

Original Paper

Trade Liberalization and the Organization of Business Partnerships

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Abstract

This paper develops a theory of partnership formation between developing-country producers and developed-country headquarters. A developing-country producer can partner with either a local headquarters or a developed-country one; in the latter case, the producer gains from technology transfer, the headquarters gains from lower production costs, and both parties bear coordination costs. I show that developing-country producers with mid-range productivity engage in cross-border partnerships, while those at either end of the productivity distribution partner locally. The theory's predictions are supported by firm-level evidence from China around the time of its WTO accession.

JEL codes: F12, F15, O14, O33.

1. Introduction

When a country liberalizes trade, its firms face several choices about how to serve foreign markets. This paper develops a theory of how producers in developing countries interact with local and developed-country headquarters, and tests the theory using data from China.

In the theory, a cross-border partnership arises when a developing-country producer and a developed-country headquarters work together. Within such a partnership, the producer benefits from technology transferred by the headquarters, while the headquarters benefits from lower production costs in the developing country. Both parties bear coordination costs arising from cross-border differences in machinery specifications, regulations, management practices, and culture. The theory therefore predicts that cross-border partnerships are formed by developing-country producers with mid-range initial productivity: at this productivity level, the gains from technology transfer outweigh the frictions of cross-border coordination, and the partnership yields sufficient profits for both parties.

Producers at the tails of the productivity distribution instead operate under within-border partnerships. Those with high initial productivity cannot retain enough of the surplus from technology transfer to make a cross-border arrangement worthwhile, while those with low initial productivity cannot generate profits large enough to attract a developed-country headquarters. The theory further predicts that high-productivity producers serve both their local market and the headquarters' home market, whereas

low-productivity producers serve only the local market because they cannot cover the fixed cost of exporting.¹ In addition, among firms in cross-border partnerships, relatively more productive producers are vertically integrated with their headquarters, while less productive ones operate at arm's length. Vertical integration delivers more effective technology transfer and smoother coordination, but at a higher fixed cost than arm's-length contracting.

I test these theoretical implications using firm-level data from China. China is an especially suitable setting: it acceded to the WTO in 2001 under developing-country terms and has since grown to become the world's largest exporting country. The theory yields three testable predictions. First, on average, Chinese producers engaged in within-border partnerships and serving only the domestic market have low productivity; those engaged in cross-border partnerships have mid-range productivity; and those engaged in within-border partnerships that serve both domestic and foreign markets have high productivity. Second, among Chinese exporters, cross-border partnerships are more prevalent than within-border partnerships in industries with more transferable technology and less productivity dispersion, and in regions with better infrastructure and institutions, since these facilitate cross-border coordination.² Third, among Chinese producers in cross-border partnerships, those with relatively high productivity are vertically integrated with their headquarters, while those with relatively low productivity operate at arm's length.

The data support all three predictions. To isolate the role of initial productivity in the first prediction, I track firms that initially operated under within-border partnerships serving only the Chinese market but later switched partnership type. Firms that switched to within-border partnerships serving both domestic and overseas markets had high pre-switch productivity; those that switched to cross-border partnerships had mid-range pre-switch productivity; and those that never switched had low productivity. These patterns directly support the view that initial productivity governs the form of interaction between headquarters and producers. By the same logic, producers under cross-border partnerships who switched from arm's length to vertical integration were more productive before the switch than those who remained at arm's length, consistent with the third prediction.

This paper contributes to three strands of the literature. First, it develops a framework in which headquarters and producers in different countries interact symmetrically. The existing literature typically treats offshore producers as passive candidates awaiting selection by developed-country

¹ The producer-headquarters relationship in the model is vertical; see, e.g., Hanson, Mataloni, and Slaughter (2005) and Hummels, Ishii, and Yi (2001) on vertical fragmentation of production. The baseline framework assumes that cross-border production primarily serves the headquarters' home market (such as the United States). Section 2.3 shows that the same results hold when cross-border partnerships serve other markets as well.

² My focus is on how infrastructure and institutions shape the composition of exporters, whereas the existing literature emphasizes their effect on aggregate trade flows. See Bougheas, Demetriades, and Morgenroth (1999), Levchenko (2007), Nunn (2007), and Nunn and Trefler (2008).

headquarters.³ In my model, producers and headquarters select each other, so that a cross-border partnership forms only if both parties find it more profitable than their outside options. Mapping the choices available to developing-country producers is essential for understanding what determines the efficiency of global production. The analysis implies that offshore producers are more productive than other local firms not only because of the technology they receive *ex post*, but also because they are *ex ante* more productive.

The second contribution is to provide evidence on the frictions between producers and headquarters in cross-border partnerships. These frictions, first emphasized by Arrow (1969), remain poorly understood because they are not directly observable. Recent work infers their existence from the organization of multinational production: U.S. multinational headquarters substitute for error-prone direct communication with offshore producers by exporting technology-embodied intermediates (Keller and Yeaple, 2013), and they vertically integrate foreign partners when offshore tasks are complex (Costinot, Oldenski, and Rauch, 2011). Notably, if cross-border partnerships were frictionless, high-productivity producers in developing countries would always find it profitable to partner with developed-country headquarters. This paper shows that, in practice, high-productivity Chinese producers choose within-border production—direct evidence of frictions in cross-border partnerships.

The third contribution is to assess the role of technology transfer in cross-border mergers and acquisitions (M&A).⁴ I show that developed-country headquarters partner with developing-country producers of mid-range, rather than high, productivity, because high-productivity producers have better outside options and therefore command larger profit shares. Headquarters can offer mid-range producers comparatively small profit shares because the technology transfer itself makes the offer sufficiently attractive.⁵

The remainder of the paper is organized as follows. Section 2 presents the theory and its predictions. Section 3 reports empirical tests of these predictions. Section 4 concludes and outlines directions for future research.

2. A Theory of Interaction between Headquarters and Producers

2.1 Environment

Consider a world consisting of a host country (H) and a source country (S), which correspond, respectively, to the developing country and the developed country in the introduction. Residual demand for differentiated products in each country takes the form

³ See Antràs and Rossi-Hansberg (2009), Helpman (2006), and Spence (2005) for surveys.

⁴ For studies on cross-border M&A, see, e.g., Neary (2007), Nocke and Yeaple (2007), and Spearot (2010). Note also that foreign producers in my model are not necessarily merged with or acquired by their headquarters; they may operate at arm's length.

⁵ The model does not consider bi-sourcing, in which a developed-country headquarters works simultaneously with a developed-country producer and a developing-country producer. See Du, Lu, and Tao (2009) for a discussion of bi-sourcing.

$$y_l = \Phi_l p_l^{-1/(1-\alpha)}, \quad (1)$$

where $l \in \{H, S\}$, p_l is price, Φ_l measures demand intensity, and $1/(1-\alpha)$ is the demand elasticity. Production of a differentiated good involves two parties: a producer X and a headquarters Z . Both parties exist in each country: X_H , X_S , Z_H , and Z_S .

The host-country producer X_H , with initial (*ex ante*) productivity $\theta > 0$, can partner with either a host-country headquarters Z_H (*within-border partnership HH*) or a source-country headquarters Z_S (*cross-border partnership HS*). The partner headquarters Z_l provides X_H with the product design. The production functions are

$$\begin{aligned} y_{HH} &= \theta x_{HH}, & (2) \\ y_{HS} &= (\gamma\theta)^\mu x_{HS}, & (3) \end{aligned}$$

where x_k (for $k \in \{HH, HS\}$) is the production input, $\gamma > 0$ is technological transferability, and $0 < \mu < 1$ is coordination efficiency. Define $g \equiv (\gamma\theta)^\mu$ as *ex post* productivity. Note that μ governs both the effectiveness of technology transfer and the realization of *ex ante* productivity, as is clear in logarithmic terms:

$$\ln g = \mu \ln \gamma + \mu \ln \theta. \quad (4)$$

For instance, doubling either γ or θ less than doubles g , and doubling both still less than doubles g .⁶

Variable trade costs are assumed to be zero for now but can be readily incorporated, as discussed below. In country H , the unit cost of the input x is c . Under within-border partnership HH , output may either serve country H only or serve both countries; in the latter case, a fixed entry cost f_{EX} (where EX stands for “exporting”) must be paid. For convenience, I treat these two cases as distinct partnership types, (HH, NON) and (HH, B) , respectively. The cross-border partnership HS is free of the entry cost f_{EX} because Z_S knows its local market well.

In country S , the unit cost of the input x is \tilde{c} . The only potential partner for X_S is Z_S . If they work together (partnership SS), the production function is

$$y_{SS} = \tilde{\theta} x_{SS}, \quad (5)$$

where $\tilde{\theta}$ is a constant, rationalized by treating X_S as the best available producer in country S .⁷ To summarize, Z_S chooses between partnerships HS and SS , while X_H chooses among (HH, NON) , (HH, B) , and HS .

The joint profits under the four partnership types are⁸

⁶ Productivity returns to γ and θ are not constant to scale; see, e.g., Belderbos, Ito, and Wakasugi (2008).

⁷ In other words, cross-border partnership becomes an option only when Z_S has exhausted domestic options for raising productivity.

