Contractual Versus Generic Outsourcing: The Role of Proximity*

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Abstract:

We explore the relationship between proximity of buyers and sellers and the organizational form of outsourcing. Outsourcing can be "contractual" in which suppliers undertake specific investments or can involve "generic" market transactions. Both proximity and foreign-worker skill expand the range or variety of products that are contractually outsourced abroad relative to the range of generic imports. Using measures of distance to capture proximity, we find support for these predictions using data for ordinary versus processing exports from Chinese provinces to destination markets. We also find support for the predictions of an extended model that allows for multinational production.

JEL codes: F1, L24

Key words: incomplete contracts, variety of goods, extensive margin, gravity model, China,

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1. Introduction

The importance of distance in international trade has been well-established by empirical work on the gravity equation. Beyond its influence on the volume of trade, however, distance can also have an impact on the organization of trade and production. For example, Evans and Harrigan (2005) have recently shown the importance of proximity between the buyer and seller in the sourcing of apparel production. More generally, we will argue in this paper that proximity between buyers and sellers is a key determinant of the contractual relations between parties engaged in international outsourcing.

To motivate our analysis, consider the contractual relations in outsourcing to China. In addition to "ordinary" exports, Chinese customs authorities also provide data on "processing" exports. As their name suggests, processing exports are goods that rely on imported inputs that are processed in China with the finished good exported. Provided the finished good is not sold domestically, Chinese customs authorities allow the imported inputs to enter the country duty free. We presume that such relationships are contractual, in the sense that the buyer specifies the characteristics of the good and makes payment accordingly. In contrast, "ordinary" exports are goods that could be equally well sold domestically, and have no special customs treatment. We presume that these exports are not specialized for a particular buyer and represent arm's-length transactions between unrelated firms.

The differences between exports in these categories are illustrated in Figure 1. There we show the manufacturing exports of China to various destination countries in 2003, broken down into the proportions accounted for by "ordinary" exports, processing exports by Chinese-owned firms (labelled "other processing"), and processing exports by foreign-owned firms (labelled "FDI processing"). Figure 1(A) shows the dollar amount of trade, and Figure 1(B) shows percentages. These proportions of trade are quite different across destination countries. For example, Japan (the closest country) imports the greatest proportion of goods as FDI processing, followed by the United States (a distant but very large country), European Union, ASEAN countries, Canada, South America and South Africa.

Apart from the distance from China to various destination countries, another aspect of proximity is the distance from a Chinese province to the nearest port or land border. There are huge differences across the 30 Chinese provinces in their proximity to the coast, and as a result, in their levels of exports and proportions of ordinary versus processing trade. Some examples are illustrated in Figure 2, where Figure 2(A) shows the dollar amount of trade and Figure 2(B) shows percentages. We see that the coastal province of Guangdong has the highest exports, followed by Jiangsu/Zhejiang, Shanghai, and other coastal regions. Guangdong also has the greatest proportion of processing exports. Both processing exports and FDI processing vary but remain high across the coastal regions. Inland areas, by contrast, have little processing trade in general, and even less accounted for by foreign-owned firms.

With these examples in mind, we explore the relationship between proximity of the buyer and seller and the organizational form of outsourcing. Our point of departure is recent literature in international trade dealing with incomplete contracts between firms in the provision of specialized inputs.[1] This literature has mostly emphasised the importance of proximity with respect to the ability to enforce contracts, monitor workers or gain information.[2] But the role of proximity is more complicated than that, because distance also affects the outside options of the firms involved in a contractual outsourcing relationship. In this paper, the outside option for the buyer is to purchase non-specialized parts on the spot market, referred to as "generic

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[1] For example, Antràs (2003) argues that in more capital-intensive industries, a greater share of trade is "intra-firm," i.e. between a parent and its subsidiaries. Antràs and Helpman (2004) analyse a more general multi-industry, multi-country model, where the type of contracts and ownership between firms will depend on features of the industry (the productivity distribution of firms) as well features of the host countries (such as factors prices). See Helpman (2005) and Spencer (2005) for surveys.

[2] For example, Antras (2005) assumes that contracts between firms in different countries are harder to enforce than contracts between firms in the same country. Grossman and Helpman (2004) suppose that it is easier to monitor workers at home. Head, Ries and Spencer (2004) emphasizes the importance of local information about the buyer's needs in designing relationship-specific investments.

outsourcing."[3] Because distance affects the price of generic inputs, it affects the outside option under Nash bargaining and hence the outcome from contractual outsourcing. It is this linkage between distance, generic outsourcing and contractual outsourcing that we investigate, both theoretically and empirically.

In the model described in sections 2 and 3 there are two countries, a high-wage country and a low-wage country. The buyer is located in the high-wage country, while suppliers can be located in either country or can take the form of a multinational with headquarters in the high-wage country and production in the low-wage country. Contacts are assumed to be incomplete: suppliers make an up-front relationship-specific investment so as to specialize an input, but are rewarded only through *ex-post* bargaining over the price of the component or part. Since the threat-point of the buyer involves the import of a generic part from a spot-market in the low-wage country, the alternative to contractual outsourcing is arm's length purchases as in standard models of perfect competition and trade.

To provide some intuition as to the workings of the model, suppose that the marginal cost of buying abroad falls, as would occur due to a reduction in transport costs. Then the model predicts that the profits of contractual exporters from the low wage country would be *unchanged* for any given level of exports. This occurs because the reduction in cost applies to generic as well as contractual goods, with the result that the buyer's outside option of arm's-length purchases improves by the amount of the cost decrease. Nash bargaining then implies that the contracted price will fall by the same amount as the arm's length price and the cost decrease. Consequently, a reduction in foreign costs has no effect on the buyer's choice between contractual and generic imports. But the tradeoff between foreign and domestic contractual outsourcing is affected, since the former is cheaper. As a result, the low-wage country exports a greater range of goods under contractual arrangements, displacing contractual production in the high-wage country. This gives rise to an

[3] Spencer and Qiu (2001), Qiu and Spencer (2002) and Head, Ries and Spencer (2004) incorporate the spot-market purchase of generic parts as an outside option for a buyer in a model of incomplete contracts. In Head, Ries and Spencer (2004), multinational firms producing abroad may contract with home country suppliers, but otherwise these papers focus on domestic contractual outsourcing. More recently, Schwartz and Van Assche (2005) also examines contractual (or "ideal") outsourcing versus arm's length purchases of inputs in an international context.

important prediction for the empirical analysis: lower trade costs due to closer proximity to a low-wage country should be associated with a higher proportion of imported varieties that are of the contractual rather than the generic type. An improvement in worker skill in the low-wage country should also raise the proportion of imported varieties of the contractual type, but, in this case, the result is driven by a reduction in the range of generic imports.

