Firm Heterogeneity and Imperfect Competition in Global Production Networks*

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Abstract

We study the role of firm heterogeneity and imperfect competition for global production networks and the gains from trade. We develop a quantifiable trade model with two-sided firm heterogeneity, matching frictions, and oligopolistic competition upstream. More productive downstream buyers endogenously match with more upstream suppliers, thereby inducing tougher competition among them and enjoying superior sourcing outcomes. We then present consistent empirical evidence using highly disaggregated data on firms' production and trade transactions for France, Chile and China. Downstream French and Chilean buyers import higher values and quantities at lower prices as upstream Chinese markets become more competitive over time, with stronger responses by larger buyers. Chinese suppliers set lower prices and mark-ups to buyers that source from more suppliers. Counterfactual analyses indicate that lower barriers to entry upstream, lower matching costs, and lower trade costs amplify firm productivity and aggregate welfare downstream, with differential effects across firms. These effects operate through a combination of improved buyer-seller matches, gains from variety, and lower mark-ups. Global production networks thus generate greater impacts and cross-border spillovers from industrial policy and trade liberalization.

Keywords: global value chains, buyer-supplier production networks, firm heterogeneity, matching frictions, imperfect competition, gains from trade

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

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1 Introduction

Global value chains have fundamentally transformed international trade and firm operations in recent decades. Firms increasingly rely on imported inputs sourced from foreign suppliers and in turn sell to both final consumers and downstream producers at home and abroad (e.g. Antras et al. 2017, Bernard and Moxnes 2018). At the same time, there has been dramatic and growing heterogeneity in productivity, size and trade participation across firms within countries and sectors. Large firms dominate global trade and transact with the greatest number of buyers and suppliers (e.g. Bernard et al. 2012, Bernard et al. 2019). The skewness and granularity of the firm size distribution affect aggregate productivity and the gains from trade (e.g. Gabaix 2011, di Giovanni et al. 2014, Melitz and Redding 2015, Gaubert and Itskhoki 2016). The rise of superstar firms has also been accompanied by higher industry concentration and mark-ups (e.g. Autor et al. 2017, De Loecker and Eeckhout 2017, 2018, Yeaple 2019). These phenomena raise important questions about the optimal design of trade and industrial policies.

This paper examines the role of firm heterogeneity and imperfect competition for global production networks and the gains from trade. We develop a quantifiable trade model with two-sided firm heterogeneity, matching frictions, and oligopolistic competition upstream. More productive downstream buyers endogenously match with more upstream suppliers, thereby inducing tougher competition among them and enjoying superior sourcing outcomes. We then present consistent empirical evidence using highly disaggregated data on firms' production and trade transactions for France, Chile, and China. Downstream French and Chilean buyers import higher values and quantities at lower prices as upstream Chinese markets become more competitive over time, with stronger responses by larger buyers. Chinese suppliers set lower prices and mark-ups to buyers that source from more suppliers. Counterfactual analyses indicate that lower barriers to entry upstream, lower matching costs, and lower trade costs amplify firm productivity and aggregate welfare downstream, with differential effects across firms. These effects operate through a combination of improved buyer-seller matches, gains from variety, and lower mark-ups. Global production networks thus generate greater impacts and cross-border spillovers from industrial policy and trade liberalization.

Our first contribution is theoretical. We develop a general-equilibrium model of global sourcing in which heterogeneous buyers transact with heterogeneous suppliers in the presence of trade costs, matching frictions, monopolistic competition downstream, and oligopolistic competition upstream. At a higher fixed cost, downstream buyers can meet more potential suppliers and choose suppliers with higher buyer-supplier match quality. The number and identity of a firm's suppliers determines its suppliers' optimal buyer-specific price and mark-up.

The combination of matching frictions and imperfect competition implies that endogenous network formation amplifies the underlying heterogeneity among firms. More productive firms source from more suppliers (with their marginal supplier being less productive), and thereby induce tougher competition within their larger pool of suppliers. More productive firms thus enjoy lower input costs because of higher input variety, better-matched input providers, and lower input mark-ups, even though their average supplier is less productive. Respectively, more productive input suppliers sell more to more buyers (with their marginal buyer being less productive) and earn higher sales revenues.

A distinctive prediction of this framework is that a fall in upstream entry costs makes the market for input suppliers more competitive. As a result, sufficiently productive downstream firms optimally match with more suppliers and benefit from lower input costs, with the latter effect increasing with buyer productivity. By contrast, reductions in trade or matching costs enable buyers in the middle of the productivity distribution that are not yet sourcing from all potential suppliers to match with more suppliers. While all input buyers enjoy a lower input price index, those that expand their supplier set gain more.

Our second contribution is empirical. We combine firm-level production data and transaction-level customs data for the universe of French, Chilean and Chinese firms in 2000-2006 to validate key predictions of the model. This allows us to examine how the dramatic expansion in firm entry and trade activity in China has affected downstream producers in two economies at different segments of the global value chain and at different levels of economic development, Chile and France. For Chile, we exploit rich data on firm imports from China that identify the seller, HS 6-digit product, value, price and quantity at the transaction level, matched to indicators for broad firm size bins. For France, we access analogous transaction-level import data without the seller identity, but instead matched to detailed firm balance sheets. Finally, for China, we use matched data on firms' export transactions and balance sheets to characterize the Chinese market structure and the set of suppliers to France, Chile and the rest of the world (ROW) by HS-6 product.

Guided by the model, we quantify the upstream market structure relevant to individual producers in Chile and France with the number of potential Chinese suppliers by product and year. We present baseline results using the number of Chinese exporters to ROW excluding respectively Chile or France. We provide robust evidence using instead the actual number of Chinese exporters to Chile or France, which is arguably exogenous from the perspective of atomistic buyers. We also instrument the latter with the number of Chinese exporters either to ROW or to a larger yet comparable market: the Pacific Alliance countries in the case of Chile, and the US in the case of France. Given the importance of Chinese inputs to Chilean and French firms and the insignificance of the Chilean and French markets to China, our identification strategy allows us to draw causal conclusions. In turn, examining both Chile and France presents an opportunity to assess whether similar economic forces operate in environments with very different market size, economic development, and economic geography.

We first empirically establish that market structure upstream and buyer heterogeneity downstream shape the pattern of global production networks in line with the model's predictions. Downstream French and Chilean firms import greater quantities, pay lower unit prices, and spend more on imported inputs from China when there are more upstream Chinese producers. Bigger buyers benefit more from tougher competition among suppliers. These results are robust to controlling for firm, product and year fixed effects, as well as product-specific time trends. They are also not driven by other supply conditions upstream, such as the distribution of supplier productivity and quality, the roles of intermediated or processing trade, and the presence of multi-product or multinational sellers. The patterns are also independent of product-specific trade costs (import tariffs) and the downstream market structure.

Exploiting the richer information on trade partner identity in the Chilean data, we then provide additional evidence that Chinese suppliers systematically vary sales prices across Chilean firms in a way consistent with the market structure in the model. In particular, upstream sellers offer lower unit prices for the same HS 6-digit product to downstream buyers that source that product from more Chinese suppliers. This result obtains in stringent specifications that account for marginal costs and quality with seller-product pair fixed effects and for downstream demand with buyer-product pair fixed effects.

Our third contribution is methodological. The model permits structural estimation and quantification despite its rich economic environment. We are able to characterize firms' optimal sourcing strategy, even though it is the outcome of a high-dimensional combinatorial discrete-choice optimization problem. We develop a solution method that extends tools from the prior literature (such as convexification, sequential supplier entry into matching markets, and Fréchet-distributed match quality) to endogenous production networks with two-sided heterogeneity and imperfect competition (Antràs et al. 2017, Arkolakis et al. 2021, Taschereau-Dumouchel 2019). The model also delivers gravity expressions for trade flows at the firm-to-firm and firm levels. This makes it possible to estimate key model parameters from the available data, while calibrating others to estimates from the literature that are consistent with the model.

Our last contribution is quantitative. We use the model to evaluate the effect of trade policy, industrial policy, and technological progress on global sourcing and the gains from trade. We find that lower barriers to entry upstream, lower matching costs, and lower trade costs amplify firm productivity, firm size dispersion, and aggregate welfare downstream. These effects operate through a combination of improved matching of buyers and suppliers, gains from greater input variety, and lower mark-ups. Shutting down one model feature at a time, we establish that two-sided firm heterogeneity, matching frictions and imperfect competition all play a large quantitative role.

These counterfactual exercises have important policy implications. Existing studies that evaluate trade policies rely on Computable General Equilibrium (CGE) models or New Quantitative Trade Models (NQTM), which typically ignore global production networks, firm granularity, and/or market power.[1] Our results indicate that taking these forces into account can generate significantly higher gains from trade. In addition, our analysis illustrates the benefits associated with reductions in buyer-supplier matching costs as distinct from trade costs. This may provide justification for policies that decrease matching costs through trade promotion, information technology or international contract enforcement. Finally, our conclusions reveal how imperfect competition in global value chains gives rise to cross-border spillovers of national industrial policies such as deregulation and other reforms that encourage firm entry.

We advance several strands of literature. Most directly, we contribute to research on the determinants of global sourcing and its implications for firm performance. Access to foreign inputs has been shown to increase aggregate welfare and firm productivity, product quality, innovation, and profitability (Amiti and Konings, 2007; Goldberg et al., 2010; Halpern et al., 2015; Yu, 2015; Bøler et al., 2015; Manova et al., 2015; Blaum

[1] Ottaviano (2014) discusses the difference between these two approaches, while Costinot and Rodríguez-Clare (2014) provide a synthetic treatment of NQTM.

et al., 2018). Recent theory emphasizes the role of firm productivity and trade costs in driving these outcomes (Antras, Fort, and Tintelnot, 2017; Furusawa et al., 2017; Boehm and Oberfield, 2018; Bernard et al., 2019). This literature assumes perfect or monopolistic competition upstream and typically abstracts from matching frictions, such that heterogeneous downstream firms source promiscuously from anonymous upstream suppliers.