⁸ See Appendix A.1 for derivations.

$$\pi_{HH,NON}(\theta) = \Psi \Phi_H \theta, \quad (6)$$

$$\pi_{HS}(\theta) = \Psi \Phi_S \Gamma \theta^\mu, \quad (7)$$

$$\pi_{HH,B}(\theta) = \Psi(\Phi_H + \Phi_S) \theta - f_{EX}, \quad (8)$$

$$\pi_{SS} = \tilde{\Psi} \Phi_S \tilde{\theta}, \quad (9)$$

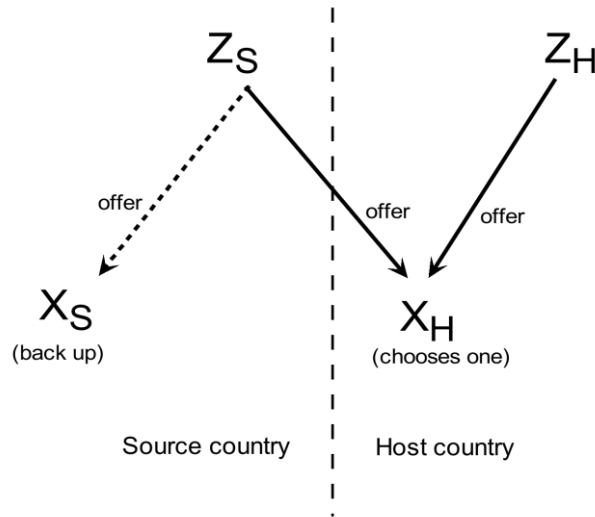
where $\theta = \theta^{\alpha/(1-\alpha)}$, $\tilde{\theta} = \tilde{\theta}^{\alpha/(1-\alpha)}$, $\Gamma = \gamma^{\alpha\mu/(1-\alpha)}$, $\Psi = (1-\alpha)/(c/\alpha)^{\alpha/(1-\alpha)}$, and $\tilde{\Psi} = (1-\alpha)/(\tilde{c}/\alpha)^{\alpha/(1-\alpha)}$. If cross-border partnership is unavailable, X_H can work only with Z_H , and the productivity threshold for exporting is $\theta^* = f_{EX}/(\Psi\Phi_S)$, obtained by equating $\pi_{HH,NON}$ and $\pi_{HH,B}$. The term Γ captures the effectiveness of technology transfer. I assume

$$\Gamma > \left[\left(\frac{\tilde{\Psi}}{\Psi} \right) \left(\frac{\tilde{\theta}}{\theta^*} \right) + \left(\frac{\Phi_H}{\Phi_S} \right) \right] \Omega, \quad (10)$$

where $\Omega \equiv (\theta^*)^{1-\mu}$. In other words, if Γ is too low, cross-border partnership is inferior to within-border partnership, because the productivity gain from technology transfer is always outweighed by the productivity loss from cross-border coordination. Finally, note that when Z_S partners with X_S , the entire profit π_{SS} accrues to Z_S because X_S has no outside option. Since $\tilde{\Psi}$, Φ_S , and $\tilde{\theta}$ are all constants, I define $\tilde{\pi} \equiv \pi_{SS} = \tilde{\Psi}\Phi_S\tilde{\theta}$ for convenience.

The timing of events is as follows. On date 1, Z_H and Z_S propose contracts to X_H , and X_H accepts one of the two. The contracts specify who partners with whom and how future revenue is divided. Z_H can propose only to X_H and exits if its proposal is rejected. Z_S partners with X_S if its proposal to X_H is rejected or if it does not want to partner with X_H . The contracting process is summarized in **Figure 1**. On date 2, production, sales, and revenue division are carried out according to the contracts.

Figure 1: The Contracting Process



2.2 Equilibrium

The equilibrium characterizes how the four parties X_H , X_S , Z_H , and Z_S choose their partners for each value of θ . As shown in Figure 1, X_S 's only option is Z_S ; the analysis therefore focuses on what Z_H

and Z_S offer X_H and how X_H chooses between them. X_H selects the contract that delivers the larger profit share, and Z_H and Z_S act strategically when making offers.

Let $\pi_{HH}(\theta)$ denote the maximum joint profit under within-border partnership:

$$\pi_{HH}(\theta) = \max\{\pi_{HH,NON}(\theta), \pi_{HH,B}(\theta)\},$$

and let $\pi_{HH}^{X_H}(\theta)$ denote the share of $\pi_{HH}(\theta)$ that accrues to X_H . The reservation profit for X_H under partnership HS is $\pi_{HH}^{X_H}(\theta)$, while the reservation profit for Z_S is $\tilde{\pi}$. Thus, partnership HS is chosen by X_H and Z_S if and only if

$$\pi_{HS}(\theta) - \pi_{HH}^{X_H}(\theta) - \tilde{\pi} > 0. \quad (11)$$

Since $\pi_{HH}^{X_H}(\theta) \leq \pi_{HH}(\theta)$, I begin by examining the stronger condition

$$\pi_{HS}(\theta) - \pi_{HH}(\theta) - \tilde{\pi} > 0, \quad (12)$$

and establish (see Appendix A.2 for the proof):

Lemma 1. (i) The equation $\pi_{HS}(\theta) - \pi_{HH}(\theta) - \tilde{\pi} = 0$ has two solutions $\underline{\theta}$ and $\bar{\theta}$, satisfying $\underline{\theta} < \theta^* < \bar{\theta}$. (ii) $\pi_{HS}(\theta) > \pi_{HH}(\theta) + \tilde{\pi}$ if and only if $\theta \in (\underline{\theta}, \bar{\theta})$.

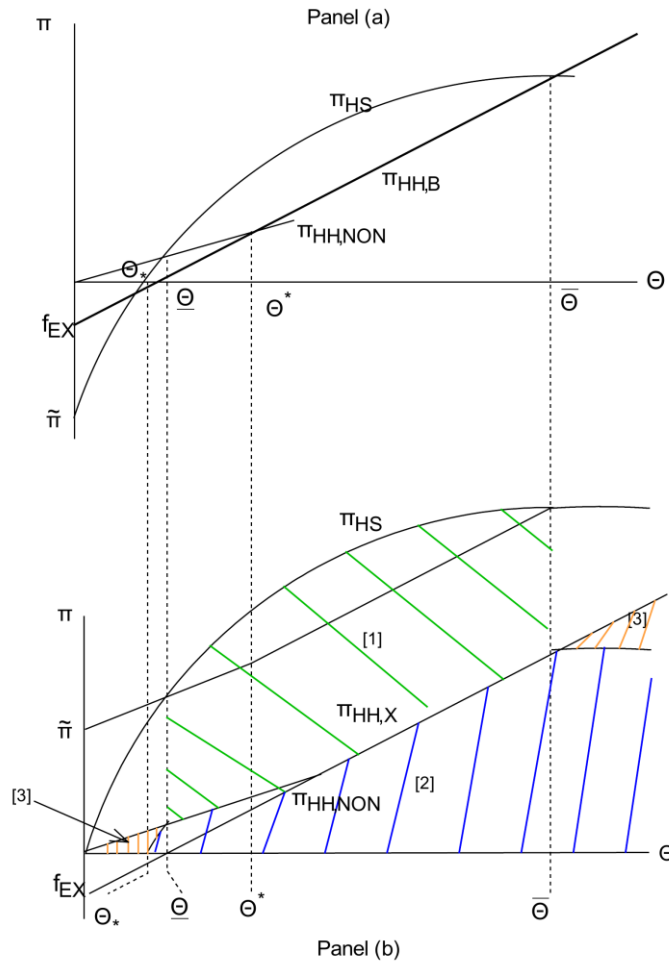
Lemma 1 identifies two productivity thresholds, $\underline{\theta}$ and $\bar{\theta}$, and shows that condition (12) holds when $\theta \in (\underline{\theta}, \bar{\theta})$.⁹ Panel (a) of Figure 2 plots the joint-profit functions. Note that Z_S 's reservation profit $\tilde{\pi}$ is exogenous and constant, and can therefore be viewed as a fixed cost from X_H 's perspective. I then establish (see Appendix A.3):

Lemma 2. Conditions (11) and (12) are equivalent.

The intuition for Lemma 2 is as follows. When $\theta \in (\underline{\theta}, \bar{\theta})$, Z_H and Z_S compete for X_H , and Z_S wins by offering X_H a profit of $\pi_{HH}(\theta)$. Z_S can match this offer by keeping no profit for itself; by Lemma 1, however, Z_H can always offer slightly more. In equilibrium, partnership HS forms, with $\pi_{HS}^{Z_H}(\theta) = 0$, $\pi_{HS}^{X_H}(\theta) = \pi_{HH}(\theta)$, $\pi_{HS}^{Z_S}(\theta) = \pi_{HS}(\theta) - \pi_{HH}(\theta)$, and $\pi^{X_S} = 0$. When $\theta \in [\bar{\theta}, \infty)$, Z_H outbids Z_S by offering X_H a profit of $\pi_{HS}(\theta) - \tilde{\pi}$. Partnership (HH, B) then forms, with $\pi^{Z_H}(\theta) = \pi_{HH,B}(\theta) - (\pi_{HS}(\theta) - \tilde{\pi})$, $\pi^{X_H}(\theta) = \pi_{HS}(\theta) - \tilde{\pi}$, $\pi^{Z_S} = \tilde{\pi}$, and $\pi^{X_S} = 0$.

