Firm Heterogeneity and Imperfect Competition in Global Production Networks*

Hanwei Huang[†]
City University of Hong Kong and CEP

Kalina Manova
UCL, *CEPR* and *CEP*

Frank Pisch
St. Gallen, *CEP* and *SIAW*

June 2021
Preliminary

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 (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. Counterfactual analyses indicate 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 variety, and lower markups. Global production networks thus generate greater impacts and international spillovers from national 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

*We thank our discussants for their valuable feedback. Thanks also to audiences at various seminars and conferences. Manova acknowledges support from The Leverhulme Trust and ERC Horizon 2020 Grant Agreement 724880. Pisch acknowledges support from the Wachter Stiftung.

[†]Hanwei Huang: huanghanwei@gmail.com. Kalina Manova (corresponding author): k.manova@ucl.ac.uk. Frank Pisch: frank.pisch@unisg.ch.

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 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. Counterfactual analyses indicate 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 variety, and lower mark-ups. Global production networks thus generate greater impacts and international spillovers from national industrial policy and trade reforms.

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 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 reductions in upstream entry costs make the market for input suppliers more competitive. As a result, sufficiently productive downstream firms can match with more suppliers and benefit from lower input costs, and this effect is greater for more productive buyers. Reductions in trade or matching costs enable buyers that are not yet sourcing from all potential suppliers to match with more suppliers. In both cases, expanding the set of suppliers lowers buyers' input price index.

Our second contribution is empirical. We combine firm-level production data and transaction-level customs data for the universe of Chinese and French firms in 2000-2006 to validate key predictions of the model. We exploit matched data on French firms' import transactions and balance sheets to obtain the set, value, price and quantity of all HS-6 inputs they source from China, along with key firm attributes. We use data on Chinese firms' export transactions and balance sheets to identify the set and properties of Chinese suppliers to France at the HS-6 digit product level. We use this information to characterize the Chinese market structure for each intermediate input that downstream firms in France face.

Guided by the model, we measure upstream market structure using the number of potential Chinese suppliers to France by product and year. We present robust results using the number of Chinese exporters to the rest of the world, to France, and worldwide. We also instrument these using the gradual and product-specific relaxation of export restrictions. Given the importance of Chinese imports to France and the insignificance of the French market to China, our identification strategy allows us to draw causal conclusions.

We empirically establish that market structure upstream, supplier heterogeneity upstream, and buyer heterogeneity downstream shape the pattern of global production networks in line with the model's predictions. Downstream French firms buy greater import quantities, pay lower unit prices, and spend more on imported inputs 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 supplier productivity and quality, intermediated or processing trade, multi-product or multinational sellers. The patterns are also independent of product-specific trade costs (import tariffs) and the downstream market structure.

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 and Eckert 2017, 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 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

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

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 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 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:

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

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, $z_{ijk}(\varphi, v)$. It is specific to downstream firm φ for two reasons: oligopolistic competition upstream and matching frictions. Imperfect competition upstream will imply that the price $p_{ijks}(\mathcal{S}_{ijk}(\varphi))$ 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:

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

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

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 $w_j f^U_{ijk}$ (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 $\pi^U_{ijks}(\varphi)$ separately from each relationship:

$$\max_{p_{ijks}(\varphi)} \pi^U_{ijks}(\varphi) = Q_{ijks}(\varphi)(p_{ijks}(\varphi) - c_{jks}) \quad (4)$$

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

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

[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.

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. $f^D_{ijk}(S_{ijk}) \geq f^D_{ijk}(S_{ijk}-1) \geq \cdots \geq f^D_{ijk}(1) \geq 0$ (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 $w_i f^D_{ijk}(S'_{ijk})$, 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.

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:

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

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:

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

[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.

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

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

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 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 $c_{ijk}(\varphi)$*.*

[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.

[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 $\mu_{ijks}(\varphi) \to \frac{\theta}{\theta-1}$.

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]

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 $B_i = \frac{1}{\sigma}(\frac{\sigma}{\sigma-1})^{1-\sigma} E_i P_i^{\sigma-1}$ 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:

[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 $\widehat{c}_{jks}^{-\theta}$.

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]

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:

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

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

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:

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

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:

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

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

We illustrate the comparative statics with respect to the number of potential upstream suppliers by numerically simulating the model. We focus on the pricing game upstream and ignore the matching between upstream and downstream firms. We assume that there is only one region and one sector (therefore η is irrelevant) and set $\delta_{ijk} = 1$.[12] The demand shifter is normalized to one. We assume that upstream producers draw their marginal cost from the Pareto distribution $G(c) = (\frac{c}{C_m})^k$. Other model parameters are listed in Table A1.[13]

[12]In this case, the residual demand elasticity faced by upstream firms is $\varepsilon_{ijks}(\varphi) = \theta + (\sigma - \theta)\chi_{ijks}(\varphi)$.
[13]To ensure that $\rho_{ijk}(\varphi) > 0$ is satisfied, we let $\theta > \sigma$.

We consider scenarios with an exogenous discrete number of suppliers S_{ijk} in the [1,30] range, and perform 500 simulations for each S_{ijk}. We compute the measures of upstream market concentration and sourcing outcomes across downstream firms, averaging across the simulations. The results are shown in Figure A1. As the number of upstream firms increases, the upstream markets for intermediate inputs become less concentrated, as measured by the C-4 index and the Herfindahl-Hirschman Index. Tougher competition pushes down mark-ups and the input price index, which boosts downstream sourcing. To demonstrate this pro-competitive effect, we also compute the input price with a constant mark-up. It declines by less compared with the input price index, which incorporates the pro-competitive effect.

3 Empirical Analysis

3.1 Institutional Context and Identification

We evaluate the empirical relevance of the model by examining the relationship between upstream market structure in China and downstream sourcing behavior in France over the 2000-2006 period. Both of these countries are large and important open economies that trade internationally in almost all product categories. At the same time, they occupy different segments of the global supply chain, with China known as factory of the world that provides intermediate inputs and assembly services to manufacturers in developed economies.

