Global Production Networks and Imperfect Competition*

Hanwei Huang[◇] Kalina Manova[⋆] Oscar Perelló[†] Frank Pisch[‡]

March 2026

Abstract

How do global production networks and market structure interact to shape the welfare effects of trade and competition policy? We develop a model with two-sided firm heterogeneity, matching frictions, and imperfect supplier competition. More productive buyers match with more suppliers, inducing tougher competition among them, lower input costs, and higher profits. Entry upstream thus benefits primarily high-productivity buyers, while lower trade or matching costs favor mid-productivity buyers. Reduced-form evidence confirms that larger French and Chilean firms import higher quantities at lower prices as more Chinese suppliers enter, and that suppliers charge diversified buyers lower markups. We estimate the model by adapting recent methods for combinatorial, discrete-choice problems. Counterfactuals reveal that the interaction of endogenous networks and markups significantly amplifies the gains from policies that facilitate supplier entry or firm matching, as well as from modern trade agreements that combine trade cost cuts with such policies.

Keywords: production networks, matching frictions, imperfect competition, gains from trade, trade and competition policy.

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

*We thank referees, discussants, seminar and conference participants for their valuable feedback. Huang acknowledges support from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project # CityU 21504720). Manova acknowledges support from The Leverhulme Trust and ERC Horizon 2020 (Consolidator Grant Agreement 724880). Access to French confidential data was made possible thanks to the secure environment provided by CASD - Centre d'accès sécurisé aux données (Ref. 10.34724/CASD). We thank Jerry Cheng, Yuchen Zhou and Arman Zhumakhan for their excellent research assistance.
◇ City University of Hong Kong, CEP and CIFER. Email: huanghanwei@gmail.com.
⋆ University College London, CEP, CEPR and CESifo. Email: k.manova@ucl.ac.uk.
† University College London. Email: oscar.perello.19@ucl.ac.uk.
‡ TU Darmstadt, CEPR, CEP and SIAW. Email: frank.pisch@tu-darmstadt.de.

1 Introduction

Global value chains (GVCs) have transformed economic activity, as firms today transact with buyers and suppliers worldwide (e.g., Bernard and Moxnes, 2018; Antrás and Chor, 2022). Both trade and market reforms have contributed to this development, with the rise of China after it joined the WTO in 2001 being a prominent example. This allowed great numbers of Chinese suppliers to enter and thicken otherwise highly concentrated international goods markets, which in turn prompted producers around the world to restructure their supplier base. Yet GVCs today face policy polarization: Alongside a rise in trade disintegration (e.g., Brexit, US-China trade war) and protectionist industrial policy (Juhász et al., 2024), new deep trade agreements increasingly combine tariff cuts with regulatory harmonization, trade promotion, and competition policy, to facilitate firm entry and firm-to-firm transactions (Maggi and Ossa, 2021).[1]

We study how firm network formation and imperfect supplier competition interact to shape GVCs and the welfare effects of trade and industrial policy. Intuitively, reforms that lower the costs of supplier entry, buyer-supplier matching, or international trade can each affect firms' marginal costs and ultimately consumer prices through two channels: Firms can both match with a larger set of potentially more productive suppliers (Antràs et al., 2017) and benefit from lower input markups due to tougher supplier competition (Alviarez et al., 2023). While these mechanisms have typically been studied in isolation, we show that the interaction of endogenous firm linkages and strategic supplier interaction has first-order consequences for the impact of policy on consumer welfare and heterogeneous firms.

We first develop a quantifiable model with two-sided firm heterogeneity, matching frictions, and oligopolistic competition upstream. In the model, more productive buyers match with more suppliers, inducing stronger competition among them, lower input costs, and higher profits. Entry upstream benefits primarily high-productivity buyers, while lower trade or matching costs favor mid-productivity buyers. Exploiting rich customs data, we then empirically confirm that Chilean and French firms (especially large ones) import higher quantities at lower prices as more Chinese suppliers enter, and that suppliers charge diversified buyers lower markups. Finally, we estimate the model by adapting recent methods for combinatorial, discrete-choice problems to the context of network formation with strategic pricing. Counterfactual analysis reveals that the interaction of endogenous networks and markups significantly amplifies the welfare gains from policies that facilitate supplier entry or firm matching, as well as from modern trade agreements that combine trade cost cuts with such policies.

[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, intellectual property, and environmental standards.

We first introduce a new model of endogenous production networks with oligopolistic supplier competition. Monopolistically competitive heterogeneous buyers choose how to source a unit interval of inputs from heterogeneous suppliers in the presence of iceberg trade costs and fixed matching costs that rise with the discrete number of suppliers. Once a buyer has chosen its suppliers, they engage in Bertrand competition for the buyer's demand, and set buyer-specific markups. The buyer then receives match-specific cost shocks, and allocates input purchases among suppliers. To build intuition, we first consider a one-country world and then extend the framework to multiple countries with national strategic supplier competition.

The key mechanism in the model is the interaction between network formation and imperfect competition. At a higher fixed cost, a firm can match with more suppliers, and benefit from both better matches for each input (due to cost shocks) and lower input markups (due to tougher supplier competition). This interplay amplifies firm heterogeneity, generates endogenous two-sided market power, and gives rise to input price discrimination. More productive firms optimally source from more suppliers, which endogenously lowers their input costs and raises their sales and profits. More productive sellers supply more buyers, with each supplier charging its less productive, less diversified buyers higher markups.

The model highlights novel effects of industrial and trade reforms across borders. Industrial policy that triggers entry upstream in one country benefits sufficiently productive manufacturers worldwide: Firms above a productivity threshold add more suppliers to enjoy lower input costs and higher sales and profits. By contrast, tariff liberalization and trade promotion that reduce iceberg and matching costs, respectively, enable mid-productivity buyers to tap more suppliers. While profits rise for all buyers, those that expand suppliers gain more. Sourcing interdependence across countries always acts as an amplification force, as unilateral or bilateral reforms induce firms to broaden their supplier portfolio in third countries as well.

We next provide empirical evidence for the model using production and customs data for China, Chile, and France over 2000-2006. We examine how the dramatic, exogenous expansion in Chinese firm entry and export capacity affected downstream producers in Chile and France—two economies that differ in size, development, and GVC position. Raw data patterns are consistent with the model: As expected, firm networks are sparse, and the market for Chinese inputs features high but declining concentration. Notably, suppliers serving more buyers vary prices more across buyers, while buyers with more suppliers pay lower input prices.[2]

Our reduced-form analysis establishes how the import price, quantity, value, and (for Chile) suppliers of Chilean and French firms respond to the number of upstream Chinese suppliers, by HS 6-digit product and year. Our identification strategy exploits the importance of Chinese

[2]Some of these patterns echo prior evidence in Atkeson and Burstein (2008), Mayer et al. (2014), Edmond et al. (2015), Fontaine et al. (2020), and Burstein et al. (2024).

inputs to Chilean and French firms and, conversely, the insignificance of the Chilean and French markets to China. Guided by our theory, we proxy the set of potential Chinese suppliers with the number of Chinese exporters to the Rest Of the World (ROW). We also provide complementary evidence based on the actual number of Chinese exporters to Chile or France, which we instrument using the number of Chinese exporters to ROW or to comparable markets (Pacific Alliance for Chile, USA for France).

Two sets of results reveal that supplier entry upstream and buyer heterogeneity downstream shape global production networks in line with the model's predictions. First, 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 findings 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 or multinational suppliers. The patterns hold controlling for import tariffs and various aspects of the market structure downstream.

Second, Chinese suppliers price discriminate across Chilean buyers, and offer lower prices for the same product to buyers that source it from more Chinese sellers. This result obtains in specifications that account for suppliers' marginal cost and quality with supplier-product-year fixed effects and for downstream demand with buyer-product fixed effects. While the first set of results above could theoretically arise from endogenous networks with or without strategic pricing, this second evidence provides direct support for imperfect supplier competition.[3]

Finally, we quantify the model and perform policy counterfactuals. We conduct the analysis for Chile and five regions that reflect its trade structure: Latin America, USA, Europe, China, and ROW. We first estimate elasticity parameters and firm cost distributions based on structural pricing equations in the model. We then estimate aggregate demand and matching costs with the simulated method of moments (SMM). We build on recent methods for high-dimensional models to accommodate the computationally demanding network formation and strategic pricing in our context. We adapt the bounding algorithm for binary discrete-choice problems in Arkolakis et al. (2023a) to a multinomial discrete-choice problem, without transforming it into a series of pairwise binary choices. This approach exploits the model structure, whereby sequential matching by supplier productivity simplifies buyer sourcing interdependence. Moreover, we decouple the solution to suppliers' buyer-specific pricing games from the network formation

[3] Several data patterns support the model assumption of national supplier competition, and indicate a limited role for cross-country strategic interactions among suppliers in our context. The vast majority of firms sourcing from China do not buy the same product from ROW. For those that do, the number of potential Chinese suppliers affects the price, quantity and value of imports from China, but not from ROW. Moreover, the number of actual Chinese (ROW) suppliers to a Chilean buyer does not move the prices of ROW (Chinese) suppliers to that buyer.

problem, based on the model result that prices depend only on the set of suppliers.

We evaluate several policy counterfactuals that illustrate how the interaction of endogenous production networks and imperfect supplier competition governs policy impact. To this end, we compare policy effects in the baseline model to alternatives that shut down endogenous firm matching or supplier markups. We consider entry upstream, matching cost reductions, and trade cost cuts—corresponding to policies that lower barriers to firm entry, buyer-supplier matching, and cross-border transactions, respectively. We benchmark the magnitude of these shocks to the rise in Chinese suppliers to Chile over 2000-2006 and the average tariff cut under the Chile-China PTA in 2006. We also study deep trade agreements that combine tariff liberalization with competition policy (entry upstream) or trade promotion (cheaper matching), motivated by the objectives of the Chile-China PTA and the CPTPP that includes Chile.[4]

We draw three conclusions. First, entry upstream, lower trade costs, and lower matching costs can each boost buyers' performance by inducing them to expand their supplier base, intensify supplier competition, and reduce input costs. However, upstream entry benefits only high-productivity firms, whereas reductions in trade or matching costs benefit all buyers but primarily mid-productivity firms. Second, the interplay between endogenous firm networks and strategic supplier pricing amplifies the welfare gains from policies that increase the availability or reduce the cost of matching with suppliers. Fixing the network prevents firms from re-optimizing suppliers, while constant markups eliminate pro-competitive savings from adding suppliers. The consumer gains from upstream entry or match facilitation in the unrestricted baseline model are more than twice as large as in the restricted alternatives. Third, deep agreements that combine tariff liberalization with competition policy or trade promotion generate substantially bigger welfare gains than shallow trade reforms, again reflecting the interaction of endogenous firm links and supplier markups.

We contribute to the burgeoning literature on the determinants and consequences of global production networks. Early studies emphasized the benefits of foreign input sourcing for downstream firms' productivity, product quality, innovation, and profitability, while abstracting from the identity and behavior 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 (Chaney, 2014; Bernard and Moxnes, 2018; Lim, 2018; Oberfield, 2018; Bernard et al., 2018, 2019; Panigrahi, 2021; Bernard et al.,

[4]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, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) explicitly includes chapters on competition policy and state-owned enterprises (Maggi and Ossa, 2021).

2022; Eaton et al., 2022; Kramarz et al., 2022; Fontaine et al., 2023; Demir et al., 2024a).

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 within *fixed* production networks (Morlacco, 2020; Dhyne et al., 2022; Alviarez et al., 2023; Burstein et al., 2024; Ignatenko, 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, that is, the intensive margin of firm-to-firm transactions. By contrast, we study imperfect competition in *endogenous* networks with matching frictions. We demonstrate that the extensive margin of firm connections gives rise to endogenous two-sided market power, and amplifies the aggregate and distributional effects of policy interventions.

The second emerging stream of research explores the welfare implications of global production networks.[5] For instance, 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 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—within a unified framework that allows us to analyze both stand-alone and package reforms. We further show that gains from trade arise from the interaction between endogenous networks and imperfect competition.[6,7]

More broadly, we speak to how micro features of production networks shape macro outcomes. Prior work indicates that firm links and supplier characteristics contribute to the large and growing firm size dispersion (Sutton, 2007; Bernard et al., 2022). We show that the interaction of endogenous networks and imperfect competition further amplifies firm heterogeneity. Separately, asymmetric production networks have been found to generate both higher growth and 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,

[5]This builds on canonical computable general equilibrium or quantitative trade models that evaluate trade policy without production networks, firm granularity, or market power (Costinot and Rodríguez-Clare, 2014).

[6]Another contribution is to show that the combination of (i) two-sided firm heterogeneity, (ii) endogenous firm links, and (iii) imperfect supplier competition is necessary and sufficient to generate key policy effects and data patterns. On necessity, models without (i) or (ii) cannot account for the variation in network activity across firms. Models that feature (i) and (ii) but omit (iii) rule out price discrimination across buyers within suppliers. In turn, models that combine (i) and (iii) without (ii) feature match-specific markups, but cannot speak to important policy shocks: Fixed networks shut down the effects of industrial policies that lower entry barriers and of deep integration or trade promotion that reduce matching costs. On sufficiency, ours is the first within a potential class of models that can accommodate (i), (ii) and (iii), yet remain tractable and parsimonious.

[7]We also add to the active literature on combinatorial discrete-choice problems. Prior work has developed solution methods for settings with binary complementary choices (Jia, 2008; Antràs et al., 2017), binary substitutable choices (Arkolakis et al., 2023a), and both types of interdependence (Castro-Vincenzi et al., 2025). Recent work also explores commercial solver and machine learning alternatives (Head et al., 2024; Kulesza, 2024). We adapt Arkolakis et al. (2023a) to *multinomial* discrete choice, exploiting model restrictions on the matching process.

2020; Acemoglu and Tahbaz-Salehi, 2024), while production linkages mediate shock propagation and business cycle co-movement across 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 reinforce these mechanisms.

The paper is organized as follows. Section 2 presents the model of global sourcing with endogenous network formation and oligopolistic competition upstream. Section 3 introduces the data and institutional context for France, Chile, and China. Section 4 provides reduced-form empirical evidence for the model's predictions. Section 5 develops the estimation strategy, and performs counterfactual analyses. The last section concludes.

2 Theoretical Framework

We develop a quantifiable model of global sourcing, in which heterogeneous buyers match with oligopolistically competitive heterogeneous suppliers in the presence of trade and matching costs. We first examine how endogenous network formation and imperfect competition interact to shape sourcing outcomes and firm performance in a one-country world. We also study the impact of upstream entry, matching frictions, and trade costs. We then extend the model to multiple countries, to guide the subsequent empirical analysis, model quantification, and counterfactual exercises. Detailed proofs are relegated to Appendix A.

2.1 Setup

Final demand Consider an economy with Cobb-Douglas consumer preferences over homogeneous and differentiated goods. The wage w is pinned down by constant-returns-to-scale production of the homogeneous good. Consumers exhibit CES preferences for available varieties $\omega \in \Omega$ of the differentiated final good:

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

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 and ideal price index P for differentiated goods, demand for variety ω with price $p(\omega)$ is:

$$q(\omega) = EP^{\sigma-1}p(\omega)^{-\sigma}. \tag{1}$$

Final producers A continuum of monopolistically competitive downstream firms ("buyers") produce differentiated final goods with productivity φ, drawn from distribution $G(\varphi)$ with support $[\underline{\varphi}, \infty)$ (Melitz, 2003; Chaney, 2008).[8] Each firm assembles a unit interval of differentiated inputs under CES production technology. We fix the measure of input varieties to one as in Antràs et al. (2017), to shut down input variety gains from adding suppliers and isolate the role of imperfect competition and matching frictions. The marginal cost of producer φ is thus:

$$c(\varphi) = \frac{1}{\varphi} \left(\int_0^1 z\left(\varphi, v\right)^{1-\lambda} dv \right)^{\frac{1}{1-\lambda}}, \tag{2}$$

where $z(\varphi, v)$ is the unit cost of input v to firm φ, and $\lambda > 1$ is the elasticity of substitution across inputs.

Final producers choose a discrete set of upstream firms ("suppliers") $\mathcal{S}(\varphi)$, and determine which input variety to source from which supplier. Each supplier s is capable of delivering any input variety within the unit interval to buyer φ at cost $z_s(\varphi, v)$, which reflects its potentially buyer-specific price $p_s(\varphi)$, an iceberg trade cost $\tau \geq 1$, and a match-specific cost shock $\xi_s(\varphi, v)$:

$$z_s(\varphi, v) = \tau \cdot p_s(\varphi) \cdot \xi_s(\varphi, v). \tag{3}$$

The shock $\xi_s(\varphi, v)$ arrives after the buyer has matched with supplier s and observed its price $p_s(\varphi)$. It can be seen as the cost to the buyer of adapting an input to its production process, or as the cost equivalent of a quality defect. This match-specific shock will imply that buyers with the same portfolio of suppliers may select different suppliers for the same input variety. We assume that $1/\xi_s(\varphi, v)$ is Fréchet distributed, $\Pr(\xi_s(\varphi, v) \geq t) = e^{-t^{\theta}}$, where a larger shape parameter θ corresponds to less shock dispersion and higher substitutability across suppliers.

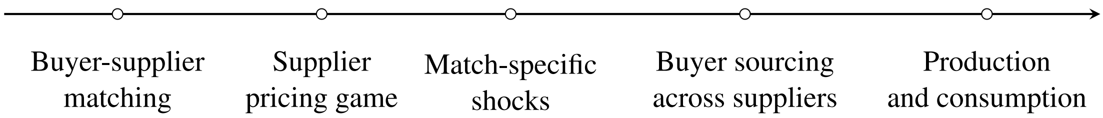
Upstream suppliers A discrete number S of upstream suppliers s produce input varieties with constant marginal cost c_s. The input sector features imperfect competition, whereby suppliers matched to a given buyer compete oligopolistically amongst themselves. Suppliers thus engage in a series of buyer-specific pricing games, and can vary prices $p_s(\varphi)$ across buyers φ.[9]

Buyer-supplier matching Final producers incur fixed matching and sourcing costs $wf(S)$ that increase with their chosen number of suppliers, $f(S) > f(S-1) > \cdots > f(1) > 0$. We assume that buyers match with suppliers in increasing order of marginal cost, such that matching with S' partners implies sourcing inputs from the top S' most productive suppliers. Therefore, the problem of choosing a supplier set $\mathcal{S}(\varphi)$ reduces to choosing the number of suppliers $S(\varphi)$. This will ensure a unique matching equilibrium and grant significant tractability:

[8] We abstract away from free entry upstream and downstream, since it is not necessary to characterize the interaction between network formation and imperfect competition.

[9] In the spirit of Neary (2016), 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.

Figure 1: Timeline of events



With S suppliers, each buyer has to evaluate only $S + 1$ potential sourcing strategies instead of a high-dimensional 2^S choice set. This assumption underlies the solution concepts in Atkeson and Burstein (2008), Eaton et al. (2012), and Gaubert and Itskhoki (2021), and can be rationalized as the equilibrium of a matching game in which suppliers also pay a higher fixed cost to meet and transact with more buyers. Moreover, the implied hierarchical pattern is consistent with empirical evidence, for instance in Bernard et al. (2019).

Timeline Figure 1 summarizes the structure of the model and the timing of events. First, buyers choose their set of suppliers $\mathcal{S}(\varphi)$, which determines the extensive margin of the production network. Second, suppliers engage in buyer-specific Bertrand pricing games, and post their buyer-specific prices $p_s(\varphi)$; this is the price at which a given supplier can in principle provide any input in the unit interval to a given buyer. Third, match-specific cost shocks $\xi_s(\varphi, v)$ are realized. Fourth, buyers decide how to allocate their input purchases across suppliers, i.e., which input to obtain from which provider and in what quantity. Lastly, buyers produce final goods, and market them to consumers.