⁹ As a numerical example, let $\Psi = \tilde{\Psi} = 1$, $\Phi_H = 1$, $\Phi_S = 1.2$, $\Gamma = 1.1$, $\mu = 0.5$, and $\tilde{\pi} = 0.3$; then $\underline{\theta} = 0.12$ and $\bar{\theta} = 0.74$.

Figure 2: Ex-ante Productivity and Partnership Type



When $\theta \in (0, \underline{\theta})$, the analysis is slightly more involved. Define θ_* by $\pi_{HS}(\theta_*) - \tilde{\pi} = 0$. For a moderately low $\theta \in (\theta_*, \underline{\theta}]$, X_H finds technology transfer from Z_S attractive, but its *ex post* productivity is not high enough to make partnership HS as profitable for X_H as partnership (HH, NON) . The reason is that, to partner with Z_S , X_H must ensure Z_S its reservation profit $\tilde{\pi}$; but with $\tilde{\pi}$ paid to Z_S , X_H earns less than it would under (HH, NON) . In equilibrium, X_H and Z_H form partnership (HH, NON) , while X_S and Z_S form partnership SS . The resulting profits are $\pi^{Z_H}(\theta) = \pi_{HH,NON}(\theta) - (\pi_{HS}(\theta) - \tilde{\pi})$, $\pi^{X_H}(\theta) = \pi_{HS}(\theta) - \tilde{\pi}$, $\pi^{Z_S} = \tilde{\pi}$, and $\pi^{X_S} = 0$. When $\theta \in (0, \theta_*]$, X_H cannot afford to pay $\tilde{\pi}$ and so has no option but to partner with Z_H , again under (HH, NON) . Under this partnership, X_H has no bargaining leverage, so $\pi_{HH,NON}^{X_H}(\theta) = 0$, and the remaining profits are $\pi_{HH,NON}^{Z_H}(\theta) = \pi_{HH,NON}(\theta)$, $\pi_{HH,NON}^{Z_S} = \tilde{\pi}$, and $\pi^{X_S} = 0$.

The profit and partnership schedules across all parties are now fully characterized. The profit schedules are summarized graphically in **Panel (b) of Figure 2**: areas [1], [2], and [3] denote the profits accruing to Z_S , X_H , and Z_H , respectively. The partnership schedules are summarized in Proposition 1.

Proposition 1. *In equilibrium, the partnership schedules are as follows:*

<i>Ex-ante productivity</i>	<i>Partnership type</i>	
$\theta \leq \underline{\theta}$	(HH, NON)	SS
$\underline{\theta} < \theta < \bar{\theta}$	HS	HS
$\theta \geq \bar{\theta}$	(HH, B)	SS

Three points are worth highlighting. First, this is a Nash equilibrium; it is neither a unilateral self-selection of X_H across partnership types based on productivity, nor a unilateral selection of producer by Z_S . Second, trade in intermediates can readily be incorporated into the model. The input x is a composite of production factors, including intermediates; if Z_S produces the intermediates in country S and ships them to country H , then c under partnership HS changes relative to \bar{c} , which simply changes Ψ relative to $\tilde{\Psi}$ and hence $\underline{\theta}$ and $\bar{\theta}$. Proposition 1 continues to hold so long as condition (10) is satisfied. Third, variable trade costs do not materially change the analysis. An iceberg trade cost lowers π_{HS} by more than it lowers $\pi_{HH,B}$, since partnership (HH, B) exports only part of its output while partnership HS exports all of it. Trade liberalization and improvements in transportation technology therefore encourage partnership HS relative to (HH, NON) and (HH, B) .

Introducing industrial and regional characteristics

Assume that θ is drawn from a Pareto distribution.¹⁰ The analysis can then be extended to allow additional parameters to vary across industries and regions. Specifically, let technological transferability γ vary by industry and let coordination efficiency μ vary by region, with producers in country H located in regions of differing infrastructure and institutional quality.¹¹ Both HS and (HH, B) involve exporting (to serve country S); their shares in the number of exporters are

$$\sigma_{HS} = \frac{V(\bar{\theta}) - V(\underline{\theta})}{1 - V(\underline{\theta})}, \quad (13)$$

$$\sigma_{HH,B} = \frac{1 - V(\bar{\theta})}{1 - V(\underline{\theta})}, \quad (14)$$

where $V(\cdot)$ is the Pareto distribution: $V(\theta) = 1 - (\theta_0/\theta)^\zeta$, with $\zeta > 0$ and θ_0 the lower bound of θ . It then follows (see Appendix A.4 for details) that:

Proposition 2. *Among exporters, cross-border partnerships become more prevalent than within-border partnerships when technology is more transferable, productivity dispersion is smaller, and cross-border coordination is easier. Formally, (i) $d(\sigma_{HS}/\sigma_{HH,B})/d\gamma > 0$; (ii) $d(\sigma_{HS}/\sigma_{HH,B})/d\mu > 0$; (iii)*

¹⁰ Axtell (2001) and Helpman, Melitz, and Yeaple (2004) provide empirical evidence on the Pareto distribution of firm productivity. Gabaix (2009) and Rossi-Hansberg and Wright (2007) offer theoretical discussions.

¹¹ Coordination may also be affected by industry characteristics, which does not alter Proposition 2. Let $\mu = \bar{\mu} + \mu_{in}$, where $\bar{\mu}$ and μ_{in} are region- and industry-specific, respectively. Then $g = (\gamma\theta)^\mu = (\gamma\theta)^{\bar{\mu} + \mu_{in}} = \gamma^{\bar{\mu}} \gamma^{\mu_{in}} \theta^{\bar{\mu} + \mu_{in}}$, where $\gamma^{\bar{\mu}}$ is industry-region specific and $\gamma^{\mu_{in}}$ is industry-specific. Parts (i) and (ii) of Proposition 2 follow as before; part (iii) does not involve γ or μ and is unaffected.

$$d(\sigma_{HS}/\sigma_{HH,B})/d\zeta > 0.$$

Proposition 2 shows how the relative prevalence of partnership types among exporters depends on industry and regional characteristics.¹² Under both *HS* and *(HH, B)*, products are “made in country *H*,” while product designs belong to country *S* and country *H*, respectively.

Organizational form

The preceding analysis ignores the organizational form of cross-border partnerships. I now assume that Z_S also specifies the organizational form $m \in \{I, O\}$ in its proposed contract, where *I* denotes vertical integration and *O* denotes arm’s length. Compared with arm’s length, vertical integration facilitates technology transfer and coordination but entails a higher fixed cost: $\Gamma_I > \Gamma_O$, $\mu_I > \mu_O$, and $f_I > f_O = 0$. The earlier analysis can thus be interpreted as the arm’s-length case.

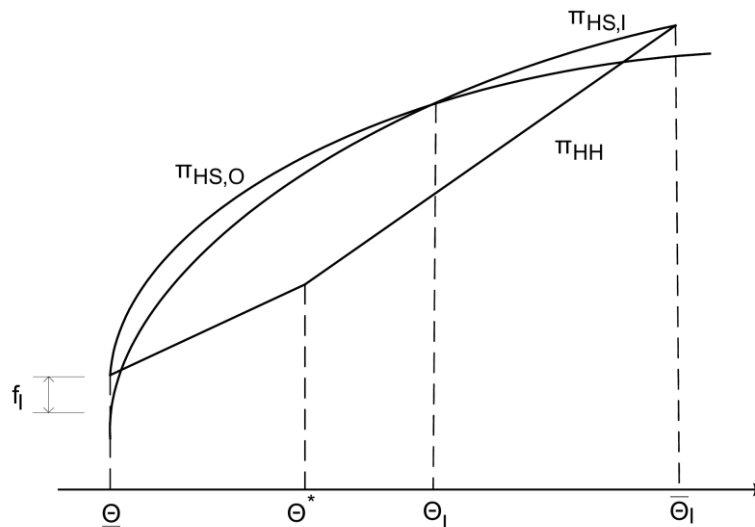
Proposition 3. Let $\underline{\theta}_m$ and $\bar{\theta}_m$ denote the new productivity thresholds across partnership types. Then:

1. $\underline{\theta}_O = \underline{\theta} < \underline{\theta}_I < \bar{\theta}_O = \bar{\theta} < \bar{\theta}_I$;
2. the thresholds between partnerships *(HH, NON)*, *HS*, and *(HH, B)* are $\underline{\theta}$ and $\bar{\theta}_I$;
3. if joint profits satisfy $\pi_{HS,I}(\bar{\theta}_I) > \pi_{HS,O}(\bar{\theta}_I)$, (15) $\pi_{HS,I}(\underline{\theta}) < \pi_{HS,O}(\underline{\theta})$ then there exists θ_I with $\underline{\theta} < \theta_I < \bar{\theta}_I$

$$\bar{\theta}_I \text{ such that } (k, m) = \begin{cases} (HS, O) & \text{if } \underline{\theta} < \theta < \theta_I, \\ (HS, I) & \text{if } \theta_I \leq \theta < \bar{\theta}_I. \end{cases}$$

The intuition for Proposition 3 is illustrated graphically in **Figure 3**. Conditions (15) ensure $\theta_I \in (\underline{\theta}, \bar{\theta}_I)$. Violating these conditions does not alter the analysis, but simply removes one of the two organizational forms from the equilibrium.