A growing research stream examines the role of firm heterogeneity in buyer-supplier production networks (see Bernard and Moxnes, 2018 for a recent survey). Bernard et al. (2019) study the impact of domestic supplier connections on firms' marginal costs and performance in Japan, whereas Bernard et al. (2018), Eaton et al. (2016), and Eaton et al. (2018) explore the matching of exporters and importers using data on firm-to-firm trade transactions for Norway, US-Colombia, and France, respectively. Bernard, Dhyne Magermann, Manova, Moxnes (2019) find that two-sided firm heterogeneity and match-specific shifters are important in explaining the variation in firm-to-firm sales in the complete domestic production network in Belgium. Recent models of buyer-seller networks feature monopolistically competitive markets that imply constant mark-ups, with generally one-sided firm heterogeneity (Chaney, 2014; Eaton et al., 2015; Bernard, Moxnes, and Ulltveit-Moe, 2018; Lim, 2018; Oberfield, 2018).

Extending these two literatures, we consider global production networks with (i) two-sided firm heterogeneity, (ii) matching frictions, and (iii) imperfect competition upstream. The interaction of these three forces gives rise to novel theoretical insights, and is thus necessary and sufficient to rationalize empirical patterns in the data that other frameworks cannot. On necessity, models without (i) or (ii) cannot simultaneously account for the variation in sourcing patterns across downstream firms, across suppliers within buyers, and across buyers within suppliers. Frameworks that feature (i) and (ii) but omit (iii) rule out heterogeneous pricing across buyers within a supplier and differential effects of changes in the market structure upstream across downstream firms; this includes a large class of models in the prior literature. On sufficiency, ours is the first within a potential class of data-consistent models that accommodate the complexity of (i), (ii) and (iii), yet remains parsimonious and highly tractable.

Indirectly, we also contribute to the literature on imperfect competition in international trade. Classic paradigms with monopolistic competition have attractive theoretical and empirical properties (Krugman 1980, Melitz 2003). Without assumptions of CES demand and Pareto-distributed productivity, however, such models typically cannot generate gravity expressions for aggregate trade flows, which restricts their use in structural estimation (Melitz and Ottaviano, 2008; Arkolakis et al., 2018; Combes et al., 2012; Head et al., 2014; Head and Spencer, 2017). Recent advances accommodate the role of superstar firms in tractable oligopolistic environments with data-inspired strategic interactions among firms (Bernard et al., 2003; Atkeson and Burstein, 2008; Edmond et al., 2015; Neary, 2016; Amiti et al., 2018). Our contribution is to develop a tractable model of imperfect competition in produciton networks that can both match micro-level empirical patterns and generate gravity trade flows conducive to counterfactual analysis.

At a broader level, we shed more light on the implications of production networks for the firm size distribution. Prior work indicates that not only own characteristics, but also characteristics of input suppliers contribute to the large and growing firm size dispersion

(Melitz, 2003, Sutton, 2007, Bernard, Dhyne Magermann, Manova, Moxnes, 2019). We show that endogenous match formation with imperfect competition upstream is one mediating force through which produciton networks augment the productivity advantage of more efficient firms and thereby amplifies the firm size dispersion.

Our work also informs the transmission of idiosyncratic and macro-economic shocks. Input-output linkages in asymmetric networks have been found to generate aggregate shocks from firm-specific shocks and enhance long-run growth (Acemoglu et al., 2012; Baqaee, 2018; Baqaee and Farhi, 2019; Acemoglu and Azar, 2017; Magerman et al. 2016). Global production networks can in turn transmit shocks across countries (Carvalho et al., 2016; Boehm et al., 2019; Lim, 2018; Tintelnot et al. 2017). Our analysis suggests imperfect competition and two-sided heterogeneity can strengthen these transmission mechanisms, while global sourcing can generate international externalities from domestic industrial and trade policies.

The paper is organized as follows. Section 2 presents the model of global sourcing with two-sided firm heterogeneity, endogenous buyer-supplier match formation, and oligopolistic competition upstream. Section 3 introduces the production and trade data for France, Chile and China, and provides reduced-form empirical evidence in line with the model's predictions. Section 4 develops and implements a structural estimation strategy for operationalizing the model. Section 5 performs counterfactual exercises within the model to evaluate the impact of industrial policies, trade reforms, and technological progress. The last section concludes.

2 Theoretical Framework

We first develop a quantifiable, general-equilibrium model of global sourcing in which heterogeneous buyers match with heterogeneous suppliers in the presence of trade costs. We examine the impact of matching frictions and oligopolistic competition upstream on the sourcing behavior of monopolistically competitive firms downstream. We characterize the endogenous formation of the global production network and key outcomes at the firm- and firm-to-firm transaction levels. We relegate detailed proofs to an online Appendix.

2.1 Final Demand

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

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

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

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

2.2 Downstream Production

In each country, a continuum of monopolistically competitive firms assemble domestic and imported inputs to manufacture final goods. Firms optimally set a constant mark-up above their marginal production cost $c_i(\omega)$ to maximize profits:

$$\max_{p_i(\omega)} \ (p_i(\omega) - c_i(\omega))q_i(\omega), \ s.t. \ q_i(\omega) = E_i P_i^{\sigma-1} p_i(\omega)^{-\sigma},$$

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

Downstream firms draw core productivity φ from distribution $G_i(\varphi)$ with support $[\overline{\varphi}_i, \infty)$, upon paying an entry cost of $w_i f_i$. They manufacture by combining varieties v produced by upstream suppliers s in countries $j \epsilon J$ and sectors $k \epsilon K$. The elasticities of substitution across varieties from the same country-sector and across varieties from different country-sectors are $\lambda > 1$ and $\eta > 1$, respectively. The marginal cost of downstream firm φ is given by:

$$c_i(\varphi) = \frac{1}{\varphi}\left(\sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi) c_{ijk}(\varphi)^{1-\eta}\right)^{\frac{1}{1-\eta}}, \ c_{ijk}(\varphi) = \left(\int_0^1 z_{ijk}\left(\varphi, v\right)^{1-\lambda} dv\right)^{\frac{1}{1-\lambda}}, \quad (2)$$

where $I_{ijk}(\varphi)$ is an indicator equal to 1 if the firm sources sector k inputs from country j, and $c_{ijk}(\varphi)$ is the composite cost index of jk inputs.

The input cost index $c_{ijk}(\varphi)$ aggregates the cost to φ of input varieties v, $z_{ijk}\left(\varphi, v\right)$. It is specific to downstream firm φ for two reasons: oligopolistic competition upstream and matching frictions. Imperfect competition upstream will imply that the price $p_{ijks}\left(\mathcal{S}_{ijk}(\varphi)\right)$ offered by supplier s to buyer φ will depend on the endogenous, discrete set of φ's suppliers in country j and sector k, $\mathcal{S}_{ijk}(\varphi)$. A supplier may thus charge different prices to different buyers. In addition, matching frictions will lead downstream firms to endogenously choose different sets of suppliers based on their productivity.

After matching with supplier s and observing s's price for variety v, firm φ receives a match-specific cost shock $\xi_{ijks}(\varphi, v)$ from a Fréchet distribution with dispersion parameter θ.[2] This shock can be thought of as the unexpected cost of adapting an input to the firm's production process, or alternatively, as the cost equivalent of an expected quality defect. Thus equally productive buyers matched with the same set of suppliers may choose different suppliers for the same input variety.

Conditional on sourcing inputs from a given country-sector, the downstream firm optimally buys variety v from the lowest-cost upstream supplier it has matched with:

$$z_{ijk}(\varphi, v) = \min_{s \in \mathcal{S}_{ijk}(\varphi)} \left\{\tau_{ijk} p_{ijks}\left(\mathcal{S}_{ijk}(\varphi)\right) \xi_{ijks}(\varphi, v)\right\}, \ \Pr(\xi_{ijks}(\varphi, v) \geq t) = e^{-t^{\theta}}, \ \theta > 0, \ (3)$$

where τ_{ijk} is the iceberg trade cost of shipping sector-k inputs from country j to i.

[2]Higher θ corresponds to higher input substitutability across suppliers.

2.3 Upstream Production

A discrete number of upstream suppliers S_{jk} produce differentiated inputs in country j and sector k at a constant marginal cost c_{jks}.[3] In order to sell to downstream buyers in country i, they have to pay a fixed cost of $w_j f_{ijk}^U$ (U for upstream), which can be thought of as the supplier registration fee to attend a trade fair in a convention center. This fixed cost will imply that only the most productive suppliers select into exporting.

Upstream suppliers $s\epsilon\mathcal{S}_{ijk}(\varphi)$ matched to downstream buyer φ in country i compete oligopolistically amongst themselves.[4] They set their optimal match-specific prices to maximize profits $\pi_{ijks}^U(\varphi)$ separately from each relationship:

$$\max_{p_{ijks}(\varphi)} \pi_{ijks}^U(\varphi) = Q_{ijks}(\varphi)(p_{ijks}(\varphi) - c_{jks}) \tag{4}$$

where $Q_{ijks}(\varphi)$ is the expected residual demand of buyers with productivity φ.

2.4 Buyer-Supplier Matching

Let S_{ijk} suppliers in country j be productive enough to export to country i in sector k. We assume there are S_{ijk} rooms in the convention center where upstream and downstream firms can meet. These rooms can hold bidding games with seats for 1, 2, $\cdots$, S_{ijk} suppliers, respectively. Each buyer from country i can choose which room to enter, but it has to pay a higher fixed cost to hold a bidding game in a bigger room, i.e. $f_{ijk}^D(S_{ijk}) \geq f_{ijk}^D(S_{ijk}-1) \geq \cdots \geq f_{ijk}^D(1) \geq 0$ (D for downstream). These matching costs can be thought of as the registration fees and sourcing managers that scale up with the number of suppliers.