2.2 Solution

We solve the model via backward induction, where firm decisions at any given stage internalize optimal firm behavior in subsequent stages.

Production In the last stage, final producers optimally set a constant markup above their marginal production cost $c(\varphi)$ to maximize profits given CES demand (1):

$$p(\varphi) = \frac{\sigma}{\sigma - 1} c(\varphi). \tag{4}$$

Buyer sourcing across suppliers In the penultimate stage, buyers have already fixed their supplier portfolio and observed supplier prices and match-specific cost shocks. Their profit maximization problem therefore reduces to minimizing their marginal production cost. Buyer φ optimally purchases input v from the lowest-cost provider among its suppliers $\mathcal{S}(\varphi)$:

$$z(\varphi, v) = \min_{s \in \mathcal{S}(\varphi)} \left\{ \tau \cdot p_s(\varphi) \cdot \xi_s(\varphi, v) \right\}. \tag{5}$$

Exploiting the properties of the Fréchet distribution, the probability that s is the lowest-cost supplier of input v to buyer φ is:

$$\chi_s(\varphi) = \frac{p_s(\varphi)^{-\theta}}{\sum_{s'=1}^{S(\varphi)} p_{s'}(\varphi)^{-\theta}}. \tag{6}$$

With a continuum of input varieties and i.i.d. cost shocks across matches, the law of large numbers implies that $\chi_s(\varphi)$ is also the share of supplier s in the buyer's input expenditure.

A buyer's marginal cost $c(\varphi)$, input cost index $\Phi(\varphi) \equiv c(\varphi)\varphi$, total input costs $X(\varphi)$, and demand for inputs $Q(\varphi)$ can therefore be expressed as:

$$c(\varphi) = \frac{\gamma\tau}{\varphi}\left[\sum\nolimits_{s=1}^{S(\varphi)} p_s(\varphi)^{-\theta}\right]^{-1/\theta}, \qquad \Phi(\varphi) \equiv c(\varphi)\varphi, \tag{7}$$

$$Q(\varphi) = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} EP^{\sigma-1}c(\varphi)^{-\sigma}, \tag{8}$$

$$X(\varphi) = Q(\varphi)c(\varphi) = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} EP^{\sigma-1}c(\varphi)^{1-\sigma}, \tag{9}$$

where $\gamma = \left[\Gamma\left(\frac{\theta+1-\lambda}{\theta}\right)\right]^{\frac{1}{\lambda-1}}$ is a constant given by the gamma function $\Gamma(\cdot)$.[10]

Supplier pricing game Oligopolistically competitive suppliers engage in Bertrand competition once all buyer-supplier links have been formed. At this stage, supplier s has expected residual demand $Q_s(\varphi) = Q(\varphi)\chi_s(\varphi)$ by buyer type φ. Since suppliers face no capacity constraints or matching costs, they make independent sales decisions across buyers, and choose the optimal price that maximizes profits from each relationship:

$$\max_{p_s(\varphi)} \pi_s^U(\varphi) = Q(\varphi)\chi_s(\varphi)(p_s(\varphi) - c_s). \tag{10}$$

While a higher price boosts a supplier's profit margin, $p_s(\varphi) - c_s$, it reduces its market share $\chi_s(\varphi)$ and residual demand $Q(\varphi)$ by raising the buyer's marginal cost $c(\varphi)$.

Solving the differentiated Bertrand game, suppliers optimally price discriminate and charge buyer-specific markups $\mu_s(\varphi)$:

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

$$p_s(\varphi) = \frac{\varepsilon_s(\varphi)}{\varepsilon_s(\varphi) - 1} c_s, \tag{11}$$

where $\varepsilon_s(\varphi) = \sigma\chi_s(\varphi) + \theta\left[1 - \chi_s(\varphi)\right]$ is the elasticity of residual demand.

[10] Per Eaton and Kortum (2002), we need $\lambda < \theta + 1$ for a well-defined price index; λ affects results only via γ.

Suppliers have more market power and set higher markups $\mu_s(\varphi) = \varepsilon_s(\varphi)/(\varepsilon_s(\varphi) - 1)$ when they have a larger market share in the buyer's input basket, provided that $\theta > \sigma$.[11, 12] This implies that downstream firms with more diversified sourcing enjoy lower input markups. Because $\partial\mu_s(\varphi)/\partial\sigma = -\chi_s(\varphi)/(\varepsilon_s(\varphi) - 1)^2 < 0$, suppliers also charge higher markups when buyers face less elastic final demand (lower σ), and can therefore more easily pass on input markups to final consumers.

Buyer-supplier matching In the first stage, final producers choose how many suppliers to transact with. Each firm φ anticipates the implications of its supplier portfolio for input price setting. Given that each firm matches with suppliers in increasing order of suppliers' marginal cost, it selects the optimal number of suppliers $S(\varphi)$ that maximizes profits, taking into account its resultant marginal cost $c(\varphi)$ and the final demand shifter $B = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} EP^{\sigma-1}$:

$$\max_{S(\varphi)\in\{0,1,2,\ldots,S\}} \pi^D(\varphi) = Bc(\varphi)^{1-\sigma} - wf(S(\varphi)), \tag{12}$$

where the firm exits the market if $S(\varphi) = 0$.

Buyers' choice of suppliers constitutes the endogenous network formation. It is a combinatorial, multinomial, discrete-choice problem without a closed-form solution. We can nevertheless characterize key properties of firms' optimal sourcing strategy.

We first establish how the number of suppliers affects a firm's production costs:

Proposition 2 *If $\theta > \sigma$, sourcing from more suppliers lowers the buyer's:*
(a) supplier-specific input cost shares $\chi_s(\varphi)$, markups $\mu_s(\varphi)$, and prices $p_s(\varphi)$;
(b) marginal cost $c(\varphi)$, and input cost index $\Phi(\varphi)$.

The effects of a broader supplier portfolio operate through three channels. First, a higher $S(\varphi)$ intensifies competition among matched suppliers, lowering their individual market shares in the buyer's input basket, and inducing them to reduce markups and prices. Second, a higher $S(\varphi)$ presents the buyer with more draws of match-specific cost shocks at the supplier-input variety level across the unit interval of input varieties. This increases the probability of finding a lower-cost supplier for each input variety. These two forces outweigh a third one, namely

[11] In Appendix B, we show that $\partial\mu_s(\varphi)/\partial\chi_s(\varphi) = (\theta - \sigma)/(\varepsilon_s(\varphi) - 1)^2$, and $\theta > \sigma$ implies strategic complementarity in pricing among upstream firms. Intuitively, if one supplier were to raise its input price, this would affect other suppliers' optimal markup through two channels. On the one hand, input substitutability across suppliers would tend to raise demand for other suppliers' inputs, incentivizing them to charge higher markups. On the other hand, the buyer's overall input costs would tend to rise, reducing final consumer demand and the buyer's input demand for all suppliers; this would induce suppliers to charge lower markups. The former effect dominates when θ is high (i.e. high input substitutability) relative to σ (i.e. final demand elasticity). This restriction and the implied behavior of markups are consistent with evidence in Amiti et al. (2019) and Dhyne et al. (2022).

[12] The pricing game reduces to classic Bertrand competition with $p_s(\varphi) = c_s$ if $\theta \to \infty$ or if there are no match-specific shocks, and to monopolistic competition with constant markup $\theta/(\theta - 1)$ without discrete suppliers.

the addition of less productive suppliers when $S(\varphi)$ expands. Of note, endogenous network formation would trigger only the latter two forces if suppliers charged constant markups. The combination of matching frictions and imperfect supplier competition thus generates the results for input markups and prices in Proposition 2a, and augments all other effects in Proposition 2.

Downstream producers thus face a trade-off when determining their optimal sourcing strategy: growing their supplier base lowers marginal input costs, but necessitates higher fixed matching costs. Since more productive firms expect higher sales all else constant, they endogenously choose to source inputs from more suppliers:[13]

Proposition 3 *Given $\theta > \sigma$, buyers' optimal sourcing strategy is such that:*
(a) the set of suppliers $\mathcal{S}(\varphi)$ is non-contracting in buyer productivity φ;
(b) the marginal cost $c(\varphi)$ and input cost index $\Phi(\varphi)$ are decreasing in buyer productivity φ.

The interaction of endogenous network formation and oligopolistic competition upstream amplifies the inherent cost advantage of more efficient firms downstream.[14] Moreover, while matching frictions alone would deliver the patterns in Proposition 3, their interaction with imperfect supplier competition augments these effects: Adding suppliers reduces buyers' input cost index even with constant input markups because of match-specific cost shocks, but the prospect of lower input markups reinforces the incentive to expand their supplier portfolio. This gives rise to endogenous two-sided market power. More productive suppliers are able to capture a bigger share of buyer's input purchases and charge higher markups than less productive suppliers (from Proposition 1 and equation (6)). At the same time, more productive buyers are able to match with more suppliers than less productive buyers, and enjoy lower input markups due to the tougher supplier competition (from Propositions 2 and 3). Market power thus endogenously varies both across buyers within suppliers and across suppliers within buyers.

Input purchases and final demand Having determined buyers' optimal set of suppliers and sourcing allocation across matched suppliers, we complete the characterization of the model equilibrium by specifying firms' total and bilateral input purchases, $X(\varphi)$ and $X_s(\varphi)$:

$$X(\varphi) = \gamma^{1-\sigma}(\sigma-1)B\varphi^{\sigma-1}\tau^{1-\sigma}\left[\sum_{s=1}^{S(\varphi)} p_s(\varphi)^{-\theta}\right]^{\frac{\sigma-1}{\theta}}, \qquad X_s(\varphi) = \chi_s(\varphi)X(\varphi). \tag{13}$$

Despite the presence of endogenous network formation and imperfect competition, the model remains tractable, and delivers gravity relationships for trade flows at the firm level. Firms'

[13]The model is thus consistent with observed negative degree assortativity among buyers and suppliers (Bernard and Moxnes, 2018; Bernard et al., 2022): More productive buyers source from a broader set of progressively less productive suppliers, and more productive suppliers serve a wider range of progressively less productive buyers.

[14]This aligns with evidence on the role of production networks for firm size dispersion (Bernard et al., 2022).

input expenditures rise with final demand B and firm productivity φ (both directly and through lower input prices), and fall with iceberg trade costs τ. Implicitly, $X(\varphi)$ increases with the endogenous choice of suppliers $S(\varphi)$ directly, as well as indirectly through lower input markups $\mu_s(\varphi)$ and marginal cost $c(\varphi)$.[15]

Lastly, the final demand shifter B captures aggregate downstream demand conditions, including total expenditure and the price index. We follow Antràs et al. (2017), and treat it as an exogenous parameter from the perspective of downstream buyers. This allows us to isolate the firm-level response to shifts in the upstream input market from downstream feedback effects.

2.3 Comparative Statics

The model allows us to characterize the impact of three relevant shocks on network formation and firm outcomes: upstream supplier entry, trade cost reduction, and matching cost reduction. We later empirically evaluate the comparative statics with respect to supplier entry, and quantify all three policy shocks in counterfactual analyses.

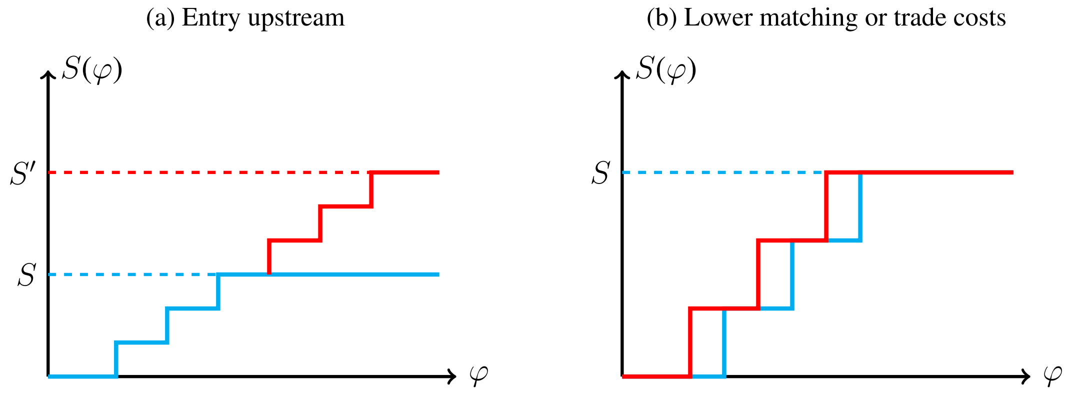
We first consider an exogenous increase in the number of potential suppliers from S to S', where entry occurs from the left tail of the productivity distribution. This could, for example, be triggered by industrial policy that lowers entry costs upstream. Buyers now have the opportunity to expand their supplier set in order to benefit from lower input costs. However, only sufficiently productive buyers would find it profitable to do so due to the higher associated matching costs:

Proposition 4 *Given $\theta > \sigma$ and final demand B, a rise in the number of potential suppliers S:*
(a) weakly expands buyers' sourcing strategy $\mathcal{S}(\varphi)$;
(b) weakly reduces buyers' marginal cost $c(\varphi)$ and input cost index $\Phi(\varphi)$;
(c) weakly increases buyers' input quantity $Q(\varphi)$, input purchases $X(\varphi)$, revenues, and profits;
(d) exerts bigger effects on more productive buyers.

Figure 2a visualizes the impact of entry upstream on sourcing downstream. It illustrates how the optimal supplier set is a step function of buyer productivity (Proposition 3), in the case when the most efficient buyers have initially matched with all potential suppliers S. Supplier entry results in this step function getting taller: Low-productivity firms do not adjust their sourcing strategy, as their revenue gains from lower input costs would not justify the higher matching

[15] The model accommodates observed positive assortativity among buyers and suppliers on the intensive margin (Benguria, 2021; Bernard and Moxnes, 2018; Sugita et al., 2023). As we show in Appendix C, firm-to-firm sales $X_s(\varphi)$ increase with supplier productivity, as lower marginal costs c_s attract more buyer demand. How $X_s(\varphi)$ varies with buyer productivity is ambiguous. On the one hand, more productive buyers face higher final demand and need more inputs; this scale effect is amplified by their endogenously lower input costs. On the other hand, more productive buyers source from more suppliers, and this competition effect reduces input demand per supplier.

Figure 2: Firm Productivity and # Suppliers: Comparative Statics



costs. Sufficiently productive firms instead expand their supplier portfolio despite higher matching costs, because they enjoy lower input costs and higher revenues and profits. Upstream entry thus amplifies performance dispersion between high- and low-productivity firms.

Second, we study the impact of lower buyer-supplier matching costs. This might, for instance, result from trade promotion or facilitation in a domestic or international context. Lower matching costs would reduce the minimum productivity threshold that justifies sourcing from any given number of suppliers, represented by the step function shifting left in Figure 2b. If the most productive buyers had already tapped all potential suppliers, buyers in the middle of the productivity distribution might be induced to grow their supplier base. Nevertheless, lower matching costs increase profits for all buyers: directly for those that do not add suppliers, and both directly and (by revealed preference) indirectly through lower input costs for those that do.

Finally, we analyze reforms that reduce iceberg trade costs τ, such as infrastructure development or tariff liberalization in a domestic or international setting. As with a fall in matching frictions, lower trade costs too would reduce the buyer productivity cut-offs that warrant any number of suppliers in Figure 2b, and some mid-productivity firms would enlarge their supplier set. Profits would now rise for all input buyers through lower input costs on incumbent purchases, and (by revealed preference) even more so for those that add more suppliers.

Proposition 5 *Given $\theta > \sigma$ and final demand B, a reduction in matching costs $f(S)$ or trade costs τ:*
(a) weakly expands buyers' sourcing strategy $\mathcal{S}(\varphi)$;
(b) weakly reduces buyers' marginal cost $c(\varphi)$ and input cost index $\Phi(\varphi)$;
(c) weakly increases buyers' input quantity $Q(\varphi)$, input purchases $X(\varphi)$, revenues, and profits;
(d) exerts bigger effects on mid-productivity buyers.

In sum, the interaction between imperfect supplier competition and endogenous network formation amplifies the effects of entry upstream, trade cost reductions, and matching cost cuts in Propositions 4 and 5 that would otherwise arise in endogenous buyer-supplier networks with constant input markups, or in fixed networks with variable markups.

2.4 Multi-Country Model

We next extend the model to multiple countries J, and study how oligopolistic competition among input suppliers interacts with endogenous link formation in global production networks. This facilitates the mapping between theory and empirics in Section 4, and enables richer counterfactual analysis in Section 5. We show that the main results from the single-country model intuitively apply to the multi-country setup, including the optimal sourcing strategy of heterogeneous buyers, the optimal buyer-specific pricing of heterogeneous suppliers, and the effects of country-specific policy shocks. In addition, sourcing complementarity across countries generates cross-country spillovers and thereby amplifies the effects of bilateral policies.

Each country is home to consumers, final-good producers, and input suppliers. Differentiated final goods are consumed locally, while the homogeneous outside good is freely tradable across countries and pins down wages in each location.[16]

Final producers in country i can source inputs globally, and inputs are Armington differentiated across countries. They produce with a two-tiered CES technology, where the inner tier aggregates the unit interval of input varieties from a given origin j (as in the one-country model), and the outer tier aggregates across origins:

$$c_i(\varphi) = \frac{1}{\varphi}\left(\sum_{j=1}^{J} I_{ij}(\varphi)c_{ij}(\varphi)^{1-\eta}\right)^{\frac{1}{1-\eta}}, \quad c_{ij}(\varphi) = \left(\int_0^1 z_{ij}\left(\varphi, v\right)^{1-\lambda} dv\right)^{\frac{1}{1-\lambda}}. \tag{14}$$

Here, $I_{ij}(\varphi)$ indicates whether firm φ from country i buys inputs from country j, and $\eta > 1$ is the Armington elasticity of substitution across origins. The composite cost index $c_{ij}(\varphi)$ aggregates the cost of input varieties v from origin j to producer φ, $z_{ij}(\varphi, v)$, which includes origin-specific iceberg trade costs τ_{ij}. Conditional on sourcing from j, a buyer that pays fixed cost $f_{ij}(S_{ij})$ to match with S_{ij} origin-j suppliers would choose the cheapest among them for each input variety, after observing all match-specific cost shocks.

Intuitively, this setup treats intermediates from different countries as imperfectly substitutable input categories. For each of these input categories, buyers face the same sourcing problem as in Section 2.2. Moreover, suppliers from different countries interact only through

[16] The multi-country model assumptions closely follow Antràs et al. (2017), so that the model would collapse to theirs without matching frictions and imperfect competition among suppliers.

their impact on the buyer's input cost index and input substitutability across markets, rather than through direct cross-border strategic competition. This assumption grants tractability, and is consistent with empirical evidence in Section 4.5.

We solve the multi-country model via backward induction, following the same steps as in the single-country baseline, and adding country subscripts as necessary for clarity.