Figure 3: Organizational Forms



¹² Only part (iii) of Proposition 2 relies on the Pareto-distribution assumption. I revisit this assumption later in the empirical analysis (see page above).

2.3 Robustness: target markets of cross-border partnership

The paper focuses on how host-country producers serve country S under different partnership types. To sharpen the analysis, the model has so far assumed that cross-border partnerships serve only country S . I now show that the earlier results hold when cross-border partnerships serve both countries. In that case, the profit function under partnership HS becomes

$$\pi_{HS}(\theta) = \Psi(\Phi_S + \Phi_H) \Gamma \theta^\mu, \quad (16)$$

and condition (10) becomes

$$\Gamma > \left[(1 - \Delta) \left(\frac{\tilde{\Psi}}{\Psi} \right) \left(\frac{\tilde{\Theta}}{\Theta^*} \right) + \Delta \right] \Omega, \quad (17)$$

where $\Delta = \Phi_H / (\Phi_H + \Phi_S)$ corresponds to Φ_H / Φ_S in condition (10).

Returning to Figure 2, the only effect of adding the country H market is to shift the intersection of π_{HS} and $\pi_{HH,B}$ to the right. Propositions 1 and 2 still hold, since the three sections of the productivity spectrum retain the same relative ordering. Proposition 3 also continues to hold, as it does not depend on the markets served under cross-border partnerships. Cross-border partnership may also serve a third market—the export-platform case discussed in the literature (e.g., Ekholm, Forslid, and Markusen, 2007). This third-market advantage arises because Z_S may have marketing and sales channels unavailable to Z_H ; technically, the effect is a variant of Δ in condition (17).

3. Empirical Evidence

3.1 Data

China's accession to the WTO was unusually late among major economies. For most of the postwar period, China operated under a Soviet-style planned economy that left little room for the price-based, rules-based trade the GATT/WTO system was built around; reform began only in 1978, and even then liberalization of foreign trade proceeded gradually. Formal negotiations to join the multilateral trading system stretched over fifteen years, culminating in a landmark bilateral agreement with the United States in November 1999 (ratified by the U.S. Congress as Permanent Normal Trade Relations in 2000), which cleared the principal remaining obstacle. China formally acceded to the WTO on December 11, 2001, as a developing-country member, committing to substantial reductions in tariffs and non-tariff barriers, the opening of its services sector, and broader regulatory harmonization with WTO rules. The sample period of this paper, 2000–2003, therefore brackets accession directly, capturing Chinese firms as they responded to a sharp and credible shift in the country's trade-policy regime.

The primary data source for the empirical analysis is the *Annual Surveys of Industrial Production* (ASIP) conducted by the National Bureau of Statistics of China for 2000–2003.¹³ The surveys collected detailed firm-level information, including sales revenue, export value, capital, employment, and wages. The industry section of the *China Statistical Yearbooks* is compiled from these surveys.

¹³ Recent papers using these data for other research topics include Hsieh and Klenow (2009), Lu, Lu, and Tao (2009), Park, Yang, Shi, and Jiang (2010), and Qian (2008).

Appendix B provides further details. Firm-level information on ownership (domestic or foreign) and sales destinations (domestic or overseas), summarized in **Table 1**, is used to identify the partnership types and organizational forms in the model. **Table 2** reports the share of each partnership type in total export value and total number of exporters for 2000–2003. Cross-border partnerships account for roughly 40% of total exported value and 35% of total exporters. Within cross-border partnerships, the ratio of arm’s length to vertical integration is approximately 2:3.

Table 1: Theoretical and Empirical Partnership Types

Theory	Data	
Partnership types & organizational forms	Ownership	Sales
(HH, NON)	domestic	domestic
(HH, B)	domestic	domestic and overseas
(HS, I)	overseas	overseas
(HS, O)	domestic	overseas

Table 2: Shares of Partnership Types and Organizational Forms in Exporters

Year	Partnership HS				Partnership (HH, B)	
	Arm’s length (HS, O)		Vertical integration (HS, I)		Value	Number
	Value	Number	Value	Number		
2000	0.112	0.107	0.281	0.229	0.607	0.664
2001	0.122	0.133	0.285	0.213	0.592	0.655
2002	0.113	0.139	0.291	0.214	0.595	0.647
2003	0.117	0.134	0.311	0.218	0.572	0.648

3.2 Relative productivity

To test Proposition 1, I begin with the regression

$$\ln TFP_{djrt} = \omega + \kappa' TYPE_d + \iota' C_{drt} + \nu_j + \nu_t + \epsilon_{djrt}, \quad (18)$$

restricted to firms whose partnership type is invariant over the sample period. This specification facilitates the estimation of productivity differences across partnership types. Regressions in the opposite direction (partnership types on productivity) are reported in Appendix C and yield the same results.

The dependent variable is total factor productivity (TFP), estimated using the Levinsohn–Petrin (2003) procedure. The indices d , j , r , and t denote firm, industry, region, and year, respectively. $TYPE_d$ is a vector of dummies indicating firm d ’s partnership type, with (HH, NON) as the reference group. Specifically, $TYPE_d = [HS_d, HHB_d]'$, where $HHB_d = 1$ if the firm is under (HH, B) , and $HS_d = 1$ if the firm is under either (HS, O) or (HS, I) . The coefficients κ_{HS} and κ_{HHB} are the corresponding

coefficients. C_{drt} is a set of firm and regional characteristics in year t . Each industry corresponds to a four-digit industry code.¹⁴ ν_j and ν_t are industry and year fixed effects, respectively, and ϵ_{dirt} is the error term.

Table 3 reports $\hat{\kappa}_{HHB} > \hat{\kappa}_{HS} > 0$, supporting Proposition 1. The difference between $\hat{\kappa}_{HS}$ and $\hat{\kappa}_{HHB}$ is statistically significant at the 1% level in all columns. Column (1) is the baseline regression without controls. Column (2) adds profit margin, capital intensity, and regional population. Profit margin, defined as pre-tax profit over sales (Phillips, 1995), purges market power from the productivity estimates; capital intensity and regional population reduce noise from industry composition and local market size.¹⁵ Columns (1)–(2) use fixed effects, while column (3) uses random effects.

Table 3: Productivity across Partnerships

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cross-border partnership (HS dummy)	0.223*** (0.003)	0.207*** (0.003)	0.205*** (0.003)	0.203*** (0.003)	0.198*** (0.005)	0.192*** (0.004)	0.108*** (0.008)	0.267*** (0.015)
Within-border partnership & serving both markets (HHB dummy)	0.357*** (0.003)	0.352*** (0.003)	0.352*** (0.003)	0.335*** (0.004)	0.301*** (0.006)	0.348*** (0.005)	0.205*** (0.010)	0.379*** (0.012)
Specification	FE	FE	RE	FE	FE	FE	FE	FE
Sample	All	All	All	All	Special Zones	Non-Special Zones	Apparel	Electronics
Control vars.	No	Yes	Yes	Yes, with tax	Yes, with tax	Yes, with tax	Yes, with tax	Yes, with tax
t-test [p-value]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
No. of obs.	376,390	376,390	376,390	376,390	130,337	246,053	12,640	18,107
No. of inds.	752	752	752	752	746	748	4	42
R ²	0.05	0.06	0.07	0.08	0.09	0.08	0.10	0.16

Notes: The dependent variable is TFP calculated from Levinsohn–Petrin estimates. The reference group is firms under within-border partnerships serving China only—type (HH, NON) . Control variables are profit margin, capital intensity, and regional population. Industry (four-digit) and year fixed effects are included in columns (1)–(2) and (4)–(8); random effects are used in column (3). Columns (4)–(8) add tax payment as a control. Columns (5)–(6) use subsamples of firms located in or out of special zones (export-promotion or free-trade zones); see text. Columns (7)–(8) use the apparel and electronics two-digit industries, respectively. Robust standard errors in parentheses. The t -test

¹⁴ China's industry classification system is similar to the United Nations' International Standard Industrial Classification (ISIC).

¹⁵ As in Antràs (2003), capital intensity is measured as the ratio of capital stock to total employment.

examines H_0 : the two coefficients are equal. The constant is suppressed. *** significant at the 1% level.

I next consider several potential confounders. First, taxation. Developing countries such as China often have local tax policies that favor cross-border partnerships. Lump-sum tax favors can contaminate *TFP* and thereby bias the results.¹⁶ To address this concern, column (4) of Table 3 adds tax payment as a control. The coefficients on *HS* and *HHB* are close to those in columns (1)–(3), indicating that lump-sum tax favors are not a serious concern. China also has export-promotion zones (EPZs) and free-trade zones (FTZs), where exports are encouraged through policy instruments—such as lower taxes, eliminated quotas, and streamlined bureaucratic procedures—that do not apply elsewhere. I divide firms into two subsamples by whether they are located in a four-digit administrative division containing an EPZ or FTZ.¹⁷ Columns (5) and (6) replicate column (4) using these subsamples and yield the same findings. The coefficients on *HS* and *HHB* differ slightly across columns, suggesting that EPZs and FTZs may have different industry compositions from the rest of the country.

