DISCUSSION PAPERS IN ECONOMICS

Working Paper No. 10-07

Cross-Border Production, Technology Transfer, and the Choice of Partner

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November2010

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Job Market Paper
November 7, 2010

I am grateful to Wolfgang Keller, James Markusen, Keith Maskus, and Stephen Yeaple for invaluable guidance, and to Arnaud Costinot, Peter Egger, Thibault Fally, Cecilia Fieler, Lionel Fontagne, Scott Fuess, Eckhard Janeba, Tobias Seidel, Carol Shiue, Jagadeesh Sivadasan, Alan Spearot, and Thierry Verdier for very helpful comments. I thank Jennifer Abel-Koch, Laurel Adams, Omar Dahi, Lawrence Fu, Sebastian Krautheim, Xiaohuan Lan, Yi Lu, Sergey Makarevich, William Olney, Mathieu Parenti, Dhimitri Qirjo, Lorenzo Rotunno, Björn Sass, Fangfang Tan, Pierre-Louis Vézina, Weiwen Yang, and Tianle Zhang for helpful discussions; the seminar participants at ETH Zurich, Graduate Institute Geneva, Paris School of Economics, University of Mannheim, and University of Colorado at Boulder; and the participants at Midwest International Economics Group, European Trade Study Group, Canadian Economic Association, European Economic Association, and Western Economic Association for useful comments. All remaining errors are mine.

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Abstract

The goods that are consumed in developed countries are increasingly manufactured in developing countries. A developing-country producer can work with a local headquarter (within-border partnership); alternatively, it can form a cross-border partnership with a headquarter in developed countries. This paper develops a theory where the choice between cross-border partnership and within-border partnership depends on the size of the gain through technology transfer from developed-country headquarters. When developing-country producers have heterogeneous productivity, those with medium levels of productivity will gain sufficiently from technology transfer and choose cross-border partnership. In contrast, high- and low-productivity producers will work with their local headquarters, and the low-productivity producers will not be able to sell their products to developed countries at all. This paper also shows that among the producers that engage in cross-border partnership, those with relatively high productivity become vertically integrated with their developed-country headquarters, while those with relatively low productivity operate at arm's length. These predictions are supported by firm-level evidence from China.

1 Introduction

Consumers in developed countries increasingly rely on goods that are produced abroad. For example, the United States, where television was invented and is watched more than in any other country, currently has no televisions produced domestically. It is apparent that every aspect of a developed economy such as the US involves products "Made in Country X" (where X refers to developing countries such as China, India, or Mexico). Much less well understood is what types of …rms in foreign countries are producing for developed countries, namely, "Made by whom in Country X." In particular, information on the productivity of foreign producers is important, because their productivity determines how e¢ ciently developed countries are served.

This paper analyzes the productivity of foreign …rms that serve developed countries. In the paper, I develop a theory that characterizes how producers in a foreign country (such as China) interact with headquarters in a home country (such as the US).[1] A foreign producer faces a trade-o¤ between the productivity gain generated by the home headquarter's technology transfer and the coordination costs resulting from cross-border di¤erences in machinery speci…cations, regulations, management routines, and cultures. As an alternative to this cross-border partnership, the foreign producer also has the option of partnering with its local headquarter. From the foreign producer's perspective, the advantage of cross-border partnership over within-border partnership decreases if the foreign producer has a higher level of initial productivity.

The model shows that foreign producers (such as those in China) with mid-range initial productivity are the …rms that engage in cross-border partnership.[2] At mid-range level of productivity, the gains from technology transfer outweigh the frictions involved in cross-border coordination, such that cross-border partnership generates su¢ cient pro…ts for both home headquarters and foreign producers. Unlike these mid-range producers, foreign producers with high levels of initial productivity cannot garner su¢ cient pro…ts for themselves from technology transfer. Likewise, foreign producers with low productivity cannot generate suf-

[1]Trade models with …rm productivity heterogeneity are analyzed in Bernard, Eaton, Jensen, and Kortum (2003), Bustos (2009), Costantini and Melitz (2008), Melitz (2003), Melitz and Ottaviano (2008), and Yeaple (2005).

[2]In the analysis I assume that developed-country headquarters are homogeneous. This removes from the analysis heterogeneity among internationally operating …rms in developed countries, which is not crucial given my focus on the trade-o¤ between technology transfer gains and coordination costs that foreign …rms face. According to the literature, these headquarters are the most productive …rms in developed countries; see, e.g., Antràs and Helpman (2004, 2008), Helpman, Melitz, and Yeaple (2004), and Grossman, Helpman, and Szeidl (2005, 2006).

…cient pro…ts for home headquarters and thus are not selected for cross-border partnership. As a result, foreign producers with either high or low productivity engage in within-border partnership.[3]

The model also shows that foreign producers with high initial productivity serve both their local market (such as China) and the market of the developed-country headquarter (such as the US),[4] while those with low productivity serve only their local market because they cannot a¤ord the …xed cost of exporting;[5] moreover, among foreign producers that unthose with relatively low productivity operate at arm's length with their headquarters.