The last two stages remain unchanged: Final producers in country i set a constant markup above marginal cost as in equation (4), and face the same cost minimization problem across suppliers s from origin j as in equation (5). Buyers' optimal allocation of input purchases across origin-j suppliers $\chi_{ijs}(\varphi)$ is therefore similarly given by:

$$\chi_{ijs}(\varphi) = \frac{p_{ijs}(\varphi)^{-\theta}}{\sum_{s'=1}^{S_{ij}(\varphi)} p_{ijs'}(\varphi)^{-\theta}}. \tag{15}$$

For buyer φ from country i, the sourcing value $X_{ij}(\varphi)$, cost index $c_{ij}(\varphi)$, and quantity $Q_{ij}(\varphi)$ of j input varieties can be expressed as:

$$X_{ij}(\varphi) = X_i(\varphi)\delta_{ij}(\varphi), \tag{16}$$

$$c_{ij}(\varphi) = \gamma\tau_{ij}\left[\sum\nolimits_{s=1}^{S_{ij}(\varphi)} p_{ijs}(\varphi)^{-\theta}\right]^{-1/\theta}, \tag{17}$$

$$Q_{ij}(\varphi) = X_{ij}(\varphi)/c_{ij}(\varphi), \tag{18}$$

where $\delta_{ij}(\varphi) = c_{ij}(\varphi)^{1-\eta}/\sum_{k=1}^{J} I_{ik}(\varphi)c_{ik}(\varphi)^{1-\eta}$ is the share of country j in buyer φ's total input purchases, $X_i(\varphi)$, given by equation (9).

Turning to suppliers' pricing game, country-j suppliers to buyer φ engage in Bertrand competition, and each supplier sets match-specific markups. However, the elasticity of residual demand for j input varieties now reflects not only final demand elasticity σ as in the one-country world, but also the input elasticity of substitution in production across origins, η:

Proposition 6 *There exists a unique Nash Equilibrium with supplier s prices*

$$p_{ijs}(\varphi) = \frac{\varepsilon_{ijs}(\varphi)}{\varepsilon_{ijs}(\varphi) - 1} c_{js}, \tag{19}$$

where $\varepsilon_{ijs}(\varphi) = \left[\sigma\delta_{ij}(\varphi) + \eta\left(1 - \delta_{ij}(\varphi)\right)\right]\chi_{ijs}(\varphi) + \theta\left[1 - \chi_{ijs}(\varphi)\right]$ is the elasticity of residual demand.

Note that if a buyer sources from a single origin ($\delta_{ij}(\varphi) = 1$), prices behave as in Proposition 1. With multi-country sourcing ($\delta_{ij}(\varphi) < 1$), suppliers likewise set higher markups when they have a bigger market share in the buyer's input basket, provided that $\theta > \sigma\delta_{ij}(\varphi) + \eta(1 -$

$\delta_{ij}(\varphi)$), that is, the elasticity of input substitution among suppliers (θ) is sufficiently large compared to the weighted average of the elasticities of input substitution across countries (η) and across final goods in consumption (σ).[17]

Lastly, buyers' profit maximization problem pins down their choice of origins to source from, $I_{ij}(\varphi)$, and the number of suppliers to tap in each activated origin, $S_{ij}(\varphi)$:

$$\max_{\substack{I_{ij}(\varphi)\in\{0,1\}_{j=1}^{J} \\ S_{ij}(\varphi)\in\{1,2,\ldots,S_j\}_{j=1}^{J}}} \quad \pi_i^D(\varphi) = B_i c_i(\varphi)^{1-\sigma} - \sum_{j=1}^{J} I_{ij}(\varphi) w_i f_{ij}(S_{ij}(\varphi)), \tag{20}$$

$$c_i(\varphi) = \frac{\gamma}{\varphi}\left\{\sum_{j=1}^{J} I_{ij}(\varphi)\tau_{ij}^{1-\eta}\left[\sum\nolimits_{s=1}^{S_{ij}(\varphi)} p_{ijs}(\varphi)^{-\theta}\right]^{-\frac{1-\eta}{\theta}}\right\}^{\frac{1}{1-\eta}}.$$

As before, there is no closed-form solution to the buyer's global sourcing problem, but we show that the results naturally extend from the single-country case. As long as final goods are more substitutable in consumption than intermediates in production ($\sigma > \eta$), and buyers' demand elasticities decrease with supplier's cost share ($\theta > \sigma\delta_{ij}(\varphi) + \eta(1-\delta_{ij}(\varphi))$), more productive buyers still optimally source from more suppliers within any given country, and also source from more countries. These conditions reflect the forces that guarantee sourcing complementarity across origins, as in Antràs et al. (2017), while incorporating the pro-competitive forces across suppliers in the same origin.

Finally, in terms of comparative statics, the multi-country setup amplifies the results from the single-location case, because buyers have an additional incentive to add suppliers. Upstream entry in one origin, for example, can induce buyers to expand suppliers from all origins due to sourcing complementarity. Reductions in bilateral matching or variable trade costs can likewise trigger complementary expansion in sourcing activity worldwide.

The following proposition formalizes these results for the multi-country setting:

Proposition 7 *As long as $\sigma > \eta$ and $\theta > \sigma\delta_{ij}(\varphi) + \eta(1-\delta_{ij}(\varphi))$:*
(a) Proposition 3 holds for both buyers' bilateral and global sourcing strategy;
(b) Propositions 4-5 hold for bilateral shocks to supplier entry, matching costs, and trade costs.

To conclude, note that the assumption of national competition among a buyer's suppliers grants tractability and is consistent with empirical evidence presented in Section 4.5. In Appendix D, we consider instead global oligopolistic competition among all of a buyer's suppliers from all origins. The main insights with respect to buyers' optimal sourcing strategy, suppliers'

[17] In Appendix B, we show that $\partial\mu_{ijs}(\varphi)/\partial\chi_{ijs}(\varphi) = [\theta - \sigma\delta_{ij}(\varphi) - \eta(1-\delta_{ij}(\varphi))]/(\varepsilon_{ijs}(\varphi)-1)^2$, and $\theta > \sigma\delta_{ij}(\varphi) + \eta(1-\delta_{ij}(\varphi))$ implies strategic complementarity in upstream firm pricing; see also footnote 11.

optimal pricing, and the endogenous network properties are preserved. The effects of supplier entry in one origin on sourcing from that origin remain qualitatively unchanged, but may be amplified or dampened depending on where these entrants fall in the worldwide distribution of supplier marginal costs (adjusted for country-specific trade costs). The impact of bilateral reductions in trade or matching costs is likewise qualitatively the same, with magnitudes dependent on the distribution of supplier production costs across and within countries.

3 Data and Institutional Context

3.1 Institutional Context

We evaluate the empirical relevance of the model by examining the impact of the evolving market structure of upstream suppliers in China on the sourcing behavior of downstream firms in Chile and France over the 2000-2006 period. China experienced dramatic export growth after joining the World Trade Organization (WTO) in 2001, gradually relaxing various barriers to firm entry, developing trade-oriented special economic zones, and shoring up physical and institutional infrastructure. We view these developments as expanding the set of potential Chinese exporters. In turn, Chile and France exemplify economies with different market sizes, economic development, economic geography, and positions in global value chains. Finding consistent evidence across both can thus reveal the significance of the mechanisms of interest.

China-France and China-Chile trade relations at the turn of the century provide an ideal institutional context for identifying the causal effect of upstream entry on downstream sourcing. China was an increasingly important input supplier to French and Chilean producers, with its share of total imports almost 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 markets for Chinese exporters, with their respective market shares stable at around 1.4-1.5% and 0.2-0.3%. The expansion of Chinese export capacity over this period is thus arguably exogenous from the perspective of atomistic firms in Chile and France.

3.2 Data

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 customs agencies. In the case of Chile, these records also report the identity of the foreign supplier. For France, we use unique firm identifiers to match customs declarations to firms' accounting statements and main industry of activity from FICUS. For Chile, we observe the primary output industry of each firm and its size bin (out of 13 based on sales) from the tax authority.

For China, we access the universe of export transactions by firm, destination country and HS-8 product from the Chinese Customs Trade Statistics (CCTS), which we aggregate up to HS-6 products. CCTS provides additional information that we exploit in robustness checks. It lists 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. CCTS also distinguishes between processing and ordinary trade transactions, where the former entails exports produced on behalf of a foreign party with 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.

We also 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 will 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, $lmaxtariff_{pt} = \ln(1 + max\_rate/100)$; all results are robust to simple averages instead.[19]

3.3 Key Patterns

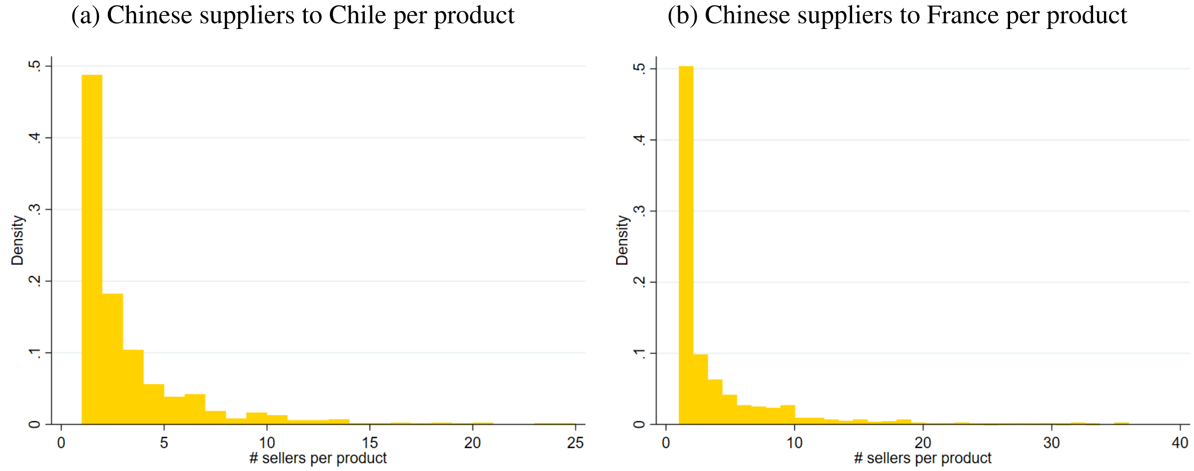
Upstream concentration and entry Figure 3 and Panel A in Appendix Table A1 demonstrate respectively the pervasive concentration in Chinese input markets at the start of the century and the dramatic trend in entry over time. In 2000, approximately 80% (65%) of all 6-digit products that Chile (France) imported from China were sold by fewer than 5 Chinese suppliers. In total, China exported 2,140 products to France, with 16.8 suppliers per product on average, and a median of 5. By 2006, this grew to 2,959 products from 37.6 suppliers on average and a median of 9. Similarly, the number of products China shipped to Chile expanded from 1,431 to 2,388 over this period, while the mean and median number of exporters per product jumped from 12.4 to 21.4 and from 5 to 7, respectively.

Two-sided firm heterogeneity Panel B in Appendix Table A1 shows how the composition of Chinese exporters evolved with rapid firm entry. China experienced secular productivity growth, with a steady increase in average value added per worker and measured TFP, and a rise in productivity dispersion. Average product quality remained stable, as proxied by firms' imported-

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

[19]Effectively applied EU tariffs on Chinese products fell from 3.9% to 2.8% on average (Appendix Table A1).

Figure 3: Concentration Upstream



Note: Histograms of the number of Chinese suppliers (a) to Chile and (b) to France per HS6 product, both in 2000.

input price index which we construct. Also relatively stable were the shares of Chinese exports mediated by trade intermediaries, multinational affiliates, or multi-product exporters. The share of processing trade declined from 36% to 26%.

Panel C in Appendix Table A1 overviews firm heterogeneity in Chile and France. Between 2000 and 2006, the number of producers sourcing inputs from China more than doubled from 12,571 to 25,737 in France and from 2,525 to 6,519 in Chile.

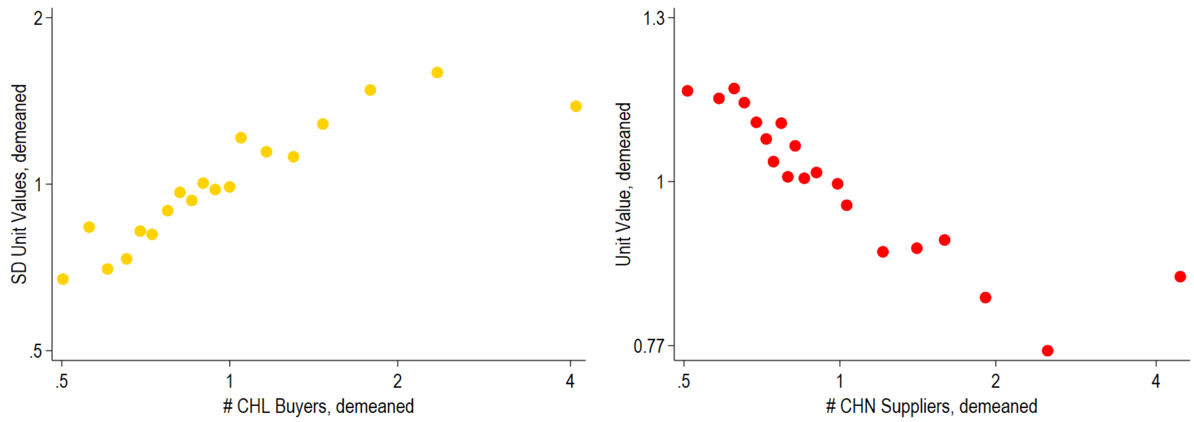
Sparse firm network The bi-partite network of upstream Chinese suppliers and downstream Chilean and French buyers is sparse with a minority of highly connected firms, consistent with prior evidence for other countries (e.g., Bernard and Zi, 2022). Appendix Figure A1 illustrates the skewed distribution of firm matches in 2000. 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. Panel D in Appendix Table A1 provides additional summary statistics for the network of Chinese supplier-Chilean buyer links at the start and end of the sample, i.e. in 2000 and 2006.

Firm links and prices Transaction prices vary significantly in the network of Chilean buyer-Chinese supplier relationships. We highlight three correlations in line with the theoretical predictions in Section 2 as motivation for the empirical analysis in Section 4.

First, more concentrated upstream markets are associated with higher input prices for downstream producers. Appendix Figure A3 presents a bin-scatter plot of the mean import price that Chilean firms pay for an HS-6 product from China, against the number of Chinese suppliers of that product to Chile in 2000. We group products into 20 bins by number of suppliers, and

Figure 4: 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 in 2000. (b) Binscatter of average log unit value of imports from China, for 20 bins of Chilean importers by number of Chinese suppliers in 2000. All values are demeaned by HS-6 product.

compute the simple average unit value across all import transactions. There is a tight negative relationship, with a slope coefficient of -0.39 for the fitted line.

Second, suppliers price discriminate across buyers and offer a wider menu of prices the more buyers they have. In Figure 4a, we group Chinese exporter-product pairs into 20 bins based on the product-demeaned number of Chilean partners in 2000. For each exporter and product, we measure the price dispersion across Chilean buyers with the standard deviation of transaction unit values, and demean by product. The bin-scatter in Figure 4a shows that average price dispersion is strongly positively correlated with buyer count across supplier bins.

Third, buyers with more suppliers pay lower input prices. In Figure 4b, we group Chilean importer-product pairs into 20 bins based on their product-demeaned number of Chinese partners in 2000. We calculate the average unit value each importer pays for a given product across its Chinese suppliers, and demean by product. The average unit value falls sharply with supplier count across buyer bins, suggesting that buyers enjoy pro-competitive gains from diversifying their supplier portfolio. This pattern is consistent with oligopolistic competition upstream and endogenous network formation as in our model.[20] By contrast, it is inconsistent with models with constant markups and either fixed or endogenous networks, which would imply a flat or positive relationship, respectively.[21]

[20] We emphasize how the extensive margin of sourcing from more suppliers correlates with input prices, which we attribute to oligopolistic competition among suppliers in setting buyer-specific markups. This is distinct from and complementary to 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).

[21] Negative degree assortativity in endogenous networks implies that more diversified buyers source from in-

4 Empirical Evidence

4.1 Identification Strategy

We next exploit the rapid expansion in Chinese export capacity over the 2000-2006 period to provide reduced-form empirical evidence for the theoretical framework in Section 2.

In the model, we consider multiple input origin countries and a unit interval of differentiated input varieties within each country. One can easily reinterpret origin countries j as origin-country $\times$ input-category pairs jp, with downstream buyers sourcing input varieties from multiple upstream suppliers within each country and input category. We can therefore readily map the multi-country model to the data, where we observe the input purchases of French and Chilean buyers by origin j and HS 6-digit product p.

Proposition 4 in the context of multiple countries characterizes the impact of firm entry upstream in origin j on the sourcing activity of downstream firms in country i. We evaluate these predictions by estimating variants of the following specification for the (log) value, quantity, and unit price of imports from China by French or Chilean firm f of HS-6 product p in year t:

$$\{\ln X_{fpt}, \ln Q_{fpt}, \ln p_{fpt}\} = \beta \ln S_{CHN\to ROW,pt} + \Gamma\Omega_{CHN,pt} + \delta_f + \delta_p + t\delta_p + \delta_t + \varepsilon_{fpt}. \quad (21)$$

This specification corresponds to model equations (16)-(18), where the import price p_{fpt} is the empirical counterpart to the cost index of Chinese input varieties. In the baseline, we analyze the average unit value across all input purchases from China at the fpt level to avoid parametric assumptions.[22] 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 potential number of Chinese exporters of product p is the metric of Chinese upstream market structure relevant to Chilean or French buyer f. We proxy this potential with the observed number of Chinese exporters to the rest of the world, excluding Chile or France respectively, by product p and year t, which we label $S_{CHN\to ROW,pt}$. We provide consistent evidence using the actual number of Chinese exporters to Chile ($S_{CHN\to CHL,pt}$) or 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. This IV strategy recognizes the possibility that the set of potential Chinese exporters varies across destinations, for instance due to input customization

creasingly higher-cost suppliers and pay higher average input prices. This would be more nuanced with quality heterogeneity, so we explicitly control for average supplier quality in the empirical analysis in Section 4.

[22] Trade quantities are recorded in kilograms for all products in the French customs data and in natural units that vary across products in the Chilean records. Any such heterogeneity is absorbed by product fixed effects.

driven by non-homothetic consumer preferences.

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 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.

Separately, we also examine the variation in input prices across Chilean buyers within Chinese suppliers at the disaggregate level of firm links (recall that we do not observe trade-partner identity in the French customs registry). Propositions 1 and 2 imply 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 variants of the following regression:

$$\ln p_{sfpt} = \beta \ln S_{CHN\to fpt} + \delta_{spt} + \delta_{fp} + \varepsilon_{sfpt}, \tag{22}$$

where $\ln p_{sfpt}$ is the log unit value Chinese supplier s charges downstream firm f for HS-6 product p, and $\ln S_{CHN\to fpt}$ is the log number of Chinese suppliers of input p to f, both at time t. We condition on supplier-product-year fixed effects δ_{spt} to account for cost and quality heterogeneity at that level. Coefficient β thus captures variation in markups within a seller across buyers with different numbers of suppliers, by product-year. We alternatively consider the combination of supplier-product and product-year fixed effects to guard against sample selection, since δ_{spt} reduces the sample to seller-product-year triplets with multiple buyers. Finally, our specification includes buyer-product fixed effects to identify β from changes in the number of suppliers within the same buyer and imported input over time. We conservatively cluster standard errors ε_{sfpt} by product-year.

4.2 Upstream Market Structure and Downstream Sourcing

Table 1 presents baseline results for the impact of upstream supplier entry in China on the sourcing behavior of downstream firms in Chile (Columns 1-2) and in France (Columns 3-4). Based on Proposition 4, a larger number of potential suppliers in China should increase input quantities and purchases, and reduce input costs for buyers sourcing from China, driven by both imperfect competition among suppliers and buyer-supplier matching frictions.