In section 4, we extend the model to include the possibility of contractual outsourcing to a multinational firm that has headquarters in the high-wage country, but produces through FDI (foreign direct investment) in the low-wage country. Again, we generate predictions about the variety of goods that would be produced under FDI as well as the previously considered forms of outsourcing. Under mild assumptions, we find that the most technologically sophisticated inputs are produced domestically through contractual outsourcing to domestic firms; the next most sophisticated are contracted to multinational firms producing through FDI; products with even less sophistication are produced through contractual outsourcing directly to firms in the low-wage country; and the simplest inputs are produced and exported under generic outsourcing. As before, a decrease in trade costs should increase the proportion of imported varieties that are of the contractual type, but the increase should be concentrated in an expansion of multinational production rather than contractual outsourcing to unaffiliated firms in the low-wage country.

For the empirical analysis, we are interested in explaining the range of processing exports versus ordinary exports as well as the range of exports produced by foreign-owned firms within the processing category. We find support for the theoretical predictions of our model. Specifically, we find that the range of processing exports from Chinese provinces are much more sensitive to internal distance (from the province to the nearest shipping port or major border crossing) than are ordinary exports. More remote provinces have a lower variety of processing exports relative to ordinary exports, as already suggested by Figure 2. Instead of using the proportions of total trade as shown in Figure 2, however, our results are obtained by using the export variety – or "extensive margin" – of ordinary exports versus processing exports. The negative effect of internal distance on the variety of processing exports is reinforced by having a less skilled provincial workforce, which also tilts trade towards ordinary exports and away from processed varieties. Furthermore, *within* processing exports, it is foreign-owned multinational firms that are the most sensitive to distance and to the quality of the workforce: a province that is closer to the border or has a higher-skilled workforce will have relatively more processed varieties exported by foreign-owned firms.[4]

Our empirical results therefore provide support for the main predictions of our model. Beyond that, our empirical method is of some general interest because it uses the "extensive margin" as the dependent variable in gravity-like equations. These regressions give very different results from using the value of trade as measured by the "intensive margin" as the dependent variable. For example, the external distance from a Chinese port to the destination market has a strong negative impact on the value of trade, but virtually no effect at all on the extensive margin. That surprising empirical result deserves more attention in further work. In addition, our general approach of using the extensive margin to shed light on the organizational structure of trade will no doubt be useful in other contexts as well (that approach is also used by Chen and Feenstra, 2005, for example).

2. The Model.

The model we develop is related to the work of Grossman and Helpman (2002, 2005), and the papers by Antràs cited above, which use the property-rights theory of Grossman and Hart (1986) to model global outsourcing. Likewise, we use a Grossman-Hart framework, which includes a relationship-specific investment (RSI) that a supplier must make, thereby creating a "holdup" problem.[5]

There are two countries: a high-wage developed country, denoted by H and a low-wage developing

[4] Feenstra and Hanson (2005) use Chinese data to examine two types of processing exports, depending on which party (the Chinese manager or foreign firm) owns and controls the imported inputs. We consider this comparison, but fewer years of data are available. As hypothesized, it is the type of processing trade where the foreign firm provides inputs to the Chinese firm (and therefore has a contract with the Chinese firm) that is most sensitive to internal distance, but this effect is statistically very weak.

[5] In contrast, Grossman and Helpman (2004) apply the incentive-systems framework of Holmstrom and Milgrom (1994) to model managerial compensation in global production, and Marin and Verdier (2002, 2003) and Puga and Trefler (2002) extend the Aghion and Tirole (1997) theory of delegation of authority to general equilibrium.

country denoted by L. We model a "buyer" in country H that produces a final good using a fixed proportion of each of a large number of intermediate goods or parts. "Suppliers" in both countries, H and L, potentially make relationship-specific investments so as to produce innovations in design (blueprints) that specialize parts in ways that are of value only to the particular buyer. Although we model just one buyer, free entry ensures that the marginal supplier earns zero profit. Infra-marginal suppliers can earn positive rents. Contracts are incomplete in the sense that it is not possible to condition payment on the level of investment. Thus each supplier must make its investment up-front with the distribution of rents subsequently determined through *ex-post* bargaining. The buyer can choose to purchase specialized parts through contractual outsourcing in either country H or country L, but also has the option of purchasing "generic" versions of the parts from a spot market. Due to the cost advantage of country L, generic parts are produced only in L.

To summarize, the various forms of outsourcing are distinguished as follows:

Contractual outsourcing:

Domestic outsourcing **- type H supplier**, RSI and production in H

Multinational supplier **- type M supplier**, RSI in H and production in L

Foreign outsourcing **- type L supplier**, RSI and production in L

Generic outsourcing: **spot market** in country L.

Suppliers undertake RSI only in their country of origin, but production can take place in either country. Thus, suppliers from country H have the option of producing at home or producing as a multinational through FDI in country L. Multinationals from H gain access to the lower wage in country L, but must pay a fixed cost, F, to set up a plant. However, suppliers from country L produce only in country L.[6] Letting the index i represent these three organizational forms, then i = L if the contract is with a supplier in L, i = H if the contract is with a supplier in H with production in H and i = M (for multinational) if a supplier in H undertakes RSI in H, but produces in L.

Parts differ with respect to the effectiveness of RSI in creating rent for the buyer. We interpret this

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[6]Suppliers from L producing in H would be dominated by suppliers from H that do not pay F.

variation as mainly reflecting differences in technological sophistication. Thus we would expect that parts with high effectiveness of RSI are the more technologically sophisticated inputs, that require significant investment to keep up with technological change.[7] Letting $\rho(z) \in (0, 1]$ denote the effectiveness of RSI for part z, parts are ordered from low to high $\rho(z)$ on the continuum $z \in [0, \check{Z}]$, where $\rho(0) > 0$ and $\rho(\check{Z}) = 1$. For convenience we assume that one unit of the final good requires just one of each of the intermediate goods.

Following Spencer and Qiu (2001), we assume that the rent created by RSI takes the form of a reduction in marginal assembly costs. For example, the blueprints created by RSI could improve the fit of each part with the other parts involved in the assembly process or, alternatively, could speed up "just-in-time" delivery. As a result, the total rent created by any given level of RSI is increasing in the output of the buyer. The idea that the scale of a buyer increases the benefits from supplier investment seems appealing in considering the extensive contractual outsourcing of a firm such as Wal-Mart.

We introduce a minimum level of RSI, denoted $\underline{k}$, that will later play an important role in distinguishing the various cases. The idea is that suppliers must invest $\underline{k}$ just to obtain a basic knowledge of the buyer's requirements. For example, $\underline{k}$ could include the set up costs for an R&D lab. Letting k represent the level of RSI, it follows that only the portion, $k - \underline{k}$, of this investment is effective in creating rent. Thus we assume that an investment, k, by a supplier of type i = H creates rent, r^H, in the form of a reduction in assembly cost for each unit purchased, where

$$r^H \equiv \rho(z)(k - \underline{k})^{1/2}. \qquad (1)$$

The functional form in (1) implies that rent per unit is increasing in k, but at a decreasing rate. Letting y represent the buyer's (and the supplier's) output, the total rent created is $r^H y$.