Upstream firms enter each bidding room sequentially in increasing order of marginal costs, until the room reaches capacity. This assumption will ensure a unique matching equilibrium and grant significant tractability: Instead of facing a high-dimensional choice over $2^{S_{ijk}}$ possible sets of jk suppliers, a downstream firm has to consider only S_{ijk} options.[5] At the cost of $w_i f_{ijk}^D(S'_{ijk})$, a buyer from country i can therefore match with the top S'_{ijk} suppliers of sector k inputs in country j.

2.5 Firm Sourcing Problem

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

[3]Upstream suppliers can produce all varieties in a given sector and can operate in multiple sectors. Their marginal cost is constant across varieties within a sector, but it can vary across sectors.

[4]In the spirit of Neary (2016), upstream suppliers are large to an individual downstream buyer, but small to the downstream sector as a whole.

[5]This assumption also underlies the solution concept in Eaton et al. (2012) and Gaubert and Itskhoki (2016). It can be rationalized for example with room-specific fixed costs, whereby more productive suppliers expect higher profits and are more likely to be profitable in bigger, more competitive rooms.

2.5.1 Sourcing Pattern Conditional on Supplier Set

Within origin country-sector jk, buyer φ will source variety v from the lowest-cost of its matched suppliers $S_{ijk}(\varphi)$ by solving the sourcing problem in equation (3). The probability that supplier s is this lowest-cost supplier is:

$$\chi_{ijks}(\varphi) = \frac{p_{ijks}(S_{ijk}(\varphi))^{-\theta}}{\sum_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(S_{ijk}(\varphi))^{-\theta}}. \tag{5}$$

With a continuum of varieties and iid cost shocks across matches, the law of large numbers implies that $\chi_{ijks}(\varphi)$ is also the market share of supplier s in the buyer's expenditure on jk inputs. Buyers' composite cost index for jk inputs is thus:

$$c_{ijk}(\varphi) = \gamma\tau_{ijk}\left[\sum_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(\varphi)^{-\theta}\right]^{-1/\theta}, \tag{6}$$

where $\gamma = \left[\Gamma(\frac{\theta+1-\lambda}{\theta})\right]^{\frac{1}{\lambda-1}}$ is a constant given by the gamma function $\Gamma(\cdot)$.[6] Downstream firms' total input costs, $C_i(\varphi)$, and demand for jk inputs, $Q_{ijk}(\varphi)$, can be expressed as:

$$C_i(\varphi) = q_i(\varphi)c_i(\varphi) = (\frac{\sigma-1}{\sigma})^{\sigma} E_i P_i^{\sigma-1} c_i(\varphi)^{1-\sigma}, \tag{7}$$

$$Q_{ijk}(\varphi) = (\frac{\sigma-1}{\sigma})^{\sigma} E_i P_i^{\sigma-1} \varphi^{\eta-1} c_i(\varphi)^{\eta-\sigma} c_{ijk}(\varphi)^{-\eta}. \tag{8}$$

From the perspective of upstream supplier s, residual demand by buyer φ is $Q_{ijks}(\varphi) = Q_{ijk}(\varphi)\chi_{ijks}(\varphi)$, such that the supplier's problem (4) becomes:

$$\max_{p_{ijks}(\varphi)} \pi^U_{ijks}(\varphi) = Q_{ijk}(\varphi)\chi_{ijks}(\varphi)(p_{ijks}(\varphi) - c_{jks}),\ s = 1, ..., S_{ijk}(\varphi). \tag{9}$$

While a higher price boosts a seller's profit margin, $p_{ijks}(\varphi) - c_{jks}$, it reduces its market share $\chi_{ijks}(\varphi)$ and residual demand $Q_{ijk}(\varphi)$ by raising the buyer's marginal cost $c_i(\varphi)$. Proposition 1 summarizes suppliers' optimal pricing strategy:

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

$$p_{ijks}(\varphi) = \frac{\varepsilon_{ijks}(\varphi)}{\varepsilon_{ijks}(\varphi) - 1} c_{jks}, \tag{10}$$

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

Upstream firms are able to price discriminate and charge buyer-specific mark-ups, $\mu_{ijks}(\varphi) = \frac{\varepsilon_{ijks}(\varphi)}{\varepsilon_{ijks}(\varphi)-1}$.[7] Suppliers set higher mark-ups when they have a bigger market

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

[7] In Atkeson and Burstein (2008), the presence of market-specific iceberg trade costs is necessary to generate pricing to market. In our model, markets are further segregated across firms due to matching frictions.

share in their buyer's input basket, if $\rho_{ijk}(\varphi) \equiv \theta - \eta + (\eta - \sigma)\delta_{ijk}(\varphi) > 0$; we assume this condition holds given evidence in the prior literature (Amiti. et al. 2019, Kikkawa et al. 2019).[8] This implies that downstream firms with more diversified sourcing portfolios and lower average $\chi_{ijks}(\varphi)$ enjoy lower mark-ups. Suppliers also have less market power (higher input demand elasticity $\varepsilon_{ijks}(\varphi)$) and charge lower mark-ups when buyers face more elastic final demand (higher σ) and inputs are more substitutable across and within countries and sectors (higher η and θ).[9]

Proposition 2 describes the benefits to a buyer associated with sourcing inputs from more suppliers:

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

These results reflect several effects: Along the extensive margin, higher $S_{ijk}(\varphi)$ increases the probability that the buyer finds a better-matched and therefore lower-cost supplier for any input variety. It also generates cost savings from gains to input variety. Along the intensive margin, higher $S_{ijk}(\varphi)$ intensifies competition among matched suppliers and lowers the price and mark-up of each incumbent variety. These three beneficial effects outweigh a final counteracting effect on the extensive margin: Given sequential supplier entry into bidding rooms, expanding the set of matched suppliers means that the buyer adds some less productive suppliers on the margin.

These effects can be illustrated by decomposing the fall in the buyer's input price index following a rise in the number of suppliers from $S_{ijk}(\varphi)$ to $S_{ijk}(\varphi)'$. If $\widehat{\mu}_{ijks}(\varphi) = \frac{\mu_{ijks}(\varphi)'}{\mu_{ijks}(\varphi)}$ denotes mark-up changes and $\sum_{s=S_{ijk}(\varphi)+1}^{S_{ijk}(\varphi)'} \chi_{ijks}(\varphi)'$ is the market share of new suppliers, the change in $c_{ijk}(\varphi)$ is:

$$\widehat{c}_{ijk}(\varphi) \equiv \frac{c_{ijk}(\varphi)'}{c_{ijk}(\varphi)} = \left[\frac{\sum_{s=1}^{S_{ijk}(\varphi)} \chi_{ijks}(\varphi)\widehat{\mu}_{ijks}(\varphi)^{-\theta}}{1 - \sum_{s=S_{ijk}(\varphi)+1}^{S_{ijk}(\varphi)'} \chi_{ijks}(\varphi)'} \right]^{-1/\theta} \Rightarrow \tag{11}$$

$$\log \widehat{c}_{ijk}(\varphi)^{-\theta} = \underbrace{\log \left(\sum\nolimits_{s=1}^{S_{ijk}(\varphi)} \chi_{ijks}(\varphi)\widehat{\mu}_{ijks}(\varphi)^{-\theta} \right)}_{\text{intensive margin}} - \underbrace{\log \left(1 - \sum\nolimits_{s=S_{ijk}(\varphi)+1}^{S_{ijk}(\varphi)'} \chi_{ijks}(\varphi)' \right)}_{\text{extensive margin}}.$$

The fall in the input price index combines changes on the intensive margin (lower mark-ups by incumbent suppliers) and the extensive margin (market share reallocation across suppliers). [10]

[8] We show that $\rho_{ijk}(\varphi) > 0$ implies strategic complementarities in price setting across upstream firms.

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

[10] If there is secular productivity growth and suppliers' marginal costs fall, this would also lower buyers' input price index. The expressions for $\widehat{c}_{ijk}(\varphi)$ would then always multiply incumbent suppliers' market shares $\chi_{ijks}(\varphi)$ with their supplier-specific cost shocks $\widehat{c}_{jks}^{-\theta}$.

2.5.2 Optimal Supplier Set

Downstream firms optimally choose their set of country-sector origins $\mathbb{I}_i(\varphi)$ and suppliers $\mathbb{S}_i(\varphi)$ by maximizing total profits:

$$\max_{\substack{I_{ijk}(\varphi)\in\{0,1\}_{j=1,k=1}^{J,K} \\ S_{ijk}(\varphi)\in\{0,1,2,\ldots,S_{ijk}\}_{j=1,k=1}^{J,K}}} \pi_i^D(\varphi) = B_i c_i(\varphi)^{1-\sigma} - \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi) w_i f_{ijk}^D(S_{ijk}(\varphi)), \tag{12}$$

$$c_i(\varphi) = \frac{\gamma}{\varphi}\Theta_i(\varphi)^{\frac{1}{1-\eta}},\ \Theta_i(\varphi) \equiv \sum_{j=1}^{J}\sum_{k=1}^{K} I_{ijk}(\varphi)\tau_{ijk}^{1-\eta}\left[\sum\nolimits_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(\varphi)^{-\theta}\right]^{-\frac{1-\eta}{\theta}}, \tag{13}$$

where $B_i = \frac{1}{\sigma}(\frac{\sigma}{\sigma-1})^{1-\sigma}E_iP_i^{\sigma-1}$ is the final demand shifter in country i, and the firm's marginal cost $c_i(\varphi)$ decreases with its *sourcing capability* $\Theta_i(\varphi)$ since $\eta > 1$. Although there is no explicit solution to this high-dimensional discrete-choice problem, the following proposition characterizes the optimal sourcing strategy:

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

Result (a) implies that downstream firms observe a pecking order of input sourcing both across country-sector origins jk and across potential jk suppliers. This holds when final goods are closer substitutes to each other than intermediate inputs in production, $\sigma > \eta$. This condition is intuitive: a laptop and a desktop are certainly more substitutable than the motherboards, soundcards, software etc. than go into the production of these devices. We assume this condition is satisfied, as it gives rise to negative degree assortative matching between buyers and suppliers on the extensive margin, in line with prior evidence in the literature (Bernard and Moxnes, 2018). In particular, more productive firms purchase inputs from more countries in more sectors. They also transact with more suppliers in each country and sector, including less productive suppliers on the margin. By contrast, less productive firms use inputs from fewer origins and suppliers within origins, and match with only the more productive suppliers. Symmetrically, more productive upstream firms sell to a wider range of downstream buyers, including to less productive buyers, compared to their less productive competitors.