Using estimating equation (21), Panel A examines how the log number of Chinese exporters of an HS 6-digit product to the rest of the world in a given year, $\ln S_{CHN\to ROW,pt}$, affects the log value of imports from China by a Chilean or French firm for that product and year, $\ln X_{fpt}$.

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**	0.078***	0.214***
	(0.014)	(0.039)	(0.010)	(0.028)
R2	0.003	0.553	0.007	0.583
Panel B. (log) Import Quantity$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.209***	0.232***	0.140***	0.284***
	(0.021)	(0.066)	(0.013)	(0.032)
R2	0.011	0.558	0.006	0.608
Panel C. (log) Import Unit Value$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	-0.181***	-0.137***	-0.062***	-0.071***
	(0.017)	(0.053)	(0.011)	(0.015)
R2	0.037	0.727	0.005	0.721
N	306,857	306,857	913,252	913,252
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$\times$year controls: log # Chilean or French importers from ROW; EU import tariff on China (Column 4); mean and variance of Chinese exporters' productivity; mean input quality of Chinese exporters; value shares of Chinese processing, intermediated, state-owned, foreign-owned and multi-product-firm exports. Singletons dropped and standard errors clustered by HS-6 product $\times$ year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Panels B and C then 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.

We consistently find that entry upstream induces downstream firms in Chile and France to expand their input purchases and quantities, while paying lower input prices. Through the lens of the model, this is consistent with firms broadening their supplier portfolio and reducing their marginal production costs through two channels: lower input markups (due to tougher supplier competition) and better buyer-supplier matches (due to match-specific cost draws). This in turn increases final demand for their output, boosting their input demand and expenditure.

These findings obtain both when we adopt a flexible specification with year fixed effects only (Columns 1, 3) and when we consider a full set of 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) and a proxy for their average output quality (based on average unit value of 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 the value shares of Chinese exports mediated by processing trade, trade intermediaries, foreign-owned exporters, state-owned enterprises, and multi-product exporters. Finally, the regression for France controls for changes in the ad-valorem EU import tariff on Chinese goods.

The estimates point to economically significant effects downstream of the market structure upstream. Our results imply that following a 1-standard-deviation (SD) rise in the number of potential Chinese suppliers, French firms' imports would increase by 11.8% of a SD, import quantities would grow by 13.3% of a SD, and import prices would fall by 6.4% of a SD. The corresponding numbers for Chilean buyers are 4.9%, 10.3% and -8.9%. The actual rise in the number of Chinese exporters to ROW over the sample period 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.

Appendix Table A2 confirms that these results survive a series of robustness checks. First, excluding wholesalers upstream reduces coefficient magnitudes, suggesting that large wholesalers play an important role in supplier competition. Excluding wholesalers downstream, by contrast, leaves the results largely unchanged. These patterns are consistent with interdependent price setting across suppliers to a buyer, but not across buyers within a supplier. Second, using CES price and quantity indices instead of simple averages yields larger estimates, consistent with downstream firms reallocating expenditure shares across inputs in response to relative price changes.[23] These indices are model-consistent but require stronger parametric assumptions. Finally, our findings hold with alternative measures of Chinese supply potential. We consider the actual number of Chinese exporters to Chile and France, respectively, which we also instrument with the baseline number of Chinese exporters to either ROW or to similar markets, namely the Pacific Alliance countries for Chile and the USA for France.

Appendix Table A3 further demonstrates the stability of the results to various specification checks. First, we restrict the sample to a balanced panel of firms in 2000-2006, or to French firms that don't source from Eastern Europe to remove concurrent structural changes in that region. Second, we define quantities and unit values in the French data based on supplementary units of accounting. Third, we include output industry $\times$ year fixed effects as a more compre-

[23] CES price and quantity indices are constructed at the firm-product-year level from transaction-level data using product-specific elasticities of substitution from Broda and Weinstein (2006).

hensive control for the market structure downstream, in place of the baseline control for the number of Chilean or French importers. Finally, we control for changes in upstream competition in other products that a firm buys with the log (import-value weighted) average number of Chinese suppliers in a buyer's products other than p, or with the log number of Chinese exporters in the HS 4-digit category p belongs to.

4.3 Downstream Firm Heterogeneity

Table 2 demonstrates that bigger downstream buyers adjust their sourcing behavior more in response to upstream supplier entry, 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 (21) interactions of indicators for buyers in the middle and top tercile with the measure of market competition upstream.[24] 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.

The evidence indicates that bigger downstream buyers benefit more from upstream supplier entry than their smaller peers: they enjoy even lower input costs, source even higher input quantities, and have even higher input purchases overall. Through the lens of the model, this is consistent with bigger buyers incurring higher matching costs to transact with more suppliers, reaping pro-competitive gains from lower markups and improved buyer-supplier matches.

The results are economically and statistically more significant when using worldwide imports 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, but they might be co-determined by firm attributes outside our model, such as the ability to match with buyers.

4.4 Upstream Price Discrimination

The findings above establish the impact of entry upstream on sourcing outcomes downstream. While these effects could arise with endogenous network formation even under constant input markups, our model emphasizes how they are amplified by strategic pricing interactions among suppliers. We therefore next provide direct evidence for the role of imperfect supplier competition that cannot be rationalized by matching frictions alone. In particular, we show that

[24] 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.

Table 2: 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		0.190***		0.122***	
	(0.039)		(0.039)		(0.030)		(0.029)	
× 2nd Down Size Tercile Dummy	0.007**		0.088***		0.018***		0.027***	
	(0.003)		(0.002)		(0.005)		(0.006)	
× 3rd Down Size Tercile Dummy	0.007		0.153***		0.048***		0.105***	
	(0.005)		(0.003)		(0.006)		(0.008)	
R2	0.553		0.557		0.587		0.584	
Panel B. (log) Import Quantity$_{fpt}$								
(log) # CHN→ROW Exporters$_{pt}$	0.215***	0.255***	0.090	0.104	0.270***	0.274***	0.188***	0.190***
	(0.066)	(0.069)	(0.065)	(0.069)	(0.033)	(0.034)	(0.032)	(0.033)
× 2nd Down Size Tercile Dummy	0.016***	0.018***	0.096***	0.114***	0.015***	0.020***	0.071***	0.078***
	(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***	0.049***	0.059***	0.114***	0.127***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.007)	(0.008)	(0.007)	(0.008)
R2	0.558	0.527	0.561	0.531	0.610	0.601	0.609	0.600
Panel C. (log) Import Unit Value$_{fpt}$								
(log) # CHN→ROW Exporters$_{pt}$	-0.128**	-0.175***	-0.130**	-0.144**	-0.080***	-0.088***	-0.065***	-0.070***
	(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	-0.005*	-0.004	-0.014***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
× 3rd Down Size Tercile Dummy	-0.013***	-0.018***	-0.008***	-0.050***	-0.000	-0.016***	-0.006*	-0.026***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
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	848,169	848,169	909,335	909,335
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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Chinese suppliers charge more diversified Chilean buyers lower prices. This is in line with the predictions of Propositions 1 and 2 that suppliers engage in price discrimination across buyers depending on the extent of competition they face from other suppliers to that buyer.

Table 3 presents results from estimating equation (22) at the most granular level of Chinese supplier - Chilean buyer - HS-6 product - year transactions. Across a range of specification checks, we consistently observe sellers setting lower input prices when more Chinese suppliers sell the same product to the same buyer. 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,

Table 3: Upstream Price Discrimination

	Chile				
	(log) UV$_{sfpt}$ (1)	(log) UV$_{sfpt}$ (2)	(log) UV$_{sfpt}$ (3)	(log) UV$_{sfpt}$ (4)	(log) UV$_{sfpt}$ (5)
(log) # CHN Suppliers$_{fpt}$	-0.033***	-0.029***	-0.017***	-0.019***	-0.009*
	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)
R2	0.860	0.892	0.928	0.928	0.932
N	330,381	326,594	285,335	285,335	130,116
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	YES
Supplier × HS-6 Product × Year FE					YES
ROW Suppliers Control				YES	YES

Note: This table examines price discrimination upstream and the pro-competitive effects of diversified sourcing. The dependent variable is the log unit value by Chinese supplier, Chilean importer, HS-6 product, and year. Chinese competition is measured by the log number of Chinese suppliers of the product to the buyer that year. Columns 4-5 control for the 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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

to identify the main coefficient of interest from changes in sourcing strategy within buyer-products over time. Column 4 additionally controls for the buyer's log number of non-Chinese suppliers of the same input. 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. Finally, Column 5 includes supplier-product-year fixed effects to absorb marginal cost and quality at that level and to ensure that any residual price variation reflects heterogeneous markups charged by the same supplier across buyers.[25]

4.5 National vs. Global Supplier Competition

Our empirical analysis has focused on the impact of upstream entry in one origin, China, on downstream firms' sourcing from that origin, in line with the multi-country manifestation of Proposition 4. This is guided by our formulation of direct strategic interaction among suppliers from the same country and only indirect cross-border interactions among suppliers. As discussed in Section 2.4, the predictions of Proposition 4 would continue to hold qualitatively under global strategic interaction among suppliers, but may be quantitatively dampened or amplified. We conclude the empirical analysis by presenting evidence consistent with the assumption of national supplier competition and limited global competition in our context.

[25] The demanding supplier-product-year fixed effects allow for particularly clean identification of markup variation across buyers, but restrict the sample to large sellers with multiple buyers for the same product in a given year. Consistent with our theory, this reduces the magnitude of the estimated effect. Indeed, replicating the regression in Column 4 on the restricted sample of Column 5 yields smaller (though still significant) effects.

Table 4: National vs. Global Supplier Competition

	CHN Prices			ROW Prices
	(log) UV$_{sfpt}$	(log) UV$_{sfpt}$	(log) UV$_{fpt}$	(log) UV$_{fpt}$
	(1)	(2)	(3)	(4)
(log) #CHN Suppliers$_{fpt}$	-0.017***	-0.025***	-0.071***	-0.010
	(0.004)	(0.008)	(0.004)	(0.009)
D(ROW Suppliers)$_{fpt}$	0.004			
	(0.006)			
(log) #ROW Suppliers$_{fpt}$		0.006		
		(0.007)		
R2	0.928	0.942	0.910	0.916
N	285,335	88,398	203,871	52,324
Supplier × HS-6 Product FE	Yes	Yes	No	No
HS-6 Product × Year FE	Yes	Yes	Yes	Yes
Buyer × HS-6 Product FE	Yes	Yes	Yes	Yes

Note: This table examines national vs. global supplier competition. The dependent variable is the log unit value by Chinese supplier, Chilean importer, HS-6 product, and year in Columns 1-2, and averaged by Chilean importer, HS-6 product, and year in Columns 3-4. Chinese competition is measured by the log number of Chinese suppliers of the product to the buyer that year. Competition from the Rest Of the World (ROW) is measured by a dummy for any ROW suppliers or the log number of ROW suppliers. Singletons dropped and standard errors clustered by HS-6 product × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We first show in Appendix Figure A2 that the vast majority of French and Chilean firms sourcing from China do not buy the same HS 6-digit product from the ROW. This immediately restricts the scope for strategic interactions among suppliers across borders.

We next examine how the rising number of potential *Chinese* suppliers affects the price, quantity, and value of Chilean and French firm imports from *ROW* at the firm-product-year level. Global supplier competition would imply negative effects. Instead, we observe insignificant or positive effects in Appendix Table A4. This is consistent with Chinese supplier entry acting as a positive demand shock rather than a negative competition shock to ROW suppliers.

Lastly, we use the richer Chilean data to analyze how a buyer's actual number of Chinese (ROW) suppliers affects the prices of its ROW (Chinese) suppliers. Columns 1-2 in Table 4 consider the prices Chinese suppliers charge their Chilean buyers by product and year as in Table 3. While we continue to observe that *Chinese* input prices respond to the number of *Chinese* suppliers, we find no material role for either the presence or log number of *ROW* suppliers. We then collapse the data to the Chilean buyer-product-year level, and study the average import prices paid by firms sourcing from both China and ROW. Column 3 confirms the role of Chinese suppliers for the average price of Chinese inputs at this level. By contrast, Column 4 shows that Chinese suppliers have no effect on the average price of ROW inputs.

In sum, these three checks lend strong empirical support to the assumptions of national imperfect supplier competition and cross-national sourcing complementarity in the model.

5 Model Quantification

We end by estimating the model and quantifying the relevance of endogenous production networks and imperfect supplier competition for the welfare effects of topical trade and industrial policies. In particular, we consider three key comparative statics our model speaks to: supplier entry upstream, matching cost reductions, and trade cost reductions. We also assess deep trade agreements that package traditional trade reforms (tariff cuts) with competition policy (entry upstream) or trade promotion (cheaper matching).

We estimate a multi-country version of the model for 1 home country (Chile), 5 upstream origins (the United States (USA), Europe (EUR), Latin America (LATAM), China (CHN), and ROW), and 4 or 5 suppliers per region (based on observed means). This setup reflects Chile's trade structure, and balances policy relevance with computational tractability. To guide the counterfactual exercises, we look to the actual rise in Chinese suppliers to Chile over the 2000-2006 sample period and the Chile-China PTA signed in 2006.

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 j selling product p to buyer φ. We log-linearize the supplier's pricing equation (11), and estimate it with supplier-product fixed effects to absorb marginal costs c_{sjp}:

$$\ln p_{sjp}(\varphi) = \ln c_{sjp} + \ln \frac{\varepsilon_{sjp}(\varphi)}{\varepsilon_{sjp}(\varphi) - 1}. \tag{23}$$

The residuals from regression (23) correspond to markups $\varepsilon_{sjp}(\varphi)/(\varepsilon_{sjp}(\varphi) - 1)$, which depend on suppliers' residual demand elasticity $\varepsilon_{sjp}(\varphi) = [\sigma\delta_{jp}(\varphi) + \eta\,(1 - \delta_{jp}(\varphi))]\,\chi_{sjp}(\varphi) + \theta\,[1 - \chi_{sjp}(\varphi)]$. We take $\hat{\sigma} = 5$ as a center value from the literature (Burstein et al., 2020; Gaubert and Itskhoki, 2021), and estimate θ and η by non-linear least squares using observed input expenditure shares $\delta_{jp}(\varphi)$ and $\chi_{sjp}(\varphi)$. We construct $\chi_{sjp}(\varphi) = m_{sjp}(\varphi)/m_{jp}(\varphi)$ as the share of supplier s in buyer φ's imports $m_{jp}(\varphi)$ of input p from country j. In the absence of data on domestic inputs, we proxy $\delta_{jp}(\varphi)$ with the share of jp inputs in buyer φ's total imports $m(\varphi)$, $\delta_{jp}(\varphi) = m_{jp}(\varphi)/m(\varphi)$.

We obtain $\hat{\eta} = 1.4$ and $\hat{\theta} = 3.9$ based on Chilean import flows in 2006, consistent with the theoretical assumption of sourcing complementarity across countries $\sigma > \eta$.[26] Moreover, these estimates imply that the condition $\theta > \eta(1-\delta_{jp}(\varphi)) + \sigma\delta_{jp}(\varphi) > 0 \iff \delta_{jp}(\varphi) < (\theta-\eta)/(\sigma-\eta) \approx 0.7$ is satisfied for the vast majority of origin-product-buyer triplets in the data. This ensures that markups rise with the supplier's share in a buyer's purchases, and there is strategic complementarity in supplier pricing. Finally, we set the elasticity of substitution across inputs to $\lambda = 3$, the median estimate from Broda and Weinstein (2006).

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 Pareto shape parameters as $\widehat{k}_j = \ln 10/(\ln c_{10,j} - \ln c_{1,j})$, and the upper bounds as $\widehat{c}_{M_j} = 100^{1/\widehat{k}_j} c_{1,j}$, where suppliers' marginal costs are proxied with the fixed effects obtained in (23).

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 exporters to Chile in 2006, close to the 1.367 estimate in Head et al. (2014) for Chinese exporters to Japan in 2000. The Pareto upper bounds for Europe and the United States significantly exceed those for China and Latin America, consistent with the former having higher production costs. Since we do not observe domestic input sourcing, we assume that Chilean suppliers share a common Pareto distribution with other Latin American countries, and adjust the upper bound by the headline iceberg trade cost estimate of 2.70 in Anderson and Van Wincoop (2004). Following Melitz and Redding (2015), we adopt a Pareto productivity distribution with shape parameter 4.25 and scale parameter 1 for Chilean downstream producers.

Demand Shifter and Matching Costs Lastly, we estimate aggregate Chilean demand B_{Chile} and the matching costs of Chilean buyers. 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 $S \geq 1$, and impose $f_j(S) = 0$:[27]

$$\ln(f_j(S)) = \ln(\beta_0) + \beta_1 \ln dist_j + \ln \beta_2 comlang_j + \beta_3 ControlCorrupt_j + \beta_4 \ln(S). \quad (24)$$

[26] 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).

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

Table 5: Parameter estimates

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}	2.806
LATAM	1.25	3.23	Base cost	β_0	2.263
USA	0.93	38.76	Distance	β_1	4.400
EUR	1.09	17.03	Common language	β_2	0.947
CHN	1.27	4.69	Control of corruption	β_3	-0.613
ROW	1.20	7.38	# Suppliers	β_4	1.594

Note: This table reports the estimated Pareto parameters for suppliers' marginal costs by region, demand shifter for Chile, and parameters of the matching cost function in equation (24).

We construct gravity variables by region 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.[28] For a guess Φ', we solve for buyers' optimal global sourcing strategy for each supplier costs draw, compute the implied model moments, and iterate until a solution $\hat{\Phi}$ produces model moments that closely match the corresponding data moments.

We target 7 empirical moments that capture prominent features of Chilean firms' import behavior. First, 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. We hence 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).[29] 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 among $\{0, 1, 2, 3, 4, 5\}$

[28] 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.

[29] 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.

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 without upstream market power or price discrimination, where input prices are fixed or uniform across buyers (Antràs et al., 2017).

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 adapt the bounding algorithm in Jia (2008), Antràs et al. (2017), and Arkolakis et al. (2023a) to binary discrete-choice problems to *multinomial* discrete-choice problems. Arkolakis et al. (2023a) show that when profit functions exhibit certain single-crossing properties, it is sufficient to examine the profitability of tapping a given supplier to rule out sub-optimal strategies without having to evaluate them. 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 E, we exploit the matching process in the model (sequential by supplier productivity) to establish this approach for a multinomial choice problem, without first transforming it into a series of all possible pairwise binary choices.[30]

To overcome the second challenge of solving pricing games, we decouple this step from the SMM estimation. From Proposition 6, the outcome of any pricing game depends only on the relevant set of suppliers. We therefore solve the pricing game once for each possible supplier set, rather than repeatedly for every buyer considering that set.

Together, these two techniques yield an efficient algorithm for computationally feasible SMM estimation of large-scale sourcing models with endogenous networks and oligopolistic competition. This allows us to estimate Φ by solving the following problem (see Appendix F):

$$\min_{\Phi} y = (\widetilde{\mathrm{m}}(\Phi) - m)\mathrm{W}(\widetilde{\mathrm{m}}(\Phi) - m)', \tag{25}$$

where $\widetilde{\mathrm{m}}(\Phi)$ are the model moments, and W is the weighting matrix.[31]

Table 6 demonstrates that our SMM algorithm delivers an effective model fit to the data. The estimated model matches very well Moment II (the progressive selection of fewer buyers into wider supplier portfolios within origins; slope -1.56 in the data and -1.22 in the model) and Moment III (the share of Chilean firms that import inputs; 7.6% in the data and 5.0% in

[30] Our elasticity estimates imply a profit function with single-crossing from below.