Multinationals of type M undertaking production in the low-wage country are less efficient than suppliers of type H in the quality of manufacture of specialized inputs due to lower skill in the workforce.

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[7]Based on U.K. manufacturing data, Acemoglu et al. (2004) finds that outsourcing (rather than vertical integration by the buyer) is more likely when the supplier is technologically intensive. The effectiveness of RSI may also be increased by other factors such as a larger cost-share in final-good production (see Spencer and Qiu, 2001, and Acemoglu et. al. 2004).

Letting $q \in (0,1)$ denote the quality of specialized inputs produced by multinationals in country L relative to quality in country H, we assume that the rent created by RSI is reduced by the fraction q. One could imagine that a less skilled workforce reduces the fraction of output that meets the exacting manufacturing tolerances of the blueprints created by RSI. Multinationals have access to the same technology as in country H, but the lower technological level of country L further reduces the quality of manufacturing by firms of type L by the fraction, $\lambda \in (0,1)$. Consequently, the rent per unit of output created by an investment k by suppliers of types L and M is given by:

$$r^L \equiv \lambda q \rho(z)(k - \underline{k})^{1/2}, \;\; r^M \equiv q \rho(z)(k - \underline{k})^{1/2}. \tag{2}$$

Suppliers from country L do not undertake FDI in country H, since the fixed cost, F, would reduce their profits relative to suppliers of type H. One could also suppose that multinationals with headquarters in country L would remain at a technological disadvantage.

In modelling contractual outsourcing, we assume that Nash bargaining takes place over the price that will be paid on delivery of the specialized input without the potential for lump-sum transfers. As a result, there is an efficiency loss due to prices that exceed marginal cost. This assumption captures an element of realism since pure-price contracts are the norm for international outsourcing between unrelated firms, perhaps because lump-sum transfers are difficult to enforce.[8] Both RSI and the cost F of FDI are assumed to be non-contractible[9], whereas the marginal costs of production in each country are contractible. Since the up-front costs of RSI create economies of scale, maximum profit is achieved when only one firm invests. Thus we

[8]The fact that prices of inputs exceed marginal cost changes final-good output and the demand for parts, but not decisions taking output as given. The exclusion of lump-sum transfers is not crucial, since our main results either hold output fixed or are independent of endogenous changes in output.

[9]RSI involves unverifiable efforts in obtaining information about the needs of the buyer and ways to coordinate with other suppliers. It is difficult to verify F since it is incurred in a foreign country and may also include the cost of managerial effort.

assume that the buyer bargains with at most one supplier of each part.[10]

The subgame perfect equilibrium incorporates three stages of decision. At stage 1, potential contractual suppliers are formed in countries L and H with full awareness of the subsequent equilibrium outcomes. Firms in country H decide whether to produce in country H (i = H) or become a multinational by investing F to set up a plant in country L (i = M). At stage 2, each supplier chooses its profit-maximizing level of investment, which becomes sunk. If a firm decides not to invest, it exits and the part is later produced only as a generic. At stage 3, the buyer engages in simultaneous Nash bargaining with suppliers of type i = H,M, or L over the prices, denoted $p^i(z)$, of parts z. The buyer also commits to its output, y, at this stage. If bargaining is successful, the buyer orders y units of each part at the contracted price. Otherwise, the buyer buys y units of a generic version of the part at marginal cost from a spot market in country L.

3. Purely domestic or purely international outsourcing.

A. Predictions of the model

In this section we consider the possibility that contractual outsourcing involves purely domestic suppliers (type i = H) or, alternatively, purely foreign suppliers (type i = L) where each supplier undertakes both RSI and production in its own country. Letting $w^H(z)$ denote the (constant) marginal cost of production of part z in country H and $w^L(z)$ the (constant) marginal cost at which the good can be produced in country L and transported to country H, then $\delta \equiv w^H(z) - w^L(z) > 0$ represents the cost advantage of country L over country H. For simplicity we assume that δ is the same across all parts.

Since k^i is sunk and not contractible, in Nash bargaining with an buyer of scale y in stage 3, a type i supplier of part z would gain a surplus of $y[p^i(z) - w^i(z)]$ from a contract at a price $p^i(z)$. Taking into account the rent created by RSI, the marginal cost of part z to the buyer is then $\gamma^i(z) \equiv p^i(z) - r^i$. The threat point of the

[10]The possibility that the buyer bargains with two suppliers so as to increase competition is less important in this context because of the option of generic outsourcing. One could imagine that there are a large number of potential suppliers for each part z, but that based on a random draw only one supplier in each country achieves the highest productivity in RSI as represented by $\rho(z)$. If more than one firm invests, then the buyer bargains with the supplier that would increase its profits the most. Since potential suppliers correctly anticipate this outcome, at most one firm will choose to invest for each part.

buyer if bargaining breaks down is to import the generic part at a marginal cost, $w^L(z)$. Consequently, the buyer gains $y[w^L(z) - \gamma^i(z)]$ from agreement. Summing the gains of the buyer and supplier, the overall surplus from agreement is $y[r^H - \delta]$ if the supplier is of type H and yr^L if the supplier is of type L. Assuming that the parties have equal bargaining power and taking into account the cost of RSI, suppliers of types H and L respectively earn profit[11]:

$$\pi^H = y(r^H - \delta)/2 - k^H \text{ and } \pi^L = yr^L/2 - k^L. \qquad (3)$$

The corresponding gains of the buyer are $y(r^H - \delta)/2$ and $yr^L/2$. Since $r^H - \delta > 0$ and $r^L > 0$, agreement is always reached for $k^i > \underline{k}$. Otherwise, generic parts are imported.

For simplicity, we assume that the number of parts required for production is sufficiently large that a change in RSI level or in the location of production for just one part will have a very small effect on overall marginal cost, which is determined by the sum of the prices paid for parts. Since the effect on the buyer's choice of output is negligible, suppliers decide on their levels of RSI taking y as given. In stage 2, setting k^i to maximize π^i for i = H, L as in (3) and using (1) and (2), we obtain:

$$k^H = (y\rho(z)/4)^2 + \underline{k}, \;\; r^H = y(\rho(z))^2/4$$

$$k^L = [\lambda q y\rho(z)/4]^2 + \underline{k}, \;\; r^L = (\lambda q)^2 y(\rho(z))^2/4. \qquad (4)$$

Thus from (3) and (4), suppliers of type H and L earn profits

$$\pi^H = \pi^H(z,y) = (y\rho(z))^2/16 - y\delta/2 - \underline{k}$$

$$\pi^L = \pi^L(z,y) = (\lambda q)^2(y\rho(z))^2/16 - \underline{k}. \qquad (5)$$

We assume that the buyer is the principal and hence the buyer's preferences dominate with respect to whether or not to bargain with a particular type of supplier. In choosing between a type H and a type L supplier, the buyer is indifferent at part $z = I^{LH}$ (I for indifference) satisfying $r^H - \delta = r^L$, where, from (4),

$$\rho(I^{LH}) = [4\delta/y(1- (\lambda q)^2)]^{1/2}. \qquad (6)$$

Since $r^H - \delta \geq r^L$ for $z \geq I^{LH}$, the buyer prefers contracts with type H suppliers for $z \geq I^{LH}$ and type L suppliers

