induce important policy interactions through the complementarity in firms' sourcing decisions across origin countries. Buyer-supplier linkages thus mediate international spillovers from national industrial and trade policy. In particular, lower barriers to entry upstream, lower matching costs, and lower trade costs improve firm performance downstream and generate aggregate welfare gains for consumers. Heterogeneous adjustments in sourcing strategy across the buyer productivity distribution imply that policy packages can significantly amplify the overall rise in real income.

Our work opens several promising avenues for future research. Incorporating imperfect competition both upstream and downstream could provide valuable insights into sourcing patterns and gains from trade. While we have studied matching frictions and imperfect competition in a bipartite network of buyers and suppliers, future work could broaden the analysis to complete networks with multiple production stages and roundabout production. Studying the role of reputational contracts and arm's-length vs. intra-firm offshoring would further improve understanding of rent sharing and shock transmission in global value chains.

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Online Appendix (not for publication)

A Proofs

A.1 Proof of Proposition 1

According to equation (8), we have $\sum_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(S_{ijk}(\varphi))^{-\theta} = c_{ijk}(\varphi)^{-\theta}\gamma^{\theta}\tau_{ijk}^{\theta}$. Therefore, we have

$$\chi_{ijks}(\varphi) = \frac{p_{ijks}(\varphi)^{-\theta}}{c_{ijk}(\varphi)^{-\theta}\gamma^{\theta}\tau_{ijk}^{\theta}} = \gamma^{-\theta}\tau_{ijk}^{-\theta}c_{ijk}(\varphi)^{\theta}p_{ijks}(\varphi)^{-\theta}. \tag{E1}$$

Substitute this result and equation (10) into the profit function of the upstream firm defined in problem (11), and we have

$$\pi_{ijks}^{U}(\varphi) = D_i(\varphi)\tau_{ijk}^{-\theta}c_{ijk}(\varphi)^{\theta-\eta}p_{ijks}(\varphi)^{-\theta}(p_{ijks}(\varphi) - c_{jks}),$$

where $D_i(\varphi) = \gamma^{-\theta}(\frac{\sigma-1}{\sigma})^{\sigma}E_iP_i^{\sigma-1}c_i(\varphi)^{\eta-\sigma}\varphi^{\eta-1}$ is the demand shifter for inputs by the downstream firm based in country i with productivity φ. When the upstream firm changes its price, it affects the price index of its own country-sector $c_{ijk}(\varphi)$ and the marginal cost of the downstream buyer $c_i(\varphi)$. The First Order Condition (FOC) $\frac{\partial\pi_{ijks}^{U}}{\partial p_{ijks}(\varphi)} = 0$ implies that

$$\frac{\partial\left(D_i(\varphi)c_{ijk}(\varphi)^{\theta-\eta}p_{ijks}(\varphi)^{-\theta}\right)}{\partial p_{ijks}(\varphi)}(p_{ijks}(\varphi) - c_{jks}) + D_i(\varphi)c_{ijk}(\varphi)^{\theta-\eta}p_{ijks}(\varphi)^{-\theta} = 0. \tag{E2}$$

For brevity, we ignore the functional argument φ from here on. It is easy to show that the FOC is equivalent to

$$\left(\frac{\partial(c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta})}{\partial p_{ijks}}p_{ijks}^{-\theta} + c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta}\frac{\partial p_{ijks}^{-\theta}}{\partial p_{ijks}}\right)(p_{ijks} - c_{jks}) + c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta}p_{ijks}^{-\theta} = 0.$$

To proceed, we compute $\frac{\partial(c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta})}{\partial p_{ijks}}$, which is

$$\begin{aligned}\frac{\partial(c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta})}{\partial p_{ijks}} &= (\eta-\sigma)c_i^{\eta-\sigma-1}c_{ijk}^{\theta-\eta}\frac{\partial c_i}{\partial c_{ijk}}\frac{\partial c_{ijk}}{\partial p_{ijks}} + (\theta-\eta)c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta-1}\frac{\partial c_{ijk}}{\partial p_{ijks}} \\ &= \frac{\partial c_{ijk}}{\partial p_{ijks}}c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta}\left(\frac{\eta-\sigma}{c_i}\frac{\partial c_i}{\partial c_{ijk}} + \frac{\theta-\eta}{c_{ijk}}\right).\end{aligned}$$

Next, using the chain rule, we have

$$\frac{\partial c_{ijk}}{\partial p_{ijks}} = \frac{\partial c_{ijk}}{\partial \ln(c_{ijk})}\frac{\partial \ln(c_{ijk})}{\partial \ln(p_{ijks})}\frac{\partial \ln(p_{ijks})}{p_{ijks}} = \frac{c_{ijk}}{p_{ijks}}\frac{\partial \ln(c_{ijk})}{\partial \ln(p_{ijks})}.$$

Since $c_{ijk} = \gamma\tau_{ijk}(\sum_{s=1}^{S_{ijk}} {p_{ijks}}^{-\theta})^{-\frac{1}{\theta}}$ we have

$$\begin{aligned}\frac{\partial \ln(c_{ijk})}{\partial \ln(p_{ijks})} &= \frac{\partial \ln(c_{ijk})}{\partial \ln(\sum_{s=1}^{S_{ijk}} {p_{ijks}}^{-\theta})}\frac{\partial \ln(\sum_{s=1}^{S_{ijk}} {p_{ijks}}^{-\theta})}{\partial(\sum_{s=1}^{S_{ijk}} {p_{ijks}}^{-\theta})}\frac{\partial(\sum_{s=1}^{S_{ijk}} p_{ijks}^{-\theta})}{\partial p_{ijks}^{-\theta}}\frac{\partial p_{ijks}^{-\theta}}{\partial \ln(p_{ijks}^{-\theta})}\frac{\partial \ln(p_{ijks}^{-\theta})}{\partial \ln(p_{ijks})} \\ &= (-\frac{1}{\theta})\frac{1}{\sum_{s=1}^{S_{ijk}} {p_{ijks}}^{-\theta}}p_{ijks}^{-\theta}(-\theta) = \frac{p_{ijks}^{-\theta}}{\sum_{s=1}^{S_{ijk}} {p_{ijks}}^{-\theta}} = \chi_{ijks}.\end{aligned}$$

Therefore, we have

$$\frac{\partial c_{ijk}}{\partial p_{ijks}} = \frac{c_{ijk}}{p_{ijks}}\chi_{ijks}.$$

Similarly, we can show that $\frac{\partial c_i}{\partial c_{ijk}} = \frac{c_i}{c_{ijk}}\delta_{ijk}$. Substituting these results into $\frac{\partial(c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta})}{\partial p_{ijks}}$, we get

$$\frac{\partial(c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta})}{\partial p_{ijks}} = \frac{\chi_{ijks}c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta}}{p_{ijks}}[(\eta-\sigma)\delta_{ijk} + (\theta-\eta)],$$

Substituting the above result back to the FOC we obtain

$$\left[\frac{\chi_{ijks}c_i^{\eta-\sigma}c_{ij}^{s\ \theta-\eta}}{p_{ijks}}((\eta-\sigma)\delta_{ijk} + (\theta-\eta))p_{ijks}^{-\theta} + c_i^{\eta-\sigma}c_{ijk}^{\theta-\eta}\frac{\partial p_{ijks}^{-\theta}}{\partial p_{ijks}}\right](p_{ijks} - c_{jks}) \\ + c_i^{\eta-\sigma}{c_{ijk}}^{\theta-\eta}p_{ijks}^{-\theta} = 0,$$

which can be simplified to

$$[(\eta-\sigma)\delta_{ijk}\chi_{ijks} + (\theta-\eta)\chi_{ijks} - \theta](p_{ijks} - c_{jks}) + p_{ijks} = 0.$$