The …rst prediction …nds strong support from a simple regression of …rm productivity on partnership types. A number of factors are considered that could potentially confound the result. The …rst is local tax policies of China—as those of other developing countries—favor cross-border over within-border partnership. I examine both ad-valorem as well as lump-sum tax favors, showing that my results are robust to incorporating taxation e¤ects into the ana8(t)9()8(h)11(a)10(c)9(o)11(i)6(p)(t)9(a)10011(1-28073co2(t)9(a)10011(1-1(1-280J)11(r)11n)11

The rest of the paper is organized as follows. Section 2 presents the model and discusses its four predictions (Propositions 1–4). Section 3 first describes the dataset and then tests the four predictions. Section 4 concludes and discusses directions for future research.

2 A Theory of Interaction

2.1 Environment

Consider a world that consists of a host country (H) and a source country (S), which correspond to the foreign country and the home country that were introduced before.[11] Their residual demand functions for differentiated products are, respectively,

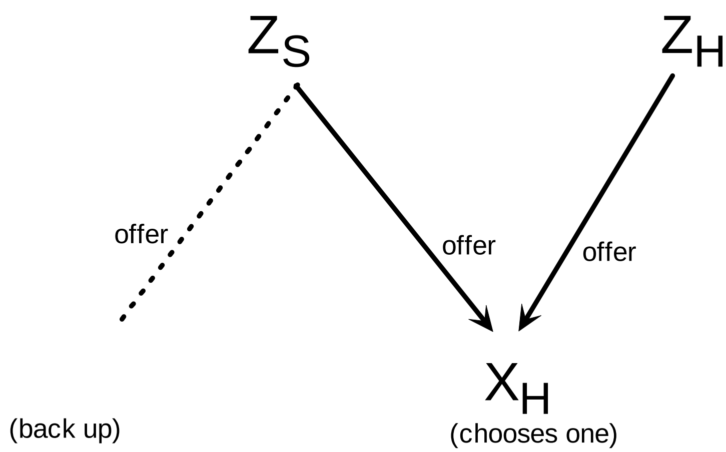
$$y_H = {}_H\, p_H^{\,1=(1 \quad)}; \qquad (1)$$

$$y_S = {}_S\, p_S^{\,1=(1 \quad)}; \qquad (2)$$

where p_l is price, ${}_l$ measures the demand level, $l \in \{H; S$

Z_S

Figure 1: The Contracting Process



according to the contracts.

2.2 Equilibrium

The equilibrium characterizes how four parties, X_H, X_S, Z_H, and Z_S, choose their partners given all possible values of . As shown in Figure 1, X_S does not have an option other than Z_S, so the analysis centers on what Z_H and Z_S offer X_H in their respective contracts and how X_H chooses between them. X_H chooses between Z_H and Z_S depending on which one offers a larger profit transfer in its contract; meanwhile, the offers by Z_H and Z_S depend on how each other responds.

Let $_{HH}(\ )$ be the maximum joint profit when X_H and Z_H become partners,

$$_{HH}(\ ) = \max \{ _{HH;NON}(\ ) \; ; \; _{HS}(\ ) \};$$

and $^{X_H}_{HH}(\ )$ be the portion in $_{HH}(\ )$ that goes to X_H. The reservation profit for X_H to choose partnership HS is $^{X_H}_{HH}(\ )$, while that for Z_S is e. Thus, partnership HS is chosen by X_H and Z_S if and only if[16]

$$_{HS}(\,) \qquad {}^{X_H}_{HH}(\,) \qquad e > 0: \tag{12}$$

I next investigate when condition (12) holds. e is known, and ${}^{X_H}_{HH}(\,)$ is unknown but its maximum is $_{HH}(\,)$. It is currently unclear whether ${}^{X_H}_{HH}(\,) = \; _{HH}(\,)$; thus, I examine instead the condition

$$_{HS}(\,) \qquad _{HH}(\,) \qquad e > 0; \tag{13}$$

which is stricter than condition (12), and then prove:

Lemma 1 (i) $_{HS}(\,) \quad _{HH}(\,) \quad e = 0$ has two solutions $\underline{\ }$ and $\overline{\ }$: $\underline{\ } < \quad < \overline{\ }$; (ii) $_{HS}(\,) > \; _{HH}(\,) + \; e$ if and only if $2 \; (\underline{\ }; \overline{\ })$.

Proof. See Appendix A.2. ■

Lemma 1 presents two thresholds of , $\underline{\ }$ and $\overline{\ }$, and shows condition (13) to hold given $2 \; (\underline{\ }; \overline{\ })$.