Second, industry composition. Certain partnership types may be concentrated in particular industries, raising the concern that the results in Table 3 are driven by industry composition. Columns (1)–(6) include either fixed or random industry effects to address this concern. I also examine two industries individually—apparel and electronics—which run the largest trade surpluses of all industries and represent opposite ends of the sophistication spectrum. Columns (7)–(8) report regressions on these two subsamples; the results match those in columns (1)–(6).

Third, outliers. **Table 4** reports quantile regressions with specifications similar to those in Table 3. The estimates are robust to extreme values. Moreover, the differences between the coefficients on the two dummies become larger at higher quantiles, indicating that the productivity premium of (*HH, B*) relative to *HS* grows with productivity. This suggests that the productivity distribution is right-skewed: the greater the productivity dispersion, the more high-productivity firms operate under (*HH, B*), consistent with the assumption of Pareto-distributed productivity introduced earlier (page *above*).

¹⁶ *Ad valorem* tax favors granted to cross-border partnership do not affect the ranking of productivity across partnership types, as is easily seen in Figure 2. I focus on lump-sum tax favors because *TFP* captures the output not explained by inputs, so reduced tax payments may show up as an increase in *TFP*.

¹⁷ Four-digit administrative divisions in China refer to prefecture-level cities, typically an urban center surrounded by a larger rural area.

Table 4: Productivity across Partnerships: Quantile Regression

	(1)	(2)	(3)	(4)	(5)
	10%	25%	50%	75%	90%
Cross-border partnership (<i>HS</i> dummy)	0.184*** (0.006)	0.138*** (0.004)	0.131*** (0.003)	0.143*** (0.004)	0.153*** (0.005)
Within-border, both markets (<i>HHB</i> dummy)	0.240*** (0.004)	0.226*** (0.002)	0.278*** (0.002)	0.345*** (0.003)	0.387*** (0.004)
Difference	0.056	0.088	0.147	0.202	0.234
No. of obs.	376,390	376,390	376,390	376,390	376,390
No. of industries	30	30	30	30	30
Pseudo R^2	0.17	0.08	0.06	0.07	0.10

Notes: The dependent variable is *TFP* calculated from Levinsohn–Petrin estimates. The reference group is firms under within-border partnerships serving China only—type (*HH, NON*). The five columns use five different quantiles. “Difference” reports the difference between the coefficients of the two dummies. Control variables are profit margin, capital intensity, and regional population. Two-digit industry fixed effects are included in all columns. The constant is suppressed. *** significant at the 1% level.

Fourth, *ex ante* productivity. The rankings in Tables 3–4 may not reflect *ex ante* productivity, which cannot be directly estimated. The estimated differences could instead reflect other differences across partnership types. For example, producers under cross-border partnerships produce intermediates, whereas producers under within-border partnerships produce final goods; measured productivity may therefore not be directly comparable across partnership types.

To address this concern, I focus on firms that change partnership type. Consider firms engaged in within-border partnerships and serving only the Chinese market in year t . In year $t + 1$, they have three options: remain in the same partnership, switch to cross-border partnership, or switch to within-border partnership serving both Chinese and overseas markets. Their production activities, although perhaps not comparable after the switch (year $t + 1$), are comparable before the switch (year t), because the firms were then under the same partnership. Formally, for every observation under (*HH, NON*), I construct two dummy variables:

$$PRE-HS_{dt} = \begin{cases} 1 & \text{if } HS_{d,t+1} = 1, \\ 0 & \text{otherwise,} \end{cases} \quad PRE-HHB_{dt} = \begin{cases} 1 & \text{if } HHB_{d,t+1} = 1, \\ 0 & \text{otherwise,} \end{cases}$$

and regress *TFP* on *PRE-HS* and *PRE-HHB* together with controls:

$$\ln TFP_{djrt} = \tau + \chi_1 PRE-HS_{dt} + \chi_2 PRE-HHB_{dt} + \iota' C_{drt} + \varrho_j + \rho_t + \epsilon_{djrt}. \quad (19)$$

The reference group consists of firms that remain in (*HH, NON*) in year $t + 1$. The prediction is $\hat{\chi}_2 > \hat{\chi}_1 > 0$ if differences in *ex ante* productivity are present.

Table 5 confirms the role of *ex ante* productivity. Switchers were on average more productive than non-switchers before their switch; and firms that later switched to (HH, B) were on average more productive than those that later switched to HS .¹⁸ The average productivity difference between HS and (HH, NON) in Table 5 is roughly one-fourth of that in Table 3, and the average difference between (HH, B) and HS in Table 5 is about half of that in Table 3. As expected, *ex ante* productivity accounts for only part of the measured productivity differences across the three partnership types.

Table 5: Partnership Switchers and Ex Ante Productivity

	(1)	(2)
Dummy: would switch to cross-border partnership ($PRE-HS$)	0.057***	0.059***
	(0.012)	(0.012)
Dummy: would switch to within-border, both markets ($PRE-HHB$)	0.196***	0.195***
	(0.005)	(0.005)
Controls	No	Yes
<i>t</i> -test [<i>p</i> -value]	[0.00]	[0.00]
No. of obs.	334,469	334,469
No. of industries	750	750
R^2	0.01	0.02

Notes: The dependent variable is TFP calculated from Levinsohn–Petrin estimates. The reference group is firms that remain under partnership (HH, NON) throughout the sample. See the text for the construction of the two dummies. Control variables are profit margin, capital intensity, and regional population. Industry (four-digit) and year fixed effects are included in column (2). Robust standard errors in parentheses. The *t*-test examines H_0 : the two coefficients are equal. The constant is suppressed. *** significant at the 1% level.

3.3 Prevalence of exporters across partnership types

Proposition 2 implies that the share of exporters under partnership HS relative to (HH, B) rises when technology becomes more transferable (γ increases), coordination becomes more efficient (μ increases), or productivity dispersion declines (ζ increases). γ and ζ are industry characteristics. Technological complexity, measured by R&D intensity, reduces transferability.¹⁹ I construct a dummy variable $HITECH$ as a proxy for γ : $HITECH = 1$ if the firm is in a high-technology industry and 0 otherwise.²⁰ ζ reflects within-industry productivity dispersion, which I denote by $DISP$ and measure

¹⁸ The difference is statistically significant at the 1% level.

¹⁹ Using R&D intensity as a measure of technological complexity follows the literature; see, e.g., Carluccio and Fally (2012) and Keller and Yeaple (2010).

²⁰ High-technology industries are identified using the “classification of manufacturing industries based on technology” in the *OECD Science, Technology and Industry Scoreboard 2005* (p. 182). I treat high

as the standard deviation of TFP . μ depends on local infrastructure and institutions. Coordination is easier when the host country has infrastructure and institutions similar to those in the source country: high-quality local infrastructure facilitates cross-border coordination between Chinese producers and their source-country headquarters, and good local institutions—intellectual property protection, legal services, accounting services—help create a business-friendly environment for cross-border partnerships.

I use the marketization index published by the *National Economic Research Institute of the China Reform Foundation* as a proxy for the quality of local infrastructure and institutions across Chinese regions. Compiled at the provincial level and denoted $LOCAL$, this index quantitatively evaluates: (1) the relationship between local government and the market (e.g., tax burden, local government size); (2) the development of the local private sector (e.g., its size relative to other sectors); (3) the efficiency of local product markets (e.g., protectionism favoring local firms); (4) the efficiency of local factor markets (e.g., financial services and labor mobility); and (5) the local legal environment and availability of market intermediaries (e.g., intellectual property protection, and the number of accountants and lawyers in the population).²¹

Data are aggregated to the industry-province-year level, and Proposition 2 is tested using

$$\left(\frac{\sigma_{HS}}{\sigma_{HH,B}}\right)_{jrt} = \varphi_0 + \varphi_1 HITECH_j + \varphi_2 DISP_{jt} + \varphi_3 LOCAL_{rt} + \vartheta' M_{jrt} + u_{jrt}, \quad (20)$$

where $\sigma_{HS}/\sigma_{HH,B}$ is the ratio of exporters under cross-border partnerships to those under within-border partnerships, and M_{jrt} is a set of industry- and province-level characteristics in year t . Here j denotes a two-digit industry, because $HITECH$ is only available at the two-digit level; in addition, the dependent variable has many fewer zeros at the two-digit level than at the four-digit level. A potential concern is that $\sigma_{HS}/\sigma_{HH,B}$ is contaminated by industry composition—for instance, labor-intensive industries tend to attract more developed-country headquarters because of low labor costs. To address this, I include capital intensity as a control. I also include provincial population to prevent $\sigma_{HS}/\sigma_{HH,B}$ from being driven by local market size.

The results are reported in **Table 6**. Column (1) presents OLS estimates on the full sample and is consistent with the theory: $\hat{\varphi}_1 < 0$, $\hat{\varphi}_2 < 0$, $\hat{\varphi}_3 > 0$.²² Column (2) drops all observations with zero

and medium-high technology industries together as high-technology, comprising: (1) aircraft and spacecraft; (2) chemicals, including pharmaceuticals; (3) office, accounting, and computing machinery; (4) radio, TV, and communications equipment; (5) medical, precision, and optical instruments; (6) electrical machinery and apparatus; (7) motor vehicles, trailers, and semi-trailers; (8) railroad equipment and other transport equipment; and (9) machinery and equipment not elsewhere classified.

²¹ The *Marketization Index Report 2006* reports cross-province marketization indices for 2001–2005, while the ASIP data cover 2000–2003. I therefore use data for the overlapping years 2001–2003.