Rearranging and solving for p_{ijks} yields

$$p_{ijks} = \frac{(1-\chi_{ijks})\theta + \chi_{ijks}[\sigma\delta_{ijk} + \eta(1-\delta_{ijk})]}{(1-\chi_{ijks})\theta + \chi_{ijks}[\sigma\delta_{ijk} + \eta(1-\delta_{ijk})] - 1}c_{jks}. \tag{E3}$$

Since the residual demand faced by a supplier is given by

$$Q_{ijks}(\varphi) = \gamma^{-\theta}(\frac{\sigma-1}{\sigma})^{\sigma}E_iP_i^{\sigma-1}\varphi^{\eta-1}c_i(\varphi)^{\eta-\sigma}\tau_{ijk}^{-\theta}c_{ijk}(\varphi)^{\theta-\eta}p_{ijks}(\varphi)^{-\theta},$$

we have

$$\begin{aligned}\varepsilon_{ijks}(\varphi) &\equiv -\frac{\partial \ln(Q_{ijks}(\varphi))}{\partial \ln(p_{ijks}(\varphi))} = -\frac{\partial \ln(c_i(\varphi)^{\eta-\sigma} c_{ijk}(\varphi)^{\theta-\eta} p_{ijks}(\varphi)^{-\theta})}{\partial \ln(p_{ijks}(\varphi))} \\ &= -[(\eta-\sigma)\chi_{ijks}\delta_{ijk} + (\theta-\eta)\chi_{ijks} - \theta]. \end{aligned} \tag{E4}$$

Equation (E3) can therefore be rewritten as

$$p_{ijks}(\varphi) = \frac{\varepsilon_{ijks}(\varphi)}{\varepsilon_{ijks}(\varphi) - 1} c_{jks}. \tag{E5}$$

We next establish the uniqueness of this equilibrium. Again, we ignore the functional argument φ to simplify the notation. Let $\Psi_{ijk} = [p_{ijk1}^{-\theta}, p_{ijk2}^{-\theta}, \cdots, p_{ijkS_{ijk}}^{-\theta}]'$ and

$$A_{ijk} = \begin{bmatrix} \chi_{ijk1}, & \cdots, & \chi_{ijk1} \\ \chi_{ijk2}, & \cdots, & \chi_{ijk2} \\ \vdots & \vdots & \vdots \\ \chi_{ijkS_{ijk}}, & \cdots, & \chi_{ijkS_{ijk}} \end{bmatrix}.$$

Then equation (7) can be written as

$$A_{ijk}\Psi_{ijk} = \Psi_{ijk}. \tag{E6}$$

Given that $\sum_{n=1}^{S_{ijk}} \chi_{ijks} = 1$, and $\chi_{ijks} > 0$ for $\forall n \in \{1, ..., S_{ijk}\}$, matrix A_{ijk} has a non-negative eigenvector with a corresponding eigenvalue $\lambda = 1$ according to the *Perron-Frobenius Theorem*. Consequently, there exists an equilibrium vector Ψ_{ijk}^* that satisfies equation (7). However, multiplying Ψ_{ijk}^* by any non-zero number and substituting it into equation (E6), the equation still holds, so that the eigenvector is not unique. Equation (E5) pins down the scale of the eigenvector, however. Formally, suppose Ψ_{ijk}^* and $\beta\Psi_{ijk}^*$ are both eigenvectors of A_{ijk}. According to equation (12), we have $p_{ijks}^* = \frac{\varepsilon_{ijks}}{\varepsilon_{ijks}-1} c_{jks}$ and $\beta p_{ijks}^* = \frac{\varepsilon_{ijks}}{\varepsilon_{ijks}-1} c_{jks}$. We therefore have $\beta = 1$ and the solution is unique.

A.2 Proof of Proposition 2

We prove the proposition for the case with one new supplier, since we can simply iterate the argument forward for cases with more than one supplier. For brevity, we simplify the notation here. Suppose a downstream buyer is matched with S upstream suppliers. The expenditure shares of the buyer for each supplier are denoted as $\chi_1, \chi_2, \ldots, \chi_S$ and we have $\sum_{n=1}^{S} \chi_n = 1$ before a new supplier enters the market. After matching with the entrant, suppose the suppliers' expenditure shares are $\chi'_1, \chi'_2, \ldots, \chi'_S, \chi'_{S+1}$ and satisfy $\sum_{n=1}^{S+1} \chi'_n = 1$. Since the market share of the entrant is positive, i.e., $\chi'_{S+1} > 0$, we have

$$\sum_{n=1}^{S} \chi'_n < 1 = \sum_{n=1}^{S} \chi_n. \tag{E7}$$

Therefore, the combined market shares of incumbents must decline. We next prove $\chi'_n < \chi_n$, for $1 \leq n \leq S$ by contradiction. Suppose there exists a firm n^* ($1 \leq n^* \leq S$) such that $\chi'_{n^*} \geq \chi_{n^*}$. Then there must be another firm j^* ($1 \leq j^* \leq S$) such that $\chi'_{j^*} < \chi_{j^*}$. Otherwise, inequality (E7) cannot hold. Using equation (7), we obtain

$$\chi'_{n^*} = \frac{{p'_{n^*}}^{-\theta}}{\sum_{n=1}^{S+1} p'^{-\theta}_n} \geq \chi_{n^*} = \frac{{p_{n^*}}^{-\theta}}{\sum_{n=1}^{S} {p_n}^{-\theta}}. \tag{E8}$$

The assumption that $\rho_{ijk}(\varphi) > 0$ implies $\frac{\partial \mu_{ijks}(\varphi)}{\partial \chi_{ijks}(\varphi)} > 0$: A higher market share leads to a higher markup. Then $\chi'_{n^*} \geq \chi_{n^*}$ implies $p'_{n^*} \geq p_{n^*}$, i.e., supplier n^* charges a higher markup as its market share increases. Rearranging inequality (E8), we have

$$\frac{\sum_{n=1}^{S} {p_n}^{-\theta}}{\sum_{n=1}^{S+1} {p'_n}^{-\theta}} \geq \left(\frac{p_{n^*}}{p'_{n^*}}\right)^{-\theta} \geq 1. \tag{E9}$$

On the other hand, given that $\chi'_{j^*} < \chi_{j^*}$, firm j^* would lower its price, so that we have

$$\begin{aligned} p'_{j^*} &< p_{j^*}, \\ \frac{{p'_{j^*}}^{-\theta}}{\sum_{n=1}^{S+1} {p'_n}^{-\theta}} &< \frac{{p_{j^*}}^{-\theta}}{\sum_{n=1}^{S} {p_n}^{-\theta}}. \end{aligned}$$

Combining the two inequalities, we have

$$\frac{\sum_{n=1}^{S} {p_n}^{-\theta}}{\sum_{n=1}^{S+1} {p'_n}^{-\theta}} < (\frac{p_{j^*}}{p'_{j^*}})^{-\theta} < 1,$$

which contradicts inequality (E9). Therefore, there cannot be such a firm as n^* and we must have $\chi'_n < \chi_n$, for $1 \leq n \leq S$. Hence, the market share of all incumbents declines together with their markups and prices. This establishes part (a).