[31] 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. To ensure global convergence and address the potential for local optima, the estimation procedure employs a multi-start strategy.

Table 6: Target Moments and Model Fit

Moments		Data	Model
Regional importer share	CHN	2.62%	2.55%
	ROW	2.98%	2.55%
	EUR	3.11%	4.96%
	LATAM	3.14%	4.98%
	USA	3.42%	4.96%
Slope of importer share wrt # suppliers		-1.56	-1.22
Aggregate importer share		7.60%	4.98%

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

the model). The model also captures well several aspects of Moment I across origins: the similar share of firms sourcing from Latin America, the USA, and Europe; the similar share of importers from China and ROW; and the fact that the former exceeds the latter.

The estimated parameters of the matching cost function in Panel B of Table 5 are economically meaningful, and illustrate the role of granularity upstream. The matching cost rises with bilateral distance and corruption at the origin, and falls by 5.3% when partners share a language (1-$\widehat{\beta}_2 \approx 0.053$). Notably, it increases rapidly with the number of suppliers, jumping $2^{\widehat{\beta_4}} = 2^{1.594} \approx 3.0$ times if 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

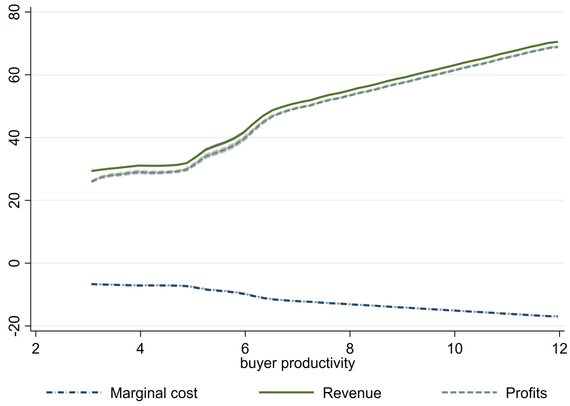
Having estimated the model, we perform counterfactual analyses to assess how the interaction between endogenous production networks and imperfect competition shapes the impact of industrial and trade policies on firm performance and welfare. We conclude that this interaction typically amplifies the welfare gains from such policy interventions, particularly when policy shocks affect the availability or cost of matching with suppliers.

Baseline Economy We simulate the Chilean economy, for 1,200 downstream firms, and report average firm outcomes across 20 draws in Figure 5.[32] 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

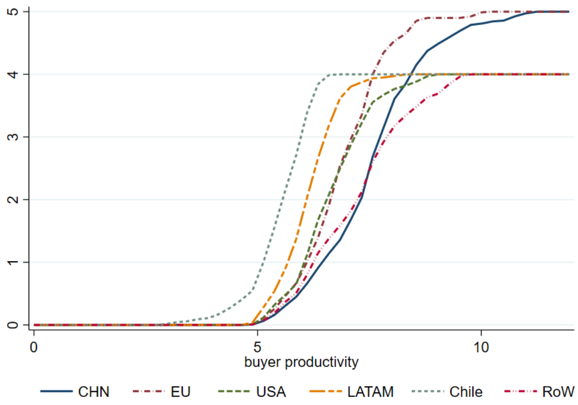
[32] We fix the demand shifter in Chile, consistent with wages being set in an outside sector.

Figure 5: Baseline Model Economy

(a) Buyer performance



(b) Buyer sourcing strategy



Note: This figure plots the simulated baseline economy, averaged across 20 simulation samples.

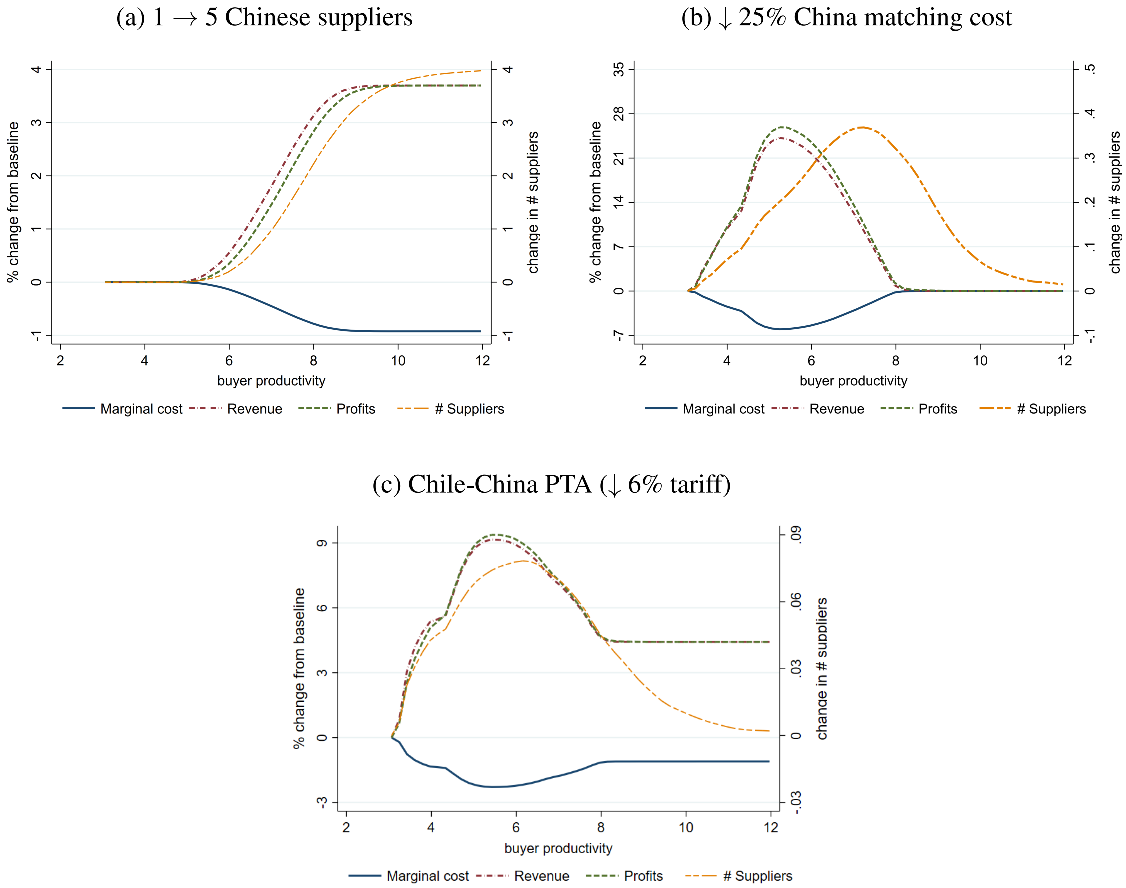
more suppliers within each region, with the granularity in matches corresponding to kinks in the cost, revenue, and profit curves.[33] Endogenous network formation thus amplifies the underlying buyer heterogeneity. The simulations also reveal a pecking order for sourcing across regions in line with variation in matching costs: 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.

Upstream Entry We first consider a counterfactual rise in the number of potential suppliers in one origin, China, from 1 to 5. This can be interpreted as market entry resulting from industrial policy, as observed after China joined the WTO in 2001. Consistent with Proposition 4, we see in Figure 6a that Chilean buyers above a certain productivity threshold expand their Chinese supplier portfolio. Moreover, sourcing complementarity induces some of them to also add suppliers from other regions (Appendix Figure A4). The most productive buyers thus enjoy almost 1% lower marginal costs and over 3.5% higher revenues and profits.

We explore the welfare gains from upstream entry in Column 1 of Table 7, and find that they are significantly amplified by the interplay of endogenous networks and imperfect supplier competition. The CPI falls by 0.57% in the baseline in Panel A as final producers pass on their lower marginal costs to consumers. By contrast, entry upstream has no effects on either welfare or corporate profits when we shut down endogenous buyer-supplier matching in Panel B and fix firms' production linkages. In Panel C, we conversely allow firms to re-optimize their supplier portfolios, but assume suppliers compete monopolistically and charge a constant input markup of $\theta/(\theta-1)$. The welfare gains are now halved to 0.28%, since entry upstream

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

Figure 6: Chile-China Counterfactuals: Chilean Firm Response



Note: This figure reports the average counterfactual percentage change in buyers' marginal cost, revenue and profits (left axis) and 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.

affords buyers only better supplier matches but no pro-competitive benefits. The comparison with the substantially larger baseline gain suggests a strong complementarity between network adjustments and the intensity of competition in generating welfare gains.

Matching Cost Reduction We next assess the impact of lower firm matching costs, which could result from trade promotion policies in one country or from deep economic integration beyond tariff cuts, such as regulatory harmonization. Specifically, we reduce by 25% two elements of the matching costs (24) for Chilean buyers sourcing from China: the base fixed cost β_0, and the elasticity with respect to the number of suppliers β_4. In line with Proposition 5, Figure 6b shows that this primarily benefits mid-productivity Chilean firms, who expand their supplier portfolio, reduce marginal costs, and increase sales. Buyer productivity cut-offs for sourcing from any number of Chinese suppliers fall, as do those for other regions due to sourcing com-

Table 7: Chile-China Counterfactuals: Chile CPI

	(1)	(2)	(3)
	Upstream entry in CHN	Cheaper matching with CHN	Chile-China PTA
Panel A. Baseline			
Δ CPI	-0.57%	-0.61%	-0.63%
Panel B. Fixed Production Network			
Δ CPI	-0.00%	-0.00%	-0.58%
Panel C. Constant Markup			
Δ CPI	-0.28%	-0.22%	-0.85%

Note: This table reports the welfare gains (fall in the consumer price index) from entry upstream, matching cost reduction, and trade cost reduction in China. Panel A presents the baseline with endogenous networks and variable markups. Panels B and C instead fix respectively the production network or input markups to $\theta/(\theta-1)$.

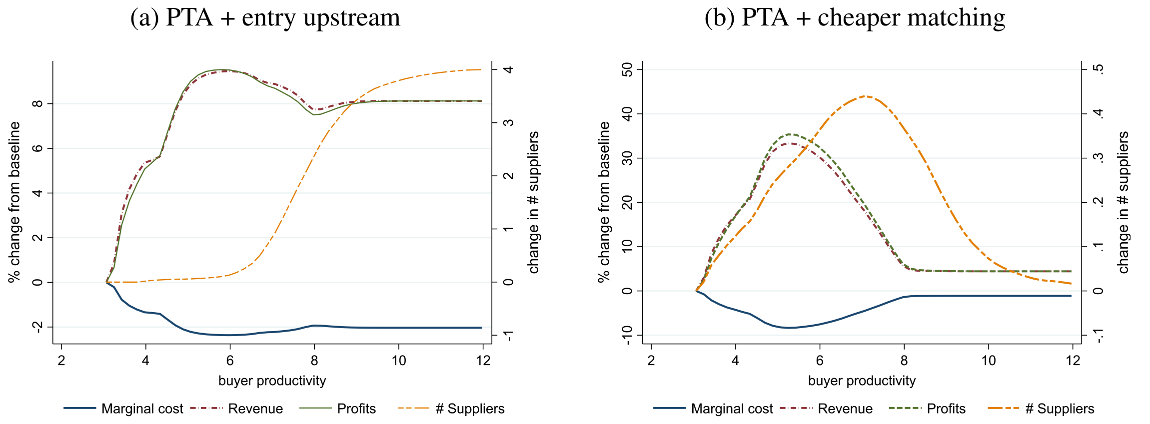
plementarity. Thus, while all buyers benefit from lower fixed matching costs on infra-marginal suppliers, mid-productivity buyers reap additional profit gains from adding suppliers.

The welfare analysis in Column 2 of Table 7 indicates that the consumer gains from a matching cost reduction are significantly boosted by the interaction of endogenous networks and imperfect competition, as with entry upstream. In the baseline, the CPI falls by as much as 0.61%. When buyer-supplier relationships are fixed, however, lower matching costs generate no reorganization of production linkages and hence no change in input or output prices. In this case, the policy intervention benefits exclusively firm profits with no pass-through to consumers. Alternatively, allowing firms to re-match but fixing input markups does improve welfare, but significantly less due to the absence of pro-competitive effects on supplier pricing: The CPI declines by 0.22%, or just over a third of the baseline.

Trade Cost Reduction We also consider the impact of a bilateral trade cost reduction, which we set to the average 6% tariff cut in the PTA Chile and China introduced in October 2006. Figure 6c shows that, consistent with Proposition 5, lower variable trade costs reduce marginal costs and increase revenues and profits for all buyers 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.

The welfare analysis in Column 3 of Table 7 reveals that endogenous networks and imperfect competition—as well as their interaction—are less consequential for the impact of policies that affect variable trade costs, compared to the policies above that influence supplier entry

Figure 7: Chile-China Package Reforms: Chilean Firm Response



Note: This figure replicates Figure 6 for a deep Chile-China trade agreement with 6% lower tariffs and (a) entry upstream from 1 to 5 suppliers; or (b) 25% lower matching costs.

or matching costs. Intuitively, this occurs because only the latter act directly on the extensive margin of firm supplier portfolios and the resultant strategic supplier interaction.

In the baseline model, Chile's CPI falls by 0.63% following tariff liberalization. This is driven directly by (i) lower iceberg trade costs, as well as indirectly by firms (ii) expanding their input demand (which pushes input markups up) and (iii) possibly adding suppliers (which improves matches and pushes input markups down). Shutting down network adjustments nullifies indirect channel (iii), and this reduces welfare gains only moderately to 0.58%. On the other hand, shutting down input markup adjustments nullifies the markup response in channels (ii) and (iii), and this raises the gains to consumer to 0.85%.

Package Reforms We conclude by evaluating package deals that reflect deeper forms of integration in modern trade agreements, blending tariff liberalization with the relaxation of entry barriers or matching frictions.[34] Upstream entry in China amplifies the response of downstream Chilean firms to tariff cuts, with a significant marginal cost decline and profit uplift across the buyer productivity distribution (Figure 7a). More productive firms now expand their global supplier portfolio more aggressively due to stronger sourcing complementarities. By contrast, a simultaneous reduction in bilateral tariffs and matching costs augments the benefits for mid-productivity buyers, who broaden their supplier base (Figure 7b).

We find that deep trade agreements generate substantially larger welfare gains than shallow trade liberalization, but only if both firm networks and input markups can adjust endogenously. As Table 8 shows, packaging tariff cuts with either entry upstream or lower matching costs

[34]Competition policy is the most frequent provision in deep trade agreements according to the World Bank database (Hofmann et al., 2017). It is followed by policy coordination that lowers transaction costs, such as policies on investment, capital and labor mobility, or intellectual property and environmental standards.

Table 8: Chile-China Package Reforms: Chile CPI

	(1)	(2)	(3)
	PTA	PTA + entry upstream	PTA + cheaper matching
Δ CPI	-0.63%	-1.19%	-1.26%

Note: This table compares the welfare gains from traditional and deep trade agreements.

approximately doubles the welfare gains. Appendix Table A5 confirms that this amplification is eliminated when the buyer-supplier network is held fixed, and that welfare gains from package reforms are always larger in the baseline economy than under fixed markups. Intuitively, lower trade costs combined with either upstream entry or matching cost reductions allow buyers to add suppliers, which exerts downward pressure on markups and overcomes the upward pressure from higher input demand. Welfare effects are therefore larger with endogenous markups, in contrast to the result with stand-alone trade cost reductions in Table 7.

In sum, our counterfactual analysis highlights the quantitative importance of endogenous network formation and imperfect supplier competition for the welfare gains from industrial and trade reforms. We conclude that their interaction generates strong amplification effects, particularly for policy shocks to the availability or cost of matching with upstream suppliers.

6 Conclusion

This paper examines how production network formation and imperfect supplier competition interact to shape firm outcomes and amplify the welfare effects of trade and industrial policy. We develop a quantifiable trade model with two-sided firm heterogeneity, matching frictions, and oligopolistic competition upstream. In the model, more productive buyers optimally choose a larger supplier base, which induces tougher supplier competition, lower input costs, and higher profits. Combining highly disaggregated data on firm production and trade transactions for China, Chile, and France, we present empirical evidence in line with the model. Downstream French and Chilean buyers import higher values and quantities at lower prices when more Chinese suppliers enter upstream. These effects are stronger for larger buyers. Moreover, Chinese suppliers price discriminate across buyers, charging more diversified producers lower input markups and prices.

Our quantitative analysis demonstrates that endogenous firm networks can interact with imperfect supplier competition to meaningfully amplify the gains from trade and industrial policy. Entry upstream and lower matching costs result in substantial reductions in consumer prices, provided downstream buyers can adjust their supplier base to reduce markups on intermediate inputs. Similarly, the interplay of endogenous firm links and strategic supplier pricing magnifies the welfare effects of modern trade agreements, which increasingly combine trade cost reductions with other provisions affecting the availability or cost of matching with suppliers.