²² Note that $DISP$ measures the dispersion of *ex post*, rather than *ex ante*, productivity. This is not a serious concern: since $g = (\gamma\theta)^\mu$, or $\ln g = \mu \ln \gamma + \mu \ln \theta$, and both γ and μ are included in the regression, $\hat{\varphi}_2$ captures the effect of *ex ante* productivity dispersion.

dependent variable; column (3) uses a Tobit estimator. Both yield the same conclusions. Finally, the dependent variable has three dimensions (industry, province, year), introducing potential province-industry autocorrelation within a year, province-year correlation within an industry, and industry-year correlation within a province. Column (4) uses OLS with the three-way clustering of Cameron, Gelbach, and Miller (2011), which simultaneously accounts for clustering in all three dimensions. The findings in columns (1)–(3) survive.

Table 6: Technology Complexity, Productivity Dispersion, and Infrastructure and Institutions

	(1)	(2)	(3)	(4)
HITECH	−0.782*** (0.173)	−1.488*** (0.300)	−1.088** (0.450)	−0.782** (0.397)
DISP	−0.306*** (0.071)	−0.618** (0.247)	−3.535*** (0.563)	−0.306** (0.136)
INST	0.470*** (0.089)	0.620*** (0.121)	2.073*** (0.124)	0.470** (0.234)
Specification	OLS, full sample	Nonzero	Tobit	Three-way cluster
No. of obs.	2,062	1,044	2,062	2,062

Notes: The dependent variable is the ratio of firms under cross-border partnerships (*HS*) to firms under within-border partnerships serving both markets (*HH, B*), at the industry-province-year level. *HITECH* is an industry-level dummy for high technological complexity; *DISP* is an industry-year-level measure of productivity dispersion; *INST* is a province-level measure of local institutional quality. See the text for details on these measures. Control variables are capital intensity and provincial population. Column (1) uses the full sample with OLS. Column (2) excludes observations with a zero dependent variable. Column (3) uses Tobit. Column (4) uses three-way clustering; see the text for details. The constant is suppressed. * 10%; ** 5%; *** 1% significance.

3.4 Organizational form

Proposition 3 predicts that, under cross-border partnerships, arm's-length producers have lower *ex ante* productivity than vertically integrated producers. Using the sample of firms under partnership *HS*, **Table 7** regresses *TFP* on a dummy equal to 1 for vertical integration, and shows that vertical integration is associated with higher average productivity than arm's length. Column (1) includes no controls; column (2) adds profit margin, capital intensity, and regional population, following column (2) of Table 3. Columns (1)–(2) use fixed effects, while column (3) uses random effects. Columns (4)–(6) add controls for tax payments and EPZ/FTZ status, paralleling the corresponding columns in Table 3. Columns (7)–(8) re-estimate the regression on the apparel and electronics subsamples. All specifications yield the same finding.

Table 7: Productivity across Organizational Forms under Cross-Border Partnership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dummy: vertical integration	0.139*** (0.006)	0.136*** (0.006)	0.139*** (0.005)	0.133*** (0.006)	0.124*** (0.009)	0.115*** (0.008)	0.113*** (0.010)	0.129*** (0.032)
Specification	FE	FE	RE	FE	FE	FE	FE	FE
Sample	All	All	All	All	Special Zones	Non-Special Zones	Apparel	Electronics
Control vars.	No	Yes	Yes	Yes, with tax	Yes, with tax	Yes, with tax	Yes, with tax	Yes, with tax
No. of obs.	376,390	376,390	376,390	376,390	130,337	246,053	12,640	18,107
No. of inds.	752	752	752	752	746	748	4	42
R ²	0.05	0.06	0.07	0.08	0.09	0.08	0.10	0.16

Notes: The dependent variable is *TFP* calculated from Levinsohn–Pettrin estimates. All firms are under cross-border partnerships. The reference group is arm’s-length producers—type (HS, O) . Control variables are profit margin, capital intensity, and regional population. Industry (four-digit) and year fixed effects are included in columns (1)–(2) and (4)–(8); random effects are used in column (3). Columns (4)–(8) add tax payment as a control. Columns (5)–(6) use subsamples by special-zone status (EPZs/FTZs); see Section 3.2. Columns (7)–(8) use the apparel and electronics two-digit industries. Robust standard errors in parentheses. The constant is suppressed. *** significant at the 1% level.

As with Table 3 in Section 3.2, Table 7 may capture differences between organizational forms other than *ex ante* productivity. For example, the documented productivity differences may reflect differences in the amount of technology transferred, or heterogeneity in source-country headquarters. To address this, **Table 8** follows the specification of Table 5 and focuses on firms that were under (HS, O) in year t but switched to (HS, I) in year $t + 1$. The dummy *PRE-I* equals 1 for these switchers. The results show that firms that later switched to (HS, I) were on average more productive than non-switchers, a finding that cannot be explained by differences in technology transfer or in source-country headquarters. This strongly supports the role of *ex ante* productivity in the choice of organizational form. Quantitatively, *ex ante* productivity explains about 70% of the productivity premium of vertical integration relative to arm’s length.²³

²³ The coefficients on *PRE-I* in Table 8 are not significant at the 1% level because of the small number of switchers in the data (58 of 7358), so caution is warranted when interpreting the magnitudes.

Table 8: Organizational-Form Switchers and Ex Ante Productivity

	(1)	(2)
Dummy: would switch to integration (<i>PRE-I</i>)	0.110*	0.098**
	(0.057)	(0.049)
Controls	No	Yes
<i>t</i> -test [<i>p</i> -value]	[0.00]	[0.00]
No. of obs.	7,358	7,358
No. of industries	28	28
R^2	0.00	0.10

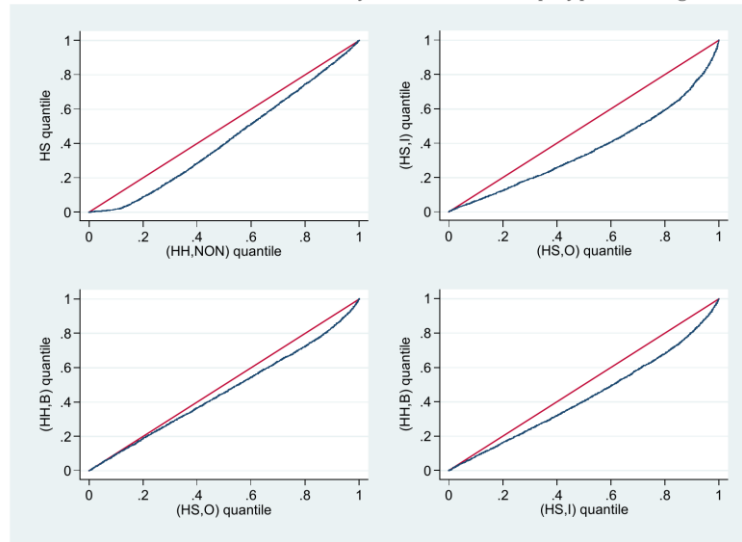
Notes: The dependent variable is *TFP* calculated from Levinsohn–Petrin estimates. The reference group is firms that remain under organizational form (*HS, O*) throughout the sample. Control variables are profit margin, capital intensity, and regional population. Industry (four-digit) and year fixed effects are included in column (2). Robust standard errors in parentheses. The constant is suppressed. * 10%; ** 5% significance.

3.5 Nonparametric results

To test the propositions without imposing parametric assumptions, I also use the relative distribution function to compare productivity across partnership types and organizational forms. Suppose that two groups—represented by the axes in the four panels of **Figure 4**—have the same *TFP* distribution. Then the blue curve in each panel, the relative cumulative density function, coincides with the diagonal. If the group on the vertical axis has a *TFP* distribution that stochastically dominates the distribution of the group on the horizontal axis, the blue curve lies below the diagonal.²⁴ The upper-left, upper-right, lower-left, and lower-right panels compare, respectively, (*HH, NON*) versus *HS*; (*HS, O*) versus (*HS, I*); (*HS, O*) versus (*HH, B*); and (*HS, I*) versus (*HH, B*). The productivity of (*HH, NON*) is stochastically dominated by that of *HS*; (*HS, O*) is dominated by (*HS, I*); and *HS* is dominated by (*HH, B*). All findings align with the parametric results reported earlier.

²⁴ Jann (2008) discusses relative-distribution methods in economics.

Figure 4: Relative Distribution of Productivity across Partnership Types and Organizational Forms



Notes: If the distributions of a variable associated with two groups are the same, the relative cumulative density function will graphically coincide with the diagonal. The upper-left, upper-right, lower-left, and lower-right panels, respectively present TFP comparisons corresponding to (HH,NON) vs. HS exporters, (HS,O) vs. (HS,I), (HS,O) vs. (HH,B), and (HS,I) vs. (HH,B).

4. Concluding Remarks

This paper provides a theory of the interaction between headquarters and producers in globalized production. Two types of developing-country producers emerge. The first type has mid-range productivity and partners with developed-country headquarters; the second type has high productivity and partners with local headquarters. The former does not serve its local market, while the latter serves both its local market and developed-country markets. The theory also predicts that cross-border partnerships are more prevalent in industries with more transferable technology and more homogeneous producers, and in regions with better infrastructure and institutions. Within cross-border partnerships, relatively more productive foreign producers are vertically integrated with their headquarters, while relatively less productive ones operate at arm's length. These predictions are supported by firm-level evidence from China.