Input price indices are $c = \gamma\tau(\sum_{n=1}^{S} p_n^{-\theta})^{-\frac{1}{\theta}}$ and $c' = \gamma\tau(\sum_{n=1}^{S+1} p_n'^{-\theta})^{-\frac{1}{\theta}}$ before and after including the new supplier, respectively. Given part (a), we have $p'_n < p_n$, for $1 \leq n \leq S$. Therefore

$$\sum_{n=1}^{S} p_n'^{-\theta} > \sum_{n=1}^{S} p_n^{-\theta}.$$

As $p'^{-\theta}_{S+1} > 0$, we have $\sum_{n=1}^{S} p'^{-\theta}_n + p'^{-\theta}_{S+1} > \sum_{n=1}^{S} p'^{-\theta}_n$, which implies a decrease in the buyer's marginal cost when a new supplier is added:

$$c' \ < \ c. \tag{E10}$$

A.3 Proof of Proposition 3

Consider two buyer firms, one with higher productivity than the other, $\varphi_H > \varphi_L$. Denote their sourcing strategies as $\{\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H)\}$, and $\{\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L)\}$. For the high productivity firm to prefer $\{\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H)\}$ over $\{\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L)\}$, we need

$$\begin{aligned}\gamma^{1-\sigma} B_i \varphi_H^{\sigma-1} \Theta_i(\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H))^{\frac{\sigma-1}{\eta-1}} - w_i \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi_H) f_{ijk}^D(S_{ijk}(\varphi_H)) \\ > \gamma^{1-\sigma} B_i \varphi_H^{\sigma-1} \Theta_i(\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L))^{\frac{\sigma-1}{\eta-1}} - w_i \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi_L) f_{ijk}^D(S_{ijk}(\varphi_L)).\end{aligned} \tag{E11}$$

For the low productivity firm to prefer $\{\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L)\}$ over $\{\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H)\}$, we need

$$\begin{aligned}\gamma^{1-\sigma} B_i \varphi_L^{\sigma-1} \Theta_i(\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L))^{\frac{\sigma-1}{\eta-1}} - w_i \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi_L) f_{ijk}^D(S_{ijk}(\varphi_L)) \\ > \gamma^{1-\sigma} B_i \varphi_L^{\sigma-1} \Theta_i(\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H))^{\frac{\sigma-1}{\eta-1}} - w_i \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi_H) f_{ijk}^D(S_{ijk}(\varphi_H)).\end{aligned} \tag{E12}$$

Combining the two inequalities above, we obtain

$$\gamma^{1-\sigma} B_i(\varphi_H^{\sigma-1} - \varphi_L^{\sigma-1}) \left(\Theta_i(\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H))^{\frac{\sigma-1}{\eta-1}} - \Theta_i(\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L))^{\frac{\sigma-1}{\eta-1}}\right) > 0. \tag{E13}$$

Given that $\varphi_H > \varphi_L$, and $\sigma, \eta > 1$, the inequality above implies $\Theta_i(\mathbb{I}_i(\varphi_H), \mathbb{S}_i(\varphi_H)) > \Theta_i(\mathbb{I}_i(\varphi_L), \mathbb{S}_i(\varphi_L))$. Therefore, we establish result (b) that the buyers' sourcing capability is non-decreasing in φ.

We next prove result (a). Under our parameter restrictions that $\sigma > \eta$ and $\rho_{ijk}(\varphi) > 0$, we show that the profit function of the downstream firm in equation (13) features increasing differences in (I_{ijk}, I_{imn}), (S_{ijk}, S_{imn}) and (I_{ijk}, S_{imn}) for $\forall\, j \neq m$ or $\forall\, k \neq n$. In addition, it also has increasing differences in (I_{ijk}, φ) and (S_{ijk}, φ) for $\forall\, j$ and k. Therefore, according to the Topkis' Theorem, we have the following monotone comparative statics result: $I_{ijk}(\varphi_H) \geq I_{ijk}(\varphi_L)$ and $S_{ijk}(\varphi_H) \geq S_{ijk}(\varphi_L)$ for $\varphi_H \geq \varphi_L$.

To show these increasing differences properties of the profit function, we first invoke Proposition 2 and note that the country-sector input price index given in equation (8) is decreasing in the number of upstream firms within the sector if $\rho_{ijk}(\varphi) > 0$; that is $c_{ijk}(S_{ijk}+1) < c_{ijk}(S_{ijk})$ $\forall S_{ijk} > 0$. We first show that the profit function is supermodular in $(c_{ijk},\, c_{imn})$. We note that

$$\frac{\partial \pi_i^D}{\partial c_{ijk}} = (1-\sigma)B_i\frac{1}{\varphi}c_i(\varphi)^{1-\sigma}\Theta_i^{\eta}I_{ijk}{c_{ijk}}^{-\eta} = (1-\sigma)\gamma^{-\sigma}B_i\varphi^{\sigma-1}\Theta_i^{\frac{\sigma}{\eta-1}+\eta}I_{ijk}{c_{ijk}}^{-\eta}.$$

Therefore, we have

$$\frac{\partial^2 \pi_i^D}{\partial c_{ijk}\partial c_{imn}} = (1-\sigma)(1-\eta)\gamma^{-\sigma}\left(\frac{\sigma}{\eta-1}+\eta\right)B_i\varphi^{\sigma-1}\Theta_i^{\frac{\sigma}{\eta-1}+\eta-1}I_{ijk}{c_{ijk}}^{-\eta}I_{imn}{c_{imn}}^{-\eta}. \quad \text{(E14)}$$

It is easy to see that, under the parameter restriction $\sigma > \eta > 1$,

$$\frac{\partial^2 \pi_i^D}{\partial c_{ijk}\partial c_{imn}} \geq 0.$$

Therefore, the profit function features increasing differences in $(c_{ijk},\, c_{imn})$:

$$\pi_i^D({c_{ijk}}^H, {c_{imn}}^H) - \pi_i^D({c_{ijk}}^L, {c_{imn}}^H) \geq \pi_i^D({c_{ijk}}^H, {c_{imn}}^L) - \pi_i^D({c_{ijk}}^L, {c_{imn}}^L),$$

for ${c_{ijk}}^H > {c_{ijk}}^L$ and ${c_{imn}}^H > {c_{imn}}^L$. Given that the country-sector price indices *decrease* in the number of upstream suppliers, we can re-write the inequality above by replacing arguments of the profit function: [28]

$$\pi_i^D({S_{ijk}}^L, {S_{imn}}^L) - \pi_i^D({S_{ijk}}^H, {S_{imn}}^L) \geq \pi_i^D({S_{ijk}}^L, {S_{imn}}^H) - \pi_i^D({S_{ijk}}^H, {S_{imn}}^H).$$

Multiplying both sides of the inequality by -1, we obtain

$$\pi_i^D({S_{ijk}}^H, {S_{imn}}^H) - \pi_i^D({S_{ijk}}^L, {S_{imn}}^H) \geq \pi_i^D({S_{ijk}}^H, {S_{imn}}^L) - \pi_i^D({S_{ijk}}^L, {S_{imn}}^L).$$

Therefore, the profit function also features increasing differences in the number of matched upstream firms (S_{ijk}, S_{imn}).