When 2 (0; _), the analysis is slightly complex. De…ne such that $_{HS}$( ) e = 0. With a moderately low 2 (; _], X_H …nds technology transfer from Z_S attractive, but its ex-post productivity is not high enough to earn X_H as much pro…t from cross-border partnership as from within-border partnership for the following reason. If X_H wants to keep

Z_S in the partnership, X_H has to pay Z_S the reservation pro…te. After paying e, X_H earns less than in within-border partnership, because in the partnership with Z_H, X_H has a stronger leverage, thanks to its alternative partner Z_S. Thus, partnership $(HH; NON)$ is formed, $^{Z_H}()$ = $_{HH;NON}()$ $(_{HS}()$ e),

producers can be from regions with di¤erent qualities of infrastructures and institutions, so the coordination di¢ culty varies between regions within Country H.[19] Note that in the previous discussion, both partnership types HS and $(HH;B)$ involve exporting (i.e., to serve Country S). Now I analyze how and a¤ect the prevalence of one partnership relative to the other in the collection of four-party sets. The shares of the two partnerships that involve exporting, HS and $(HH;B)$, are respectively

$$_{HS} = \frac{V(\overline{\ })\quad V(\_)}{1\quad V(\_)}; \tag{17}$$

$$_{HH;B} = \frac{1\quad V(\overline{\ })}{1\quad V(\_)}: \tag{18}$$

These two equations imply that more exporters will be under partnership HS relative to partnership $(HH;B)$ if (1) the technology transfer from Z_S to X_H becomes more e¤ective (increases), or (2) the coordination between Z_S and X_H becomes easier because of the higher quality of infrastructures and institutions in the region where X_H is located (increases).

Next, I assume $V(\ ) = 1 \quad (\ _0 = \ )$, > 0; i.e., follows a Pareto distribution.[20] Thus, $_{HS} = 1 \quad \_=\overline{\ }$, $_{HH;B} = \ \_=\overline{\ }$. It follows that more exporters would be under partnership HS relative to partnership $(HH;B)$ if the dispersion of becomes smaller (increases). To summarize,[21;22]

Proposition 3 Among exporters, cross-border partnership becomes more prevalent than within-border partnership, given more transferable technology, less productivity dispersion, and easier cross-border coordination. Formall

s4u31(F)90(o)F68)T97-Tf 133.157 4.338 Td[(2)-31(1)]TJ/

regional characteristics. Notably, under partnership types HS and $(HH; B)$, the products are both "Made in Country H;" but the product designs are from Country S and Country H, respectively, as designs are provided by headquarters (see Section 2.1).

2.5 Organizational form

The previous discussion does not consider the organizational form of cross-border partnership. Now I assume that Z_S also specifies the organizational form $m \in \{O; I\}$ in its proposed contract, where I and O denote vertical integration and arm's length, respectively. Compared with arm's length, vertical integration facilitates technology transfer and coordination, but incurs a higher fixed cost: $_I > \ _O$, $_I > \ _O$, $f_I > f_O = 0$.[23] Then, the model can be resolved and generates the following findings:

Proposition 4 Let $\underline{\ }_m$ and $\bar{\ }_m$ be the new productivity thresholds among partnership types. Then, (i) $\underline{\ }_O = \underline{\ } < \underline{\ }_I < \bar{\ }_O = \bar{\ } < \bar{\ }_I$, (ii) the thresholds between partnership types $(HH; NON)$, HS, and $(HH; B)$ are $\underline{\ }$ and $\bar{\ }_I$; (iii) if joint profits satisfy

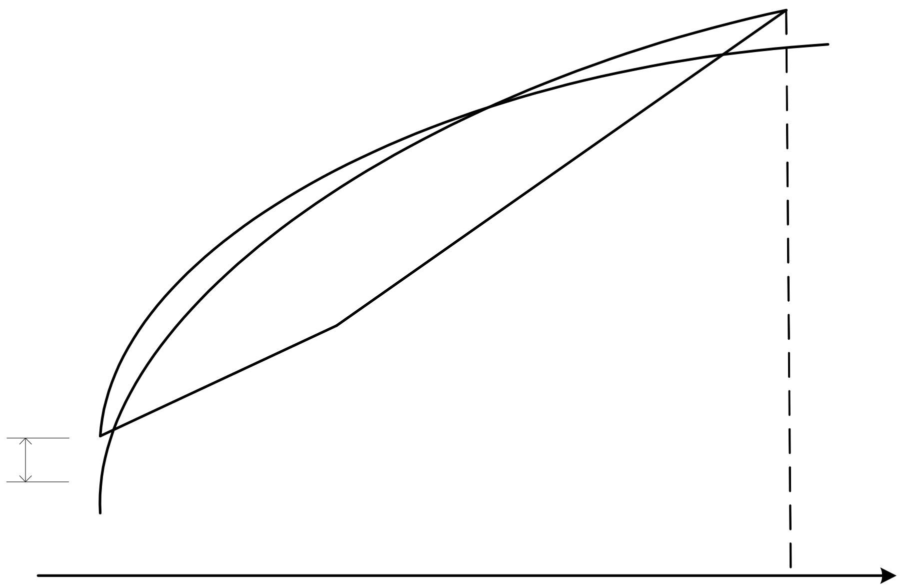
$$
\begin{aligned}
{}_{HS;I}(\bar{\ }_I) &> {}_{HS;O}(\bar{\ }_I) \\
{}_{HS;I}(\underline{\ }) &< {}_{HS;O}(\underline{\ });
\end{aligned}
\tag{19}
$$

there exists $_I$ such that $\underline{\ } < \ _I < \bar{\ }_I$ and

$$
(k; m) = \begin{cases} (HS; O) & \text{if } \underline{\ } < \quad < \ _I \\ (HS; I) & \text{if } \ _I \quad < \bar{\ }_I; \end{cases}
$$