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 (7), we have $\sum_{s=1}^{S(\varphi)} p_s(S(\varphi))^{-\theta} = \Phi(\varphi)^{-\theta}\gamma^{\theta}\tau^{\theta}$. Therefore, we have

$$\chi_s(\varphi) = \frac{p_s(\varphi)^{-\theta}}{\Phi(\varphi)^{-\theta}\gamma^{\theta}\tau^{\theta}} = \gamma^{-\theta}\tau^{-\theta}\Phi(\varphi)^{\theta}p_s(\varphi)^{-\theta}. \tag{E1}$$

Substitute this result and equation (8) into the profit function of the upstream firm defined in problem (10) to obtain

$$\begin{aligned}\pi_s^U(\varphi) &= Q(\varphi)\chi_s(\varphi)(p_s(\varphi)-c_s) = Q(\varphi)\gamma^{-\theta}\tau^{-\theta}\Phi(\varphi)^{\theta}p_s(\varphi)^{-\theta}(p_s(\varphi)-c_s)\\ &= D\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta}(p_s(\varphi)-c_s),\end{aligned}$$

where $D = \gamma^{-\theta}\tau^{-\theta}(\frac{\sigma-1}{\sigma})^{\sigma}EP^{\sigma-1}$ is the downstream demand shifter for inputs. The First Order Condition (FOC) $\partial\pi_s^U/\partial p_s(\varphi) = 0$ implies that

$$\frac{\partial\left(\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta}\right)}{\partial p_s(\varphi)}(p_s(\varphi)-c_s) + \Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta} = 0.$$

We note that as

$$\frac{\partial\left(\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta}\right)}{\partial p_s(\varphi)} = (\theta-\sigma)\Phi(\varphi)^{\theta-\sigma-1}\frac{\partial\Phi(\varphi)}{\partial p_s(\varphi)}p_s(\varphi)^{-\theta} + (-\theta)p_s(\varphi)^{-\theta-1}\Phi(\varphi)^{\theta-\sigma}$$

and $\Phi(\varphi) = \gamma\tau\left(\sum_{s=1}^{S(\varphi)} p_s(\varphi)^{-\theta}\right)^{-\frac{1}{\theta}}$, we have

$$\frac{\partial\Phi(\varphi)}{\partial p_s(\varphi)} = \gamma\tau p_s(\varphi)^{-\theta-1}\left(\sum_{s=1}^{S(\varphi)} p_s(\varphi)^{-\theta}\right)^{-\frac{1}{\theta}-1} = \Phi(\varphi)\frac{p_s(\varphi)^{-\theta}}{\sum_{s=1}^{S(\varphi)} p_s(\varphi)^{-\theta}}p_s{}^{-1} = \chi_s(\varphi)\frac{\Phi(\varphi)}{p_s(\varphi)}.$$

Therefore

$$\begin{aligned}\frac{\partial\left(\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta}\right)}{\partial p_s(\varphi)} &= (\theta-\sigma)\Phi(\varphi)^{\theta-\sigma-1}\frac{\partial\Phi(\varphi)}{\partial p_s(\varphi)}p_s(\varphi)^{-\theta} + (-\theta)p_s(\varphi)^{-\theta-1}\Phi(\varphi)^{\theta-\sigma}\\ &= p_s(\varphi)^{-\theta-1}\Phi(\varphi)^{\theta-\sigma}\left[(\theta-\sigma)\chi_s(\varphi)-\theta\right].\end{aligned}$$

Hence, the FOC becomes

$$
\begin{aligned}
\frac{\partial\left(\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta}\right)}{\partial p_s(\varphi)}(p_s(\varphi)-c_s)+\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta} &= 0 \\
p_s(\varphi)(1-(\sigma\chi_s(\varphi)+(1-\chi_s(\varphi))\theta)) &= -\left[\sigma\chi_s(\varphi)+(1-\chi_s(\varphi))\theta\right]c_s,
\end{aligned}
$$

from which we can solve for the price

$$
p_s(\varphi)=\frac{\sigma\chi_s(\varphi)+(1-\chi_s(\varphi))\theta}{\sigma\chi_s(\varphi)+(1-\chi_s(\varphi))\theta-1}c_s.
$$

Given the residual demand faced by a supplier

$$
Q_s(\varphi)=Q(\varphi)\gamma^{-\theta}\tau^{-\theta}\Phi(\varphi)^{\theta}p_s(\varphi)^{-\theta},
$$

we have

$$
\begin{aligned}
\varepsilon_s(\varphi) &\equiv -\frac{\partial\ln(Q_s(\varphi))}{\partial\ln(p_s(\varphi))}=-\frac{\partial\ln(D\Phi(\varphi)^{\theta-\sigma}p_s(\varphi)^{-\theta})}{\partial\ln(p_s(\varphi))}=-\frac{\partial\ln(\Phi(\varphi)^{\theta-\sigma})+\partial\ln(p_s(\varphi)^{-\theta})}{\partial\ln(p_s(\varphi))} \\
&= (\sigma-\theta)\frac{\partial\ln(\Phi(\varphi))}{\partial\ln(p_s(\varphi))}+\theta. \qquad \text{(E2)}
\end{aligned}
$$

Note that $\partial\Phi(\varphi)/\partial p_s(\varphi)=\chi_s(\varphi)\Phi(\varphi)/p_s(\varphi)$, and therefore

$$
\frac{\partial\ln(\Phi(\varphi))}{\partial\ln(p_s(\varphi))} = \frac{\partial\ln(\Phi(\varphi))}{\partial\Phi(\varphi)}\frac{\partial\Phi(\varphi)}{\partial p_s(\varphi)}\frac{\partial p_s(\varphi)}{\partial\ln(p_s(\varphi))}=\frac{1}{\Phi(\varphi)}\chi_s(\varphi)\frac{\Phi(\varphi)}{p_s(\varphi)}p_s(\varphi)=\chi_s(\varphi),
$$

and

$$
\varepsilon_s(\varphi)=(\sigma-\theta)\chi_s(\varphi)+\theta=(1-\chi_s(\varphi))\theta+\chi_s(\varphi)\sigma.
$$

Therefore, we have

$$
p_s(\varphi)=\frac{\varepsilon_s(\varphi)}{\varepsilon_s(\varphi)-1}c_s. \qquad \text{(E3)}
$$

We next establish the uniqueness of this equilibrium. We omit the functional argument φ to simplify notation. For any buyer with S' suppliers, let $\Psi\equiv[p_1,p_2,\cdots,p_{S'}]'$ be the vector of supplier prices and $\Psi^{-\theta}\equiv[p_1^{-\theta},p_2^{-\theta},\cdots,p_{S'}^{-\theta}]'$, and a matrix of supplier market shares be

$$
A=\begin{bmatrix}
\chi_1, & \cdots, & \chi_1 \\
\chi_2, & \cdots, & \chi_2 \\
\vdots & \vdots & \vdots \\
\chi_{S'}, & \cdots, & \chi_{S'}
\end{bmatrix}.
$$

Then equation (6) can be written as

$$A\Psi^{-\theta} = \Psi^{-\theta}. \tag{E4}$$

Given that $\sum_{s=1}^{S'} \chi_s = 1$, and $\chi_s > 0$ for $\forall S' \in \{1, ..., S\}$, matrix A has a non-negative eigenvector with a corresponding eigenvalue $\lambda = 1$ according to the *Perron-Frobenius Theorem*. Consequently, there exists an equilibrium vector $\Psi^{-\theta}$ that satisfies equation (6). Equation (E3) pins down the scale of this eigenvector: Formally, suppose Ψ^* and $\beta\Psi^*$ both satisfy equation (E4). According to equation (11), we have $p_s^* = \frac{\varepsilon_s}{\varepsilon_s - 1} c_s$ and $\beta p_s^* = \frac{\varepsilon_s}{\varepsilon_s - 1} c_s$, as $\varepsilon_s = (1 - \chi_s)\theta + \chi_s \sigma$ and χ_s remain unchanged when all supplier prices are scaled proportionally. We therefore have $\beta = 1$, and the solution is unique.

A.2 Proof of Proposition 2

We prove this proposition for the case with one new supplier. We can simply iterate the arguments forward for cases with more than one supplier. For brevity, we omit the functional argument φ. 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. Suppose the suppliers' expenditure shares are $\chi_1', \chi_2', \ldots, \chi_S', \chi_{S+1}'$ and satisfy $\sum_{n=1}^{S+1} \chi_n' = 1$ after matching with the entrant. Since the market share of the entrant is positive, i.e., $\chi_{S+1}' > 0$, we have

$$\sum_{n=1}^{S} \chi_n' < 1 = \sum_{n=1}^{S} \chi_n. \tag{E5}$$

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 (E5) cannot hold. Using equation (6), we obtain

$$\chi_{n^*}' = \frac{{p_{n^*}'}^{-\theta}}{\sum_{n=1}^{S+1} {p_n'}^{-\theta}} \geq \chi_{n^*} = \frac{{p_{n^*}}^{-\theta}}{\sum_{n=1}^{S} {p_n}^{-\theta}}. \tag{E6}$$

The assumption that $\theta > \sigma$ implies $\partial\mu_s(\varphi)/\partial\chi_s(\varphi) > 0$: 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 (E6), we have

$$\frac{\sum_{n=1}^{S} {p_n}^{-\theta}}{\sum_{n=1}^{S+1} {p_n'}^{-\theta}} \geq \left(\frac{p_{n^*}}{p_{n^*}'}\right)^{-\theta} \geq 1. \tag{E7}$$

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

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

which contradicts inequality (E7). 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 $\Phi = \gamma\tau(\sum_{n=1}^{S} p_n^{-\theta})^{-\frac{1}{\theta}}$ and $\Phi' = \gamma\tau(\sum_{n=1}^{S+1} p_n'^{-\theta})^{-\frac{1}{\theta}}$ 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 $p_{S+1}'^{-\theta} > 0$, we have $\sum_{n=1}^{S} p_n'^{-\theta} + p_{S+1}'^{-\theta} > \sum_{n=1}^{S} p_n'^{-\theta}$, which implies a decrease in the buyer's input cost index when a new supplier is added: $\Phi' < \Phi$, and marginal cost $c' = \Phi'/\varphi < c = \Phi/\varphi$.

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 $\mathcal{S}(\varphi_H)$, and $\mathcal{S}(\varphi_L)$, respectively. For the high productivity firm H to prefer $\mathcal{S}(\varphi_H)$ over $\mathcal{S}(\varphi_L)$, we need

$$
B\varphi_H^{\sigma-1}\Phi(\mathcal{S}(\varphi_H))^{1-\sigma} - wf(\mathcal{S}(\varphi_H)) > B\varphi_H^{\sigma-1}\Phi(\mathcal{S}(\varphi_L))^{1-\sigma} - wf(\mathcal{S}(\varphi_L)). \tag{E8}
$$

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

$$
B\varphi_L^{\sigma-1}\Phi(\mathcal{S}(\varphi_L))^{1-\sigma} - wf(\mathcal{S}(\varphi_L)) > B\varphi_L^{\sigma-1}\Phi(\mathcal{S}(\varphi_H))^{1-\sigma} - wf(\mathcal{S}(\varphi_H)). \tag{E9}
$$

Combining the two inequalities above, we obtain

$$
B(\varphi_H^{\sigma-1} - \varphi_L^{\sigma-1})(\Phi(\mathcal{S}(\varphi_H))^{1-\sigma} - \Phi(\mathcal{S}(\varphi_L))^{1-\sigma}) > 0. \tag{E10}
$$

Given that $\varphi_H > \varphi_L$ and $\sigma > 1$, the inequality above implies $\Phi(\mathcal{S}(\varphi_H)) < \Phi(\mathcal{S}(\varphi_L))$. Furthermore,

$$c(\varphi_H) = \frac{\Phi(\mathcal{S}(\varphi_H))}{\varphi_H} < c(\varphi_L) = \frac{\Phi(\mathcal{S}(\varphi_L))}{\varphi_L}.$$

Therefore, we establish result (b) that the buyers' marginal cost $c(\varphi)$ and input costs $\Phi(\varphi)$ are decreasing in φ.

Next, we prove result (a). Under our parameter restriction that $\theta > \sigma$, we show that the profit function of the downstream firm in equation (12) features increasing differences (S, φ). We first invoke Proposition 2 and note that the input price index given in equation (7) is decreasing in the number of upstream firms if $\theta > \sigma$, that is $\Phi(S+1) < \Phi(S), \forall S > 0$. Next, from equations (7) and (12), it is obvious that the profit function has decreasing differences in (Φ, φ) for $\sigma > 1$. Therefore, we have $\Phi(\varphi_H) \leq \Phi(\varphi_L)$ for $\varphi_H > \varphi_L$. Given that Φ is decreasing in S, we have $S(\varphi_H) \geq S(\varphi_L)$. Finally, since buyers match with suppliers in increasing order of marginal cost, then we have $\mathcal{S}(\varphi_L) \subseteq \mathcal{S}(\varphi_H)$. Therefore, we have the following monotone comparative statics result: $S(\varphi_H) \geq S(\varphi_L)$ for $\varphi_H \geq \varphi_L$.

A.4 Proof of Proposition 4

According to Proposition 3, the optimal number of suppliers $S^*(\varphi)$ is a non-decreasing step function of buyer productivity, such that $S(\varphi_H) \geq S(\varphi_L)$ for any $\varphi_H > \varphi_L$. This implies that an expansion in the set of potential suppliers N only affects the sourcing behavior of firms that possess sufficient scale to offset the additional fixed matching costs.

Consider an increase in the number of potential suppliers from N to N'. We define a sequence of productivity thresholds $\{\overline{\varphi}_S\}_{S=1}^{N'}$, where $\overline{\varphi}_S$ represents the minimum productivity required for a firm to optimally match with S suppliers. The impact of upstream entry is partitioned as follows: (1) high-productivity firms ($\varphi \geq \overline{\varphi}_{N'}$): These firms have sufficient scale to match with all new entrants, expanding their network to $S^*(\varphi) = N'$. (2) intermediate-productivity firms ($\overline{\varphi}_{N+1} \leq \varphi < \overline{\varphi}_{N'}$): These firms respond at the extensive margin by increasing their number of matched suppliers to some $S' \in (N, N')$, depending on their specific position in the productivity distribution. (3) low-productivity firms ($\varphi < \overline{\varphi}_{N+1}$): For these firms, the marginal increase in variable profits from an additional supplier is strictly less than the incremental fixed matching cost $wf(N+1)$. Consequently, their sourcing strategy remains unchanged at the baseline level S.

For all firms that expand their supplier network ($S' > S$), Proposition 2 ensures a reduction in both the aggregate input cost index $\Phi(\varphi)$ and the firm's marginal cost $c(\varphi) = \Phi(\varphi)/\varphi$, establishing result (a).

Given the demand and cost structures defined in Equations (8) and (9), a reduction in marginal cost, holding the demand shifter B constant, necessarily drives an increase in the equilibrium input quantity $Q(\varphi)$ and total input expenditure $X(\varphi)$. This confirms results (b) and (c). Finally, for low-productivity firms ($\varphi < \overline{\varphi}_{N+1}$) whose sourcing sets remain stagnant, the variables $\Phi(\varphi)$, $c(\varphi)$, $Q(\varphi)$, and $X(\varphi)$ are unaffected, establishing result (d).

A.5 Proof of Proposition 5

First, we consider the effect of a reduction in the iceberg trade cost τ. According to Proposition 2, if $\theta > \sigma$, an expansion of the set of matched suppliers $\mathcal{S}(\varphi)$, or an increase in the number of suppliers S, results in an increase in the aggregate sourcing potential $\equiv \sum_{n=1}^{S} p_n^{-\theta}$. This increase reduces the buyers input cost index $\Phi(\varphi) = \gamma\tau[\sum_{n=1}^{S(\varphi)} p_n^{-\theta}]^{-1/\theta}$ and, consequently, the marginal cost $c(\varphi) = \Phi(\varphi)\varphi$. Substituting the marginal cost into the profit function (Equation 12), the variable component of profit is proportional to $c(\varphi)^{1-\sigma}$. When $\sigma > 1$, profit is a decreasing function of marginal cost. Because $\Phi(\varphi)$ is multiplicative in τ and the sourcing potential, the profit function $\pi^D(\varphi, S, \tau)$ exhibits increasing differences in $(S, -\tau)$. Specifically, a lower τ increases the marginal gain in profit from adding an additional supplier. By Topkis' Theorem, the optimal number of suppliers $S^*(\varphi)$ is weakly decreasing in τ (i.e., S increases as trade costs fall), establishing result (a). A similar argument applies to the matching cost $f(S)$: A reduction in the matching cost scale lowers the hurdle for adding suppliers, thereby weakly increasing $S^*(\varphi)$.

Results (b) and (c) follow directly from the properties established in Proposition 4. The intensive margin (lower costs for a given S) and the extensive margin (the increase in S) both work in the same direction to reduce costs and increase profits.

Finally, the distributional impact specified in result (d) follows from the discrete nature of the sourcing set. Low-productivity firms, facing low scale, find the marginal profit gain from an additional supplier insufficient to cover the fixed matching cost $wf(S)$, even after a reduction in τ. Conversely, the most productive firms may already have matched with all N potential suppliers. Therefore, the extensive margin response and the resulting disproportionate gains are concentrated among mid-productivity firms who are induced to cross the threshold and expand their supplier network.

A.6 Proof of Proposition 6

The profit of an upstream supplier s from country j selling to buyer φ in country i is:

$$\pi_{ijs}^{U}(\varphi) = (p_{ijs} - c_{js})Q_{ijs}(\varphi), \tag{E11}$$

where the residual demand $Q_{ijs}(\varphi) = \chi_{ijs}(\varphi)\delta_{ij}(\varphi)\frac{c_i(\varphi)Q_i(\varphi)}{c_{ij}(\varphi)}$ can be derived as:

$$Q_{ijs}(\varphi) = D_i(\varphi)c_i(\varphi)^{\eta-\sigma}\tau_{ij}^{-\theta}c_{ij}(\varphi)^{\theta-\eta}p_{ijs}(\varphi)^{-\theta}, \tag{E12}$$

where $D_i(\varphi) =\gamma^{-\theta}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma} E_i P_i^{\sigma}\varphi^{\eta-1}$ is the demand shifter. For brevity, we now omit functional argument φ. The optimal price satisfies the standard Lerner index rule $p_{ijs} = \frac{\varepsilon_{ijs}}{\varepsilon_{ijs}-1}c_{js}$, where $\varepsilon_{ijs} \equiv -\frac{d\ln Q_{ijs}}{d\ln p_{ijs}}$. To derive ε_{ijs}, we apply the chain rule to the logs of the price indices:

$$\varepsilon_{ijs} = \theta - (\theta-\eta)\frac{d\ln c_{ij}}{d\ln p_{ijs}} - (\eta-\sigma)\frac{d\ln c_i}{d\ln p_{ijs}}. \tag{E13}$$

Using the properties of the CES cost index, the elasticity of the country-specific cost index c_{ij} and the aggregate index c_i with respect to price are the respective expenditure shares:

$$\frac{d\ln c_{ij}}{d\ln p_{ijs}} = \chi_{ijs} \quad \text{and} \quad \frac{d\ln c_i}{d\ln p_{ijs}} = \frac{d\ln c_i}{d\ln c_{ij}}\frac{d\ln c_{ij}}{d\ln p_{ijs}} = \delta_{ij}\chi_{ijs}, \tag{E14}$$

where χ_{ijs} is the supplier's share within country j, and δ_{ij} is country j's share in buyer i's total input spending. Substituting these shares into the expression for ε, we obtain the residual demand elasticity as a weighted average of the nesting elasticities:

$$\varepsilon_{ijs} = (1-\chi_{ijs})\theta + \chi_{ijs}\left[(1-\delta_{ij})\eta + \delta_{ij}\sigma\right]. \tag{E15}$$

Finally, following the same logic as in the proof of Proposition 1, we can show that the Nash equilibrium of the Bertrand pricing game exists and is unique.

A.7 Proof of Proposition 7

The residual demand elasticity $\varepsilon_{ijs} = \theta - (\theta-\eta)\chi_{ijs} - (\eta-\sigma)\delta_{ij}\chi_{ijs}$ satisfies

$$\frac{\partial\varepsilon_{ijs}}{\partial\chi_{ijs}} = \sigma\delta_{ij} + \eta(1-\delta_{ij}) - \theta < 0 \Longleftrightarrow \theta > \sigma\delta_{ij} + \eta(1-\delta_{ij}).$$

Defining the markup as $\mu_{ijs} = \frac{\varepsilon_{ijs}}{\varepsilon_{ijs}-1}$, we have

$$\frac{\partial\mu_{ijs}}{\partial\chi_{ijs}} > 0 \Longleftrightarrow \theta > \sigma\delta_{ij} + \eta(1-\delta_{ij}).$$

Therefore, following the same logic of the proof for Proposition 2, an increase in $S_{ij}(\varphi)$ reduces $\mu_{ijs}(\varphi)$ and $c_{ij}(\varphi)$ as long as $\theta > \sigma\delta_{ij} + \eta(1-\delta_{ij})$.