Finally, from equation (E14), it is obvious that the profit function has decreasing differences in $(c_{ijk},\, \varphi)$ and $(c_{ijk},\, I_{ijk})$. Since c_{ijk} is decreasing in S_{ijk}, the profit function has increasing differences in $(S_{ijk},\, \varphi)$ and $(S_{ijk},\, I_{ijk})$. To conclude, as long as $\sigma > \eta$, it is obvious that the profit function has increasing differences in $(I_{ijk},\, I_{imn})$ and $(I_{ijk},\, \varphi)$.

[28] The number of upstream suppliers also affects the profit function through the fixed costs. Since they enter additively, however, they are differenced out.

A.4 Proof of Proposition 4

According to Proposition 3, we have $S_{ijk}(\varphi_H) \geq S_{ijk}(\varphi_L)$ for $\varphi_H > \varphi_L$. Therefore, firms that are sufficiently productive will be able to include the new entrants as suppliers. To be specific, before the entry of new suppliers, buyers with productivity $\varphi > \overline{\varphi}_{ij,S_{ijk}}$ can include the marginal upstream firm with the highest marginal cost as a supplier. When there are new entrants such that $S'_{ijk} > S_{ijk}$, then buyers with productivity $\varphi > \overline{\varphi}_{ij,S'_{ijk}}$ now source from $S_{ijk}(\varphi) = S'_{ijk}$ suppliers from country j in sector s, buyers with productivity $\overline{\varphi}_{ij,S'_{ijk}-1} < \varphi < \overline{\varphi}_{ij,S'_{ijk}}$ now source from $S_{ijk}(\varphi) = S'_{ijk} - 1$ suppliers, and buyers with productivity $\overline{\varphi}_{ij,S_{ijk}+1} < \varphi < \overline{\varphi}_{ij,S_{ijk}+2}$ now source from $S_{ijk}(\varphi) = S_{ijk} + 1$ suppliers. Finally, firms with productivity $\varphi < \overline{\varphi}_{ij,S_{ijk}+1}$ do not change their sourcing strategy, as they cannot afford the higher fixed cost of more suppliers. In sum, firms with productivity higher than $\overline{\varphi}_{ij,S_{ijk}+1}$ increase the number of matched suppliers. Moreover, the higher a buyer's productivity, the more additional suppliers it adds to its portfolio. This establishes part (a) and (c).

Now we invoke result (b) of Proposition 2, which states that a higher number of upstream suppliers $S_{ijk}(\varphi)$ reduces the cost index $c_{ijk}(\varphi)$. Furthermore, it is easy to see from equations (10) and (15) that the quantity $Q_{ijk}(\varphi)$ and value $X_{ijk}(\varphi)$ of trade rise when the price index $c_{ijk}(\varphi)$ drops. According to result (a) above, downstream buyers weakly increase the matched number of upstream suppliers, with a larger magnitude for high-productivity firms. Naturally, this tends to reduce the price index $c_{ijk}(\varphi)$, increase trade quantity $Q_{ijs}(\varphi)$ and value $X_{ijk}(\varphi)$, with stronger effect for high productivity downstream firms.

A.5 Proof of Proposition 5

If sourcing decisions exhibit complementarity, the profit function specified in problem (13) features increasing differences between the sourcing decisions and the sourcing potential. Using Topkis's theorem, we have $\mathbb{I}_i(\varphi, \vec{\phi}_i(\varphi)) \subseteq \mathbb{I}_i(\varphi, \vec{\phi}_i{}'(\varphi))$, $\mathbb{S}_i(\varphi, \vec{\phi}_i(\varphi)) \subseteq \mathbb{S}_i(\varphi, \vec{\phi}_i{}'(\varphi))$, where $\vec{\phi}_i(\varphi) = \{\phi_{ijk}(\varphi)\}_{j=1,k=1}^{J,K}$ is the vector of sourcing potentials and $\phi_{ijk}(\varphi)' \geq \phi_{ijk}(\varphi)$ due to lower iceberg costs. The profit function also features increasing differences between the sourcing decisions and the matching friction. We have $\mathbb{I}_i(\varphi, \vec{f}_i) \subseteq \mathbb{I}_i(\varphi, \vec{f}_i{}')$, $\mathbb{S}_i(\varphi, \vec{f}_i) \subseteq \mathbb{S}_i(\varphi, \vec{f}_i{}')$, where $\vec{f}_i = \{f^D_{ijs}(S)\}_{j=1,k=1,s=1}^{J,K,S_{ijk}}$ and $f_{ijs}(S)' \leq f_{ijs}(S)$ for $S \geq 0$. However, the low-productivity firms will not be able to source from the additional suppliers. The most productive firms have already been matched with all potential suppliers. Therefore, it is the mid-productivity buyer firms that add additional suppliers and benefit the most.

B Pricing of Upstream Firms

First, from equation (12), we know that an upstream supplier's markup when matched to a buyer with productivity is given by

$$\mu_{ijks}(\varphi) = \frac{\varepsilon_{ijks}(\varphi)}{\varepsilon_{ijks}(\varphi) - 1},$$

where $\varepsilon_{ijks}(\varphi) = -[(\eta - \sigma)\chi_{ijks}(\varphi)\delta_{ijk}(\varphi) + (\theta - \eta)\chi_{ijks}(\varphi) - \theta]$. Since $\frac{\partial \varepsilon_{ijks}(\varphi)}{\partial \chi_{ijks}(\varphi)} = -[(\eta - \sigma)\delta_{ijk}(\varphi) + (\theta - \eta)] = -\ \rho_{ijk}(\varphi)$, we have

$$\frac{\partial \mu_{ijks}(\varphi)}{\partial \chi_{ijks}(\varphi)} = \frac{-\frac{\partial \varepsilon_{ijks}(\varphi)}{\partial \chi_{ijks}(\varphi)}}{(\varepsilon_{ijks}(\varphi) - 1)^2} = \frac{\rho_{ijk}(\varphi)}{(\varepsilon_{ijks}(\varphi) - 1)^2}.$$

Next, we define an upstream firm's *competitor markup elasticities* (Amiti et al., 2019) as:

$$\Gamma_{-ijks}(\varphi) = \sum_{n \neq s, n=1,\dots,S_{ijks}} \frac{\partial \mu_{ijks}(\varphi)}{\partial p_{ijkn}(\varphi)}.$$

If the markup elasticity with respect to competitor prices is *positive*, i.e., $\Gamma_{-ijks}(\varphi) > 0$, there are strategic complementarities in price setting among upstream firms: a supplier increases its markup in response to a competitor's price hike.

For brevity, we omit φ in the rest of the proof. Using equations (7) and (12), we find that

$$\begin{aligned} \Gamma_{-ijks} &= \sum_{n \neq s, n=1,\dots,S_{ijks}} \frac{\partial \mu_{ijks}}{\partial p_{ijkn}} = \sum_{n \neq s, n=1,\dots,S_{ijks}} \frac{\partial \mu_{ijks}}{\partial \chi_{ijks}} \frac{\partial \chi_{ijks}}{\partial p_{ijkn}} \\ &= \frac{\rho_{ijk}}{(\varepsilon_{ijks} - 1)^2} \sum_{n \neq s, n=1,\dots,S_{ijks}} \frac{\partial \chi_{ijks}}{\partial p_{ijkn}}, \end{aligned}$$

and

$$\begin{aligned} \frac{\partial \chi_{ijks}}{\partial p_{ijkn}} &= \frac{-p_{ijks}^{-\theta}(-\theta p_{ijkn}^{-\theta-1})}{(\sum_n p_{ijkn}^{-\theta})^2} = \frac{\theta p_{ijks}^{-\theta}}{\sum_n p_{ijkn}^{-\theta}} \frac{p_{ijkn}^{-\theta}}{\sum_n p_{ijkn}^{-\theta}} p_{ijkn}^{-1} \\ &= \theta \chi_{ijks} \chi_{ijkn} p_{ijkn}^{-1}. \end{aligned}$$

Combing the two results above, we find that

$$\begin{aligned} \Gamma_{-ijks} &= \frac{\rho_{ijk}}{(\varepsilon_{ijks} - 1)^2} \sum_{n \neq s, n=1,\dots,S_{ijks}} \theta \chi_{ijks} \chi_{ijkn} p_{ijkn}^{-1} \\ &= \frac{\rho_{ijk}}{(\varepsilon_{ijks} - 1)^2} \theta \chi_{ijks} \sum_{n \neq s, n=1,\dots,S_{ijks}} \chi_{ijkn} p_{ijkn}^{-1}. \end{aligned} \tag{E15}$$

Therefore, as long as $\rho_{ijk} > 0$, we have $\Gamma_{-ijks} > 0$ and upstream supplier pricing features strategic complementarity.