[11] Since $p^H(z) - w^H(z) = w^L(z) - \gamma^H(z) = (r^H - \delta)/2$ and $p^L(z) - w^L(z) = w^L(z) - \gamma^L(z) = r^L/2$, (3) follows from $\pi^i = y(p^i(z) - w^i(z)) - k^i$.

for $z < I^{LH}$. However suppliers must also be willing to invest. Letting part $\underline{H}$ satisfy $\pi^H(\underline{H},y) = 0$ and part $\underline{L}$ satisfy $\pi^L(\underline{L},y) = 0$, then, from (5) we obtain:

$$\rho(\underline{H}) = 4[\underline{k} + y\delta/2]^{1/2}/y, \quad \rho(\underline{L}) = 4(\underline{k})^{1/2}/y\lambda q. \tag{7}$$

Thus a requirement for investment is $z \geq \underline{H}$ for type H suppliers and $z \geq \underline{L}$ for type L.

It is notable from (5) that the profit of a type L supplier is independent of marginal cost, $w^L(z)$. Since $w^L(z)$ represents both the marginal cost of suppliers of type L and the marginal cost of suppliers of generic parts, the total surplus generated by a supplier of type L is simply the rent, r^L, generated by RSI. This surplus is shared equally between the parties by increasing the price, $p^L(z)$, to just offset any increase in $w^L(z)$. By contrast, the total surplus generated by an agreement with a supplier of type H is reduced by δ, due to the threat point of importing generic parts. Consequently, as shown by (7), an increase in δ raises $\underline{H}$, so as to reduce the entry of suppliers of type H, but δ has no effect on the part $z = \underline{L}$ at which a supplier of type L is just willing to produce.

Proposition 1 (see Appendix A for the proof) sets out the conditions that determine the choice of organizational form. To express these conditions, we define $\beta^{\lambda q} \equiv (\lambda q)^2/(1 - (\lambda q)^2)$ for $\lambda q < 1$, which is increasing in λq, the quality of manufacturing of suppliers of type L. If λq is sufficiently close to 1, then suppliers of type L would drive out suppliers of type H due to the lower wage in L. To focus on internal solutions, we assume $\rho(I^{LH}) < 1$, $\rho(\underline{L}) < 1$ and $\rho(\underline{H}) < 1$, which require[12]:

$$16\underline{k}/[(y)^2 - 16\underline{k}] < \beta^{\lambda q} < y/4\delta - 1 \text{ and } \underline{k}/y\delta < y/16\delta - ½. \tag{8}$$

Proposition 1: *Assume (8).*

(A) If $\underline{k}/y\delta \geq \beta^{\lambda q}/2$ then $I^{LH} < \underline{H} \leq \underline{L}$ and contractual outsourcing is restricted to purely domestic type H suppliers in the high-wage country. The buyer contracts with H for parts, $z \in [\underline{H}, \check{Z}]$, with higher productivity of RSI and imports generic parts $z \in [0, \underline{H})$.

(B) If $\underline{k}/y\delta < \beta^{\lambda q}/2$, then a range of parts with the highest productivity of RSI are produced domestically in

[12]From (6) and (7), $16\underline{k}/(y)^2 < (\lambda q)^2 < 1 - 4\delta/y$.

the high-wage country through contractual outsourcing to suppliers of type H, whereas a range of parts with the next highest productivity level of RSI are imported from the low-wage country through contractual outsourcing to suppliers of type L. The remaining parts are imported as generics. There are two subcases:
(i) If $(\beta^{\lambda q} - 1)/4 \leq \underline{k}/y\delta < \beta^{\lambda q}/2$, *then* $\underline{L} < \underline{H}$ *and* $I^{LH} \leq \underline{H}$ *. The buyer contracts with H for parts* $z \in [\underline{H}, \check{Z}]$*, with L for parts* $z \in [\underline{L}, \underline{H})$ *and imports generic parts* $z \in [0, \underline{L})$*.*
(ii) If $\underline{k}/y\delta < (\beta^{\lambda q} - 1)/4$ *then* $\beta^{\lambda q} > 1$ *and* $\underline{L} < \underline{H} < I^{LH}$ *. The buyer contracts with H for parts* $z \in [I^{LH}, \check{Z}]$*, and with L for parts* $z \in [\underline{L}, I^{LH})$ *and imports generic parts* $z \in [0, \underline{L})$*.*

As Proposition 1 shows, the value of the minimum investment, $\underline{k}$, required for RSI relative to the cost savings, δy, from production in the low-wage country L is critical for determining the range of parts produced by each type of supplier. A high value of $\underline{k}/y\delta$ acts as a barrier to entry for suppliers of type L, particularly for parts with a low productivity of RSI due to a low $\rho(z)$. From Proposition 1(A), if $\underline{k}/y\delta \geq \beta^{\lambda q}/2$, then $\underline{H} \leq \underline{L}$, which implies that it is profitable for type L to produce only the parts with high productivity of RSI that type H suppliers also find profitable. Since $I^{LH} < \underline{H}$, the buyer prefers a contract with type H over type L with the result that imports are limited to generic parts with low productivity of RSI.

Alternatively, if $\underline{k}/y\delta < \beta^{\lambda q}/2$, as in Proposition 1(B), then $\underline{L} < \underline{H}$, reflecting the greater ease of entry of type L suppliers. The buyer engages in both international and domestic contractual outsourcing, but parts with the highest productivity of RSI are produced at home. This case is illustrated in Figure 3(a), where we arrange parts by their effectiveness of RSI, z. For z above a critical value the buyer will purchase from domestic suppliers, denoted by H; for z in an intermediate range the buyer will outsource to foreign suppliers in the low-wage country, denoted by L; and for z in the lowest range the buyer will purchase those parts generically from the low-wage country, on the spot market.

The critical values between the H, L and Generic ranges illustrated in Figure 3(a) depends on which of two sub-cases we are in, as described in Proposition 1. For $(\beta^{\lambda q} - 1)/4 < \underline{k}/y\delta < \beta^{\lambda q}/2$, we show in B(i) that the buyer prefers type H suppliers if they are willing to enter ($I^{LH} < \underline{H}$) and hence type L suppliers gain contracts only for the parts, $z \in [\underline{L}, \underline{H})$, with lower productivity of RSI that type H suppliers are not willing to produce. The case $\underline{k}/y\delta < \beta^{\lambda q} - 1$, examined in B(ii), is a possibility only if type L and type H suppliers are sufficiently similar in terms of quality of manufacturing that $\beta^{\lambda q} > 1$. This similarity means that the buyer tends to favor low-cost suppliers of type L ($\underline{H} < I^{LH}$). Thus type L suppliers gain contracts for parts $z \in [\underline{H}, I^{LH})$ that type H would like to produce. Contracts are awarded to type H for $z \geq I^{LH}$ and to type L for $z \in [\underline{L}, I^{LH})$. Again, generic parts are imported for $z < \underline{L}$.