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 firms, accounting for a share of 5.7 % in total French imports in 2006. By contrast, France does not constitute a key export market for Chinese producers with its market share of around one percent. This makes the French-Chinese case an ideal context in which to identify the role of upstream entry on downstream sourcing.

From Proposition 4, we expect the number of Chinese exporters of HS 6-digit product p to France in year t, $S_{CHN\to FRA,pt}$, to affect the value, quantity and price of the Chinese imports of French buyer f, $\{X_{fpt}, Q_{fpt}, c_{fpt}\}$. Conceptually, if $S_{CHN\to FRA,pt}$ endogenously responded to import demand in France, this would be consistent with our model of global sourcing with imperfect competition. However, such a correlation may also be driven by forces outside our model and fail to capture the actual availability of upstream suppliers.

To alleviate these concerns, we proxy the number of potential Chinese suppliers to France with the number of Chinese exporters of HS 6-digit product p to the rest of the world in year t, $S_{CHN\to ROW,pt}$. In robustness analyses, we alternatively consider $S_{CHN\to FRA,pt}$, as well as an IV strategy based on reforms to export restrictions. Given that France is a small export destination and individual French firms are small buyers from the perspective of Chinese suppliers, we believe our reduced form estimation strategy identifies the causal effects of interest.

We estimate the following log-linear specification:

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

where our theory suggests $\ln Y_{fpt} = \{\ln X_{fpt}, \ln Q_{fpt}, \ln c_{fpt}\}$. We proxy these outcomes with the total import value, the total quantity, and average unit value (value divided by quantity) of any fpt flow. In the robustness analyses we furthermore consider CES indices as an alternative.

We condition on a series of product-year specific controls to ensure market structure $\ln S_{CHN\to ROW,pt}$ does not capture trade costs or other supply conditions in China, as discussed below. In progressively more stringent specifications, we further include product fixed effects and specific time trends, as well as firm and year fixed effects, δ_p, $t\delta_p$, δ_f, and δ_t. We cluster errors conservatively by firm and product.

3.2 Data

We exploit micro-level production and trade data for the near universe of French and Chinese firms. For 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 French Customs Agency. We obtain data on the balance-sheet characteristics and the main industry of activity for all tax-registered firms from FICUS and match the two datasets based on unique firm identifiers.

For China, we use the same 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 standard filter in 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 and freight, we access EU import tariffs on Chinese goods from UN WITS to proxy trade costs. We use applied ad-valorem tariffs at the HS 6-digit level, and take the maximum value whenever there are multiple tariff 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 B 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.

Panel C demonstrates the stable composition of Chinese exporters in terms of the shares of trade intermediaries, multinational affiliates, or multi-product exporters. At the same time, 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 A summarizes the extent of downstream firm heterogeneity in France. Between 2000 and 2006 the number of French producers sourcing inputs from China almost doubled from 10,691 to 20,896. Their total 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, the median sales per worker, value added per worker and total import value of French buyers from China remained very stable or even fell as their number grew.

3.3 Upstream Market Structure and Downstream Sourcing

Table 2 presents the baseline results from 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 French firm for that product and year, $\ln X_{fpt}$. Panels B and C decompose $\ln X_{fpt}$ and repeats the analysis for the log quantity (in kilos) and log unit value of imports from China at the French firm - product - year level.

[Insert Table 2 about here]

We find that more competition upstream systematically induces suppliers to charge lower input prices and incentivizes downstream buyers to purchase higher input quantities. Through the lens of the model, this can be attributed to the pro-competitive effect of upstream competition on buyers' input prices. This raises final demand for the output of downstream firms, which in turn increases their input demand. Together, these pro-competitive and scale effects result in higher input purchases (import values).

Quantitatively, the effects we find are economically significant. For illustration, suppose the (log) number of potential upstream suppliers in China increases by one SD. Our results imply that the total import value increases by 11.7% of an SD, total quantity by 13.2% of an SD, and prices fall by 6.5% of an SD. Alternatively, the total rise in the number of Chinese exporters to ROW over our sample period led to changes in French firm sourcing outcomes of 9.6%, 12.2%, and -2.7%, respectively.

These findings are not driven by any stable or linearly trending characteristics of products, nor by differences in transient buyer properties. Moreover, the patterns cannot be attributed to global shocks that are subsumed by the year fixed effects. The baseline results also do not reflect the role of other product-year specific supply conditions in China, downstream market structure in France, or bilateral trade costs: The preferred and most stringent specification in Column 4 controls 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); a proxy for the average output quality of Chinese exporters (based on the average unit value of each exporter's imported inputs); and the number of French importers from China. It further conditions on four shares of Chinese exports conducted respectively by trade intermediaries, under the processing regime, by foreign-owned exporters, and by multi-product exporters. Finally, the specification controls for the ad-valorem EU import tariff on Chinese goods.

[Insert Table 3 about here]

Table 3 confirms that the main results in Column 5 of Table 2 survive a series of robustness checks.

We first explore different sub-samples of firms. In Column 1, we restrict the sample to a balanced set of French firms that are active in every period in the 2000-2006 panel. This reduces the number of observations significantly, but the estimates are stable. In Columns 2 and 3 we drop firms identified as wholesalers upstream or downstream, respectively. This weakens the results for prices, suggesting that large wholesalers play an important role in the context of imperfect competition.

We next consider alternative price and quantity measures. In Column 4, we construct CES indices (instead of averages) of unit values and quantities at the firm-product-year level from the underlying transaction-level data; we use product-specific elasticities of substitution from Broda and Weinstein (2006). In Column 5, we define quantities and unit values based on supplementary information on different units of accounting (instead of kilos), available for a subset of products.