(iv) Define

$$
b_{HS;O} \quad \frac{1}{V(\ _I) \quad V(\underline{\ })} \int_{\underline{\ }}^{\ _I} \quad dV(\ ) \quad ;48(2n)120(0)
$$



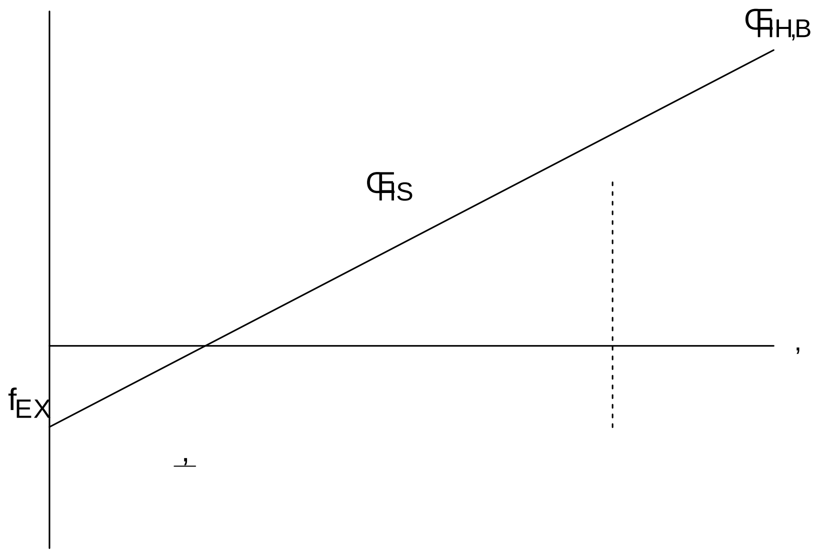
but it removes one of the two organizational forms from the equilibrium.

2.6 Robustness: served market and functional form

This paper focuses on how host-country producers with di¤erent levels of productivity serve Country S in di¤erent partnership types. To sharpen the analysis, the model has so far assumed cross-border partnership to serve only Country S. I now show that the previous

Returning to Figure 2, the only di¤erence that this additional served market introduces

Figure 4: Different Functional Forms



3 Empirical Evidence

3.1 Data

The primary data source for my empirical work is the Annual Surveys of Industrial Production (ASIP) from 2000 through 2003 conducted by the National Bureau of Statistics of China.[26] These annual surveys collected detailed information on …rms that were either state- or non-state owned with annual sales of 5,000,000 Yuan or more,[27] including sales revenue, exported value, capital, employment, and wage. The industry section of China Statistical Yearbooks was compiled using these surveys. I provide more details on these surveys in Appendix B.

Firm-level information on ownership (domestic or overseas) and sales destination (domestic or overseas) reported by the ASIP, as summarized in Table 1, is used to identify the partnership types and organizational forms speci…ed in the theoretical model. Recall that there are three partnership types for host-country producers: $(HH; NON)$, HS, and $(HH; B)$. The two $(HH; NO)$ partnership types (0)-334(Y391.9F68 11.955 Tf 4.552 0 T1(a)11(t)8()11(b(r)11(t)8(e)9(dd)11(s spond to domestically owned firms that serve only the Chinese market and both Chinese and overseas markets, respectively. The partnership type of cross-border partnership, HS, refers to the firms that serve only the overseas market; they can be either domestically owned or foreign-owned,[28] depending on their organizational form: arm's length $(HS;O)$ or vertical integration $(HS;I)$.

Table 2 reports the share of each partnership type in total value of exports and total number of exporters during the years 2000-2003. Cross-border partnership, or HS, accounts for roughly 40% in total exported value and 35% in total number of exporters. Under partnership HS, the ratio between ownerships (domestic to overseas) is about 2:3.

3.2 Relative productivity

Propositions 2–4 are directly testable and I start with Proposition 2. I first specify a simple regression

$$\ln TFP_{djrt} = \omega + \beta' TYPE_d + \gamma' C_{drt} + \eta_j + \delta_t + \varepsilon_{djrt}; \qquad (26)$$

and include in the sample only those firms with invariant partnership types over time. This specification is convenient in estimating productivity differences among partnership types. Regressions in the other way around (i.e., partnership types on TFP) are reported in Appendix C and show the same results.