Proposition 3. Denote the sourcing strategy of a firm φ as $\mathcal{S}_i(\varphi) = \{S_{ij}(\varphi)\}_{j=1}^{J}$ and

$\mathcal{I}_i(\varphi) = \{I_{ij}(\varphi)\}_{j=1}^{J}$, the input cost index as $\Phi_i(\varphi) = \left[\sum_k I_{ik}(\varphi)c_{ik}(\varphi)^{1-\eta}\right]^{1/(1-\eta)}$, and the marginal cost as $c_i(\varphi) = \Phi_i(\varphi)/\varphi$. Applying the same logic in the proof of Proposition 3, from the buyers' profit function, we have

$$B_i(\varphi_H^{\sigma-1} - \varphi_L^{\sigma-1})(\Phi_i(\mathcal{S}_i(\varphi_H), \mathcal{I}_i(\varphi_H))^{1-\sigma} - \Phi_i(\mathcal{S}_i(\varphi_L), \mathcal{I}_i(\varphi_L))^{1-\sigma}) > 0, \tag{E16}$$

which implies that $\Phi(\mathcal{S}_i(\varphi_H), \mathcal{I}_i(\varphi_H)) < \Phi(\mathcal{S}_i(\varphi_L), \mathcal{I}_i(\varphi_L))$ given that $\varphi_H > \varphi_L$, $\sigma > 1$, as well as:

$$c_i(\varphi_H) = \frac{\Phi_i(\mathcal{S}(\varphi_H), \mathcal{I}_i(\varphi_H))}{\varphi_H} < c_i(\varphi_L) = \frac{\Phi(\mathcal{S}_i(\varphi_L), \mathcal{I}_i(\varphi_L))}{\varphi_L}.$$

Next, we show that the profit function exhibits increasing differences in $(\mathcal{S}_i(\varphi), \varphi)$ and $(\mathcal{I}_i(\varphi), \varphi)$. First, following the logic of Antràs et al. (2017), the profit function features increasing differences in (I_{ik}, φ) and $(-c_{ik}, \varphi)$ under the assumption that $\sigma > \eta$ (i.e., different sourcing origins are complementary in generating the final firm profit). Second, as shown above, an increase in $S_{ij}(\varphi)$ strictly reduces $c_{ij}(\varphi)$ provided that $\theta > \sigma\delta_{ij} + \eta(1 - \delta_{ij})$. Therefore, the profit function exhibits increasing differences in $(S_{ij}(\varphi), \varphi)$ provided that $\theta > \sigma\delta_{ij} + \eta(1 - \delta_{ij})$ and $\sigma > \eta$. By Topkis' Theorem, the optimal extensive margin choices of suppliers $\mathcal{S}_i^*(\varphi)$ and origin selection $\mathcal{I}_i^*(\varphi)$ are non-decreasing in buyer productivity φ.

Proposition 4. Intuitively, the increase in the potential suppliers from S_j to S_j' relaxes the capacity constraint $S_{ij}^*(\varphi) \leq S_j$. For buyers whose optimal unconstrained choice was strictly less than S_j, the relaxed constraint does not bind, and their optimal strategy remains unchanged.

Because the optimal sourcing strategy $\mathcal{S}_i^*(\varphi)$ is strictly increasing in φ (as established above), the constraint $S_{ij}^*(\varphi) \leq S_j$ binds precisely for the most productive firms. Therefore, the expansion of potential suppliers allows the high-productivity buyers to increase their selected S_{ij}^*. Consequently, the expansion of S_j primarily benefits the most productive buyers.

Proposition 5. The effective cost of intermediate inputs from country j for a buyer with productivity φ is $c_{ij}(\varphi) = \gamma\tau_{ij}\left[\sum_{s=1}^{S_{ij}(\varphi)} p_{ijs}(\varphi)^{-\theta}\right]^{-1/\theta}$. A reduction in the bilateral trade costs τ_{ij} mechanically reduces the origin-specific cost index $c_{ij}(\varphi)$. In addition, different origins act as complements if $\sigma > \eta$. Thus, the profit function features increasing differences in $(I_{ik}(\varphi), -\tau_{ij})$ for any k and j. Furthermore, under the condition $\theta > \sigma\delta_{ij} + \eta(1 - \delta_{ij})$, the benefit of adding a supplier increases as trade costs fall, which implies that the profit function also features increasing differences in $(S_{ik}(\varphi), -\tau_{ij})$ for any k and j. Applying Topkis' Theorem to these complementarities, the optimal sourcing strategy is weakly decreasing in τ_{ij}. Thus, as trade costs fall, both the intensive and extensive margins of sourcing ($\mathcal{S}_i(\varphi)$ and $\mathcal{I}_i(\varphi)$) weakly increase. The most productive firms that already sourced from all the suppliers are constrained by the maximum number of suppliers and cannot expand. The least productive firms would not be able to tap into the market and do not respond. Therefore, it is the mid-productivity firms that benefit. A similar logic can be applied to the fixed cost of sourcing.

B Pricing of Upstream Firms

First, from equation (11), we know that an upstream supplier's markup when matched to a buyer with productivity φ is given by

$$\mu_s(\varphi) = \frac{\varepsilon_s(\varphi)}{\varepsilon_s(\varphi) - 1},$$

where $\varepsilon_s(\varphi) = \sigma\chi_s(\varphi) + \theta\,[1 - \chi_s(\varphi)]$. Since $\frac{\partial \varepsilon_s(\varphi)}{\partial \chi_s(\varphi)} = \sigma - \theta$, we have

$$\frac{\partial \mu_s(\varphi)}{\partial \chi_s(\varphi)} = \frac{-\frac{\partial \varepsilon_s(\varphi)}{\partial \chi_s(\varphi)}}{(\varepsilon_s(\varphi) - 1)^2} = \frac{\theta - \sigma}{(\varepsilon_s(\varphi) - 1)^2}.$$

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

$$\Gamma_{-s}(\varphi) = \sum_{n \neq s, n=1,\ldots,S} \frac{\partial \mu_s(\varphi)}{\partial p_n(\varphi)}.$$

If the markup elasticity with respect to competitor prices is *positive*, i.e., $\Gamma_{-s}(\varphi) > 0$, 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 (6) and (11), we find that

$$\begin{aligned} \Gamma_{-s} &= \sum_{n \neq s, n=1,\ldots,S} \frac{\partial \mu_s}{\partial p_n} = \sum_{n \neq s, n=1,\ldots,S} \frac{\partial \mu_s}{\partial \chi_s}\frac{\partial \chi_s}{\partial p_n} \\ &= \frac{\theta - \sigma}{(\varepsilon_s - 1)^2} \sum_{n \neq s, n=1,\ldots,S} \frac{\partial \chi_s}{\partial p_n}, \end{aligned}$$

and

$$\frac{\partial \chi_s}{\partial p_n} = \frac{-p_s^{-\theta}(-\theta p_n^{-\theta-1})}{(\sum_n p_n^{-\theta})^2} = \frac{\theta p_s^{-\theta}}{\sum_n p_n^{-\theta}} \frac{p_n^{-\theta}}{\sum_n p_n^{-\theta}} p_n^{-1} = \theta \chi_s \chi_n p_n^{-1}.$$

Combining the two results above, we find that

$$\begin{aligned} \Gamma_{-s} &= \frac{\theta - \sigma}{(\varepsilon_s - 1)^2} \sum_{n \neq s, n=1,\ldots,S_s} \theta \chi_s \chi_n p_n^{-1} \\ &= \frac{\theta - \sigma}{(\varepsilon_s - 1)^2} \theta \chi_s \sum_{n \neq s, n=1,\ldots,S_s} \chi_n p_n^{-1}. \end{aligned} \tag{E17}$$

Therefore, as long as $\theta > \sigma$, we have $\Gamma_{-s} > 0$ and upstream supplier pricing exhibits strategic complementarity.

Similarly, in the multi-country case, $\varepsilon_{ijs} = [\sigma\delta_{ij} + \eta(1-\delta_{ij})]\,\chi_{ijs} + \theta\,[1-\chi_{ijs}]$ implies

$$\frac{\partial \mu_{ijs}}{\partial \chi_{ijs}} = \frac{-\frac{\partial \varepsilon_{ijs}}{\partial \chi_{ijs}}}{(\varepsilon_{ijs}-1)^2} = \frac{\theta - (\sigma\delta_{ij} + \eta(1-\delta_{ij}))}{(\varepsilon_{ijs}-1)^2},$$

and

$$\Gamma_{-ijs} = \frac{\theta - (\sigma\delta_{ij} + \eta(1-\delta_{ij}))}{(\varepsilon_{ijs}-1)^2} \sum_{n\neq s, n=1,\ldots,S_{ijs}} \theta \chi_{ijs}\chi_{ijn} p_{ijn}^{-1}. \tag{E18}$$

Therefore, we have $\partial\mu_{ijks}/\partial\chi_{ijks} > 0$ and $\Gamma_{-ijs} > 0$ as long as $\theta > \sigma\delta_{ij} + \eta(1-\delta_{ij})$.

C Firm-to-Firm Trade

Combining equations (6), (7), (9), and (11), the imports of downstream firm φ from supplier s are given by:

$$X_s(\varphi) = \gamma^{1-\sigma}(\sigma-1)B\varphi^{\sigma-1}\tau^{1-\sigma}\left[\sum_{s=1}^{S(\varphi)} p_s(\varphi)^{-\theta}\right]^{\frac{\sigma-1}{\theta}} \frac{p_s(\varphi)^{-\theta}}{\sum_{s'=1}^{S(\varphi)} p_{s'}(\varphi)^{-\theta}}, \tag{E19}$$

where $p_s(\varphi) = \mu_s(\varphi)c_s$. Equation (E19) highlights that firm-to-firm trade flows are a function of aggregate final demand B, buyer productivity φ, supplier marginal cost c_s, and iceberg trade costs τ.

A reduction in a supplier's marginal cost c_s reduces the price $p_s(\varphi)$, which facilitates a higher market share within the buyer's input bundle ($\uparrow \chi_s(\varphi)$) and simultaneously lowers the buyers marginal cost. In contrast, the relationship between firm-to-firm sales and buyer productivity is determined by the net effect of two opposing forces. On the one hand, a scale effect exists: more productive buyers face higher demand for their own output and consequently require a larger volume of intermediate inputs, as captured by the term $\varphi^{\sigma-1}$. This effect is further amplified by the fact that these high-productivity buyers endogenously achieve lower input costs. On the other hand, a competition effect arises because more productive buyers source from a wider set of suppliers $S(\varphi)$. This expansion of the supplier network increases the competitive pressure on any individual supplier s and reduces the average $\chi_s(\varphi)$, potentially reducing the trade volume per supplier as the buyer's expenditure is partitioned across a larger variety of inputs.

D Oligopolistic Competition with Global Interaction

Downstream demand is the same as the baseline model. On the supply side, to allow strategic interaction among firms from different countries, we relax the nested CES production structure and assume that downstream buyers combine intermediate inputs from all global suppliers through a single-tier CES aggregator. The marginal cost of a country-i firm is given by:

$$c_i(\varphi) = \frac{1}{\varphi}\left(\int_0^1 z_i\left(\varphi, v\right)^{1-\lambda} dv\right)^{\frac{1}{1-\lambda}}, \tag{E20}$$

which decreases with core productivity φ and aggregates the cost of each variety v, $z_i\left(\varphi, v\right)$ ($\lambda > 1$ is the elasticity of substitution across varieties).

A buyer φ in country i chooses a sourcing strategy $\mathbf{S}_i(\varphi) = \{S_{i1}(\varphi), S_{i2}(\varphi), \ldots, S_{iJ}(\varphi)\}$, where $S_{ij} \leq \bar{S}_j$ is the number of suppliers sourced from in origin j, and $\bar{S}_j$ is the total number of potential suppliers in j. Conditional on matching with a set of suppliers, $\mathcal{S}_i(\varphi) = \bigcup_{j=1}^{J} \mathcal{S}_{ij}(\varphi)$, where $\mathcal{S}_{ij}(\varphi)$ is the set of matched suppliers from country j, buyer φ optimally purchases variety v from the lowest-cost provider among them:

$$z_i(\varphi, v) = \min_{s\in\mathcal{S}_i(\varphi)} \left\{\tau_{ij}\cdot p_s(\varphi)\cdot \xi_s(\varphi, v)\right\}. \tag{E21}$$

Here, $\xi_s(\varphi, v)$ is a match-specific cost shock realized after the buyer has matched with supplier s and observed its *cif* price, $p_{ijs}(\varphi) = \tau_{ij}\cdot p_s(\varphi)$, where $p_s(\varphi)$ is the *fob* price. As in the baseline model, we assume that $1/\xi_s(\varphi, v)$ is Fréchet distributed: $\Pr(\xi_s(\varphi, v) \geq t) = e^{-t^{\theta}}$. Integrating over the continuum of varieties, the buyer's realized marginal cost is:

$$c_i(\varphi) = \gamma\frac{\Phi_i(\mathbf{S}_i(\varphi))}{\varphi},$$

where the global input cost index is:

$$\Phi_i(\mathbf{S}_i(\varphi)) = \left(\sum_{j\in J}\sum_{s=1}^{S_{ij}(\varphi)} p_{ijs}(\varphi)^{-\theta}\right)^{-\frac{1}{\theta}}, \tag{E22}$$

and γ is a constant defined by the Gamma function. The global expenditure share of a specific supplier s from country j is given by:

$$\chi_{ijs}(\varphi) = \frac{p_{ijs}(\varphi)^{-\theta}}{\sum_{j\in J}\sum_{s=1}^{S_{ij}(\varphi)} p_{ijs}(\varphi)^{-\theta}}. \tag{E23}$$

Suppliers engage in buyer-specific Bertrand competition. Because there is a discrete and finite number of matched global suppliers, suppliers internalize their direct impact on the buyer's global cost index Φ_i. Similar to the baseline model, the residual demand elasticity faced by supplier s from country j is:

$$\varepsilon_{ijs}(\varphi) = \theta(1 - \chi_{ijs}(\varphi)) + \sigma\chi_{ijs}(\varphi). \tag{E24}$$

The Lerner rule implies that the optimal price is a markup over the trade-adjusted marginal cost:

$$p_{ijs}(\varphi) = \frac{\varepsilon_{ijs}(\varphi)}{\varepsilon_{ijs}(\varphi) - 1}\tau_{ij}c_{js}. \tag{E25}$$

where c_{js} is the marginal cost of supplier s from country j.

Notice that strategic interaction now crosses borders directly: The addition of a supplier from country $k \neq j$ lowers Φ_i, which mechanically reduces the global share $\chi_{ijs}(\varphi)$ of an incumbent supplier in country j. Because $\frac{\partial\varepsilon_{ijs}}{\partial\chi_{ijs}} = \sigma - \theta < 0$, the drop in share increases the incumbent's elasticity, forcing the supplier in country j to lower its markup.

The buyer chooses the optimal sourcing strategy to maximize its profits:

$$\max_{\mathbf{S}_i} \pi_i(\varphi, \mathbf{S}_i) = B_i\varphi^{\sigma-1}\Phi_i(\mathbf{S}_i)^{1-\sigma} - \sum_{j\in J} wf_{ij}(S_{ij}), \tag{E26}$$

subject to $S_{ij} \leq \bar{S}_j$ for all $j \in J$.

Proposition 8 *As long as $\theta > \sigma$, an increase in the number of potential suppliers $\bar{S}_k$ in any country k triggers pro-competitive effects, lowering the global cost index and marginal cost for the more productive buyers.*

Proof. Let $\Delta_k\pi_{op}$ be the change in operating profit from adding an additional supplier from country k:

$$\Delta_k\pi_{op} = B\varphi^{\sigma-1}[\Phi_i(\mathbf{S}_i \cup \{s_k\})^{1-\sigma} - \Phi_i(\mathbf{S}_i)^{1-\sigma}]. \tag{E27}$$

As long as $\theta > \sigma$, adding a supplier strictly decreases the cost index ($\Phi_i(\mathbf{S}_i \cup \{s_k\}) < \Phi_i(\mathbf{S}_i)$) due to the pro-competitive effect. Hence, the bracketed term is positive. Furthermore, since $\sigma > 1$, the marginal benefit of adding a supplier is strictly increasing in the buyer's productivity φ. Hence, the profit function features increasing differences in $(\mathbf{S}_i, \varphi)$. By Topkis' Theorem, the unconstrained optimal sourcing network $\mathbf{S}_i^*(\varphi)$ is non-decreasing in φ.

Because $\mathbf{S}_i^*(\varphi)$ is increasing in φ, the upstream capacity constraint $S_{ik} \leq \bar{S}_k$ binds only for firms above a certain productivity threshold. For less productive firms, the optimal number of suppliers is strictly less than $\bar{S}_k$, so the constraint is slack. When upstream entry occurs (an exogenous increase in $\bar{S}_k$), the constraint is relaxed. Previously unconstrained firms do not change their sourcing strategy. In contrast, the constrained, highly productive firms expand their sourcing network.

This extensive margin expansion triggers a pro-competitive effect: The global expenditure shares χ_{ijs} of their incumbent suppliers (across all origins $j \in J$) fall, elasticities rise, and global markups μ_{ijs} are compressed. Consequently, the input cost index $\Phi_i(\varphi)$ and marginal cost $c_i(\varphi) = \gamma\Phi_i(\varphi)/\varphi$ fall for firms that add new suppliers. ■

Hence, upstream entry still benefits large downstream buyers more than small ones.

E The Combinatorial Multinomial Discrete Choice Problem

We consider the following combinatorial multinomial discrete choice problem,

$$\max_{\mathcal{M}\in\mathbb{Z}^n} \pi(\mathcal{M}, \varphi), \tag{E28}$$

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 $\pi(\mathcal{M}, \varphi)$.[35] 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 (E28). 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 build on the method of Jia (2008), Antràs et al. (2017) and Arkolakis et al. (2023a) for combinatorial *binary* choice problems to combinatorial *multinomial* choice problems. As in these papers, the key idea is to eliminate non-optimal choice sets without evaluating the profit function for all possible choices. Importantly, however, our assumptions (i) that buyers are matched with suppliers in the order of increasing marginal costs and (ii) that matching costs are symmetric allow us to go further and exclude a larger number of non-optimal choice sets. In the following, we prove that our algorithm is a valid special case of the one in Arkolakis et al. (2023a).

Definition 9 *The marginal value operators, D_i^+ and D_i^- are defined as*

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

[35] For example, firms in our model choose the number of suppliers to maximize profit in problem (20). 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.

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 10 *For any two decisions* $\mathbf{0} \leq \mathcal{M}_1 \leq \mathcal{M}_2 \leq \mathcal{S}$*, the profit function* $\pi(\mathcal{M},\varphi)$ *obeys single crossing differences from above (SCD-A) if for any option* $i \in \{1, 2, ..., n\}$*, we have*

$$D_i^+\pi(\mathcal{M}_2,\varphi) \geq 0 \;\Rightarrow\; D_i^+\pi(\mathcal{M}_1,\varphi) \geq 0, \tag{E29}$$
$$D_i^-\pi(\mathcal{M}_2,\varphi) \geq 0 \;\Rightarrow\; D_i^-\pi(\mathcal{M}_1,\varphi) \geq 0, \tag{E30}$$

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

$$D_i^+\pi(\mathcal{M}_1,\varphi) \geq 0 \;\Rightarrow\; D_i^+\pi(\mathcal{M}_2,\varphi) \geq 0, \tag{E31}$$
$$D_i^-\pi(\mathcal{M}_1,\varphi) \geq 0 \;\Rightarrow\; D_i^-\pi(\mathcal{M}_2,\varphi) \geq 0 \tag{E32}$$

where $\mathbf{0} = [0, ..., 0]$ *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.[36] 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 11 *(Squeezing procedure) Suppose the profit function* $\pi(\mathcal{M}_1,\varphi)$ *exhibits SCD-B. Then for problem (E28), 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*

$$S^B([\underline{\mathcal{M}}^{(k)}, \overline{\mathcal{M}}^{(k)}]) = [\underline{\mathcal{M}}^{(k+1)}, \overline{\mathcal{M}}^{(k+1)}], \tag{E33}$$

such that

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

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

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

$$\mathbb{1}_i^{k+} = \begin{cases} 1 & \text{if } D_i^+(\underline{\mathcal{M}}^{(k)}) \geq 0, \\ 0 & \text{otherwise ;} \end{cases} \quad \text{and } \mathbb{1}_i^{k-} = \begin{cases} 1 & \text{if } D_i^-(\overline{\mathcal{M}}^{(k)}) < 0, \\ 0 & \text{otherwise .} \end{cases} \tag{E34}$$

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 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 12 *Given the problem specified in (E28), 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

$$\underline{\mathcal{M}}^{(k+1)} = \underline{\mathcal{M}}^{(k)} + [\mathbb{1}_1^{k+}, \mathbb{1}_2^{k+}, ..., \mathbb{1}_n^{k+}], \tag{E35}$$

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

$$\overline{\mathcal{M}}^{(k+1)} = \overline{\mathcal{M}}^{(k)} - [\mathbb{1}_1^{k-}, \mathbb{1}_2^{k-}, ..., \mathbb{1}_n^{k-}], \tag{E36}$$

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 $n \cdot \max_{i=1,\ldots,n}\{S_i + 1\}$. 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 (E35) and (E36). ■

F The Estimation Algorithm

Here, we describe the algorithm to estimate the demand shifter and fixed cost of sourcing by the Simulated Method of Moments.