B. Comparative static effects

In our empirical analysis we are able to measure international contractual outsourcing, but not contractual outsourcing at home, so henceforth we assume $\underline{L} < \underline{H}$ to ensure that there is some contractual outsourcing to firms in country L. From Proposition 1, this requires $\underline{k}/y\delta < \beta^{\lambda q}/2$ so as to rule out case (A) in which contractual outsourcing is restricted to country H. Of primary interest for the empirical analysis is the effect of trade costs as measured by the distance between the various outsourcing locations and destination countries. Since $w^L(z)$ includes the cost of transport to country H, a reduction in trade costs would increase the cost advantage, δ, of the low-wage country. We are also interested in the effects of an improvement in the quality, q, of manufacturing in country L, which we will measure as worker skill. In addition, we consider the effects of variations in the scale, y, of the buyer. Corollary 1 sets out the relevant comparative static effects.

Corollary 1. *Assume $\underline{L} < \underline{H}$ and (8).*

(A) An increase in scale, y, of the buyer reduces $\underline{L}$, $\underline{H}$ and I^{LH}, and hence reduces the range of generic exports from country L and raises the range of parts produced under contractual outsourcing in country H.

(B) Hold y fixed.(i) An increase in the cost advantage δ, has no effect on $\underline{L}$, but $\underline{H}$ and I^{LH} increase. Thus the range of contractual exports from country L rises at the expense of contractual outsourcing in country H. The range of generic exports is unchanged (ii) An improvement in quality, q, reduces $\underline{L}$, has no effect on $\underline{H}$, but increases I^{LH}. Thus the range of contractual exports from country L is increased at the expense of generic exports. If $\underline{k}/y\delta < (\beta^{\lambda q} - 1)/4$, then $\underline{H} < I^{LH}$ and the reduction in the buyer's preference for type H suppliers

arising from the increase in I^{LH}, narrows the range of parts produced through contractual outsourcing in country H.

<u>Proof</u>: The proof of Corollary 1 follows directly from the expressions for $\underline{L}$, $\underline{H}$ and I^{LH} in (6) and (7) and Proposition 1.

This corollary is illustrated in Figure 3(b), where we show how the critical values between the outsourcing regions are affected by an increase in the cost advantage of the low-wage country, δ, or in the quality of that workforce, q, or in the scale of the buyer, y. Holding the buyer scale fixed for a moment, these results provide us with the following testable hypotheses:[13]

(I) An increase in the cost advantage δ of the low-wage country raises its range of contractual exports, with no impact on its range of generic exports;

(II) An increase in the quality q of the foreign workforce raises the range of contractual exports, and lowers the range of generic exports.

We test these hypotheses by constructing measures of the range of contractual and generic exports from Chinese provinces to destination countries, and examining the impact of differences in the provinces' cost advantage (due to proximity to the destination countries) and workforce quality. Before turning to these empirical tests, we should note one potential difficulty: hypotheses (I) and (II) are derived holding the scale of the buyer, y, fixed, but in principle this scale is endogenous because it depends on the buyer's marginal cost. Marginal cost is determined by adding up the buyer's net marginal cost for each part, which in turn depends on the range of parts covered by each organizational form. If a change in a parameter leads to a shift in organizational form that reduces marginal cost, then we would expect the output of the buyer to rise (given demand).[14] But with an increase in y, Corollary 1(A) states that the range of generic exports from the low-

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[13]Corollary 1 refers to effects on the range of exports, which are our primary focus of interest. Predictions as to the volume of exports may differ. For example, an increase in scale reduces the range of generic imports, but since the volume increases, the effect on the value of generic exports is ambiguous.

[14]See Spencer and Qiu (2001) for an analysis of the feedback effects between marginal cost, output and RSI for the case in which only type H suppliers undertake RSI.

wage country are reduced, with an ambiguous impact on its range of contractual exports (as illustrated by the change in critical values in Figure 3(b)), which therefore modifies hypotheses (I) and (II).

Fortunately, the ambiguity arising from endogenous changes in the scale of output (which we cannot control for empirically) can be resolved. Instead of focusing on the absolute range of contractual or generic exports from the low-wage country, we consider their relative magnitude, i.e. the proportion of exported varieties that are contractual rather than generic. As shown in Corollary 2, this approach allows us to vary the scale of output y endogenously, and still obtain definite predictions about how the cost advantage δ, and quality q, affect the relative range of products produced through contractual versus generic outsourcing.

Corollary 2. *Assume $\underline{L} < \underline{H}$ and (8).*

Let ω denote the proportion of exported varieties from country L that are of the contractual rather than generic type. Then ω is increasing in (i) the scale, y, of the buyer, (ii) the cost advantage, δ, of country L and (iii) the quality q, of the workforce in country L.

Proof: The results follow from $\omega \equiv 1 - \rho(\underline{L})/\rho(\underline{H}) = 1 - (\underline{k})^{1/2}/\lambda q(\underline{k} + y\delta/2)^{1/2}$ for $(\beta^{\lambda q} - 1)/4 \leq \underline{k}/y\delta < \beta^{\lambda q}/2$, and $\omega \equiv 1 - \rho(\underline{L})/\rho(I^{LH}) = 1 - (\underline{k}/y\delta)^{1/2}/\beta^{\lambda q}$ for $\underline{k}/y\delta < (\beta^{\lambda q} - 1)/4$, so $d\omega/dy > 0$, $\partial\omega/\partial\delta > 0$ and $\partial\omega/\partial q > 0$. □

This Corollary leads to our third testable hypothesis:

(III) An increase in the cost-advantage of the low-wage country or the quality of its workforce (with any induced increase in buyer scale) raises the proportion of exported varieties from country L that are contractual rather than generic.

In our empirical work we will examine hypotheses (I) and (II) using separate regressions where the dependent variables are the range of contractual versus generic exports, respectively. Because these two hypotheses hold buyer scale constant, we should not necessarily expect the hypotheses to apply as stated. But the weaker hypothesis (III), which involves a *comparison* of the two regressions, should hold even with endogenous changes in the scale of the buyer.

C. Estimation

To test these comparative statics effects we use disaggregate Chinese exports by province to each destination country for the years, 1988-2003.[15] Chinese exports are distinguished by whether they are "ordinary" versus "processing" exports. The latter category is composed of goods for which parts are initially imported duty-free, then processed into finished goods, which must then be exported (since no duties were paid on the parts, the goods cannot be sold domestically). By its very nature, we can expect that processing trade is done under contract with some foreign buyer. However, the same categories of final goods can instead be purchased as "ordinary" exports, which does not necessarily involve any prior agreement between buyer and seller as to the import of parts, methods of assembly, etc. Therefore, we identify Chinese processing exports as resulting from *contractual* outsourcing, and Chinese ordinary exports as what we have called *generic* outsourcing.