In Colums 6 and 7, we exploit reforms to export restrictions that affected different products differentially over time, as detailed in the Online Appendix. In particular, minimum size requirements on firms were binding and variable across industries at the start of the sample period, but were gradually and unevenly relaxed over time (Bai et al. 2017). Based on the initial set of firms producing in each sector and the extent to which these export restrictions were binding pre-reforms, we construct predicted values for the number of Chinese firms that would be able to export post-reforms, $\ln \widehat{S}_{CHN\rightarrow ALL,pt}$. We then use these predicted values as instruments for the actual number of Chinese firms that export to France or to anywhere in the world, $\ln S_{CHN\rightarrow FRA,pt}$ and $\ln S_{CHN\rightarrow ALL,pt}$. The results remain qualitatively unchanged.

Finally, we address several further concerns in Online Appendix Table A2 and our findings prove highly robust. First, although we control for the number of French importers in any 4 digit downstream industry throughout, this may not be sufficient to rule out that aspects of downstream market structure affect our results. We therefore include industry by year fixed effects in Column 1. In Column 2 we control for a French buyer's total export volume, which may correlate with sourcing behavior. In Columns 3 and 4 we ensure that changes in upstream competition in *other products* that a firm sources do not confound our estimates: first, we control for the (import value weighted) average number of Chinese suppliers in a buyer's products other than p, and, second, we control for the total number of Chinese exporters to the ROW in the HS 4 digit category p belongs to. Finally, in Column 5 we restrict the sample to French 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.

3.4 Firm Heterogeneity

Table 4 demonstrates that bigger downstream buyers adjust their sourcing behavior more in response to greater competition upstream, in line with our theoretical predictions. We use three different proxies for downstream firm size: total employment, total sales, and total imports. We construct indicator variables for buyers that belong in the middle and top tercile of each size distribution, and interact these dummies with the measure of market competition upstream, $\ln S_{CHN \to ROW,pt}$. The level effect of the dummies is subsumed by the firm fixed effects.

[Insert Table 4 about here]

The results in Columns 1-3 indicate that bigger downstream buyers benefit more from stronger 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 effects on both prices and quantities support the presence of the pro-competitive and scale effects of upstream competition.

The results are economically and statistically most significant when using worldwide imports to measure buyers' size. This suggests that under global sourcing, domestic employment may be a noisy measure of firm size as it does not capture total production inputs. The stronger predictive power of imports compared to sales in turn raises the possibility that global sourcing decisions may vary across firms for unobserved technological reasons that are not fully captured by total sales. To the extent there are economies of scale in overcoming matching costs, the overall amount of imported input purchases may therefore be a more accurate indicator of firms' ability to match with more suppliers and benefit from stiffer competition among them.

Column 4 confirms that these findings are robust to using CES indices for imported input prices and quantities across import transactions, instead of the baseline averages. Column 5 establishes that the differential effects of market competition across the firm size distribution are not driven by other supply conditions upstream. In particular, this column additionally controls for interactions of the size dummies with the average productivity and with the productivity variance across upstream suppliers.

Finally, Table 5 investigates how the effects of upstream competition on downstream sourcing depend on heterogeneity among suppliers. We measure dispersion in fundamental productivity based on four proxies, sales per worker, value-added per worker, the suppliers' import shares, and their export prices vis-a-vis the ROW. The first two characteristics are direct indicators of labor productivity, while the latter two are outcomes commonly and strongly associated with it. We rely on coefficients of variation throughout.

[Insert Table 5 about here]

Our estimates suggest that increased competition among suppliers lowers the prices at which importers whenever these upstream firms are characterized by strong heterogeneity. Moreover, upstream dispersion in marginal costs or productivity raises the positive effect on imported quantities. Our model delivers ambiguous theoretical predictions for these patterns, but our findings strongly imply a role for firm heterogeneity in determining the impact of market power on international sourcing.

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 a French buyer φ using French 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. To do so, we will have to make functional assumptions for $f_{ijk}^{D}(S_{ijk}(\varphi))$ and exploit firm-to-firm trade data. In this step, we need to solve firms' optimal sourcing Problem (12), which is a high-dimensional discrete choice optimization problem. To solve this problem, we develop a solution method by extending the tools from the prior literature (Antràs et al. 2017, Arkolakis and Eckert 2017, and Taschereau-Dumouchel 2019).

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.

References

Acemoglu, D. and Azar, P.D., 2017. Endogenous production networks (No. w24116). National Bureau of Economic Research.

Acemoglu, D., Carvalho, V.M., Ozdaglar, A. and Tahbaz-Salehi, A., 2012. The network origins of aggregate fluctuations. Econometrica, 80(5), pp.1977-2016.

Amiti, M., Itskhoki, O. and Konings, J., 2018. International shocks, variable markups, and domestic prices. The Review of Economic Studies.

Amiti, M. and Konings, J., 2007. Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. American Economic Review, 97(5), pp.1611-1638.

Antràs, P. and De Gortari, A., 2017. On the geography of global value chains (No. w23456). National Bureau of Economic Research.

Antràs, P., Fort, T.C. and Tintelnot, F., 2017. The margins of global sourcing: Theory and evidence from us firms. American Economic Review, 107(9), pp.2514-64.

Arkolakis, C., Costinot, A., Donaldson, D. and Rodriguez-Clare, A., 2018. The elusive pro-competitive effects of trade. The Review of Economic Studies, 86(1), pp.46-80.

Arkolakis, C. and Eckert, F., 2017. Combinatorial discrete choice. Working paper.

Atkeson, A. and Burstein, A., 2008. Pricing-to-market, trade costs, and international relative prices. American Economic Review, 98(5), pp.1998-2031.

Autor, D., D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen (2017) ?The fall of the labor share and the rise of superstar firms,? NBER working paper no. 23396

Bai, X., Krishna, K. and Ma, H., 2017. How you export matters: Export mode, learning and productivity in China. Journal of International Economics, 104, pp.122-137.

Baqaee, D.R., 2018. Cascading failures in production networks. Econometrica, 86(5), pp.1819-1838.

Baqaee, D.R. and Farhi, E., 2019. The macroeconomic impact of microeconomic shocks: beyond Hulten's Theorem. Econometrica, 87(4), pp.1155-1203.