Figure 1a illustrates the negative degree assortative matching between upstream suppliers (top row of circles) and downstream buyers (bottom row of circles) under sourcing complementarity, with circle sizes indicating firm productivity. For reference, Figure 1b shows one possible counteractual network that would emerge under sourcing substitutability. [11]

[Insert Figure 1 about here]

[11] Therefore, our model shows that the sourcing technology faced by downstream firms determines the assortativity of the buyer-supplier network.

Together with Proposition 2, result (b) implies that endogenous sourcing in global production networks amplifies the productivity advantage of more efficient downstream firms. This prediction is also consistent with earlier evidence in the literature for the contribution of production networks to the firm size dispersion (Bernard et al. 2019).

2.6 Trade Flows

We next characterize trade flows at different levels of aggregation. The gravity expressions we derive here underlie our structural estimation methodology.

2.6.1 Firm-to-Firm Trade

Imports of sector-k inputs by downstream firm φ in country i from an upstream supplier s in country j are:

$$\begin{aligned} X_{ijks}(\varphi) &= A_i \varphi^{\eta-1} c_i(\varphi)^{\eta-\sigma} \tau_{ijk}^{-\theta} c_{ijk}(\varphi)^{1+\theta-\eta} p_{ijks}(\varphi)^{-\theta} \\ &= \gamma^{\eta-\sigma} A_i \varphi^{\sigma-1} c_{jks}^{-\theta} \tau_{ijk}^{-\theta} \Psi_{ijk}(\varphi, c_{jks}, S_{ijk}) \end{aligned} \tag{14}$$

where $A_i = \gamma^{-\theta}(\frac{\sigma-1}{\sigma})^{\sigma} E_i P_i^{\sigma-1}$. The second equality obtains from equations (2), (6) and (10) for $c_i(\varphi)$, $c_{ijk}(\varphi)$ and $p_{ijks}(\varphi)$, where $\Psi_{ijk}(\varphi, c_{jks}, S_{ijk}) \equiv \Theta_i(\varphi)^{\frac{\sigma-\eta}{\eta-1}} \mu_{ijks}(\varphi)^{-\theta} c_{ijk}(\varphi)^{\theta+1-\eta}$ varies across downstream firms φ because matching frictions and imperfect competition upstream affect their sourcing capability $\Theta_i(\varphi)$ and input mark-ups $\mu_{ijks}(\varphi)$.

Firm-to-firm sales $X_{ijks}(\varphi)$ increase with the productivity of the supplier. A higher marginal cost c_{jks} reduces the supplier's market share in the buyer's input purchases and additionally drives down the buyer's overall input demand.

How firm-to-firm sales vary with buyer productivity depends on the net effect of two opposing forces. On the one hand, more productive downstream firms face higher output demand and need more intermediate inputs. This scale effect is amplified by the endogenously higher sourcing capability of more productive firms. On the other hand, more productive buyers source from more suppliers, and this competition effect reduces input demand from an individual supplier. If the scale effect dominates, $X_{ijks}(\varphi)$ increases with the productivity of the buyer. We assume this holds as it implies positive assortative matching between buyers and suppliers on the intensive margin, consistent with evidence in the literature (Sugita et al., 2014; Benguria, 2015; Bernard and Moxnes 2018). This is illustrated by the thickness of the arrows in the network map in Figure 1a.

2.6.2 Firm-Level Trade

At the firm level, imports by downstream firm φ in country i of sector-k inputs from country j are:

$$\begin{aligned} X_{ijk}(\varphi) &= (\frac{\sigma-1}{\sigma})^{\sigma} E_i P_i^{\sigma-1} \varphi^{\eta-1} c_i(\varphi)^{\eta-\sigma} c_{ijk}(\varphi)^{1-\eta} = \\ &= \gamma^{1-\eta}(\frac{\sigma-1}{\sigma})^{\sigma} E_i P_i^{\sigma-1} \varphi^{\eta-1} c_i(\varphi)^{\eta-\sigma} \tau_{ijk}^{1-\eta} \left(\sum\nolimits_{s=1}^{S_{ijk}(\varphi)} \mu_{ijks}(\varphi)^{-\theta} {c_{jks}}^{-\theta}\right)^{\frac{\eta-1}{\theta}}, \end{aligned} \tag{15}$$

where the last equality follows from equations (6) and (10) for $c_{ijk}(\varphi)$ and $p_{ijks}(\varphi)$. Matching frictions and imperfect competition upstream both influence firm-level imports: $X_{ijk}(\varphi)$ increases with the endogenous choice of suppliers $S_{ijk}(\varphi)$ both directly and indirectly through lower mark-ups $\mu_{ijks}(\varphi)$.

2.6.3 Sector-Level Trade

Aggregating across firms, total sector-k imports from country j into country i are:

$$X_{ijk} = \int_{\overline{\varphi}_{ijk}}^{\infty} X_{ijk}(\varphi) dG_i(\varphi), \tag{16}$$

where $\overline{\varphi}_{ijk}$ is the least productive downstream buyer in i that sources jk inputs.

2.7 Industry and General Equilibrium

In equilibrium, free entry into downstream production implies that expected profits from entry must equal the fixed cost of entry, such that only firms above a threshold productivity $\overline{\varphi}_i$ begin operations:

$$\int_{\overline{\varphi}_i}^{\infty} \pi_i^D(\varphi) dG_i(\varphi) = w_i f_i. \tag{17}$$

In the upstream sector, all country-j input producers below a certain marginal cost cut-off will be able to sell to downstream buyers in country i. This selection results from the combination of fixed export costs per destination and sequential entry into bidding rooms. The number of suppliers from j to i, S_{ijk}, is determined by the profits of the least productive, marginal supplier $\overline{s}_{ijk}$, $\Pi^U_{\overline{s}_{ijk}, S_{ijk}}$:

$$\Pi^U_{\overline{s}_{ijk}, S_{ijk}} = \Delta_i \int_{\overline{\varphi}_{ijk\overline{s}}}^{\infty} \pi^U_{\overline{s}_{ijk}, S_{ijk}}(\varphi) dG_i(\varphi), \; \Pi^U_{\overline{s}_{ijk}, S_{ijk}} \geq w_j f^U_{ijk}, \; \Pi^U_{\overline{s}_{ijk}+1, S_{ijk}} < w_j f^U_{ijk}, \tag{18}$$

where $\overline{\varphi}_{ijk\overline{s}}$ is the least productive downstream buyer in country i that buys sector-k inputs from the marginal upstream supplier in country j. It can be shown that the equilibrium mass of downstream firms in i, Δ_i, is given by:

$$\Delta_i = \frac{\alpha L_i}{\sigma \left[\int_{\overline{\varphi}_i}^{\infty} \sum_{j \otimes k \in \mathbb{I}_i(\varphi), S_{ijk} \in \mathbb{S}_i(\varphi)} f^D_{ijk}(S_{ijk}) dG_i(\varphi) + f_i \right]}. \tag{19}$$

2.8 Comparative Statics

How do industrial policy, trade policy and technological progress affect firms in a global production network?

Consider first an exogenous increase in the number of upstream suppliers in country j and sector k from S_{ijk} to $S_{ijk}{}'$. This could for example result from deregulation that lowers entry costs or encourages more firms to export. Since the marginal upstream entrants are less productive, the impact on downstream buyers combines (positive) pro-competitive and love-of-variety effects and a (negative) selection effect of entry. From Proposition 2, sourcing from more suppliers $S_{ijk}(\varphi)$ does reduce buyer φ's input price index $c_{ijk}(\varphi)$ on net. However, not all buyers will match with more suppliers following firm entry upstream: From Proposition 3, more productive downstream firms will be more likely to enter a bigger bidding room, expand their pool of suppliers, and benefit from deregulation upstream. We summarize the effect of a rising number of suppliers in the sourced country on downstream sourcing in the following proposition.

Proposition 4 *Under sourcing complementarity, a rise in the number of country-j sector-k suppliers S_{ijk}*
(a) weakly increases the number of jk suppliers to a buyer;
(b) weakly reduces buyers' input price index $c_{ijk}(\varphi)$ and weakly increases quantities $Q_{ijk}(\varphi)$ and purchases $X_{ijk}(\varphi)$ of jk inputs;
(c) exerts bigger effects on more productive buyers.

Figure 2 (a) visualizes the effect of result (a). As we can see, only firms productive enough will be able to include the new suppliers. More productive buyers weakly include more new suppliers.

We next consider a reduction in trade costs τ_{ijk} or matching costs $f^D_{ijk}(S_{ijk})$. Intuitively, both would make it more profitable for more downstream buyers to source inputs from more country-sector origins and from more suppliers within country-sectors.

Proposition 5 *Under sourcing complementarity $\sigma > \eta$ and a fixed market demand shifter B_i, a fall in country-j sector-k trade costs τ_{ijk} or matching costs $f^D_{ijk}(S_{ijk})$*
(a) weakly expands buyers' sourcing strategy $\mathbb{I}_i(\varphi)$ and $\mathbb{S}_i(\varphi)$;
(b) weakly reduces buyers' input price index $c_{ijk}(\varphi)$ and weakly increases input purchases $X_{ijk}(\varphi)$ of jk inputs;
(c) exerts bigger effects on more productive buyers.