Two directions seem especially promising for future research. The first is to study the dynamic aspects of the model. For instance, advanced technology transferred from a developed-country headquarters to a developing-country producer may carry over to that producer's future partnerships with local headquarters, providing incentives and disincentives, respectively, for the foreign producer and the developed-country headquarters to enter cross-border partnerships in the first place. The second direction is to incorporate general-equilibrium effects. Technology transfer may raise factor prices in the developing country, forcing the least productive foreign producers to exit; the developing country's aggregate productivity would then be improved both by technology transfer and by competition.

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Appendices

A. Derivations and proofs

A.1. Derivation of profit functions

Under partnership (HH, NON) , $p_H = (\Phi_H/y_{HH,NON})^{1-\alpha}$, so

$$R_{HH,NON} = p_H y_{HH,NON} = \Phi_H^{1-\alpha} y_{HH,NON}^\alpha = \Phi_H^{1-\alpha} (\theta x_{HH,NON})^\alpha.$$

Profit is $R_{HH,NON} - c x_{HH,NON}$. The first-order condition gives $x_{HH,NON} = \alpha R_{HH,NON}/c$. Substituting back into $R_{HH,NON}$ yields

$$R_{HH,NON} = \Phi_H \theta^{\alpha/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)}.$$

The profit function becomes

$$\begin{aligned} R_{HH,NON} - c x_{HH,NON} &= R_{HH,NON} - \alpha R_{HH,NON} \\ &= (1 - \alpha) R_{HH,NON} \\ &= (1 - \alpha) \Phi_H \theta^{\alpha/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)} \equiv \Psi \Phi_H \theta. \end{aligned}$$

The case of partnership SS is analogous.

Under partnership HS , $p_S = (\Phi_S/y_{HS})^{1-\alpha}$, so

$$R_{HS} = p_S y_{HS} = \Phi_S^{1-\alpha} y_{HS}^\alpha = \Phi_S^{1-\alpha} (\gamma^\mu \theta^\mu x_{HS})^\alpha.$$

Profit is $R_{HS} - c x_{HS}$. The first-order condition gives $x_{HS} = \alpha R_{HS}/c$. Substituting back yields

$$R_{HS} = \Phi_S \gamma^{\alpha\mu/(1-\alpha)} \theta^{\alpha\mu/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)}.$$

The profit function becomes

$$\begin{aligned} R_{HS} - c x_{HS} &= (1 - \alpha) R_{HS} \\ &= (1 - \alpha) \Phi_S \gamma^{\alpha\mu/(1-\alpha)} \theta^{\alpha\mu/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)} \equiv \Psi \Phi_S \Gamma \theta^\mu. \end{aligned}$$

Under partnership (HH, B) , $p_H = (\Phi_H/\gamma_{HH,B,H})^{1-\alpha}$ and $p_S = (\Phi_S/\gamma_{HH,B,S})^{1-\alpha}$, so

$$\begin{aligned} R_{HH,B} &= R_{HH,B,H} + R_{HH,B,S} = p_H \gamma_{HH,B,H} + p_S \gamma_{HH,B,S} \\ &= \Phi_H^{1-\alpha} (\theta x_{HH,B,H})^\alpha + \Phi_S^{1-\alpha} (\theta x_{HH,B,S})^\alpha. \end{aligned}$$

Profit is $R_{HH,B} - c x_{HH,B,H} - c x_{HH,B,S} - f_{EX}$. The first-order conditions give $x_{HH,B,H} = \alpha R_{HH,B,H}/c$ and $x_{HH,B,S} = \alpha R_{HH,B,S}/c$. Substituting back yields

$$R_{HH,B,H} = \Phi_H \theta^{\alpha/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)}, \quad R_{HH,B,S} = \Phi_S \theta^{\alpha/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)}.$$

The profit function becomes

$$\begin{aligned} R_{HH,B} - c x_{HH,B,H} - c x_{HH,B,S} - f_{EX} &= (1 - \alpha)(R_{HH,B,H} + R_{HH,B,S}) - f_{EX} \\ &= (1 - \alpha)(\Phi_H + \Phi_S) \theta^{\alpha/(1-\alpha)} (\alpha/c)^{\alpha/(1-\alpha)} - f_{EX} \\ &\equiv \Psi(\Phi_H + \Phi_S) \theta - f_{EX}. \end{aligned}$$

A.2. Proof of Lemma 1

Define

$$\begin{aligned} \Lambda(\theta) &\equiv \pi_{HS}(\theta) - \pi_{HH}(\theta) - \tilde{\pi} \quad (21) \\ &= \Psi \Phi_S \Gamma \theta^\mu - \Psi \Phi_H \theta - \tilde{\Psi} \Phi_S \tilde{\theta}. \end{aligned}$$

By condition (10),

$$\Gamma > \frac{\Psi \Phi_H \theta^* + \tilde{\Psi} \Phi_S \tilde{\theta}}{\Psi \Phi_S (\theta^*)^\mu},$$

so $\Lambda(\theta^*) > 0$. For sufficiently large θ , $\Lambda(\theta) < 0$; and as $\theta \rightarrow 0$, $\Lambda(\theta) < 0$. Therefore, there exist two values of θ —one in $(0, \theta^*)$ and one in (θ^*, ∞) —satisfying $\Lambda(\theta) = 0$. Denote them $\underline{\theta}$ and $\bar{\theta}$, respectively. Any $\theta \in (\underline{\theta}, \bar{\theta})$ then satisfies $\pi_{HS}(\theta) - \pi_{HH}(\theta) - \tilde{\pi} > 0$. ◻

A.3. Proof of Lemma 2

The “if” part is immediate, since condition (12) is stricter than condition (11). The “only if” part is equivalent to the following claim: if $\theta \notin (\underline{\theta}, \bar{\theta})$, then condition (11) fails. Recall the productivity level θ_* defined by $\pi_{HS}(\theta_*) - \tilde{\pi} = 0$.

Case 1: $\theta \in (0, \theta_*]$. Since $d\pi_{HS}(\theta)/d\theta > 0$ for all $\theta > 0$, we have $\pi_{HS}(\theta) - \tilde{\pi} \leq 0$, so $\pi_{HS}(\theta) - \pi_{HH}^{X_H}(\theta) - \tilde{\pi} < 0$.

Case 2: $\theta \in (\theta_*, \underline{\theta}]$. By Lemma 1, $\pi_{HS}(\theta) - \pi_{HH,NON}(\theta) - \tilde{\pi} < 0$; however, $\pi_{HS}(\theta) - \pi_{HH,NON}^{X_H}(\theta) - \tilde{\pi}$ can be positive if $\pi_{HH}^{X_H}(\theta) < \pi_{HH}(\theta)$. Suppose $\pi_{HS}(\theta) - \pi_{HH,NON}^{X_H}(\theta) - \tilde{\pi} > 0$, so that it is profitable for Z_S to choose X_H over X_S . To recruit X_H , Z_S can offer a profit transfer $T^{Z_S}(\theta) \in [0, \pi_{HS}(\theta) - \tilde{\pi}]$; but Z_H will outbid any such offer by $T^{Z_H}(\theta) = T^{Z_S}(\theta) + \varepsilon$, where ε is a small positive number, because its profit is

$$\pi^{Z_H}(\theta) = \pi_{HH,NON}(\theta) - (\pi_{HS}(\theta) - \tilde{\pi} + \varepsilon) = -(\pi_{HS}(\theta) - \pi_{HH,NON}(\theta) - \tilde{\pi}) - \varepsilon > 0;$$

Z_S would in turn outbid by $T^{ZH}(\theta) + \varepsilon'$, and so on. The only equilibrium is for Z_H to offer $T^{ZH}(\theta) = \pi_{HS}(\theta) - \tilde{\pi}$: at this point Z_H has no incentive to deviate (its reservation profit is zero) and Z_S has no incentive to outbid further. Therefore $\pi^{XH}(\theta) = \pi_{HS}(\theta) - \tilde{\pi}$, and

$$\pi_{HS}(\theta) - \pi_{HH, \text{NON}}^{XH}(\theta) - \tilde{\pi} = \pi_{HS}(\theta) - \pi_{HS}(\theta) + \tilde{\pi} - \tilde{\pi} = 0.$$

Case 3: $\theta \in [\bar{\theta}, \infty)$. As in Case 2, the only equilibrium is for Z_H to offer $T^{ZH}(\theta) = \pi_{HS}(\theta) - \tilde{\pi}$, so $\pi^{XH}(\theta) = \pi_{HS}(\theta) - \tilde{\pi}$ and $\pi_{HS}(\theta) - \pi_{HH, B}^{XH}(\theta) - \tilde{\pi} = 0$. ◻

A.4. Proof of Proposition 2

Note that $\sigma_{HS}/\sigma_{HH, B} = [V(\bar{\theta}) - V(\underline{\theta})]/[1 - V(\bar{\theta})]$.

Parts (i) and (ii). The goal is to show $d\bar{\theta}/d\gamma > 0$, $d\bar{\theta}/d\mu > 0$, $d\underline{\theta}/d\gamma < 0$, and $d\underline{\theta}/d\mu < 0$.