Benguria, F., 2015. The matching and sorting of exporting and importing firms: theory and evidence. Working paper.

Bernard, A.B., Jensen, J.B., Redding, S.J. and Schott, P.K., 2012. The empirics of firm heterogeneity and international trade. Annu. Rev. Econ., 4(1), pp.283-313.

Bernard, A.B., Dhyne, E., Magerman, G., Manova, K. and Moxnes, A., 2019. The origins of firm heterogeneity: A production network approach (No. w25441). National Bureau of Economic Research.

Bernard, A.B., Eaton, J., Jensen, J.B. and Kortum, S., 2003. Plants and productivity in international trade. American Economic Review, 93(4), pp.1268-1290.

Bernard, A.B. and Moxnes, A., 2018. Networks and trade. Annual Review of Economics, 10, pp.65-85.

Bernard, A.B., Moxnes, A. and Saito, Y.U., 2019. Production networks, geography, and firm performance. Journal of Political Economy, 127(2), pp.639-688.

Bernard, A.B., Moxnes, A. and Ulltveit-Moe, K.H., 2018. Two-sided heterogeneity and trade. Review of Economics and Statistics, 100(3), pp.424-439.

Blaum, J., Lelarge, C. and Peters, M., 2018. The gains from input trade with heterogeneous importers. American Economic Journal: Macroeconomics, 10(4), pp.77-127.

Bøler, E.A., Moxnes, A. and Ulltveit-Moe, K.H., 2015. R&D, international sourcing, and the joint impact on firm performance. American Economic Review, 105(12), pp.3704-39.

Boehm, J. and Oberfield, E., 2018. Misallocation in the Market for Inputs: Enforcement and the Organization of Production (No. w24937). National Bureau of Economic Research.

Boehm, C.E., Flaaen, A. and Pandalai-Nayar, N., 2019. Input linkages and the transmission of shocks: Firm-level evidence from the 2011 Tōhoku earthquake. Review of Economics and Statistics, 101(1), pp.60-75.

Broda, C. and Weinstein, D.E., 2006. Globalization and the Gains from Variety. The Quarterly journal of economics, 121(2), pp.541-585.

Carvalho, V.M., Nirei, M., Saito, Y. and Tahbaz-Salehi, A., 2016. Supply chain disruptions: Evidence from the great east Japan earthquake. Columbia Business School Research Paper, (17-5).

Chaney, T., 2014. The network structure of international trade. American Economic Review, 104(11), pp.3600-3634.

Combes, P.P., Duranton, G., Gobillon, L., Puga, D. and Roux, S., 2012. The productivity advantages of large cities: Distinguishing agglomeration from firm selection. Econometrica, 80(6), pp.2543-2594.

Costinot, A. and Rodríguez-Clare, A., 2014. Trade theory with numbers: Quantifying the consequences of globalization. In Handbook of international economics (Vol. 4, pp. 197-261). Elsevier.

De Loecker, J. and Eeckhout, J., 2017. The rise of market power and the macroeconomic implications (No. w23687). National Bureau of Economic Research.

De Loecker, J. and Eeckhout, J., 2018. Global market power (No. w24768). National Bureau of Economic Research.

Di Giovanni, J., Levchenko, A.A. and Mejean, I., 2014. Firms, destinations, and aggregate fluctuations. Econometrica, 82(4), pp.1303-1340.

Eaton, J., D. Jinkins, J. Tybout, and D.Y. Xu, Two-sided Search in International Markets, 2016. NBER

Eaton, J. and Kortum, S., 2002. Technology, geography, and trade. Econometrica, 70(5), pp.1741-1779.

Eaton, J., Kortum, S. and Kramarz, F., 2011. An anatomy of international trade: Evidence from French firms. Econometrica, 79(5), pp.1453-1498.

Eaton, J., Kortum, S. and Kramarz, F., 2018. Firm-to-Firm Trade: Imports, exports, and the labor market. Brown University, unpublished manuscript.

Eaton, J., Kortum, S.S. and Sotelo, S., 2012. International trade: Linking micro and macro (No. w17864). National bureau of economic research.

Edmond, C., Midrigan, V. and Xu, D.Y., 2015. Competition, markups, and the gains from international trade. American Economic Review, 105(10), pp.3183-3221.

Furusawa, T., Inui, T., Ito, K. and Tang, H., 2017. Global sourcing and domestic production networks. Working paper.

Gabaix, X., 2011. The granular origins of aggregate fluctuations. Econometrica, 79(3), pp.733-772.

Gaubert, C. and Itskhoki, O., 2018. Granular comparative advantage (No. w24807). National Bureau of Economic Research.

Goldberg, Pinelopi K., Amit Khandelwal, Nina Pavcnik, and Petia Topalova. Imported Intermediate Inputs and Domestic Product Growth: Evidence from India. Quarterly Journal of Economics, 125(4), 2010, pp. 1727-67.

Halpern, L., Koren, M. and Szeidl, A., 2015. Imported Inputs and Productivity. The American Economic Review, 105(12), pp.3660-3703.

Head, K., Mayer, T. and Thoenig, M., 2014. Welfare and trade without Pareto. American Economic Review, 104(5), pp.310-16.

Head, K. and Spencer, B.J., 2017. Oligopoly in international trade: Rise, fall and resurgence. Canadian Journal of Economics/Revue canadienne d'èconomique, 50(5), pp.1414-1444.

Kikkawa, K., Magerman, G. and Dhyne, E., 2019. Imperfect competition in firm-to-firm trade. Working paper.

Krugman, P., 1980. Scale economies, product differentiation, and the pattern of trade. The American Economic Review, 70(5), pp.950-959.

Lim, K., 2018. Endogenous production networks and the business cycle. Working Paper. University of Toronto.

Magerman, G., De Bruyne, K., Dhyne, E. and Van Hove, J., 2016. Heterogeneous firms and the micro origins of aggregate fluctuations (No. 312). NBB Working Paper.