The effect is demonstrated in Figure 2 (b). A reduction of trade costs or matching costs reduces the productive cut-offs to source from certain number of suppliers. For the most productive firms, they would have sourced from every suppliers anyway. For the least productive firms, the cost reduction is not enough to induce them to buy from foreign suppliers. Therefore, the effect is bigger for the mid productive buyers.

We define the *supply potential* of country j in sector k for buyer φ as $\phi_{ijk}(\varphi) = \tau_{ijk}^{1-\eta}\left[\sum_{s=1}^{S_{ijk}(\varphi)} p_{ijks}(\varphi)^{-\theta}\right]^{-\frac{1-\eta}{\theta}}$, which captures country-sector jk's potential to supply low-cost inputs to φ and is thus related to φ's global sourcing capability in equation (13). Countries' supply potential can improve if bilateral shipping costs fall or if a secular productivity shock lowers input producers' marginal costs. One can show that positive shocks to upstream productivity or supply potential in jk would benefit downstream buyers as a decline in trade or matching costs in Proposition *5*. Note that any reductions in the country-sector input price index $c_{ijk}(\varphi)$ of a downstream producer translate into reductions in its marginal cost $c_i(\varphi)$ in equation (2).

[Insert Figure 2 about here]

2.9 Numerical Analysis

Our model does not permit an analytical solution. To explore the model properties further, we resort to numerical analysis. Building on the recent literature on methods to solve optimization problems of combinatorial binary discrete choice (Jia 2008, Antràs et al. 2017, and Arkolakis et al. 2021), we develop a new method to solve an optimization problem with interdependent combinatorial *multinomial* discrete choices for heterogeneous firms.[12]

To demonstrate the numerical solution, we solve a model of two countries, home and foreign, and with one sector. In the baseline, we assume that the home buyers can source from 3 suppliers in each market at most. Sourcing from the foreign country entails iceberg trade costs, while domestic sourcing does not. Moreover, we assume that the fixed cost of matching with suppliers is a linear function in terms of the number of suppliers, i.e., $f(S) = \alpha \times S$. In the baseline, we assume that $\alpha = 1$. As for the upstream suppliers, we assume that their costs are drawn from the discrete Pareto distribution. The distribution is specified in Appendix Table A1, along with other parameters of the model.

Figure 3 depicts the baseline solution. The sourcing strategy from the domestic and foreign market is a step-function: firms with higher productivity tend to buy from more suppliers. Moreover, due to additional iceberg trade costs when sourcing from the foreign market, the productivity cut-offs for sourcing from a given number of suppliers tend to be higher for the foreign market.

[Insert Figure 3 about here]

To further explore the effect of other model parameters and other outcomes, we conduct numerical comparative statics in Figure 4. Specifically, we examine three sets of comparative statics: trade liberalization, which reduces the iceberg trade costs; improvement in the matching technology, which reduces the fixed cost of matching; and upstream entry with additional suppliers, which increases input market competition. We study the effects on a firm's marginal costs and revenue.

Trade liberalization leads to lower productivity cut-offs for sourcing from the foreign market. However, the sourcing complementarity also lowers the productivity cut-offs for sourcing from the domestic market. It thus enables firms with low productivity to adjust the extensive margin of their sourcing choice by buying from more domestic and foreign suppliers, which reduces their marginal costs. Since high productivity firms have already sourced from all potential suppliers, they only adjust intensive margins, which helps boost their revenues.

For an improvement in matching technology we find that it induces firms to adjust their sourcing strategy in both markets. Firms that buy from more suppliers enjoy a reduction in their marginal costs and an increase in revenues. These tend to be buyers in the middle of the productivity distribution. Firms with very high or very low productivity leave their sourcing strategies unchanged.

[12] The method can be applied to solving other similar problems with interdependent multinomial discrete choice, e.g., a firm considering how many stores to set up in each market, or a manager thinking about how many workers to have for each team. The algorithm and code will be posted online.

[Insert Figure 4 about here]

Finally, we conduct an experiment on input market structure by having one more foreign potential supplier enter the upstream market. Consistent with theoretical results, only buyers at the top end of the productivity distribution buy from the new supplier, while firms with lower productivity do not adjust their sourcing strategies. Upstream entry therefore amplifies inequality in marginal costs and revenues between high- and low-productivity firms.

3 Empirical Analysis

3.1 Institutional Context

We evaluate the empirical relevance of the model by examining the relationship between upstream market structure in China and downstream sourcing behavior in Chile and France over the 2000-2006 period. All three countries have high trade openness and are active on global markets in almost all product categories. At the same time, they occupy different segments of the global value chain, with China known as factory of the world that supply intermediate inputs and assembly services to manufacturers in both developed and developing economies. In turn, Chile and France exemplify economies with very different market sizes, levels of economic development and institutional strength, and internal and external economic geography. Finding consistent evidence for two contrasting downstream markets can arguably reveal the ubiquity and significance of the mechanisms of interest.

China experienced dramatic export growth after joining the WTO in 2001, gradually relaxing various barriers to entry, developing trade-oriented special economic zones, and shoring up physical and institutional infrastructure to support trade activity. This made China an important new input supplier from the perspective of French and Chilean firms, accounting for 5.7% of total French imports and 9.9% of total Chilean imports in 2006. By contrast, France and Chile are not key export markets for Chinese producers, with their respective market shares of around 1% and 0.3%. This makes French-Chinese and Chilean-Chinese tarde relationships ideal contexts in which to identify the role of upstream entry on downstream sourcing.

3.2 Identification Strategy

The theoretical framework in Section 2 delivers sharp predictions for the impact of the upstream market structure in China on the sourcing of Chinese inputs by downstream French and Chilean firms. We evaluate these predictions for the value, quantity and unit price of imports from China by firm f of HS 6-digit product p in year t with variants of the following log-linear specification:

$$\{\ln X_{fpt}, \ln Q_{fpt}, \ln c_{fpt}\} = \beta \ln S_{CHN\to ROW,pt} + \Gamma\Omega_{CHN,pt} + \delta_f + \delta_p + t\delta_p + \delta_t + \varepsilon_{fpt}. \quad (20)$$

We proxy unit prices with the average unit value across multiple input purchases from China at the fpt level in the baseline, and present robust results using instead model-consistent CES import price indices that weight unit values across multiple input transactions by import value, scaled by Broda-Weinstein elasticities of substitution.

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

To alleviate such concerns, we quantify the number of potential Chinese suppliers to Chile (to France) with the number of Chinese exporters to the rest of the world excluding Chile (France), by product p and year t. With some abuse of notation, we label this proxy $S_{CHN \to ROW,pt}$ for both Chile and France. Guided by the model, we provide consistent evidence using the actual number of Chinese exporters to Chile $S_{CHN \to CHL,pt}$ (to France $S_{CHN \to FRA,pt}$), which is arguably exogenous from the perspective of atomistic buyers. We also instrument the latter either with $S_{CHN \to ROW,pt}$ or with the number of Chinese exporters to a larger yet comparable market: the Pacific Andes countries in the case of Chile, and the US in the case of France.

Given that Chile and France is a small export destination and individual French firms are small buyers from the perspective of Chinese suppliers, we believe this reduced-form estimation strategy allows us to isolate causal effects of interest. In particular, 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 also guard against omitted variable bias by including a large vector of product-year specific controls, $\Omega_{CHN,pt}$. These ensure that the market structure indicators do not capture trade costs or other supply conditions in China, as discussed below. We therefore identify coefficient β purely from the impact of changes in the Chinese market structure within firms over time. We cluster errors ε_{fpt} by product-year - at the level of the main variable of interest - to account for common supply and demand shocks across firms within product-years.

The theoretical model also characterizes the variation in trade activity across buyers from the perspective of suppliers. In particular, a distinctive prediction of the model with endogenous network formation and oligopolistic competition upstream is that a Chinese seller will price discriminate across its customers depending on the number of suppliers they source from. We confront this prediction with data using variants of the following regression equation:

$$\ln p_{sfpt} = \beta \ln S_{CHN \to fpt} + \delta_{sp} + \delta_{fp} + \delta_{pt} + \varepsilon_{sfpt}, \tag{21}$$

where $\ln p_{sfpt}$ is the log unit value Chinese supplier s charges when selling HS-6 product p to downstream firm f in year t, and $\ln S_{CHN \to fpt}$ is the log number of Chinese suppliers that f buys varieties of input p at time t. We estimate this specification only on the transaction-level data for Chile which identifies foreign suppliers, unlike the French customs registry. We condition on seller-product pair fixed effects that account for variation in marginal costs and quality at that level, such that we implicitly identify the variation in mark-ups across buyers within a seller-product, on the assumption of minimal product customization across trade partners. In progressively more stringent specifications, we further add year fixed effects; or both product-year and buyer-product fixed effects. We conservatively cluster standard errors ε_{sfpt} at the product-year level, but the results are virtually identical when alternatively clustering by buyer-product-year.

3.3 Data

We exploit micro-level production and trade data for the near universe of Chilean, French and Chinese firms. For Chile and France, we use information on the value, quantity and price (unit value) of all import transactions at the firm - origin country - HS 6-digit product level from the Chilean and French Customs Agencies, respectively. In the case of Chile, these records additionally report the identity of the foreign supplier, which makes it possible to identify the bi-partite network of seller-buyer matches. For France, we obtain detailed accounting statements and the main industry of activity for all tax-registered firms from FICUS, and match these to the customs declarations based on unique firm identifiers. For Chile, we likewise observe the primary output industry of each firm, but are able to access only information on which of 13 broad size categories a firm belongs to based on total firm sales, from the Chilean Tax Authority.