The dependent variable is total factor productivity (TFP) calculated using Levinsohn-Petrin (2003) estimates.[29] Indices d, j, r, and t represent firm, industry, region, and year, respectively. $TYPE_d$ is a vector of dummy variables that indicates firm d's partnership type. Firms under $(HH;NON)$ serves as the reference group. $TYPE_d = [HS_d; HHB_d]'$, $HHB_d = 1$ if the firm is under $(HH;B)$, $HS_d = 1$ if the firm is under either $(HS;O)$ or $(HS;I)$, and β_{HS} and β_{HHB} are their respective coefficients. C_{drt} is a set of firm/region characteristics in year t. An industry is defined by a four-digit industry code. η_j and δ_t are industry and year fixed effects, respectively. ε_{djrt} is a classic error term.

Table 3 shows $b_{HHB} > b_{HS} > 0$, supporting the prediction of Proposition 2. The difference between b_{HS} and b_{HHB} is statistically significant at 1% level in all columns.

[28] According to The Law of the People's Republic of China on Foreign-funded Enterprises, overseas-owned firms refer to "those enterprises established in China by foreign investors, exclusively with their own capital, in accordance with relevant Chinese laws."

[29] TFP is the output not explained by inputs used in production. Its value relies on the estimated coefficients of inputs in the production function. OLS estimates of the input coefficients are potentially biased by unobservables. To address the bias, the Levinsohn and Petrin (2003) method uses intermediate inputs to proxy for the unobservables.

Column (1) is the baseline regression without control variables. Column (2) is similar to (1) but controls for pro…t margin, capital intensity, and regional population. The pro…t margin, de…ned as pre-tax pro…t over sales in the literature (Phillips, 1995), purges possible market power from the estimated productivity; capital intensity and regional population as control variables reduce noises caused by industry composition and local market size.[30] Columns (1)–(2) have included …xed e¤ects, while column (3) includes random e¤ects.

Next I discuss whether various confounding factors in‡uence these results. First, I examine whether the results are a¤ected by taxation e¤ects Developing countries such as China usually have local tax policies that favor cross-border partnership. I consider ad-valorem andtn10 -17.927 v255 Tf 1av211(r)11(o)11()(r)-404(c)9(r)11(o)11(111(r)11(o)sr)-276(d)11(d)-315(11(i)(

Second, I determine whether the results are affected by industry composition. Certain partnership types may be concentrated in an industry for some reason, and thus the results options in year $t+1$: stay under the same partnership, switch to cross-border partnership (i.e., HS in the model) or switch to within-border partnership serving both Chinese and overseas markets (i.e., $(HH; B)$ in the model). Their production activities, even if not comparable after switching (year $t+1$), were comparable before the switching (year t), because they were then undertaking the same production activity under the same partnership.[32] Formally, each observation (a firm-year pair) under partnership $(HH; NON)$ is assigned two dummy variables:

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

and

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

and TFP is regressed on $PRE\text{-}HS$ and $PRE\text{-}HHB$ along with control variables:

$$\ln TFP_{djrt} = \quad + \quad _1 PRE\text{-}HS_{dt} + \quad _2 PRE\text{-}HHB_{dt} + {}^0 C_{drt} + \%_{\rho} + \quad _t + \quad _{djrt} : \qquad (27)$$

The reference group is now firms that remain under partnership $(HH; NON)$ in year $t+1$. Then, $b_2 > b_1 > 0$ if the difference in ex-ante productivity is present.

Table 5 establishes the effect of ex-ante productivity. First, switchers were on average more productive than non-switchers before switching; second, firms that eventually switched to $(HH; B)$ were on average more productive than those that eventually switched to HS (the difference is statistically significant at 1% level). Notably, the average productivity difference between HS and $(HH; NON)$ in Table 5 is approximately one fourth of that in Table 3, and the average productivity difference between $(HH; B)$ and HS in Table 5 is about half of that in Table 3. That is, as expected, ex-ante productivity explains only part of the differences in measured productivity among the three partnership types.

[32] In terms of the theory, in an ideal setting, researchers study firms on date 1 (interaction and contracting). In practice, however, date 1 finishes quickly and date 2 (production) immediately follows, such that what statistical agencies observe is only date 2. This paper's approach is to examine the change in partnership type between one date 2 and another date 2. Specifically, if a firm in partnership type $(HH; NON)$ in year t switches to partnership HS or $(HH; B)$ in year $t+1$, there must be a new date 1 (another interaction and contracting) that takes place between the two consecutive years. Date 1 is not documented in the data, but it is reflected in the production activity of year $t+1$.

3.3 Prevalence of exporters across partnership types

Proposition 3 says that the share of exporters in partnership HS relative to $(HH; B)$ rises if technology transfer becomes more effective (increases), coordination difficulty lowers (increases), or dispersion of productivity diminishes (increases). and are industrial characteristics. Technology complexity measured by R&D intensity reduces the effectiveness of technology transfer.[33] A dummy variable $HITECH$ is constructed to proxy for , which equals 1 if a given firm is from a high-technology industry and 0 otherwise.[34] reflects the productivity similarity among firms within an industry, from all firms being almost identical to all firms ranked clearly as a spectrum, and it is inversely measured by the standard deviation of TFP, denoted by $DISP$.