Manova, K., Wei, S.J. and Zhang, Z., 2015. Firm exports and multinational activity under credit constraints. Review of Economics and Statistics, 97(3), pp.574-588.

Melitz, M.J. and Ottaviano, G.I., 2008. Market size, trade, and productivity. The Review of Economic Studies, 75(1), pp.295-316.

Melitz, M.J. and Redding, S.J., 2015. New trade models, new welfare implications. American Economic Review, 105(3), pp.1105-46.

Neary, J.P., 2016. International trade in general oligopolistic equilibrium. Review of International Economics, 24(4), pp.669-698.

Oberfield, E., 2018. A theory of input?output architecture. Econometrica, 86(2), pp.559-589.

Ottaviano, G.I., 2014. European integration and the gains from trade. Chapter prepared for the Handbook of the Economics of European Integration, edited by Harald Badinger and Volker Nitsch, Routledge.

Sugita, Y., Teshima, K. and Seira, E., 2016. Assortative matching of exporters and importers. Institute of Developing Economies (IDE).

Sutton, J., 2007. Market share dynamics and the" persistence of leadership" debate. American Economic Review, 97(1), pp.222-241.

Taschereau-Dumouchel, M., 2019. Cascades and fluctuations in an economy with an endogenous production network. Available at SSRN 3115854.

Tintelnot, F., Kikkawa, A.K., Mogstad, M. and Dhyne, E., 2018. Trade and domestic production networks (No. w25120). National Bureau of Economic Research.

Yeaple, Stephen R., 2019. Multinationals, Markets, and Mark-Ups. Mimeo.

Yu, Miaojie., 2015. Processing Trade, Tariff Reductions and Firm Productivity: Evidence from Chinese Firms. The Economic Journal 125, no. 585: 943-988.

Figures and Tables

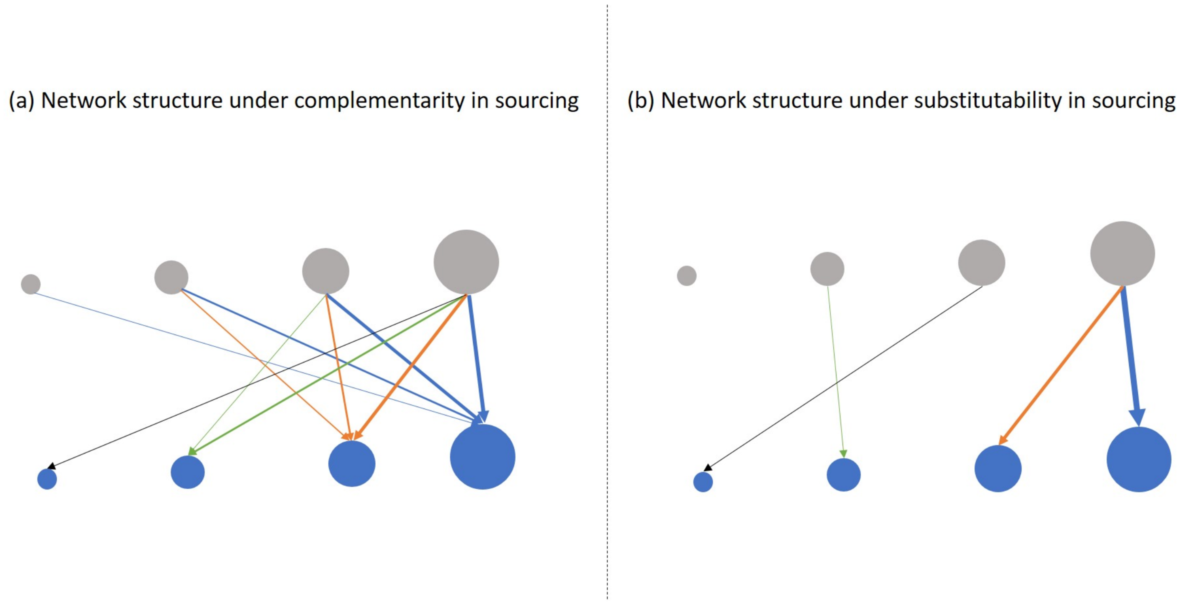
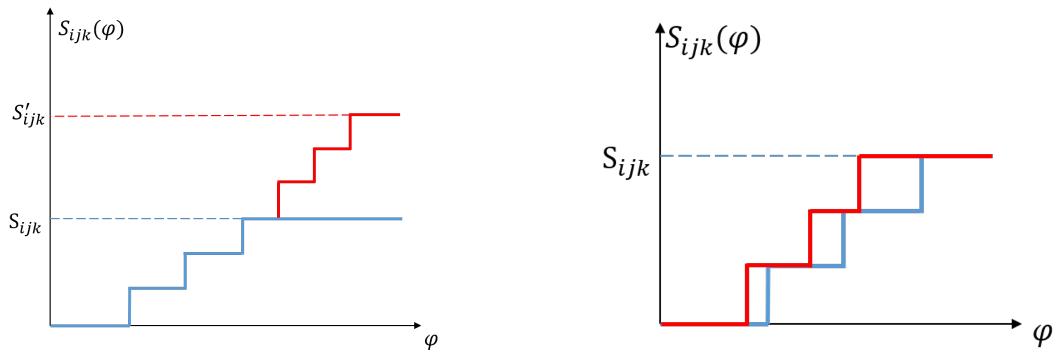


Figure 1: Network Structure



(a) (b)