For China, we use comprehensive information on the universe of export transactions at the firm - destination country - HS 8-digit product category from the Chinese Customs Trade Statistics (CCTS), which we aggregate up to the HS 6-digit level. CCTS reports additional information that we employ in robustness checks. For example, CCTS distinguishes between processing-trade and ordinary-trade transactions, where the former entail exports produced on behalf of a foreign party using imported inputs that are exempt from import duties. CCTS also contains firm names, which makes it possible to identify direct traders from trade intermediaries based on a common word filter from the literature. It further identifies private domestic enterprises, state-owned enterprises (SOEs), joint ventures, and affiliates of foreign multinationals. Where we need information on additional firm characteristics, we exploit the Chinese Annual Survey of Industrial Enterprises (ASIE) which covers non-SOEs with sales above 5 million Yuan and all SOEs. We match ASIE and CCTS using standard algorithms in the literature based on firm names, zip code and phone number.

Since import transactions are recorded inclusive of cost, insurance freight, we are careful to consider changes in trade duties over time. For Chile, regular MFN import tariffs applied on Chinese products and remained unchanged throughout the 2000-2006 period of interest. These will therefore be subsumed by product fixed effects in the analysis.[13] For France, we account for the gradual relaxation in import barriers on Chinese goods with time-varying EU import tariffs from UN WITS. We use applied ad-valorem tariffs at the HS 6-digit level, and take the maximum value whenever there are multiple tariff

[13]Chile and China signed a Preferential Trade Agreement only in 2007, after the end of our sample period.

lines within a product code. All results are fully robust to using simple averages instead. Throughout the sample period, China was subject to the EU's GSP program and faced very low tariffs for most of its goods. Consequently, the vast majority of products carry zero tariffs, and there is little variation over time. As standard in the literature, we compute the tariff measure as $lmaxtariff_{pt} = \ln(1 + max\_rate/100)$.

[Insert Table 1 about here]

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

Panel B demonstrates that the dramatic firm entry in China during 2000-2006 changed the composition of Chinese exporters in some respects. In particular, China experienced secular productivity growth, with a steady increase in measured average value added per worker and average TFP, along with a rise in productivity dispersion. Average product quality remained relatively stable, as proxied by input price indices constructed from firm-product-level import data in the customs records. At the same time, Chinese export activity exhibited stable features in other dimensions, such as the share of trade performed by trade intermediaries, multinational affiliates, or multi-product exporters. Effectively applied EU tariffs on Chinese goods fell from 3.9% to 2.8% for the average product, while the overall share of processing trade declined from 36% to 26%.

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

Panel D overviews the bi-partite network of seller-buyer links that we observe for Chilean firms sourcing inputs from China. Between 2000 and 2006, the average number of Chilean buyers per product remained stable for Chinese sellers. Similarly, the average number of Chinese suppliers per product shows little variation for Chilean producers. This is consistent with both a significant entry of Chinese suppliers per product and a sharp increase in the number of Chilean producers sourcing from China, as shown in Panel A. Yet, Chilean buyers widened the range of import values and unit prices across suppliers, while the dispersion of trade values and unit prices across buyers also increased for Chinese sellers.

3.4 Upstream Market Structure and Downstream Sourcing

Table 2 presents baseline results for the impact of the upstream market structure in China on the sourcing behavior of downstream firms in Chile (Columns 1-2) and in France (Columns 3-4), based on estimating equation (20). 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, $\ln X_{fpt}$. Panels B and C decompose $\ln X_{fpt}$, and repeat the analysis for the log quantity and log unit value of imports from China at the downstream firm - product - year level. Trade quantities are systematically recorded in kilograms across all products in the French customs data, and are available instead in natural units of accounting that vary across products in the Chilean records. Any heterogeneity in this respect is inconsequential for the analysis in the presence of product fixed effects.

[Insert Table 2 about here]

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

These findings obtain both when we adopt a very flexible specification with year fixed effects only in Columns 1 and 3, and when we consider in Columns 2 and 4 the most stringent variant of specification (20) with a full set of buyer firm, year and product fixed effects, along with product-specific time trends and additional controls. The results can thus not be attributed to intransient buyer characteristics, global shocks, stable or trending product features. They also do not reflect the role of other product-year specific supply conditions in China, as we control for the average and the variance of the productivity of Chinese exporters (based on log value added per worker in the matched ASIE-CCTS data) and a proxy for the average output quality of Chinese exporters (based on the average unit value of each exporter's imported inputs). Columns 2 and 4 also include the log number of Chilean or French importers in the same output industry that import from the rest of the world, to capture potentially relevant differences in downstream demand and market structure. We further conditions on five value shares of Chinese exports conducted respectively by trade intermediaries, under the processing regime, by foreign-owned exporters, by state-owned enterprises, and by multi-product exporters. Finally, the specification for French firms controls for the ad-valorem EU import tariff on Chinese goods as a proxy for changing trade costs.

Quantitatively, we estimate economically significant effects of the upstream market structure on downstream outcomes. For illustration, suppose the (log) number of potential upstream suppliers in China were to increase by one SD. Our results imply that French firms' import value would increase by 11.8% of a SD, total quantity would grow by 13.3%

of a SD, and prices would fall by 6.4% of an SD. The corresponding numbers for Chilean buyers would be 4.9%, 10.3% and -8.9%. Alternatively, the total rise in the number of Chinese exporters to ROW over the sample period would trigger an adjustment in French firms' import values, quantities and prices by 22%, 28.1% and -6.1%, respectively, while Chilean producers would experience analogous changes of 10.9%, 26.8% and -15.9%.

[Insert Table 3 about here]

Table 3 confirms that these baseline results survive a series of robustness checks. We first explore different sub-samples of firms. In Column 1, we drop upstream suppliers identified as wholesalers. This lowers all point estimates and makes the results for French import prices weakly insignificant, suggesting that large wholesalers play an important role in the context of imperfect competition upstream. In Column 2, we remove instead wholesale buyers downstream. If anything, this magnifies coefficient magnitudes in the case of Chile and slightly dampens those for France. Together, these results are consistent with interdependencies in price setting across suppliers within a buyer but not across buyers within a supplier, such that dropping important suppliers can underestimate the impact of upstream competition. In contrast, dropping individual buyers reveals does not, with the caveat that the model predicts bigger effects of the upstream market structure on larger, more productive downstream firms - a prediction we formally evaluate below.

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

In Colums 4-6, we explore instead alternative proxies for the upstream market structure in China. From the perspective of individual buyers in Chile or France, the total number of Chinese exporters to their country can be considered exogenous. It may moreover better reflect the set of potential suppliers to their market, given differences in market size, proximity and institutional context across countries that drive the export decisions of Chinese sellers. Column 4 establish that $\ln S_{CHN \to CHL,pt}$ and $\ln S_{CHN \to FRA,pt}$ indeed generate robust results in line with the baseline estimates. Column 5 provides additional corroborative evidence when instrumenting the actual number of Chinese exporters to Chile or France with the baseline number of Chinese exporters to ROW, excluding Chile or France respectively. Column 6 applies a more fine-tuned instrument that is based on Chinese export entry into markets with similar characteristics as Chile and France rather than ROW. We consider Chile's neighbors and co-signatories to the Pacific Andes Countries organization (Colombia, Mexico, Peru), and use the US as a benchmark for France. The results remain qualitatively unchanged.

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

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

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

3.5 Downstream Firm Heterogeneity

Table 4 demonstrates that bigger downstream buyers adjust their sourcing behavior more in response to greater competition upstream, in line with the theoretical predictions. We use two different proxies for downstream firm size - total sales and total imports - and group buyers into three terciles based on each size distribution, separately for Chile and France. We then construct indicator variables for buyers that belong in the middle or in the top tercile, and add interactions of these two dummies with the baseline measure of market competition upstream in specification (20). 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. The level effects of the size dummies are subsumed by the firm fixed effects. We report results using either simple unit values and quantities as in the baseline or the CES price and quantity indices.

[Insert Table 4 about here]

The evidence in Table 4 indicates that bigger downstream buyers benefit more from tougher upstream competition than their smaller peers: They enjoy even lower input prices, source even higher input quantities, and have even higher imported input purchases overall. Through the lens of the model, these patterns are consistent with bigger buyers being able to incur higher matching costs, transact with more suppliers, and benefit from lower mark-ups induced by the greater competition among their suppliers.

The results are economically and statistically more significant when using worldwide imports to measure buyers' size, compared to using firm sales. The role of total buyer imports is consistent with price setting from the perspective of upstream sellers in the model: Total input purchases by a downstream buyer determine the seller's expected profits from the relationship and therefore the optimal input price. The buyer's own sales are only relevant to the extent that they are monotonic in firm productivity and thereby in total input purchases. This raises the possibility that global sourcing decisions may vary across firms for unobserved reasons that are not fully captured by total sales. To the extent that there are economies of scale in overcoming matching costs, the total amount of imported inputs may therefore be a more accurate indicator of firms' ability to match with more suppliers and benefit from stiffer competition among them.

3.6 Upstream Price Discrimination

The findings above documents the impact of the upstream market structure on downstream buyers. We conclude by complementing this analysis with evidence on the pricing strategy of Chinese exporters across buyers. The results strongly support the model's prediction that sellers charge buyers with more suppliers systematically lower mark-ups and prices, even within finely disaggregated product categories. This is consistent with sellers engaging in price discrimination across buyers depending on the extent of competition they face from other suppliers to that buyer.