At $\bar{\theta}$, define $\mathcal{E} = \pi_{HS}(\bar{\theta}) - \pi_{HH, B}(\bar{\theta}) - \tilde{\pi} = 0$. By the implicit function theorem,

$$\begin{aligned} \frac{d\bar{\theta}}{d\gamma} &= -\frac{d\mathcal{E}/d\gamma}{d\mathcal{E}/d\bar{\theta}} = -\frac{d\pi_{HS}(\bar{\theta})/d\gamma}{d\pi_{HS}(\bar{\theta})/d\bar{\theta} - d\pi_{HH, B}(\bar{\theta})/d\bar{\theta}}, \\ \frac{d\bar{\theta}}{d\mu} &= -\frac{d\mathcal{E}/d\mu}{d\mathcal{E}/d\bar{\theta}} = -\frac{d\pi_{HS}(\bar{\theta})/d\mu}{d\pi_{HS}(\bar{\theta})/d\bar{\theta} - d\pi_{HH, B}(\bar{\theta})/d\bar{\theta}}. \end{aligned}$$

Since $d\pi_{HS}(\bar{\theta})/d\bar{\theta} - d\pi_{HH, B}(\bar{\theta})/d\bar{\theta} < 0$, $d\pi_{HS}(\bar{\theta})/d\gamma > 0$, and $d\pi_{HS}(\bar{\theta})/d\mu > 0$, it follows that $d\bar{\theta}/d\gamma > 0$ and $d\bar{\theta}/d\mu > 0$.

At $\underline{\theta}$, define $\mathcal{E}' = \pi_{HS}(\underline{\theta}) - \pi_{HH, \text{NON}}(\underline{\theta}) - \tilde{\pi} = 0$. Then

$$\begin{aligned} \frac{d\underline{\theta}}{d\gamma} &= -\frac{d\mathcal{E}'/d\gamma}{d\mathcal{E}'/d\underline{\theta}} = -\frac{d\pi_{HS}(\underline{\theta})/d\gamma}{d\pi_{HS}(\underline{\theta})/d\underline{\theta} - d\pi_{HH, \text{NON}}(\underline{\theta})/d\underline{\theta}}, \\ \frac{d\underline{\theta}}{d\mu} &= -\frac{d\mathcal{E}'/d\mu}{d\mathcal{E}'/d\underline{\theta}} = -\frac{d\pi_{HS}(\underline{\theta})/d\mu}{d\pi_{HS}(\underline{\theta})/d\underline{\theta} - d\pi_{HH, \text{NON}}(\underline{\theta})/d\underline{\theta}}. \end{aligned}$$

Since $d\pi_{HS}(\underline{\theta})/d\underline{\theta} - d\pi_{HH, \text{NON}}(\underline{\theta})/d\underline{\theta} > 0$, $d\pi_{HS}(\underline{\theta})/d\gamma > 0$, and $d\pi_{HS}(\underline{\theta})/d\mu > 0$, it follows that $d\underline{\theta}/d\gamma < 0$ and $d\underline{\theta}/d\mu < 0$.

Part (iii). $\sigma_{HS} = 1 - (\underline{\theta}/\bar{\theta})^\zeta$, with $\underline{\theta} < \bar{\theta}$, so $d\sigma_{HS}/d\zeta > 0$. Similarly, $d\sigma_{HH, B}/d\zeta < 0$. ◻

B. Data details

The primary data source is the Annual Surveys of Industrial Production conducted by the National Bureau of Statistics of China for 2000–2003. These survey data are proprietary.

Each firm in the survey has an ID number. About 10 IDs are duplicated in each year, and I drop these firms. The datasets for 2000, 2001, 2002, 2003, and 2004 contain 162,869, 169,017, 181,545, and 196,206 observations, respectively. The data for all years are then merged on the firm ID. Three further cleaning steps follow. First, I drop firms outside manufacturing (four-digit industry code < 1311 or > 4392), removing 60,415 observations. Second, I drop firms not in normal operation (status code $\neq 1$), removing 16,141 observations. Third, I drop observations with incorrect industry or area codes, removing about 140 observations.

My study focuses on domestically owned firms (registration type code < 200) that export some or all of their output, and on foreign-owned firms (registration type codes 230 and 330) that export all of their output. After applying these filters, the working dataset contains 512,832 observations. I also drop

firms that appear only once over the four-year span, because their productivity cannot be estimated using the Levinsohn–Petrin method. Descriptive statistics are reported in **Table S1**. The partnership types (HH, NON) , (HH, B) , (HS, O) , and (HS, I) have 338,532, 64,335, 15,845, and 14,107 observations, respectively.

Table S1: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.
Employment	432,819	312.1	1,176.6
Exported value	432,819	7,893.9	104,344.1
Profit	432,819	2,143.9	35,735.3
Fixed assets	432,819	26,536.6	303,054.2
Sales	432,819	55,765.3	417,282.3
Intermediates	432,819	43,643.4	329,399.6
Tax payment	432,819	112.9	1,414.3

C. Supplementary results

Section 3 of the paper regresses TFP on partnership type or organizational form. This approach is convenient for estimating productivity differences across the three partnership types and between the two organizational forms. The alternative specification—regressing partnership choice on TFP —is more intuitive: it shows how productivity predicts the choice across partnership types and between organizational forms.

Table S2 estimates a multinomial logit model. The dependent variable is partnership type: (HH, NON) , HS , and (HH, B) take values 0, 1, and 2, respectively, with (HH, NON) as the reference group. Columns (1)–(2) show that more productive firms are more likely to choose HS relative to (HH, NON) , and still more likely to choose (HH, B) relative to (HH, NON) . Control variables are as described in the text. As in the text, columns (3)–(4) add tax payment as an additional control, and columns (5)–(6) and (7)–(8) re-estimate on the apparel and electronics subsamples, respectively. All columns yield the same findings.

Table S2: Multinomial Logit Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline		With Tax Included		Apparel		Electronics	
	HS	(HH,B)	HS	(HH,B)	HS	(HH,B)	HS	(HH,B)
Productivity	0.715***	1.402***	0.804***	1.282***	0.778***	1.261***	1.198***	1.471***
	(0.016)	(0.012)	(0.017)	(0.012)	(0.057)	(0.062)	(0.069)	(0.055)
No. of obs.	376390	376390	376390	376390	12640	12640	18107	18107

Notes: The dependent variable is partnership type: 0 for (HH, NON) , 1 for HS , and 2 for (HH, B) . Productivity is TFP from Levinsohn–Petrin estimates. Control variables are profit margin, capital intensity, and regional population. Columns (1)–(2) are the baseline. Columns (3)–(4) add tax payment. Columns (5)–(6) and (7)–(8) use the apparel and electronics subsamples. The constant is suppressed. *** significant at the 1% level.

Table S3 uses the same specification as Table S2 but estimates an ordered logit model. The theory suggests that HS is a better choice than (HH, NON) for producers with sufficiently high productivity, and that (HH, B) is in turn a better choice than HS for producers with sufficiently high productivity. I therefore order the three partnership types (HH, NON) , HS , and (HH, B) as 0, 1, and 2, and examine whether a productivity premium—in the form of an “upgrade probability”—is present across these types. As expected, productivity has a positive and significant coefficient in all columns.

Table S3: Partnership Choice: Ordered Logit Results

	(1)	(2)	(3)	(4)
	Baseline	With Tax	Apparel	Electronics
Productivity	1.213***	1.083***	1.003***	1.319***
	(0.010)	(0.010)	(0.046)	(0.045)
No. of obs.	376,390	376,390	12,640	18,107

Notes: The dependent variable is partnership type: 0 for (HH, NON) , 1 for HS , and 2 for (HH, B) . Productivity is TFP from Levinsohn–Petrin estimates. Control variables are profit margin, capital intensity, and regional population. Column (1) is the baseline. Column (2) adds tax payment. Columns (3) and (4) use the apparel and electronics subsamples. The constant is suppressed. *** significant at the 1% level.

Table S4 uses a logit model to examine the choice of organizational form under partnership HS : (HS, O) and (HS, I) take values 0 and 1, respectively. The structure of Table S4 mirrors Table 7 and Table S2. Notably, the magnitude of the productivity effect is smaller in column (4) than in column (3). This may be because productivity heterogeneity is less pronounced in industries in which China has a comparative disadvantage. Specifically, China has a comparative disadvantage in highly sophisticated industries such as electronics, so the productivity dispersion of Chinese electronics firms is below average, and the productivity difference across organizational forms is correspondingly smaller.

Table S4: Organizational-Form Choice: Logit Results

	(1)	(2)	(3)	(4)
	Baseline	With Tax	Apparel	Electronics
Productivity	0.306***	0.309***	0.340***	0.143***
	(0.012)	(0.012)	(0.030)	(0.025)
No. of obs.	22,016	22,016	3,888	1,282

Notes: The dependent variable is the organizational form of cross-border production: 0 for (HS, O) and 1 for (HS, I) . Productivity is TFP from Levinsohn–Petrin estimates. Marginal effects are reported. Control variables are profit margin, capital intensity, and regional population. Column (1) is the baseline. Column (2) adds tax payment. Columns (3) and (4) use the apparel and electronics subsamples. The constant is suppressed. *** significant at the 1% level.