Our primary interest is in the *ranges* of goods exported by the low-wage country: these ranges are given in our theory by $[0,\underline{L})$ for generic outsourcing and $[\underline{L}, \underline{H})$ or $[\underline{L}, I^{LH})$ for contractual outsourcing. (We do not attempt to measure outsourcing within the high-wage country). In order to measure the ranges of goods empirically, we appeal to the "extensive margin" recently used by Hummels and Klenow (2005). To define this, let $I_t^{jk} \subset \{1,\ldots,N\}$ denote the set of goods exported by province j of China to destination county k in year t, and $I_t^* \equiv \bigcup_{j,k} I_t^{jk}$ denote the total set of goods exported by China. Also, let x_{it}^*, $i \in I_t^*$ denote the total value of exports of good i from China to the world in year t and x^*_t total exports from China. With this notation, the *extensive margin* of province j to country k in year t is defined by:

$$EM_t^{jk} \equiv \frac{\sum_{i \in I_t^{jk}} x_{it}^*}{\sum_{i \in I_t^*} x_{it}^*} = \frac{\sum_{i \in I_t^{jk}} x_{it}^*}{x_t^*} \qquad (9)$$

[15] Data sources are described in Appendix B.

Feenstra (1994) shows how this type of formula can be obtained from an underlying CES aggregator function, and represents the theoretically appropriate way to measure product variety in a CES framework. Notice that the numerator and denominator of (9) differ only by the set of goods over which the summation is taken: in the numerator, the summation is taken over the set of goods exported by province j to country k, whereas in the denominator the summation is taken over all goods exported by China in year t. Therefore, the variation in (9) across provinces and destination countries represents differences in the product varieties traded between them, and not in the value of exports.

Letting x_{it}^{jk}, $i \in I_t^{jk}$ represent the value of exports of good i from province j to country k in year t, where $x_t^{jk} \equiv \sum_{i \in I_t^{jk}} x_{it}^{jk}$, Hummels and Klenow (2005) further propose the following formula for the *intensive margin* of exports between region j and country k:

$$IM_t^{jk} \equiv \frac{\sum_{i \in I_t^{jk}} x_{it}^{jk}}{\sum_{i \in I_t^{jk}} x_{it}^{*}} = \frac{x_t^{jk}}{\sum_{i \in I_t^{jk}} x_{it}^{*}} \tag{10}$$

Notice that the difference between the numerator and denominator of (10) comes from the value of exports: in the numerator it is the exports from province j to country k, summed over goods $i \in I_t^{jk}$, whereas in the denominator it is total Chinese exports, summed over the same set $i \in I_t^{jk}$. In this sense, the intensive margin measures the amount exported by each province to each country, relative to the country total. By multiplying the extensive and intensive margins we obtain exports from province j to country k, relative to Chinese total exports:

$$EM_t^{jk} \times IM_t^{jk} = \frac{x_t^{jk}}{x_t^{*}}. \tag{11}$$

Thus, the extensive and intensive margins are a decomposition of the exports from each province to each country into their variety and volume components, respectively.

In Figure 4 we illustrate the extensive margins in ordinary trade and processing trade for 2003, averaged across regions in China and destination countries. It is clear that the extensive margin in processing trade differs a great deal more across regions than does the extensive margin in ordinary trade. Four regions have extensive margins in both ordinary or processing trade that are greater than 0.9, meaning that they are exporting more that 90% of the product varieties coming from China as a whole. These four regions are: Beijing and Tianjin; Shanghai; Jiangsu and Zhejiang; and Guangdong. For the other regions the extensive margins in ordinary trade fluctuate between 0.85 and 0.95, while the extensive margins in processing trade are much smaller (as low as 0.1 for the North West provinces), though the two margins are still correlated across regions.

We first estimate the gravity equation on a yearly basis using both the extensive margin and intensive margin as dependent variables. We then pool across the years 1988-2003. We include a fixed effect for each year as well as allowing those coefficients that changed over the time period to be interacted with a time trend. We also allow the regression error to differ as a random effect across provinces, and cluster the standard errors across provinces. The regression estimates using the extensive margin as the dependent variable are shown in columns (1)-(3) of Table 1. The regression in column (1) uses the extensive margin constructed from ordinary exports as the dependent variable, while the regression in column (2) uses the extensive margin constructed from processing exports. In column (3), we report the regression using the difference between these two dependent variables. Regressions using the intensive margin as the dependent variable are shown in columns (4) and (5).

The regressors include GDP per capita and population in the source province and destination country, as well as a measure of the educational attainment of the provincial workforce that we call labor skill. To construct that variable, we run a preliminary regression of provincial manufacturing wages on the fraction of the population with primary, junior, senior and university education. The predicted wage from this regression is a log-linear combination of the education variables, and is used as labor skill, representing the quality q of manufacturing in our model. In addition, we use two measures of distance: the *internal distance* from the province to the nearest shipping port or major border crossing; and then the *external distance* from that port/border crossing to the destination country. Both of these measure transportation costs, with provinces that are closer to their destination markets having a cost advantage over more distant provinces. Consequently, in our model, these distance measures should affect the parameter δ, which is the cost advantage of the low-wage country in exporting both contractual and generic goods.

Our primary interest is in the effect of distance on the extensive margins. The theoretical hypothesis (I) is that distance should reduce the range of contractual outsourcing, i.e. the extensive margin of processing exports, but not impact the range of generic outsourcing, i.e. the extensive margin of ordinary exports. From columns (1) and (2) of Table 1, we see that *external distance* has a very small positive coefficient on the extensive margin of either ordinary or processing exports, but the effect on processing exports is not significant. (The typical negative effect of distance on the intensive margins can be seen in columns (4) and (5)). *Internal distance* affects both extensive margins negatively, though the impact on the extensive margin of ordinary trade is smaller than that on processing trade. So the range of processing relative to ordinary exports *expands* as internal distance is reduced, which is consistent with hypothesis (III). The difference between the coefficients on the ordinary and processing extensive margins is formally tested in column (3), which shows that internal distance has a significantly stronger negative impact on the extensive margin of processing trade. We take these estimates as providing support for our hypothesis that the range of contractual (processing) exports is more sensitive to distance than the range of generic (ordinary) exports, at least for the internal distance from the province to the nearest port/border crossing.

A second hypothesis is that a higher quality workforce in the source province will contribute to a greater range of processing exports. This hypothesis is tested by the coefficient of the labor skill variable, which is positive for the extensive margin of both ordinary and processing trade, and substantially larger for processing trade. From hypothesis (II) we expected a rise in labor quality to increase the range of processing exports, as found in Table 1, but to reduce the range of generic exports, which we do not find. Nevertheless, hypothesis (III) states that the range of processing relative to ordinary exports should increase as labor quality rises, and that is supported by the negative (and significant) coefficient on labor quality in column (3), where the dependent variable is the range of ordinary relative to processing exports.