[Insert Table 5 about here]

Table 5 presents results from estimating specification (21) on the full set of Chinese supplier - Chilean buyer - HS6 product - year observations in the data. Column 1 includes seller-product and year fixed effects, such that the impact of the buyer's portfolio of suppliers is identified from the variation within a supplier across buyers of the same product. Colmn 2 then replaces the year fixed effects with product-year fixed effects that more flexible control for changes in supply and demand conditions by product over time. Column 3 then further adds a stringent set of buyer-product fixed effects, such that the main coefficient of interest is now identified from changes in sourcing strategie within buyer-product input lines over time. Finally, Column 4 additionally controls for the log number of non-Chinese suppliers of the relevant product that a buyer sources from. This implicitly accounts for changes in supply conditions in other origin countries but China.

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

4 Structural Estimation (in progress)

In this section, we estimate the model primitives using micro-level production and trade data. Our strategy is to first estimate each country's sourcing potential $\phi_{ijk}(\varphi)$ for buyers

φ using French and Chilean firm-level input purchases. Then we will estimate the elasticity parameters (θ, η, and σ) using price variations due to exogenous shifters such as tariffs. In the last step, we will estimate the matching friction $f_{ijk}^D(S_{ijk}(\varphi))$ and other parameters using the simulated method of moments and the numerical method that we have developed to solve the combinatorial multinomial discrete choice optimization problem. To do so, we will have to make functional assumptions for $f_{ijk}^D(S_{ijk}(\varphi))$ and exploit Chilean firm-to-firm trade data.

5 Counterfactual analysis (in progress)

Having structurally estimated the model, we perform three counterfactual analyses to assess the role of industrial policy, trade policy and technological progress on global sourcing and the gains from trade. We find that lower barriers to entry upstream, lower matching costs, and lower trade costs amplify firm productivity, firm size dispersion, and aggregate welfare downstream. These effects operate through a combination of improved matching of buyers and suppliers, gains from greater input variety, and lower mark-ups. Shutting down one model feature at a time, we establish that two-sided firm heterogeneity, matching frictions and imperfect competition all play a large quantitative role.

These counterfactual exercises have important policy implications. Existing studies that evaluate trade policies rely on Computable General Equilibrium (CGE) models or New Quantitative Trade Models (NQTM), which typically ignore global production networks, firm granularity and/or market power. Our results indicate that taking these forces into account can generate significantly higher gains from trade. In addition, our analysis illustrates the benefits associated with reductions in buyer-supplier matching costs as distinct from trade costs. This may provide justification for policies that decrease matching costs through trade promotion, information technology or international contract enforcement. Finally, our conclusions reveal how imperfect competition in global value chains gives rise to cross-border spillovers of national industrial policies such as deregulation and other reforms that encourage firm entry.

6 Conclusion

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

Our analysis indicate that global production networks amplify the gains from trade liberalization. Moreover, they can generate international spillovers from national industrial and trade policy. In particular, lower barriers to entry upstream, lower matching costs, and lower trade costs amplify firm productivity, firm size dispersion and aggregate welfare downstream.

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 production networks. Studying the role of reputational contracts and arm's-length vs. intra-firm off-shoring would improve our understanding of rent sharing and shock transmission in global value chains.

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Figures and Tables

Figure 1: Network Structure

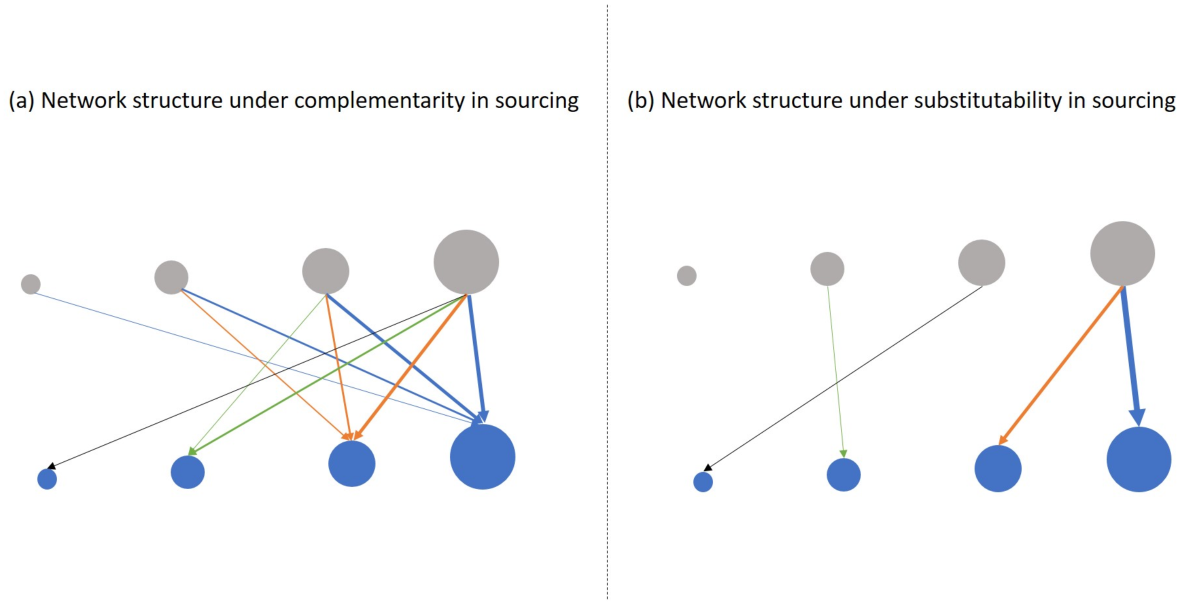


Figure 2: Comparative statics on firms' sourcing strategy

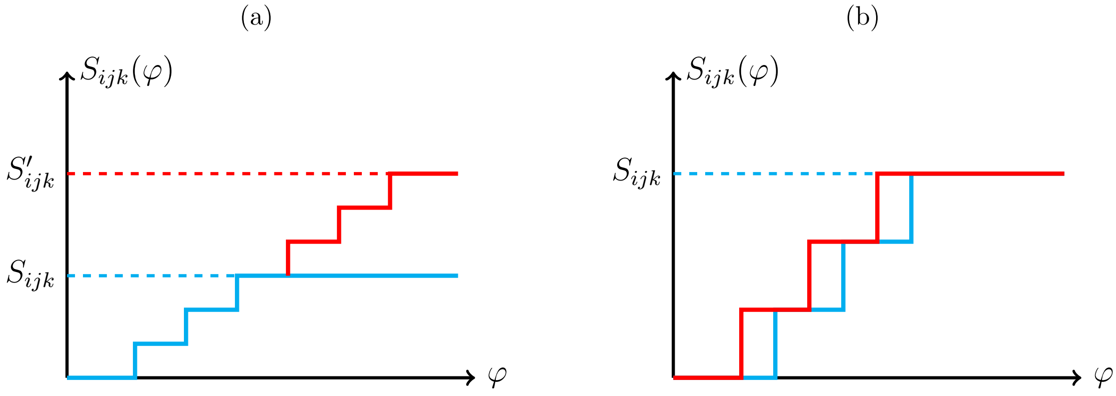
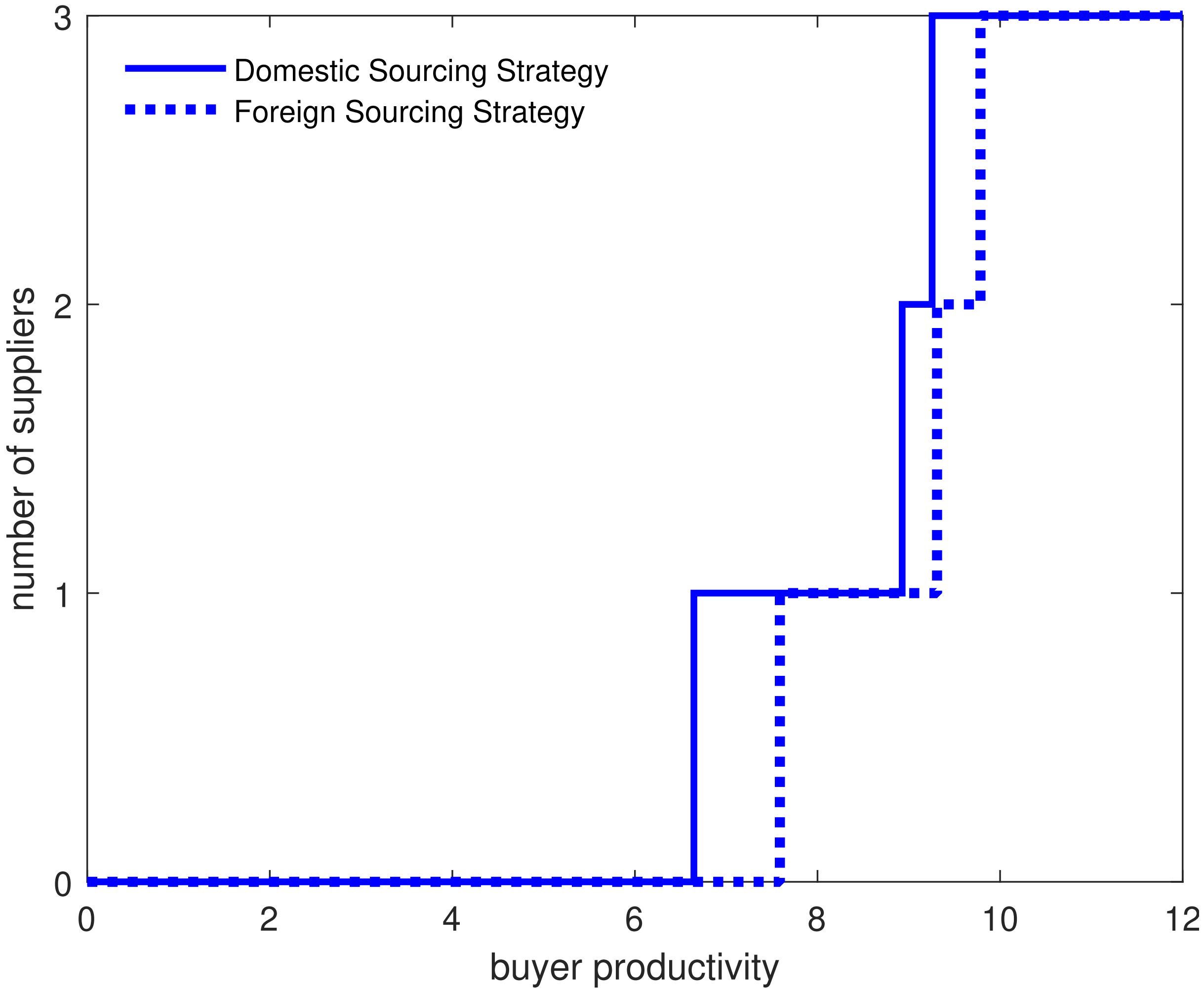