C The Combinatorial Multinomial Discrete Choice Problem

We consider the following combinatorial multinomial discrete choice problem,

$$\max_{\mathcal{M} \in \mathbb{Z}^n} \pi(\mathcal{M}, \varphi), \tag{E16}$$

where a firm of productivity φ chooses a vector $\mathcal{M} = [M_1, M_2, ..., M_n]$ of non-negative finite integers $M_i \in \{0, 1, 2, ..., S_i\}$ and $i \in \{1, 2, ..., n\}$ to maximize the profit $\pi(\mathcal{M}, \varphi)$.[29] The collection of all permissible vectors is denoted by $\mathbb{Z}^n$, while S_i is the upper bound of option i and satisfies $1 \leq S_i < \infty$. If $S_i = 1$ for all i, it is a binary choice problem.

We next discuss the algorithm to search for $\mathcal{M}^*$, the solution to the problem (E16). A brute force algorithm has a computational complexity of $\Pi_{i=1}^{n}(S_i + 1)$, which rises rapidly when the number of options n or the upper bound of each option S_i increases. To solve this problem, we extend the method of Jia (2008), Antràs et al. (2017) and Arkolakis et al. (2023a) for combinatorial *binary* choice problems to combinatorial *multinomial* choice problems. The key idea is to eliminate non-optimal choice sets without evaluating the profit function for all possible choices.

Definition 6 *The marginal value operators, D_i^+ and D_i^- are defined as*

$$\begin{aligned} D_i^+\pi(\mathcal{M}, \varphi) &= \pi([..., M_i + 1, ...], \varphi) - \pi([..., M_i, ...], \varphi), \;\; for\ M_i < S_i, \\ D_i^-\pi(\mathcal{M}, \varphi) &= \pi([..., M_i, ...], \varphi) - \pi([..., M_i - 1, ...], \varphi), \;\; for\ M_i > 0. \end{aligned}$$

Therefore, when we apply D_i^+ to the profit function $\pi(\mathcal{M}, \varphi)$, we obtain the marginal value of expanding option i of $\mathcal{M}$ by 1, while D_i^- pertains the marginal value of shrinking $\mathcal{M}$ by 1 for option i. The problem is combinatorial as long as the marginal values are not fully independent across options; otherwise, we can solve the problem option by option.

To reduce the choice set, we exploit two properties.

Definition 7 *For any two decisions **0** $\leq \mathcal{M}_1 \leq \mathcal{M}_2 \leq \mathcal{S}$, the profit function $\pi(\mathcal{M}, \varphi)$ obeys*

[29] For example, firms in our model choose the number of suppliers to maximize profit in problem (13). It can also be a firm making decisions on the number of workers to hire for teams within the firm, or the number of stores to operate across locations.

single crossing differences from above (SCD-A) if for any option $i \in \{1, 2, ..., n\}$, we have

$$D_i^+\pi(\mathcal{M}_2, \varphi) \geq 0 \;\; \Rightarrow \;\; D_i^+\pi(\mathcal{M}_1, \varphi) \geq 0, \tag{E17}$$
$$D_i^-\pi(\mathcal{M}_2, \varphi) \geq 0 \;\; \Rightarrow \;\; D_i^-\pi(\mathcal{M}_1, \varphi) \geq 0, \tag{E18}$$

and single crossing differences from below (SCD-B) if

$$D_i^+\pi(\mathcal{M}_1, \varphi) \geq 0 \;\; \Rightarrow \;\; D_i^+\pi(\mathcal{M}_2, \varphi) \geq 0, \tag{E19}$$
$$D_i^-\pi(\mathcal{M}_1, \varphi) \geq 0 \;\; \Rightarrow \;\; D_i^-\pi(\mathcal{M}_2, \varphi) \geq 0 \tag{E20}$$

where $\boldsymbol{0} = [0, ..., 0]$ *and* $\mathcal{S} = [S_1, S_2, ..., S_n]$ *are the lower and upper bounds of the firm's choice.*

Therefore, if the profit function exhibits SCD-B, the marginal value of a larger choice ($\mathcal{M}_2$) is positive whenever the marginal value of a smaller choice ($\mathcal{M}_1$) is positive.[30] Intuitively, the choices are complementary. Similarly, under SCD-A, the choices are substitutes.

Next, we show that we can use a "squeezing procedure" to eliminate the non-optimal choices by iteration. For brevity, we demonstrate it for the scenario of SCD-B, the case of complementarity, which is what we focus on in this paper.

Definition 8 *(Squeezing procedure) Suppose the profit function* $\pi(\mathcal{M}_1, \varphi)$ *exhibits SCD-B. Then for problem (E16), its bounding choices* $[\underline{\mathcal{M}}^{(k)}, \overline{\mathcal{M}}^{(k)}]$ *are the output of the* k^{th} *application of the mapping of* S^B *given by*

$$S^B([\underline{\mathcal{M}}^{(k)}, \overline{\mathcal{M}}^{(k)}]) = [\underline{\mathcal{M}}^{(k+1)}, \overline{\mathcal{M}}^{(k+1)}], \tag{E21}$$

such that

$$\begin{aligned} \underline{\mathcal{M}}^{(k+1)} &= \underline{\mathcal{M}}^{(k)} + [\mathbb{1}_1^{k+}, \mathbb{1}_2^{k+}, ..., \mathbb{1}_n^{k+}], \\ \overline{\mathcal{M}}^{(k+1)} &= \overline{\mathcal{M}}^{(k)} - [\mathbb{1}_1^{k-}, \mathbb{1}_2^{k-}, ..., \mathbb{1}_n^{k-}], \end{aligned}$$

where $\mathbb{1}_i^{k+}$ *and* $\mathbb{1}_i^{k-}$ *are indicators such that*

$$\mathbb{1}_i^{k+} = \begin{cases} 1 & \textit{if } D_i^+(\underline{\mathcal{M}}^{(k)}) \geq 0, \\ 0 & \textit{otherwise} \; ; \end{cases} \quad \textit{and } \mathbb{1}_i^{k-} = \begin{cases} 1 & \textit{if } D_i^-(\overline{\mathcal{M}}^{(k)}) < 0, \\ 0 & \textit{otherwise} \; . \end{cases} \tag{E22}$$

Every time the squeezing procedure is applied, it raises $\underline{\mathcal{M}}$ by increasing those options that have positive marginal value and decreases $\overline{\mathcal{M}}$ by reducing those options that have negative

[30] $\mathcal{M}_2 \geq \mathcal{M}_1$ if every element of $\mathcal{M}_2$ is greater than, or equal to, the corresponding element of $\mathcal{M}_1$.

marginal value. By iteration, similar to Arkolakis et al. (2023a), the squeezing procedure converges to a fixed point that bounds the optimal solution in polynomial time, as established in the result below.