Unlike and , is primarily affected by local infrastructures and institutions. Coordination would not be an issue if the host country had infrastructures and institutions identical to those in the source country. High-quality local infrastructures facilitate cross-border coordination between Chinese producers and their source-country headquarters. Meanwhile, good local institutions, including the protection of intellectual properties and availability of legal and accounting services, are also important in providing a business-friendly environment for cross-border partnership.

This paper uses the marketization index published by the National Economic Research Institute of the China Reform Foundation as a proxy for local infrastitutions across regions in China. Compiled for each province, this index, denoted by $LOCAL$

The data are then aggregated to the industry-province-year level, and Proposition 3 is tested with the regression:

$$\left(\frac{HS}{HH;B}\right)_{jrt} = {'}_0 + {'}_1 HITECH_j + {'}_2 DISP_{jt} + {'}_3 LOCAL_{rt} + \#^{0} M_{jrt} + u_{jrt} \; ;$$

gration, and shows that vertical integration is associated with a higher average productivity than arm's length. Column (1) includes no control variables, while column (2) includes profit margin, capital intensity, and regional population with the same rationale as in column (2) of Table 3. Both columns (1) and (2) use fixed effects while column (3) uses random effects. Columns (4)–(6) consider tax payments and EPZ/FTZ as their counterparts in Table 3. In columns (7)–(8), the regression is rerun with the subsamples of firms in apparel and electronics. Al these specifications lead to the same finding.

Similar to Table 3 in section 3.2, Table 7 may capture differences between organizational forms other than ex-ante productivity. For example, the estimated productivity differences could result from technology transfer between organizational forms rather than ex-ante productivity. It should be noted that my theoretical model does predict more effective technology transfer in vertical integration than at arm's length; however, this effect ultimately works through the influence of ex-ante productivity. Also, the estimated productivity difference in Table 7 may also result from the heterogeneity in source-country headquarters.

To address the above concerns,

distribution function is now employed to compare the distribution of productivity across partnership types and organizational forms.

Supposing that two groups, represented by two axes in the four panels of Figure 5 , have the same distribution of of partnership types $(HH; NON)$ vs. HS, $(HS; O)$ vs. $(HS; I)$, $(HS; O)$ vs. $(HH; B)$, and $(HS; I)$ vs. $(HH; B)$. Clearly, the productivity of $(HH; NON)$ is stochastically dominated by HS, $(HS; O)$ by $(HS; I)$, and HS by $(HH; B)$, all in line with the results using parametric methods as shown above. I now turn to some concluding remarks.

4 Concluding Remarks

This paper provides a theory of the interaction between headquarters and producers in a world of globalized production. Specifically, it addresses what types of foreign producers are serving developed countries. There are two types of these foreign producers. The first type has mid-range productivity and works with developed-country headquarters, while the second type has high productivity and partners with local headquarters. The former does not serve its local market, while the latter serves both local and developed-country markets.

The theory also predicts that cross-border partnership is more prevalent in the industries with more transferable technologies and less heterogeneous producers, as well as in the regions with higher quality infrastructures and institutions, and that in cross-border partnership, foreign-country producers with relatively high productivity are vertically integrated with their headquarters, while those with relatively low productivity operate at arm's length with their headquarters. These predictions are supported by firm-level evidence from China.

There are at least two important directions for future research. The first is to examine the dynamic aspects of the model. For instance, an advanced technology in the developed country, once transferred to a foreign producer, may carry over to that producer's future partnership with its local headquarter. This provides the foreign producer and the developed-country headquarter incentive and disincentive, respectively, to undertake cross-border partnership. The second is to consider general-equilibrium effects in the model. For instance, technology transfer may drive up factor prices in the foreign country, which forces the least productive foreign producers to exit; therefore, the foreign country gains from improved aggregate productivity.

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shows $x_{HH;NON} = \frac{R_{HH;NON}}{c}$. Plugging $x_{HH;NON}$ back to $R_{HH;NON} = \frac{1}{H}(x_{HH;NON})$, I get $R_{HH;NON} = {}_{H}\,\overline{1}\,(\frac{}{c})\,\overline{1}$. The pro…t function is

$$
\begin{aligned}
& R_{HH;NON} \quad cx_{HH;NON} \\
&= R_{HH;NON} \quad c\frac{R_{HH;NON}}{c} \\
&= (1 \quad)R_{HH;NON} \\
&= (1 \quad)\;{}_{H}\,\overline{1}\,(\frac{}{c})\,\overline{1} \qquad {}_{H}\;:
\end{aligned}
$$

The case of partnership SS is similar.