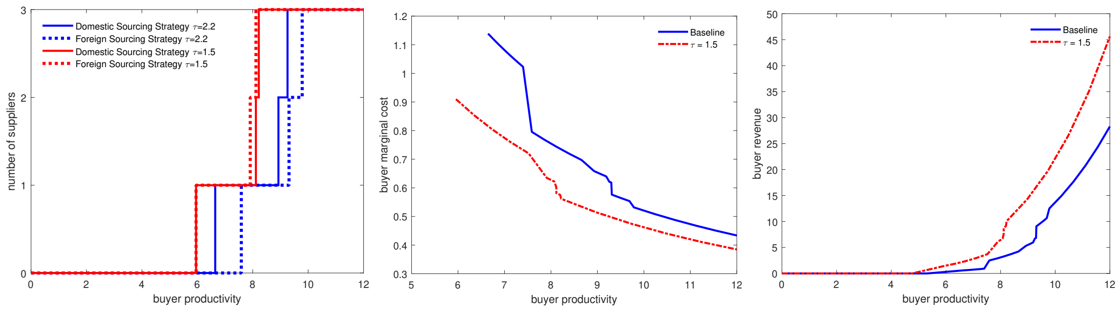
Figure 3: Baseline Sourcing Strategy



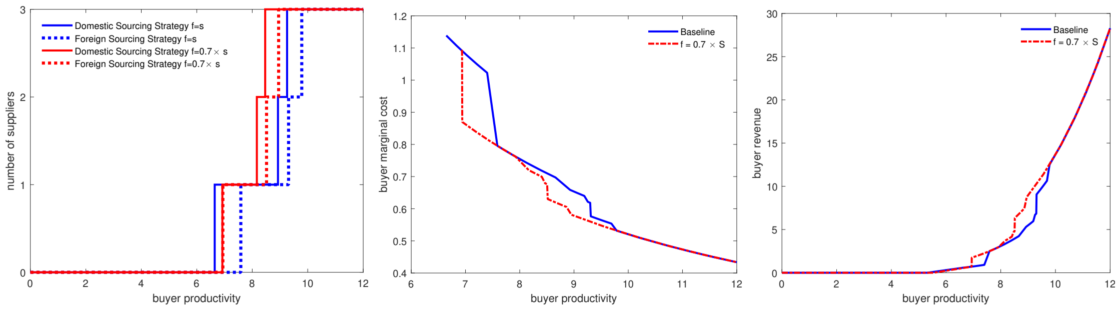
This figure plots the sourcing strategy from domestic market (the solid line), and sourcing from the foreign market (the dashed line) in terms of the number of suppliers for buyer firms with different level productivity. We assume that there are at most 3 suppliers that a buyer can buy from in each market. Other model parameters are specified in Table A1.

Figure 4: Trade Liberalization, Matching Technology, and Market Structure

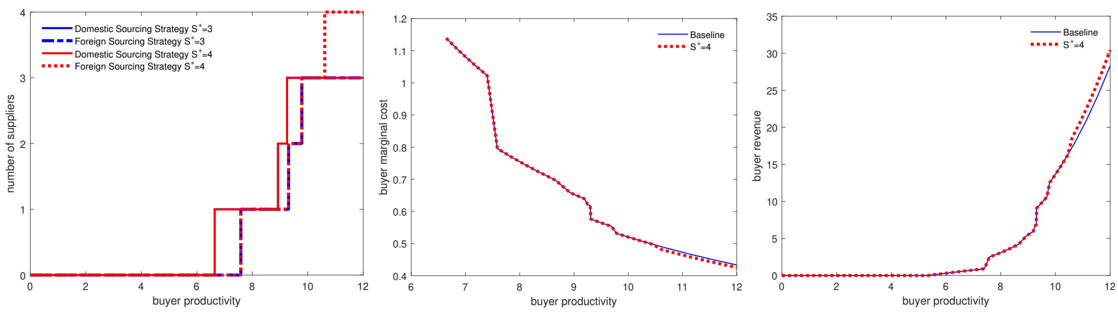
(a) Trade Liberalization



(b) Matching Technology



(c) Upstream Market Structure



This figure plots how the buyer firms' sourcing strategy, marginal cost function, and revenue function respond to reduction in iceberg trade costs (fig a), reduction in matching costs (fig b), and increase in the number of suppliers in the foreign market (fig c). The baseline model parameters are specified in Table A1. In figure (a), iceberg trade cost τ reduces from 2.2 to 1.5. In figure (b), the fixed cost of matching changes from $f(S) = S$ to $f(S) = 0.7S$. In figure (c), the number of potential suppliers in the foreign goes up from 3 to 4.

Table 1: Summary Statistics

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

This table provides summary statistics for the variation in upstream Chinese market structure across HS-6 products in Panel A, other upstream control variables across HS-6 products in Panel B, downstream Chilean and French firm characteristics in Panel C, and characteristics of the sourcing network of Chilean buyers and Chinese suppliers in Panel D.

Table 2: Baseline Results

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

This table examines the effect of upstream market structure on downstream sourcing. The dependent variable is the log value, quantity or unit value of imports from China by Chilean or French firm, HS 6-digit product and year. The upstream market stucture is measured with the (log) number of Chinese exporters to ROW by HS 6-digit product and year. The product $\times$ year controls include the (log) number of Chilean or French importers from ROW; the EU ad-valorem import tariff on Chinese exports in Columns 3 and 4; 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 3: Robustness

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

This table reports estimates for the effect of upstream market stucture—measured by the (log) number of Chinese exporters to ROW by HS 6-digit product and year—on the outcomes in the rows. Coefficients in Columns 1 and 2 exclude Chinese wholesale exporters and Chilean or French wholesale importers, respectively. Column 3 considers CES price indices of unit values and quantities across a firm's import transactions within an HS-6 digit product and year, using Broda-Weinstein (2006) elasticities of substitution. In Columns 4 and 5, the main regressor is the actual number of Chinese exporters to Chile or France, instrumented with the number of Chinese suppliers to the Pacific Alliance or the US, and with the number of Chinese suppliers to ROW. The product × year controls include the (log) number of Chilean or French importers from ROW; the EU ad-valorem import tariff on Chinese exports in Panel B; 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 × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Downstream Heterogeneity

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

This table explores heterogeneity in the effect of upstream market structure on downstream sourcing across downstream firms of different sizes. French firm size tercile dummies are based on total sales in Columns 1, 2, 5, and 6, and on total imports in Columns 3, 4, 7, and 8. Columns 2, 4, 6 and 8 consider CES price indices of unit values and quantities across a firm's import transactions within an HS-6 digit product and year, using Broda-Weinstein (2006) elasticities of substitution. The product x year controls include the (log) number of Chilean or French importers from ROW; the EU ad-valorem import tariff on Chinese exports in columns 5-8; 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 × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: Upstream Price Discrimination

	Chile			
	(log) UV_{sfpt}	(log) UV_{sfpt}	(log) UV_{sfpt}	(log) UV_{sfpt}
	(1)	(2)	(3)	(4)
(log) # CHN $Suppliers_{fpt}$	-0.033***	-0.029***	-0.017***	-0.019***
	(0.003)	(0.003)	(0.004)	(0.004)
(log) # ROW $Suppliers_{fpt}$				0.019***
				(0.006)
R2	0.860	0.892	0.928	0.928
N	330,381	326,594	285,335	285,335
Year FE	YES			
Supplier × HS-6 Product FE	YES	YES	YES	YES
HS-6 Product × Year FE		YES	YES	YES
Buyer × HS-6 Product FE			YES	YES

This table explores upstream price discrimination and pro-competitive effects. The dependent variable is the (log) unit value charged by a Chinese supplier to a Chilean importer for a given HS 6-digit product and year. The level of competition faced by the Chinese supplier is measured by the (log) number of Chinese suppliers selling the same HS 6-digit product to that buyer in a given year. Column 1 includes seller-product and year fixed effects, so the impact of the number of Chinese suppliers 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 control for supply and demand conditions by product over time. Column 3 adds buyer-product fixed effects, so the coefficient is now identified from changes in sourcing strategies within buyer-product pairs over time. Column 4 also controls for the (log) number of non-Chinese suppliers that a buyer has for the same product. Singletons are dropped and standard errors are clustered by HS-6 product × year.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A1: Baseline Parameters for Simulation

Parameters	Definition	value
σ	elasticity of final-good demand	5
η	elasticity of substitution between country-sector	2
θ	Fréchet parameters capturing differentiation between upstream firms	3.5
C_m	upper bound of Pareto distribution for suppliers' marginal cost	2
k	shape of Pareto distribution for suppliers' marginal cost	4
τ	iceberg trade costs sourcing from foreign	2.2

Table A2: Additional Robustness

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

This table confirms the robustness of the results in Columns 2 and 4 of Table 1. Columns 3 and 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 which p belongs to. Sample (1) includes trade flows of firms that are present in all years under consideration. Sample (2) includes trade flows of firms that never trade with an Eastern European country during our sample period. The product × year controls include the (log) number of French importers from ROW; the EU ad-valorem import tariff on Chinese exports in Columns 8-16; 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 × year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.