Theorem 9 *Given the problem specified in (E16), if $\pi(\mathcal{M}, \varphi)$ obeys SCD-B, successively applying S^B to $[\mathbf{0}, \mathcal{S}]$ returns a sequence of bounding choices such that $\underline{\mathcal{M}}^{(k)} \leq \underline{\mathcal{M}}^{(k+1)} \leq \mathcal{M}^* \leq \overline{\mathcal{M}}^{(k+1)} \leq \overline{\mathcal{M}}^{(k)}$ in $\mathcal{O}(n)$ time.*

Proof. We prove the theorem by induction. We apply S^B from $\underline{\mathcal{M}}^{(1)} = \mathbf{0}$, and $\overline{\mathcal{M}}^{(1)} = \mathcal{S}$. It is trivially true that $\mathbf{0} \leq \underline{\mathcal{M}}^{(1)}$ and $\overline{\mathcal{M}}^{(1)} \leq \mathcal{S}$. We first show that $\underline{\mathcal{M}}^{(1)} \leq \mathcal{M}^* \leq \overline{\mathcal{M}}^{(1)}$. By SCD-B and $\mathbf{0} \leq \underline{\mathcal{M}}^{(1)}$, we have $D_i^+\pi(\mathbf{0}, \varphi) \geq 0 \implies D_i^+\pi(\underline{\mathcal{M}}^{(1)}, \varphi) \geq 0$. Since $D_i^+\pi(\underline{\mathcal{M}}^{(1)}, \varphi) \geq 0$ is true for any i, increasing any element of $\underline{\mathcal{M}}^{(1)}$ leads to an equal or higher profit. It must be that $\underline{\mathcal{M}}^{(1)} \leq \mathcal{M}^*$. Similarly, $D_i^-\pi(\mathcal{M}^*, \varphi) \geq 0$ by the optimality of $\mathcal{M}^*$. Then given $\overline{\mathcal{M}}^{(1)} \leq \mathcal{S}$ and SCD-B, we have $D_i^-\pi(\mathcal{S}, \varphi) \geq 0$ for any i; reducing any element of $\overline{\mathcal{M}}^{(1)}$ therefore leads to an equal or higher profit. Therefore, it must be that $\mathcal{M}^* \leq \overline{\mathcal{M}}^{(1)}$.

Suppose $\underline{\mathcal{M}}^{(k-1)} \leq \underline{\mathcal{M}}^{(k)} \leq \mathcal{M}^* \leq \overline{\mathcal{M}}^{(k)} \leq \overline{\mathcal{M}}^{(k-1)}$ for any $k > 1$. Given $\underline{\mathcal{M}}^{(k-1)} \leq \underline{\mathcal{M}}^{(k)} \leq \mathcal{M}^*$, it must be that $D_i^+\pi(\overline{\mathcal{M}}^{(k-1)}, \varphi) \geq 0$, i.e., raising any element of $\overline{\mathcal{M}}^{(k-1)}$ leads to an equal or higher profit. Then by SCD-B and $\underline{\mathcal{M}}^{(k-1)} \leq \underline{\mathcal{M}}^{(k)}$, we have $D_i^+\pi(\underline{\mathcal{M}}^{(k)}, \varphi) \geq 0$. Defining

$$\underline{\mathcal{M}}^{(k+1)} = \underline{\mathcal{M}}^{(k)} + [\mathbb{1}_1^{k+}, \mathbb{1}_2^{k+}, ..., \mathbb{1}_n^{k+}], \tag{E23}$$

we have $\underline{\mathcal{M}}^{(k)} \leq \underline{\mathcal{M}}^{(k+1)}$. Therefore, due to SCD-B, we have $D_i^+\pi(\underline{\mathcal{M}}^{(k+1)}, \varphi) \geq 0$, and that increasing any element of $\underline{\mathcal{M}}^{(k+1)}$ leads to an equal or higher profit. Naturally, $\underline{\mathcal{M}}^{(k+1)} \leq \mathcal{M}^*$, given the optimality of $\mathcal{M}^*$. Similarly, from $\mathcal{M}^* \leq \overline{\mathcal{M}}^{(k)} \leq \overline{\mathcal{M}}^{(k-1)}$, by the optimality of $\mathcal{M}^*$, we know that

$$D_i^-\pi(\overline{\mathcal{M}}^{(k)}, \varphi) \leq 0,$$

i.e., reducing $\overline{\mathcal{M}}^{(k)}$ by any element leads to a higher or equal profit.

If we define

$$\overline{\mathcal{M}}^{(k+1)} = \overline{\mathcal{M}}^{(k)} - [\mathbb{1}_1^{k-}, \mathbb{1}_2^{k-}, ..., \mathbb{1}_n^{k-}], \tag{E24}$$

we have $\overline{\mathcal{M}}^{(k+1)} \leq \overline{\mathcal{M}}^{(k)}$. Then, by SCD-B, we have

$$D_i^-\pi(\overline{\mathcal{M}}^{(k+1)}, \varphi) \leq 0.$$

Therefore, reducing any element of $\overline{\mathcal{M}}^{(k+1)}$ leads to a higher profit and we have $\mathcal{M}^* \leq \overline{\mathcal{M}}^{(k+1)}$ by the optimality of $\mathcal{M}^*$. Combing the results above, we have $\underline{\mathcal{M}}^{(k)} \leq \underline{\mathcal{M}}^{(k+1)} \leq \mathcal{M}^* \leq \overline{\mathcal{M}}^{(k+1)} \leq \overline{\mathcal{M}}^{(k)}$.

The above squeezing procedure stops within $\sum_{i=1}^{n}(S_i+1)$ iterations, which is bounded by $n \cdot \max_{i=1,...,n}\{S_i+1\}$. To see that, we note that the procedure does not decrease the lower bound choice or increase the upper bound choice, as evident in equations (E23) and (E24). ■

D The Estimation Algorithm

Here we describe the algorithm to estimate the demand shifter and fixed cost of sourcing by simulated method of moments.

- Step 1: draw K random samples of suppliers and marginal costs and N buyer firms and their productivity. We obtain $M = KN$ samples by interacting the two random samples, each with a particular productivity and supplier cost sample.
- Step 2: compute and save prices charged by suppliers for every possible supplier configuration for each supplier cost draw.
- Step 3: Guess an initial value for parameters to be estimated and denote it as Φ_0.
- Step 4: For a guess of Φ_t, use the extended algorithm in appendix section C to solve the optimal sourcing problem for each downstream buyer for the drawn buyers and suppliers.
- Step 5: For each moment m_i, compute it as the sample average across the M samples of buyers and suppliers (denoted by $\tilde{\mathrm{m}}_i(\Phi_t)$).
- Step 6: Compute the Euclidean distance between the model moments and data moments for a given weighting matrix W:

$$y_t = (\widetilde{\mathrm{m}}(\Phi_t) - m)\mathrm{W}(\widetilde{\mathrm{m}}(\Phi_t) - m)', \tag{E25}$$

  where $\widetilde{\mathrm{m}}(\Phi_t) = [m_1(\Phi_t), ..., m_S(\Phi_t)]$ are the set of targeted moments and $m = [m_1, ..., m_s]$ are the data counterparts.