Figure 2: Comparative statics on firms' sourcing strategy

Table 1: Summary Statistics

	2000				2006			
	N	Mean	St Dev	Median	N	Mean	St Dev	Median
Panel A. Importer Characteristics (Firm)								
employment	10,691	210	2,673	19	20,896	171	2,816	16
sales (EUR 1,000)	11,319	59,600	609,900	4,000	22,790	48,400	574,300	3,200
sales / worker (EUR 1,000)	10,679	460	2,854	215	20,860	466	3,530	222
VA / worker (EUR 1,000)	10,634	63	477	44	20,822	64	661	51
total imports (EUR 1,000)	12,571	785	7,088	43	25,737	864	7,631	32
Panel B. Market Structure (HS-6 product)								
# CHN exporters to FRA	2,139	16.9	38.3	5	2,954	37.7	92.3	9
C4 CHN exporters to FRA	2,139	0.87	0.19	0.99	2,954	0.82	0.23	0.94
HHI CHN exporters to FRA	2,139	0.52	0.34	0.46	2,954	0.45	0.33	0.36
# CHN exporters to ROW w/o FRA	2,865	272	426	124	3,695	729	1,452	231
C4 CHN exporters to ROW w/o FRA	2,865	0.53	0.25	0.51	3,695	0.48	0.25	0.44
HHI CHN exporters to ROW w/o FRA	2,865	0.16	0.19	0.09	3,695	0.14	0.18	0.07
# FRA importers from CHN	2,863	28.6	72.1	6	3,671	56.6	142.1	9
# FRA importers from ROW w/o CHN	2,903	374.1	652.8	195	3,711	355	562	169
Panel C. Control Variables (HS 6-digit level)								
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)	2,863	1.6	1.1	1.46	3.689	1.69	1.25	1.71
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 state-owned exporters	2,865	0.66	0.14	0.67	3,695	0.26	0.12	0.25
share CHN multi-product exporters	2,865	0.95	0.11	0.99	3,695	0.94	0.11	0.99

Summary statistics are at the French firm level in Panel A and at the HS 6 digit product level in Panels B and C.

Table 2: Baseline Results

	(1)	(2)	(3)	(4)
Panel A. (log) Import Value$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.085***	0.118**	0.206***	0.224***
	(0.024)	(0.058)	(0.036)	(0.041)
N	897,091	897,091	897,091	897,091
R2	0.008	0.163	0.585	0.585
Panel B. (log) Import Quantity$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.141***	0.233***	0.269***	0.286***
	(0.030)	(0.063)	(0.040)	(0.046)
N	897,091	897,091	897,091	897,091
R2	0.006	0.170	0.605	0.605
Panel C. (log) Import Unit Value$_{fpt}$				
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	-0.056**	-0.115***	-0.063***	-0.063***
	(0.025)	(0.022)	(0.018)	(0.020)
N	897,091	897,091	897,091	897,091
R2	0.005	0.505	0.714	0.714
Year FE	YES	YES	YES	YES
HS-6 Product FE		YES	YES	YES
HS-6 Product Trend		YES	YES	YES
Firm FE			YES	YES
Product $\times$ Year Controls				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 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 x year controls include the (log) number of French importers from ROW; the EU ad-valorem import tariff on Chinese exports; the average productivity of Chinese exporters, the variance of the productivity of Chinese exporters, the average quality of Chinese exporters; the value shares of processing trade, intermediated trade; and the share of foreign-owned, multi-product, state-owned firms in Chinese exports. Singletons are dropped and standard errors are clustered by French firm and HS-6 product. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Robustness

	Balanced Sample	No Wholesalers		CES Import Price Index	Natural Quantity Units	CHN→FRA Exporters	
		Upstream	Downstream			OLS	IV: Export Restrictions
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. (log) Import Value$_{fpt}$							
(log) # CHN→ROW Exporters$_{pt}$	0.152***	0.123***	0.115		0.281***	0.195***	0.271
	(0.041)	(0.029)	(0.072)		(0.054)	(0.017)	(0.226)
N	486,849	897,091	134,482		308,718	811,958	811,958
R2	0.481	0.585	0.446		0.592	0.581	0.580
Panel B. (log) Import Quantity$_{fpt}$							
(log) # CHN→ROW Exporters$_{pt}$	0.196***	0.112***	0.159**	0.285***	0.359***	0.212***	0.648**
	(0.046)	(0.034)	(0.079)	(0.044)	(0.062)	(0.019)	(0.281)
N	486,849	897,091	134,482	897,091	308,718	811,958	811,958
R2	0.525	0.605	0.534	0.596	0.635	0.600	0.598
Panel C. (log) Import Unit Value$_{fpt}$							
(log) # CHN→ROW Exporters$_{pt}$	-0.043**	0.011	-0.041	-0.078***	-0.078***	-0.017**	-0.378*
	(0.020)	(0.015)	(0.032)	(0.030)	(0.029)	(0.008)	(0.194)
N	486,849	897,091	134,482	897,091	308,718	811,958	811,958
R2	0.696	0.714	0.740	0.694	0.791	0.707	0.701
KP Stage 1							10.95
Firm, Year, HS-6 Product FE	YES	YES	YES	YES	YES	YES	YES
HS-6 Product Trend	YES	YES	YES	YES	YES	YES	YES
Product × Year Controls	YES	YES	YES	YES	YES	YES	YES

This table confirms the robustness of the results in Column 4 of Table 2. Column 1 restricts the sample to firms who appear in each year in the panel. Columns 2 and 3 exclude Chinese wholesale exporters and French wholesale importers respectively. Column 4 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. Column 5 uses natural quantity units instead of kilograms. Columns 7 and 8 measure the upstream market structure with the (log) number of Chinese exporters to France, which is instrumented with Chinese export restrictions by product and year. The product x year controls include the (log) number of French importers from ROW; the EU ad-valorem import tariff on Chinese exports; the average productivity of Chinese exporters, the variance of the productivity of Chinese exporters, the average quality of Chinese exporters; the value shares of processing trade, intermediated trade; and the share of foreign-owned, multi-product, state-owned firms in Chinese exports. Singletons are dropped and standard errors are clustered by French firm and HS-6 product. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Downstream Heterogeneity