- **Step 1: Simulation of Firms.** Draw K independent realizations of supplier marginal cost distributions and N buyer productivity levels. These are combined to form a total sample of $M = KN$ synthetic firms, where each firm is characterized by a unique productivity-cost draw pair.

- **Step 2: Pre-computation of Prices.** For each supplier cost draw, calculate and store the equilibrium prices for every possible supplier configuration.

- **Step 3: Global Search and Multi-start Initialization.** Define a set of R initial parameter guesses, $\{\Phi_{0,r}\}_{r=1}^{R}$, using the global sampling strategy Latin Hypercube Sampling (LHS). Evaluate the objective function for all R candidates and retain the best $R' < R$ points to serve as starting values for local optimization.

- **Step 4: Optimal Sourcing Solution.** For each candidate parameter vector $\Phi_{t,r}$, solve the buyer's optimal sourcing problem. This utilizes the discrete choice algorithm detailed in Appendix E to determine the optimal supplier set for each of the M simulated firms.

- **Step 5: Moment Simulation.** Calculate the simulated moments $\tilde{m}_i(\Phi_{t,r})$ as the sample average across the M simulated firms:

$$\tilde{m}_i(\Phi_{t,r}) = \frac{1}{M}\sum_{j=1}^{M} m_{i,j}(\Phi_{t,r}). \tag{E37}$$

- **Step 6: Objective Function Evaluation.** Compute the distance between the simulated moments $\tilde{m}(\Phi_{t,r})$ and the empirical data moments m using a weighting matrix W:

$$y_{t,r} = (\tilde{m}(\Phi_{t,r}) - m)\, W\, (\tilde{m}(\Phi_{t,r}) - m)', \tag{E38}$$

  where $\tilde{m}(\Phi_{t,r}) = [m_1(\Phi_{t,r}), \ldots, m_S(\Phi_{t,r})]$ is the vector of targeted moments.

- **Step 7: Local Convergence.** If the objective value $y_{t,r} < \epsilon$, where ϵ is a small positive tolerance capturing numerical precision, the local optimization for path r has converged. Otherwise, update the parameter guess to $\Phi_{t+1,r}$ and return to Step 4.

- **Step 8: Global Minimum Selection.** After all R' local optimizations have converged to their respective optima Φ_r^*, identify the global estimate Φ^* that yields the minimum objective value across all starting points:

$$\Phi^* = \underset{r \in \{1,\ldots,R'\}}{\arg\min}\; y_r^*(\Phi_r^*) \tag{E39}$$

G 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	2,140	16.8	38.3	5	2,959	37.6	92.2	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 (%)	2,905	3.9	7.5	1.5	3,608	2.8	7.1	0.00
mean VA / worker CHN exporters (log)	2,691	4.16	0.82	4.09	3,574	5.00	0.87	4.93
variance VA / worker CHN exporters (log)	2,519	7.18	2.22	7.28	3,444	9.24	2.28	9.28
mean TFP CHN exporters (log)	2,691	6.95	0.88	6.89	3,574	7.58	0.97	7.49
variance TFP CHN exporters (log)	2,519	13.0	2.22	13.2	3,444	14.7	2.27	14.7
mean input unit value CHN exporters (log), de-meaned	2,869	4.17	1.40	4.21	3,698	4.29	1.48	4.30
share CHN processing trade	2,871	0.36	0.32	0.29	3,704	0.26	0.27	0.16
share CHN trade intermediares	2,871	0.41	0.24	0.40	3,704	0.32	0.20	0.30
share CHN foreign-owned exporters	2,871	0.17	0.12	0.15	3,704	0.17	0.12	0.14
share CHN multi-product exporters	2,871	0.95	0.11	0.99	3,704	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 (1m EUR)	11,319	596	6,099	4	22,790	484	5,743	3
FRA total imports (EUR 1,000)	12,572	785	7,088	43	25,738	864	7,631	32
FRA sales / worker (EUR 1,000)	10,679	4,603	28,543	215	20,860	4,657	35,298	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: Robustness

Reported Regressor: (log) # CHN→ROW Exporters$_{pt}$	No Wholesalers: Upstream (1)	No Wholesalers: Downstream (2)	CES Import Price Index (3)	Regressor: CHN→CHL/FRA Exporters: OLS (4)	IV: # CHN→ROW Exporters (5)	IV: # CHN→PA/US Exporters (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$_{fpt}$	0.123***	0.128**		0.113***	0.259***	0.126***
(log) Import Quantity$_{fpt}$	0.124***	0.197***	0.297***	0.151***	0.359***	0.232***
(log) Import Unit Value$_{fpt}$	-0.001	-0.069**	-0.091***	-0.038***	-0.100***	-0.106***
N	913,252	137,662	913,252	902,571	902,571	894,937
KP-Stat					610	349
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 exclude 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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3: Additional Robustness

	Balanced Sample (1)	Natural Quantity Units (2)	(3)	(4)	(5)	No Eastern Europe Importers (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$_{fpt}$	0.136***	0.282***	0.122***	0.116***	0.111***	0.090***
(log) Import Quantity$_{fpt}$	0.189***	0.369***	0.160***	0.153***	0.145***	0.127***
(log) Import Unit Value$_{fpt}$	-0.053***	-0.087***	-0.038***	-0.037***	-0.034***	-0.037***
N	497,024	311,431	840,407	633,852	902,571	324,616
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. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4: National vs. Global Competition

	France			Chile		
	(1) log(Price)$_{fpt}$	(2) log(Quantity)$_{fpt}$	(3) log(Value)$_{fpt}$	(4) log(Price)$_{fpt}$	(5) log(Quantity)$_{fpt}$	(6) log(Value)$_{fpt}$
log(# CHN $\rightarrow$ ROW Exporters)$_{pt}$	0.009	0.026**	0.034***	0.102***	-0.027	0.075***
	(0.031)	(0.034)	(0.017)	(0.031)	(0.034)	(0.017)
Imports from	ROW	ROW	ROW	ROW	ROW	ROW
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
Observations	8,376,869	8,376,869	8,376,869	1,343,923	1,343,923	1,343,924

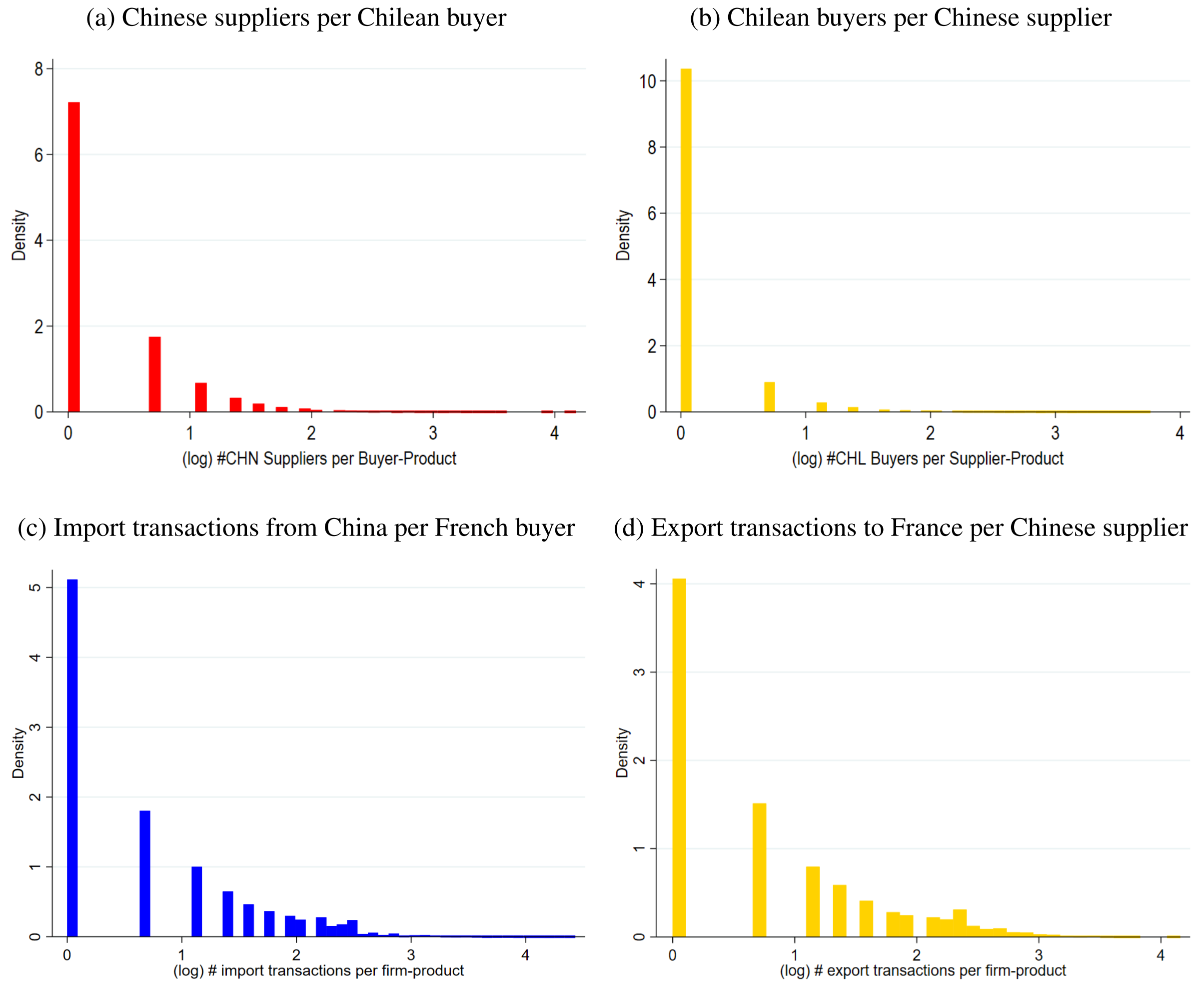
Note: This table examines the effect of supplier entry upstream on sourcing activity downstream. The dependent variable is the log value, quantity, or unit value of imports from China by Chilean or French firm, HS-6 product, and year. The main regressor is the log # Chinese exporters to ROW by product and year. Product$\times$year controls: log # Chilean or French importers from ROW; EU import tariff on China; mean and variance of Chinese exporters' productivity; mean input quality of Chinese exporters; value shares of Chinese processing, intermediated, state-owned, foreign-owned and multi-product-firm exports. Singletons dropped and standard errors clustered by HS-6 product $\times$ year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5: Chile-China Package Reforms: Consumer Price Index

	(1)	(2)	(3)
	China PTA	China PTA + Upstream market entry	China PTA + Lower matching costs
Panel A. Baseline			
Δ CPI	-0.63%	-1.19%	-1.26%
Panel B. Fixed Production Network			
Δ CPI	-0.58%	-0.57%	-0.58%
Panel C. Constant Markup			
Δ CPI	-0.85%	-1.12%	-0.88%

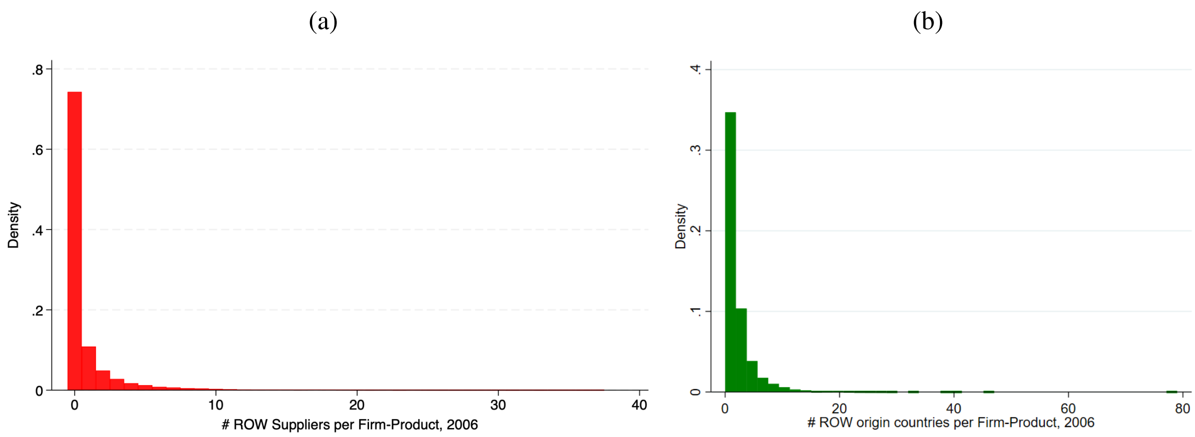
Note: This table presents changes in consumer welfare, measured in terms of consumer price index, for trade-cost reductions alone (Column 1) and combined with either upstream supplier entry (Column 2) or lower matching costs (Column 3). Panel A presents the baseline model with endogenous production networks and variable markups. Panel B conducts simulations after fixing buyer firms' sourcing strategies to baseline economy ones. Panel C conducts simulations assuming supplier firms charge a constant markup of $\theta/(\theta-1)$.

Figure A1: Sparse Production Networks



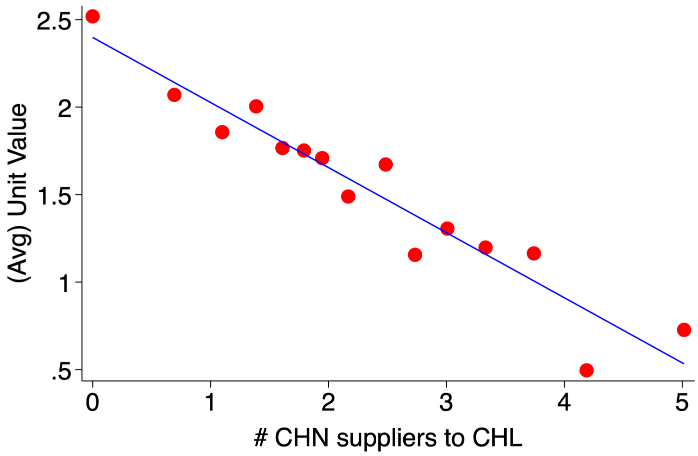
Note: Histograms of log number of (a) Chinese suppliers per Chilean buyer-HS6 product, (b) Chilean buyers per Chinese supplier-product, (c) import transactions from China per French buyer-product, and (d) export transactions to France per Chinese supplier-product.

Figure A2: ROW Suppliers to French and Chilean Buyers Sourcing from China



Note: Histograms of (a) the number of ROW suppliers by product and Chilean buyer conditional on importing the product from China; and (b) the number of ROW origins by product and French buyer conditional on importing the product from China.

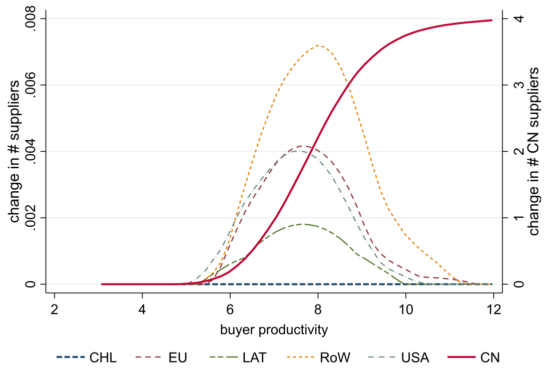
Figure A3: Average Input Price



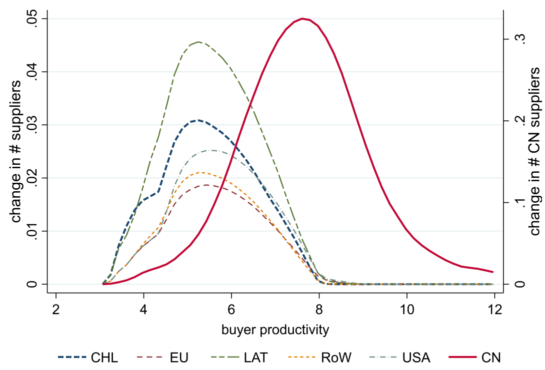
Note: Binscatter of the average log unit value for Chinese products exported to Chile (HS 6-digit), grouped into 20 bins sorted by the log number of Chinese exporters selling each product to Chile. Note that the bottom products all have 1 supplier, so the figure displays 15 bins.

Figure A4: Change in the Number of Suppliers per Origin

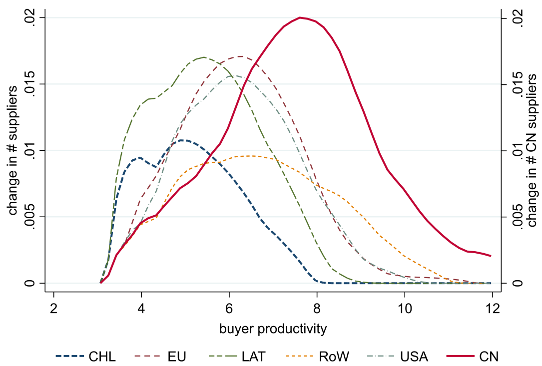
(a) 1 → 5 Chinese suppliers



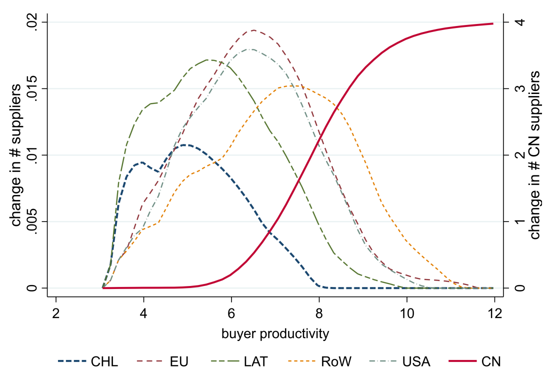
(b) ↓ 25% China matching costs



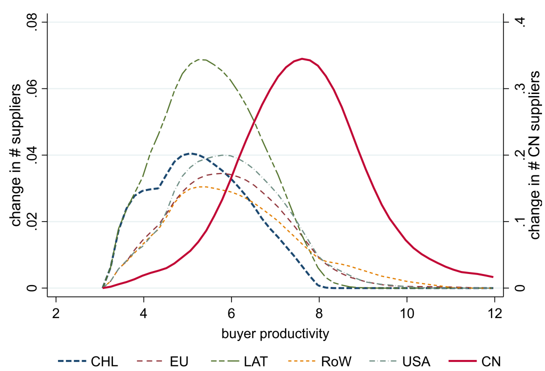
(c) Chile-China PTA (↓ 6% tariff)



(d) PTA + entry upstream



(e) PTA + cheaper matching



Note: The figure shows comparisons between the baseline model and counterfactual simulations for the number of suppliers (note that Chinese suppliers are on the right axis). 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 with China and an increase in the # of potential Chinese suppliers from 1 to 5; plot e) a 6% trade cost reduction with China and a reduction of β_0 and β_4 by 25%.