- Step 7: Stop if $y_t < \epsilon$ where ϵ is a small positive number capturing the numerical precision. Otherwise, we go back to Step 3 and start with a new guess Φ_{t+1}.

E Additional Tables and Figures

Table A1: Summary Statistics

	2000				2006			
	N	Mean	St Dev	Median	N	Mean	St Dev	Median
Panel A. Market Structure (by HS-6 product)								
# CHN exporters to CHL	1,431	12.4	23.5	5	2,388	21.4	43.8	7
# CHN exporters to ROW w/o CHL	1,952	353	488	183	3,030	868	1,577	313
# CHL importers from CHN	1,954	14.8	29.8	4	3,034	22.9	46.8	6
# CHN exporters to FRA	2,139	16.9	38.3	5	2,954	37.7	92.3	9
# CHN exporters to ROW w/o FRA	2,865	272	426	124	3,695	729	1,452	231
# FRA importers from CHN	2,863	28.6	72.1	6	3,671	56.6	142.1	9
Panel B. Control Variables (by HS-6 product)								
applied EU import tariff (%)	2,899	3.9	7.5	1.5	3,600	2.8	7.1	0
mean VA / worker CHN exporters (log)	2,699	4.16	0.82	4.09	3,576	5.01	0.88	4.94
variance VA / worker CHN exporters (log)	2,546	7.23	2.23	7.31	3,454	9.30	2.27	9.35
mean TFP CHN exporters (log)	2,699	6.93	0.89	6.85	3,576	7.57	0.97	7.50
variance TFP CHN exporters (log)	2,546	13	2.22	13.2	3,454	14.7	2.25	14.7
mean input unit value CHN exporters (log), de-meaned	2,863	4.17	1.4	4.22	3,689	4.29	1.48	4.30
share CHN processing trade	2,865	0.36	0.32	0.29	3,695	0.26	0.27	0.16
share CHN trade intermediares	2,865	0.41	0.24	0.40	3,695	0.43	0.22	0.44
share CHN foreign-owned exporters	2,865	0.17	0.12	0.15	3,695	0.17	0.12	0.14
share CHN multi-product exporters	2,865	0.95	0.11	0.99	3,695	0.94	0.11	0.99
Panel C. Importer Characteristics (Firm-level)								
CHL sales (1m CHL Pesos)	2,164	20,681	55,141	1,050	6,488	16,173	48,987	1,050
CHL total imports (USD 1,000)	2,525	730	3,532	74	6,519	1,193	7,511	71
FRA sales (EUR 1,000)	11,319	59,600	609,900	4,000	22,790	48,400	574,300	3,200
FRA total imports (EUR 1,000)	12,571	785	7,088	43	25,737	864	7,631	32
FRA sales / worker (EUR 1,000)	10,679	460	2,854	215	20,860	466	3,530	222
Panel D. Chilean Sourcing Network with China								
# CHL importer - CHN exporter pairs (by HS-6 product)	1,954	26.1	67.5	5	3,034	37.3	91.5	8
trade value (by HS-6 product, USD 1,000)	1,954	439	1,848	37.2	3,034	1,122	5,124	99.3
unit value (by HS-6 product, USD 1,000)	1,954	1.1	37.4	0.005	3,034	3.6	120	0.005
# CHL importers (by exporter-HS-6 product)	37,954	1.3	1.5	1	89,714	1.3	1.3	1
trade value (by exporter-HS-6 product, USD 1,000)	37,954	22.6	106	2.9	89,714	37.9	272	3.78
unit value (by exporter-HS-6 product, USD 1,000)	37,954	0.14	10	0.004	89,714	0.38	23.1	0.005
# CHN exporters (by importer-HS-6 product)	28,940	1.8	2.0	1	69,542	1.6	1.8	1
trade value (by importer-HS-6 product, USD 1,000)	28,940	29.7	180	1.8	69,542	48.9	378	2.4
unit value (by importer-HS-6 product, USD 1,000)	28,940	0.14	9.9	0.003	69,542	0.46	28.4	0.005

Note: This table reports summary statistics for the upstream market structure and other characteristics in China across HS-6 products (Panels A-B), downstream Chilean and French firm characteristics (Panel C), and characteristics of the network of Chilean buyers and Chinese suppliers (Panel D).

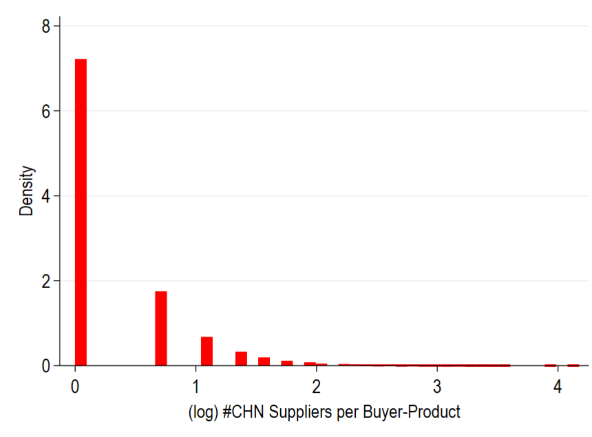
Table A2: Additional Robustness

	Balanced Sample	Natural Quantity Units				No Eastern Europe Importers
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Chile						
(log) Import Value$_{fpt}$	0.021		0.089	0.089**	0.129***	
(log) Import Quantity$_{fpt}$	0.200***		0.231***	0.241***	0.317***	
(log) Import Unit Value$_{fpt}$	-0.179***		-0.140***	-0.152***	-0.188***	
N	169,436		294,149	301,370	306,857	
Panel B. France						
(log) Import Value$_{fpt}$	0.148***	0.277***	0.126***	0.125***	0.114***	0.094***
(log) Import Quantity$_{fpt}$	0.194***	0.356***	0.159***	0.160***	0.145***	0.126***
(log) Import Unit Value$_{fpt}$	-0.045***	-0.078***	-0.033***	-0.036***	-0.030***	-0.033***
N	486,849	308,718	829,308	803,363	887,062	319,098
Firm, Year, HS-6 Product FE	YES	YES	YES	YES	YES	YES
HS-6 Product Trend	YES	YES	YES	YES	YES	YES
Product $\times$ Year Controls	YES	YES	YES	YES	YES	YES
Downstr. Industry x Year FE			YES			
(log) # CHN$\rightarrow$ROW Exporters$_{pt}$ other products				YES		
(log) # CHN$\rightarrow$ROW Exporters$_{pt}$ in HS-4					YES	
Sample	(1)					(2)

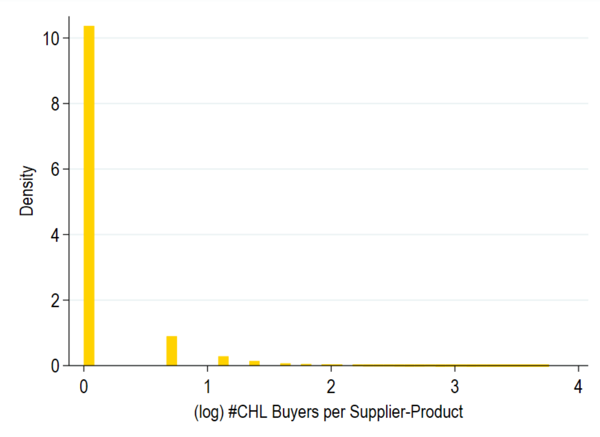
Note: This table confirms the robustness of the results in Columns 2 and 4 of Table 1. Column 3 includes the (log) number of Chinese exporters to the rest of the world in all products of a firm other than p as a control. Columns 4 and 12 include the (log) number of Chinese exporters to the rest of the world in the HS 4 product to which p belongs. Sample (1) includes trade flows of firms that are present in all years. Sample (2) includes firms that never trade with Eastern European countries during our sample period. The product $\times$ year controls include the (log) number of French importers from ROW; the EU ad-valorem import tariff on Chinese exports; the average productivity of Chinese exporters, the variance of the productivity of Chinese exporters, the average quality of Chinese exporters; the value shares of processing trade, intermediated trade; and the share of foreign-owned, multi-product, state-owned firms in Chinese exports. Singletons are dropped, and standard errors are clustered by HS-6 product $\times$ year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure A1: Sparse Production Networks