Two control variables are related to the size of the destination countries – their GDP per capita and populations – which might have captured the scale of the buyer. However, it turns out that both these variables are very small and often insignificant, so we are not controlling for that variable. Instead, our regression indicates that there is a scale effect of the source province: an increase in the provincial population has a much greater positive effect on the range of processing exports than ordinary exports, especially in more recent years. This finding suggests to us that an expanded model with free entry of buyers might be appropriate, whereby larger provinces can support the outsourcing requirements of a greater number of foreign buyers, especially for contractual outsourcing. That empirical prediction is beyond the scope of the model in this paper, however.

The next variables shown in Table 1 are interactions between a time trend and regressors whose coefficients change over time. Most of these interaction terms have small coefficients on the extensive margins, with the exception of labor skill. The coefficients on labor skill are larger in the early years of the sample, starting in 1988, and close to zero by the end of the sample, 2003.[16] In the year-by-year regressions (not shown), labor skill has a significantly greater impact on the range of processing relative to ordinary trade in the early years (consistent with hypothesis III), but no significant impact on the extensive margins in the last years of the sample.

The final regressors in Table 1 are indicator variables for the level of infrastructure in each province, taken from Dolar *et al* (2004). These authors collect several variables reflecting the investment climate in 23 Chinese cities across 19 provinces. Their infrastructure variable measures the likelihood of goods being stolen en route to port, and is therefore a "rule of law" variable. Since theft on the road would raise the cost of transport of both ordinary and processing exports, this variable should affect the cost-advantage parameter, δ, of our theoretical model in a similar way to distance. In the next section concerned with alternative

[16] The time trends used in Tables 1-4 are normalized at zero in the middle of the sample (1996 for Tables 1, 2 and 4 and 2000 for Table 3), so the coefficients shown on labor skill or other regressors apply to that middle year.

specifications, we consider some additional variables from Dollar *et al* (2004), namely the court time needed to resolve commercial disputes, the ease of entry and exit of firms, labor market flexibility, and the use of skilled technology (and therefore skilled workers). Each observation of each variable is assigned a letter grade between A and C. We have assigned an indicator variable to each letter grade, where the 11 provinces with cities that were not sampled (mostly interior provinces) have 0 on every indicator variable.

From Table 1, the coefficients obtained on the infrastructure indicator variables are positive for the extensive margins in columns (1) and (2), and larger for processing trade than for ordinary trade.[17] As predicted by hypothesis (III), for the B grade of infrastructure, the difference between the coefficient on the ordinary and processing extensive margin is significant at the 10% level. Since this variable acts in a similar manner to internal distance (having the greatest impact on processing trade), we maintain it in the alternative specifications that follow.

D. Alternative Specifications

So far, the maintained assumption in our model is that the cost advantage δ of the low-wage country applies equally to generic and contractual trade. It might be, however, that the interior provinces have some other disadvantage that make it more difficult to engage in contractual outsourcing there, and this disadvantage (rather than transportation costs per se) is being picked up in our regression results. To check for this, we re-run the regression in Table 1 while adding indicator variables for our four additional measures of investment climate from Dollar *et al* (2004). Only one of the additional measures is included in each regression. As previously mentioned, the measures are the court time needed to resolve commercial disputes, ease of entry and exit of firms, labor market flexibility, and the use of skilled technology.

For brevity, Part A of Table 2 reports the coefficients obtained on interior distance and labor skill in the extensive margin regressions, but not the coefficients on the indicator variables themselves. The first row of Table 2 just reproduces the results from Table 1, which included infrastructure. Following that, the

[17] The indicator variable for the C grade of infrastructure is dropped due to multicollinearity.

subsequent rows in Part A show the coefficients obtained on interior distance and labor quality with the inclusion of our four additional measures, one at a time. The conclusion to be drawn from Part A is that the coefficients of interior distance and labor skill are quite robust to the inclusion of these measures for the investment climate: interior distance has a greater negative impact and labor skill a more positive impact on the extensive margin of processing trade than ordinary trade (though the labor quality effect is sometimes only significant at the 10% level).

Besides using alternative regressors, we have also experimented with an alternative specification of the dependent variables. In Table 1 we distinguished between processing and ordinary trade, under the presumption that the former requires more contractual arrangements. We now consider differing *types* of processing trade for the years 1997-2003 (shorter than the 1988-2003 time period used in Table 1). In those years, our data provides processing trade broken down into two categories: "import-and-assembly," under which the Chinese firms both import raw materials and manufacture goods for export; and "pure assembly," under which Chinese firms receive the raw materials from foreign firms abroad, and then manufacture these into goods for export. These two categories of processing trade are discussed more fully by Feenstra and Hanson (2005), but the important distinction is that the foreign firms are actually providing inputs in the latter case of pure assembly, and must therefore have a contract with the Chinese firm for the manufacture of the finished export. In the former case, import-and-assembly, the Chinese firms could be manufacturing a good for export without first having a foreign buyer, nor having a contract with that buyer. So analogous to the presumption we have made between processing and ordinary trade, we can hypothesize that pure assembly requires greater contractual relations than does import-and-assembly.

To test this alternative specification, we construct the extensive and intensive margins for exports from each Chinese province to their various destination markets, separately over the two types of processing trade. We then re-run the regressions of Table 1 over the period 1997-2003, with the results shown in Table 3. Internal distance has a slightly more negative impact on the pure assembly extensive margin, in column (2), than the import-and-assembly, in column (1), but this difference is not statistically significant, as seen from column (3). The labor skill variable turns out to be entirely insignificant for either type of processing trade, while it was significant for the overall extensive margin of processing trade in Table 1. This is understandable since the regressions in Table 3 are run over a much short time period, 1997-2003, and in those later years the labor skill variable is unimportant in any of the specifications we use.

For completeness, we also re-run the regressions in Table 3 using our four additional investment climate variables from Dollar *et al* (2004). The resulting coefficients on interior distance and labor skill are shown in Part B of Table 2. In every case, interior distance has a slightly more negative impact on the extensive margin for pure-assembly processing, as compared to import-and-assembly, but that difference is never statistically significant. So we obtain coefficient magnitudes that are consistent with our expectations, but the effect is too subtle to show up as significant.

4. Outsourcing production via FDI

A: Predictions of the model

This section adds the possibility of contractual outsourcing to multinational suppliers of type M that undertake RSI in country H, but set up a wholly owned subsidiary to manufacture the parts in country L. Compared with type H suppliers, multinationals benefit from the lower wage in country L, but they must pay the fixed cost, F, to set up a plant, and the lower quality of manufacturing in country L reduces the rent created by RSI (see (2)). Type L suppliers have an even lower quality of manufacturing due to inferior technology, but they are not subject to the fixed cost.