Importer Size Measure	Employment	Sales	Total Imports		
			Baseline	CES Index	Interacted Controls
	(1)	(2)	(3)	(4)	(5)
Panel A. (log) Import Value$_{fpt}$					
(log) # CHN→ROW Exporters$_{pt}$	0.216***	0.198***	0.123***		0.116***
	(0.044)	(0.043)	(0.041)		(0.042)
x 2nd Down Size Tercile Dummy	0.011	0.019	0.027***		0.031***
	(0.012)	(0.012)	(0.010)		(0.011)
x 3rd Down Size Tercile Dummy	0.033**	0.049***	0.105***		0.115***
	(0.014)	(0.016)	(0.014)		(0.015)
N	811,740	836,678	893,300		893,300
R2	0.589	0.588	0.590		0.590
Panel B. (log) Import Quantity$_{fpt}$					
(log) # CHN→ROW Exporters$_{pt}$	0.285***	0.268***	0.173***	0.170***	0.165***
	(0.049)	(0.048)	(0.047)	(0.048)	(0.047)
x 2nd Down Size Tercile Dummy	0.010	0.015	0.036***	0.044***	0.043***
	(0.012)	(0.013)	(0.011)	(0.012)	(0.012)
x 3rd Down Size Tercile Dummy	0.033**	0.048***	0.119***	0.138***	0.131***
	(0.015)	(0.017)	(0.015)	(0.017)	(0.016)
N	811,740	836,678	893,300	893,300	893,300
R2	0.607	0.607	0.609	0.601	0.610
Panel C. (log) Import Unit Value$_{fpt}$					
(log) # CHN→ROW Exporters$_{pt}$	-0.068***	-0.071***	-0.050**	-0.047**	-0.049**
	(0.021)	(0.021)	(0.021)	(0.022)	(0.021)
x 2nd Down Size Tercile Dummy	0.001	0.003	-0.009**	-0.020***	-0.012***
	(0.003)	(0.003)	(0.004)	(0.005)	(0.004)
x 3rd Down Size Tercile Dummy	0.001	0.001	-0.014**	-0.041***	-0.016**
	(0.004)	(0.004)	(0.005)	(0.007)	(0.006)
N	811,740	836,678	893,300	893,300	893,300
R2	0.713	0.713	0.714	0.694	0.714
Firm, Year, HS-6 Product FE	YES	YES	YES	YES	YES
HS-6 Product Trend	YES	YES	YES	YES	YES
Product x Year Controls	YES	YES	YES	YES	YES

This table explores non-linearities in the effect of upstream market structure on downstream sourcing across downstream firms of different sizes, based on Column 4 of Table 2. French firm size tercile dummies are based on employment in Column 1, total sales in Column 2, and total imports in Columns 3-5. Column 4 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. Column 5 additionally controls for interactions of the size tercile dummies for downstream French firms with the average and with the variance of the productivity of upstream Chinese suppliers. The product x year controls include the (log) number of French importers from ROW; the EU ad-valorem import tariff on Chinese exports; the average productivity of Chinese exporters, the variance of the productivity of Chinese exporters, the average quality of Chinese exporters; the value shares of processing trade, intermediated trade; and the share of foreign-owned, multi-product, state-owned firms in Chinese exports. Singletons are dropped and standard errors are clustered by French firm and HS-6 product. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: Upstream Heterogeneity

Upstream Dispersion Measure	Sales per Worker (1)	VA per Worker (2)	Import Share (3)	Export Price (4)
Panel A. (log) Import Value$_{fpt}$				
(log) # CHN→ROW Exporters$_{pt}$	0.215***	0.158***	0.257***	0.284***
	(0.056)	(0.050)	(0.051)	(0.051)
x 2nd Up Dispersion Tercile Dummy	-0.029	0.048	-0.012	-0.073*
	(0.052)	(0.036)	(0.044)	(0.043)
x 3rd Up Dispersion Tercile Dummy	0.024	0.098**	-0.114*	-0.094*
	(0.055)	(0.042)	(0.064)	(0.048)
N	897,082	897,082	897,082	897,082
R2	0.585	0.585	0.585	0.585
Panel B. (log) Import Quantity$_{fpt}$				
(log) # CHN→ROW Exporters$_{pt}$	0.222***	0.171***	0.289***	0.346***
	(0.060)	(0.057)	(0.057)	(0.061)
x 2nd Up Dispersion Tercile Dummy	0.033	0.122***	0.016	-0.063
	(0.058)	(0.047)	(0.055)	(0.058)
x 3rd Up Dispersion Tercile Dummy	0.099*	0.154***	-0.037	-0.108*
	(0.060)	(0.052)	(0.073)	(0.061)
N	897,082	897,082	897,082	897,082
R2	0.605	0.605	0.605	0.605
Panel C. (log) Import Unit Value$_{fpt}$				
(log) # CHN→ROW Exporters$_{pt}$	-0.007	-0.013	-0.031	-0.062**
	(0.026)	(0.028)	(0.026)	(0.025)
x 2nd Up Dispersion Tercile Dummy	-0.062***	-0.073***	-0.028	-0.010
	(0.021)	(0.025)	(0.025)	(0.025)
x 3rd Up Dispersion Tercile Dummy	-0.075***	-0.056**	-0.077***	0.014
	(0.024)	(0.027)	(0.031)	(0.026)
N	897,082	897,082	897,082	897,082
R2	0.714	0.714	0.714	0.714
Firm, Year, HS-6 Product FE	YES	YES	YES	YES
HS-6 Product Trend	YES	YES	YES	YES
Product x Year Controls	YES	YES	YES	YES

This table explores heterogeneity in the effect of upstream market structure on downstream sourcing across input products with different levels of upstream firm heterogeneity, based on Column 4 of Table 2. The tercile dummies for upstream firm heterogeneity are based on the coefficient of variation across Chinese exporters in log sales per worker in Column 1, log value added per worker in Column 2, the share of imported inputs in total input purchases in Column 3, and the log export unit values in Column 4. The product x year controls include the (log) number of French importers from ROW; the EU ad-valorem import tariff on Chinese exports; the average productivity of Chinese exporters, the variance of the productivity of Chinese exporters, the average quality of Chinese exporters; the value shares of processing trade, intermediated trade; and the share of foreign-owned, multi-product, state-owned firms in Chinese exports. Singletons are dropped and standard errors are clustered by French firm and HS-6 product. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure A1: Upstream Market Structure and Firm Sourcing