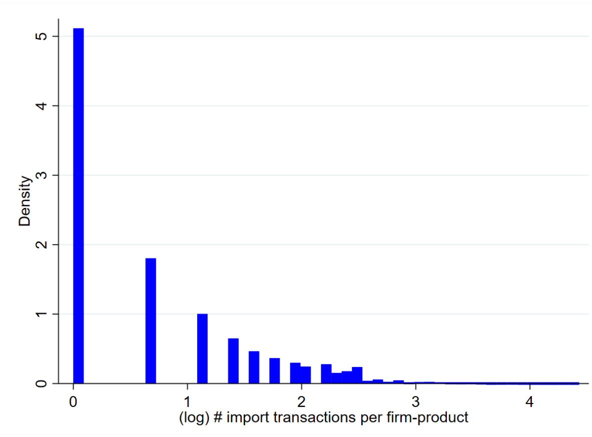
(a) Chinese suppliers per Chilean buyer



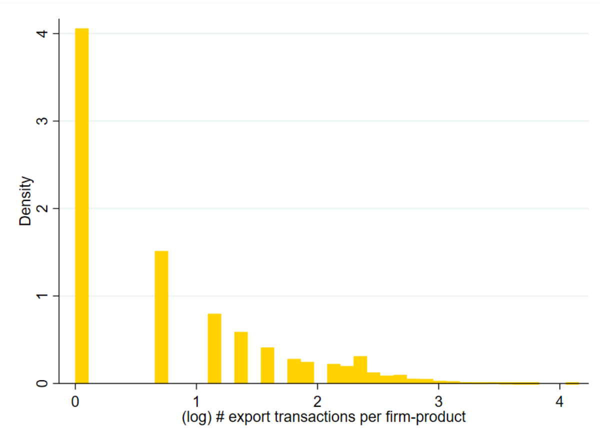
(b) Chilean buyers per Chinese supplier



(c) Import transactions from China per French buyer

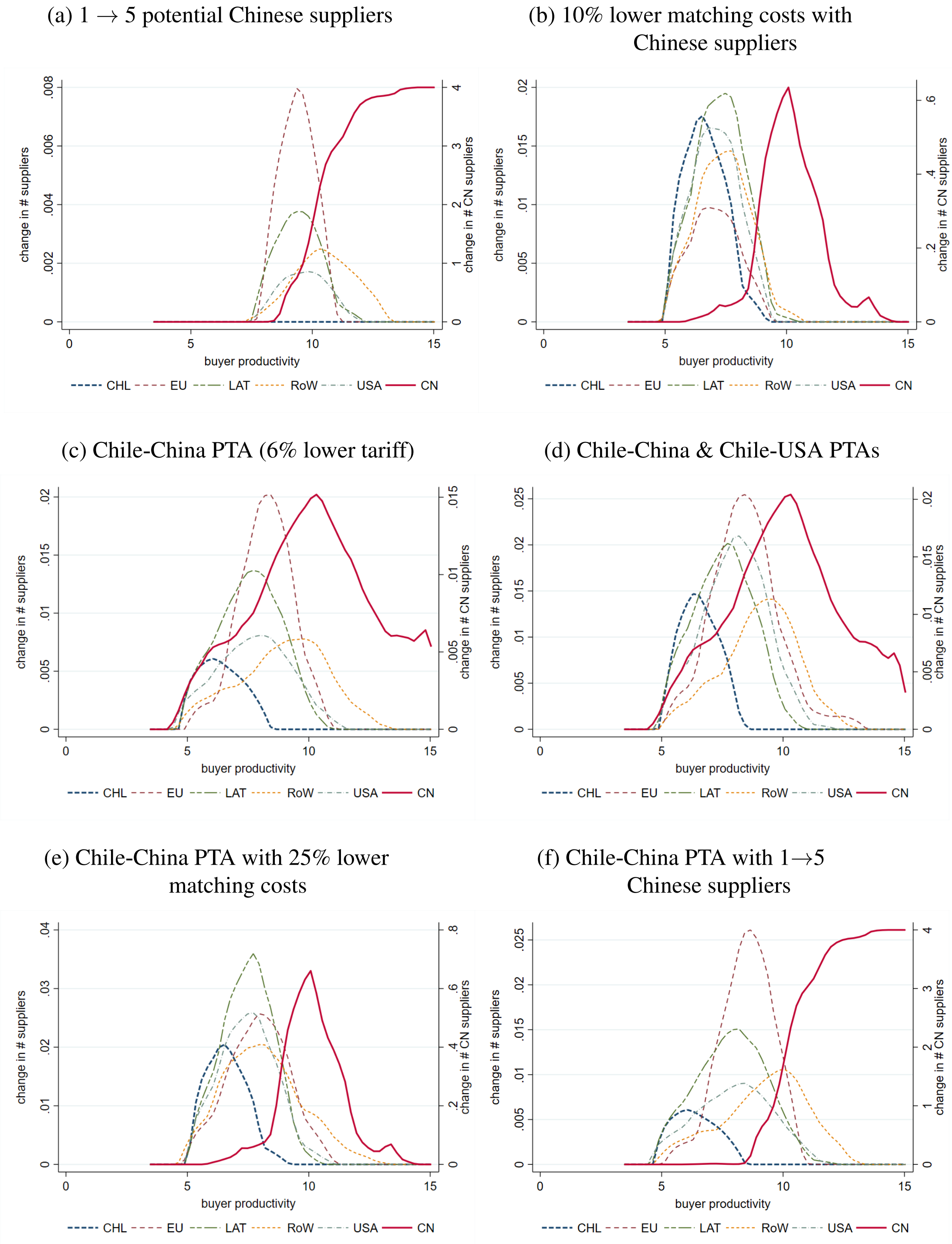


(d) Export transactions to France per Chinese supplier



Note: Histograms of log number of (a) Chinese suppliers per Chilean buyer-HS6 product, (b) Chilean buyers per Chinese supplier-product, (c) import transactions from China per French buyer-product, and (d) export transactions to France per Chinese supplier-product.

Figure A2: Change in the Number of Suppliers per Origin



Note: Figure shows comparisons between the baseline model and counterfactual simulations for the number of suppliers. Plot a) illustrates an increase in the # of potential Chinese suppliers from 1 to 5; plot B a 25% reduction in β_0 and β_4; plot c) a trade cost reduction of 6% with China; plot d) a 6% trade cost reduction vis-a-vis China and the USA; plot e) a 6% trade cost reduction with China and a reduction of β_0 and β_4 by 25%; plot f) a 6% trade cost reduction with China and an increase in the # of potential Chinese suppliers from 1 to 5.