Under partnership HS, $p_S = (\frac{S}{y_{HS}})^{1}$, so $R_{HS} = p_S y_{HS} = \frac{1}{S}\; y_{HS} = \frac{1}{S}(\quad x_{HS})$. The pro…t is $R_{HS} \quad cx_{HS}$, the …rst order condition of which shows $x_{HS} = \frac{R_{HS}}{c}$. Plugging x_{HS} back to $R_{HS} = \frac{1}{S}(\quad x_{HS})$, I get $R_{HS} = {}_{S}\,\overline{1}\;\overline{1}\,(\frac{}{c})\,\overline{1}$. The pro…t function is

$$
\begin{aligned}
& R_{HS} \quad cx_{HS} \\
&= R_{HS} \quad c\frac{R_{HS}}{c} \\
&= (1 \quad)R_{HS} \\
&= (1 \quad)\;{}_{S}\,\overline{1}\;\overline{1}\,(
\end{aligned}
$$

. TheheThe

$_S$ $^{\frac{1}{}}(\frac{}{c})^{\frac{1}{}}$. The pro…t function is

$$R_{HH;B} \quad cx_{HH;B;H} \quad cx_{HH;B;S} \quad f_{EX}$$
$$= R_{HH;B;H} + R_{HH;B;S} \quad c\frac{R_{HH;B;H}}{c} \quad c\frac{R_{HH;B;S}}{c} \quad f_{EX}$$
$$= (1 \quad)R_{HH;B;H} + (1 \quad)R_{HH;B;S} \quad f_{EX}$$
$$= (1 \quad)(_H + _S) ^{\frac{1}{}}(\frac{}{c})^{\frac{1}{}} \quad f_{EX}$$
$$(_H + _S) \quad f_{EX}:$$

A.2. The proof of Lemma 1

De…ne

$$( ) \quad _{HS}( ) \quad _{HH}( ) \quad e \qquad (29)$$
$$= \quad _S \quad _H \quad e \quad _S e:$$

By condition (11),

$$> \frac{_H + e \quad _S e}{_S};$$

so ( ) > 0. If is su¢ ciently large, so ( ) < 0; if ! 0, ( ) < 0 so there exist two values respectively(0;) and (; 1) at which ( ) = 0 . Denote them by _ and ¯, respectively. Then, any 2 (_; ¯) satis…es $_{HS}( )$ $_{HH}( )$ e> 0 (part (ii) proved). QED.

A.3. The proof of Lemma 2

The "if" part is obvious, as condition (13) is stricter than condition (12). The "only if" part is equivalent to this claim: if 2 (_; ¯), condition (12) fails. The proof is as follows. De…ne such that $_{HS}( )$ e = 0.

Case 1: 2 (0;]. Since d $_{HS}( )$ =d > 0 for any 2 R_{++}, $_{HS}( )$ e< 0, so $_{HS}( )$ $^{X_H}_{HH}( )$ e< 0.

Case 2: 2 (; _]. By Lemma 1, $_{HS}( )$ $_{HH;NON}( )$ e< 0; however, $_{HS}( )$ $^{X_H}_{HH;NON}( )$ e can be positive if $^{X_H}_{HH}( )$ < $_{HH}( )$. If $_{HS}( )$ $^{X_H}_{HH;NON}( )$ e> 0, it is pro…table for Z_S to choose X_H instead of X_S. To get X_H, Z_S can o¤er X_H any pro…t transfer $T^{Z_S}( )$ 2 [0; ( ) bt, Z_H ibiany $T^{Z_S}( )$ y

B. Details on the data

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

Each firm in the survey has an ID number. There are about 10 duplicate IDs in each year, and I dropped these observations. The dataset for the years 2000-2004 has 162,869, 169,017, 181,545, and 196,206 observations, respectively. Then, data for all years are merged by ID number. Further data cleaning takes three steps. First, firms outside manufacturing industries (four-digit industry code < 1311 or > 4392) are dropped, which reduces the sample size by 60,415. Second, firms that are not in normal operation (i.e., status code does not equal 1) are dropped, which reduces the sample size by 16,141. Third, observations with wrong industry and area codes are also dropped, which reduces the sample size by about 140.

My study focuses on domestically owned firms (registration type code < 200) that export some or all of their outputs, and foreign-owned firms (registration type codes: 230 and 330) that export all of their outputs. Keeping these firms only, my working dataset has 512,832 observations. I then drop the firms that are present only once in the four-year time span, because their productivity cannot be estimated using the Levinsohn-Petrin method. Descriptive statistics are reported in Table S1 . The within-border partnership serving the Chinese market only, within-border partnership serving both markets, cross-border partnership at arm's length, and cross-border partnership in vertical integration have 338,532, 64,335, 15,845, and 14,107 observations, respectively.

C. Supplementary results

Section 3 of the paper regresses TFP on either partnership types or organizational forms. This approach is useful because of its simplicity in estimating productivity differences among the three partnership types or between the two organizational forms. The alternative specification, i.e., regressing partnership on TFP, is more intuitive as it suggests how productivity predicts the choices between partnership types or organizational forms.