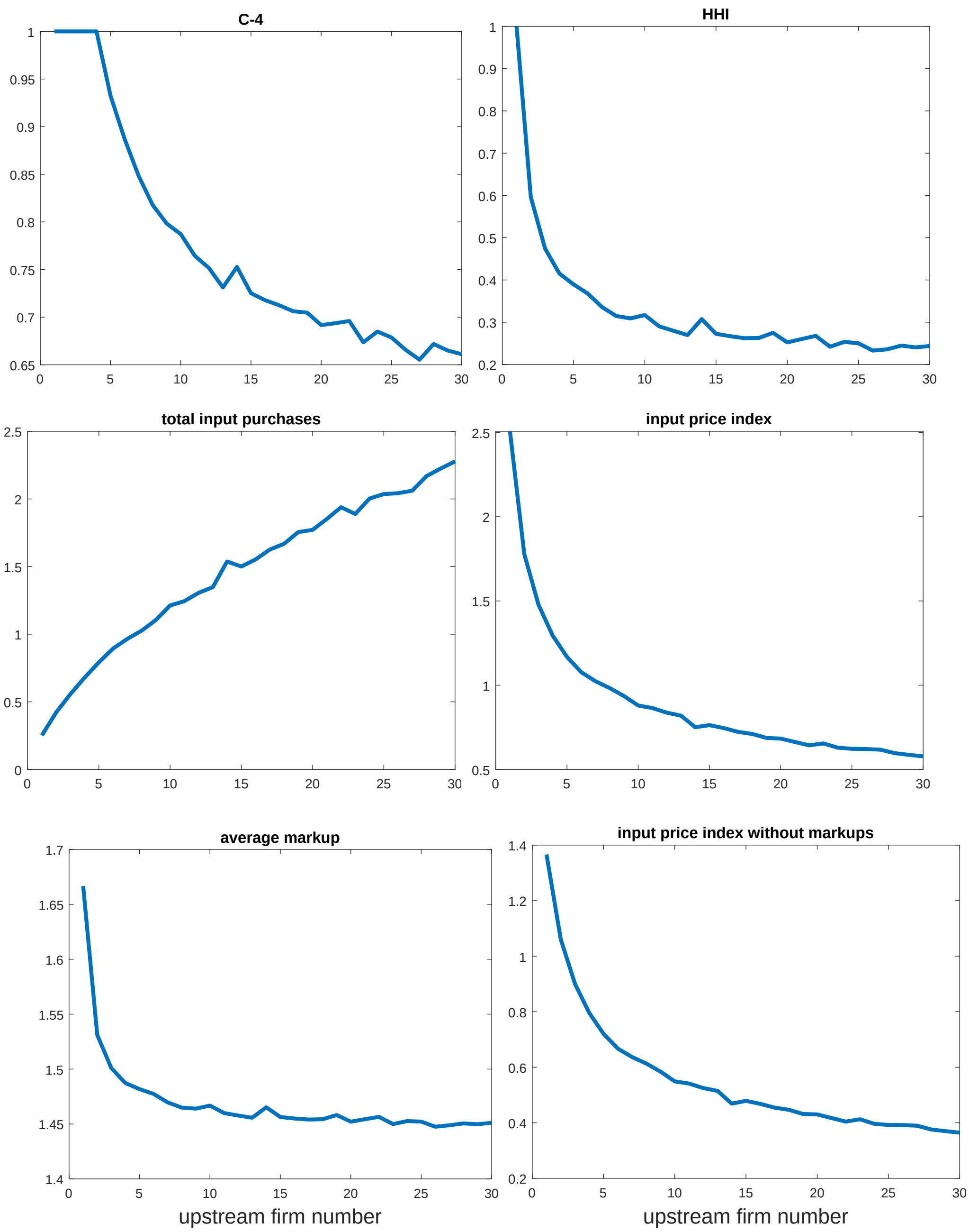


Table A1: Parametrization

Parameters	Definition	value
σ	elasticity of final-good demand	2.5
θ	Fréchet parameters capturing differentiation between upstream firms	3.5
C_m	upper bound of Pareto distribution for upstream firm's marginal cost	2
k	shape of Pareto distribution for upstream firm's marginal cost	3

Table A2: Further Robustness

	(1)	(2)	(3)	(4)	(5)
Panel A. (log) Import Value$_{fpt}$					
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.127***	0.117***	0.126***	0.115***	0.094***
	(0.015)	(0.016)	(0.016)	(0.015)	(0.020)
N	829,308	621,822	803,363	887,062	319,098
R2	0.590	0.461	0.586	0.584	0.469
Panel B. (log) Import Quantity$_{fpt}$					
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	0.160***	0.149***	0.161***	0.145***	0.126***
	(0.017)	(0.017)	(0.017)	(0.016)	(0.022)
N	829,308	621,822	803,363	887,062	319,098
R2	0.608	0.535	0.602	0.604	0.529
Panel C. (log) Import Unit Value$_{fpt}$					
(log) # CHN $\rightarrow$ ROW Exporters$_{pt}$	-0.033***	-0.033***	-0.035***	-0.030***	-0.033***
	(0.008)	(0.007)	(0.008)	(0.008)	(0.009)
N	829,308	621,822	803,363	887,062	319,098
R2	0.714	0.710	0.707	0.713	0.724
Firm, Year, HS-6 Product FE	YES	YES	YES	YES	YES
Downstr. Industry x Year FE	YES				
HS-6 Product Trend	YES	YES	YES	YES	YES
Product x Year Controls	YES	YES	YES	YES	YES
(log) Export value		YES			
(log) # ROW Exporters$_{pt}$ other products			YES		
(log) # ROW Exporters$_{pt}$ in HS-4				YES	
Sample					(1)

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