Table S2 estimates a multinomial logit model. The dependent variable is partnership type: within-border partnership serving the Chinese market only (0), cross-border partner-are respectively linked to partnerships $(HH; NON)$, HS, and $(HH; B)$ in the text. The reference group is $(HH; NON)$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	0.223***	0.207***	0.205***	0.203***	0.198***	0.192***	0.108***	0.267***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.008)	(0.015)
	0.357***	0.352***	0.352***	0.335***	0.301***	0.348***	0.205***	0.379***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.006)	(0.005)	(0.010)	(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				

Table 4: Productivity across Partnerships, Quantile Regression

	(1)	(2)	(3)	(4)	(5)
	10%	25%	50%	75%	90%
Cross-border partnership (HS dummy)	0.184***	0.138***	0.131***	0.143***	0.153***
	(0.006)	(0.004)	(0.003)	(0.004)	(0.005)
	0.240***	0.226***	0.278***	0.345***	0.387***
	(0.004)	(0.002)	(0.002)	(0.003)	(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 inds.	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 with Levinsohn-Petrin estimates. Firms undertaking within-border

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 partnership and serving two markets (PRE-HHB)	0.196***	0.195***
	(0.005)	(0.005)
Control vars.	No	Yes
t-test [p-value]	[0.00]	[0.00]
No. of obs.	334,469	334,469
No. of inds.	750	750
R^2	0.01	0.02

Notes: The dependent variable is TFP calculated with Levinsohn-Petrin estimates. The firms that remain under partnership (HH,NON) in the surveyed periods is the reference group. See text for details on the two dummy variables. Control variables are profit margin, capital intensity, and regional population. Industry (four-digit) and year fixed effects are controlled for in column (2). Robust standard errors in parentheses. The t-test examines if the coefficients of two dummy variables are equal (H0: equal). ``No. of inds.'' reports the number of four-digit industries in the used sample. Constant term is suppressed. *, significant at 10%; **, significant at 5%; ***, significant at 1%.

Table 6: Technology Intensity, Productivity Dispersion, and Local Infrastructures and Institutions

	(1)	(2)	(3)	(4)
HITECH	-0.782***	-1.488***	-1.088**	-0.782**
	(0.173)	(0.300)	(0.450)	(0.397)
DISP	-0.306***	-0.618**	-3.535***	-0.306**
	(0.071)	(0.247)	(0.563)	(0.136)
INST	0.470***	0.620***	2.073***	0.470**
	(0.089)	(0.121)	(0.124)	(0.234)
Specification	OLS/full sample	Nonzero	Tobit	Three-way cluster
No. of obs.	2062	1044	2062	2062

Notes: The dependent variable is the ratio of the number of firm undertaking cross-border partnership (HS) to that of firms undertaking within-border partnership and serving both markets (HH,B) at the industry-province-year level. HITECH is an industry-level dummy variable for high technology intensity. DISP is an industry-year-level measure of productivity dispersion. INST is a province-level measure of local institutional quality. See text for details on these measures. Control variables are capital intensity and provincial population. Column (1) uses the full sample and regular OLS estimation. Column (2) excludes observations whereof the dependent variable equals 0. Column (3) uses Tobit instead of OLS estimation. Column (4) uses three-way clustering; see text for details. Constant term is suppressed. *, significant at 10%; **, significant at 5%; ***, significant at 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	0.139***	0.136***	0.139***	0.133***	0.124***	0.115***	0.113***	0.129***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.009)	(0.008)	(0.010)	(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		

Table 8: Organizational-Form Switchers and Ex-ante Productivity

	(1)	(2)
Dummy: would switch to integration	0.110*	0.098**
	(0.057)	(0.049)
Control vars.	No	Yes
t-test [p-value]	[0.00]	[0.00]
No. of obs.	7358	7358
No. of inds.	28	28
R^2	0.00	0.10

Notes: The dependent variable is TFP calculated with Levinsohn-Petrin estimates. The firms that remain under organizational form (HS,O) in the surveyed periods is the reference group. Control variables are profit margin, capital intensity, and regional population. Industry (four-digit) and year fixed effects are controlled for in column (2). Robust standard errors in parentheses. ``No. of inds.'' reports the number of four-digit industries in the used sample. Constant term is suppressed. *, significant at 10%; **, significant at 5%; ***, significant at 1%.

Table S1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.
Employment	432819	312.1014	1176.646
Exported value	432819	7893.862	104344.1
Profit	432819	2143.871	35735.33
Fixed assets	432819	26536.57	303054.2
Sales	432819	55765.27	417282.3
Intermediates	432819	43643.36	329399.6
Tax payment	432819	112.9358	1414.343

	(1)	(2)	(3)	(4)
Productivity	1.213***	1.083***	1.003***	1.319***
	(0.010)	(0.010)	(0.046)	(0.045)
No. of obs.	376390	376390	12640	18107

	(1)	(2)	(3)	(4)
Productivity	0.306***	0.309***	0.340***	0.143***
	(0.012)			