More formally, type M suppliers earn profit, given by $\pi^M = y[p^M(z) - w^L(z)] - k^M - F$, where $p^M(z)$ is the price of the product determined by Nash bargaining with the buyer at stage 3. Since both k^M and F are not contractible, it follows, analogous to the previous bargaining outcomes (see (3)), that $\pi^M = yr^M/2 - k^M - F$, where $r^M \equiv q\rho(z)(k^M - \underline{k})^{1/2}$ from (2). The buyer gains $yr^M/2$. From profit maximization at stage 2, we obtain

$$k^M = (yq\rho(z))^2/16 + \underline{k}, \quad r^M = y(q\rho(z))^2/4. \tag{12}$$

Consequently, we can express the stage 1 profit of a multinational as:

$$\pi^M = \pi^M(z,y,F) = (yq\rho(z))^2/16 - \underline{k} - F. \tag{13}$$

As (13) shows, just as for contractual suppliers from country L, the profits of multinationals from contractual production in L do not depend on the marginal cost, $w^L(z)$.

Setting $r^H - \delta = r^M$ to define part $z = I^{MH}$, the buyer prefers a type H rather than a type M supplier if and only if $z \geq I^{MH}$ where, letting $\beta^q \equiv (q)^2/(1 - (q)^2)$ and using (12) and (4), we obtain

$$\rho(I^{MH}) = [4\delta/y(1- (q)^2)]^{½} = [4\delta(1 + \beta^q)/y]^{½}. \tag{14}$$

However, the buyer always prefers type M to type L due to type M's greater creation of rent[18]. Letting $z = \underline{M}$ satisfy $\pi^M(\underline{M},y,F) = 0$, investment by multinationals is profitable only if $z \geq \underline{M}$, where

$$\rho(\underline{M}) = 4(\underline{k} + F)^{1/2}/yq. \tag{15}$$

Proposition 2 (see Appendix A for the proof) describes the various outcomes with respect to the choice of supplier. To reduce the number of cases, we restrict attention to $F/y\delta \leq 1/4$ in Proposition 2A, which implies that the fixed cost of FDI is at most one quarter of the savings, $y\delta$, from the lower wage in country L. With fixed costs in this lower range, there is a closer correspondence between the buyer's preference for type M suppliers and their availability.[19] As Proposition 2(A) shows, if $F/y\delta \leq 1/4$ and $\underline{H} \leq \underline{M}$, then the buyer prefers H over M for $z \geq \underline{H}$ (due to $I^{MH} \leq \underline{H}$). In this case, type H suppliers drive out type M suppliers and the possibilities with respect to contractual and generic outsourcing are described by Proposition 1, parts (A) and (B)(i).[20] Proposition 2(B) then develops the various cases that arise when some parts are supplied by multinationals. In part B(i), we compare type H with type M suppliers, whereas in B(ii), we compare type M with type L suppliers and also consider the potential for generic imports. Again to focus on internal solutions,

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[18]From (12) and (4), $r^L = (\lambda)^2 r^M$ where $\lambda < 1$.

[19] The assumption $F/y\delta \leq 1/4$ rules out $\underline{H} < \underline{M} < I^{MH}$ in which the buyer contracts with H for $z \in [\underline{H}, \underline{M})$ (type M is not available), with M for $z \in [\underline{M}, I^{MH})$ and again with H for $z \geq I^{MH}$.

[20]The possibility $\underline{L} < \underline{H} < I^{LH}$ in Proposition 1 part (B)(ii) is ruled out since if the buyer prefers suppliers of type H whenever M would enter (i.e. $I^{MH} < \underline{M}$) , then the buyer also prefers H to L whenever L would enter (i.e. $I^{LH} < \underline{L}$).

we assume $\rho(I^{MH}) < 1$ and $\rho(\underline{M}) < 1$ which require[21]:

$$16(\underline{k} + F)/[(y)^2 - 16(\underline{k} + F)] < \beta^q < y/4\delta - 1. \tag{16}$$

Proposition 2 *Assume (8) and (16).*

(A) If $(\beta^q/2 - \underline{k}/y\delta)/(1 + \beta^q) \leq F/y\delta \leq 1/4$, *then* $I^{MH} \leq \underline{H} \leq \underline{M}$ *and* $I^{LH} \leq \underline{H}$. *Purely domestic suppliers of type H drive out multinationals and Proposition 1, parts (A) and (B)(i) apply.*

(B) Suppose $F/y\delta < (\beta^q/2 - \underline{k}/y\delta)/(1 + \beta^q)$, *which requires* $\underline{k}/y\delta < \beta^q/2$.

(i) Parts with the highest productivity of RSI are produced through domestic contractual outsourcing to suppliers of type H, whereas parts with the next highest productivity level are contracted to multinationals of type M that export from country L. (a) If $\underline{k}/y\delta \geq (\beta^q - 1)/4$, *then* $\underline{M} < \underline{H}$ *and* $I^{MH} < \underline{H}$. *The buyer contracts with H for* $z \in [\underline{H}, \check{Z}]$ *and with M for* $z \in [\underline{M}, \underline{H})$. *(b) If* $\underline{k}/y\delta < (\beta^q - 1)/4$, *then* $\underline{M} < \underline{H} < I^{MH}$. *The buyer contracts with H for* $z \in [I^{MH}, \check{Z}]$ *and with M for* $z \in [\underline{M}, I^{MH})$.

(ii) Purely domestic (type L) suppliers in country L gain contracts only for lower productivity parts that multinationals (type M) are not willing to produce. If $F/\underline{k} > 1/\beta^\lambda$, *then* $\underline{L} < \underline{M}$. *The buyer contracts with type L for* $z \in [\underline{L}, \underline{M})$ *and imports generic parts for* $z \in [0, L)$.

As B(i) of Proposition 2 demonstrates, parts with the highest productivity of RSI are produced at home through contractual outsourcing in country H, whereas parts with the next highest productivity are produced through contractual outsourcing to multinationals of type M that undertake RSI in country H, but produce in L through FDI. Turning to B(ii), we show that if $F/\underline{k} > 1/\beta^\lambda$ where $\beta^\lambda \equiv (\lambda)^2/(1 - (\lambda)^2)$, suppliers of type L receive contracts for a range of parts in which the productivity of RSI is further reduced. Because of the higher quality of manufacturing, the buyer always prefers a type M over a type L supplier. Consequently, there is a role for contracting with suppliers of type L only for the range of parts $z \in [\underline{L}, \underline{M})$, where the fixed cost, F, is sufficiently high to prevent the entry of M. If $F/\underline{k} \leq 1/\beta^\lambda$, then M drives out L. At the lowest levels of productivity of RSI, only generic parts are exported from country L.

[21] We use (14) and (15) to obtain $16(\underline{k} + F)/(y)^2 < (q)^2 < 1 - 4\delta/y$.

Figure 5, part (a), illustrates the ranking of suppliers with respect to the productivity of RSI: the most productive firms are type H suppliers (i.e. domestic outsourcing); followed by type M suppliers (multinationals); followed by type L suppliers (foreign outsourcing); followed by generic suppliers of intermediate inputs on the spot market in country L. This type of ranking is similar in spirit to that obtained by Antràs and Helpman (2004) (see also the survey by Helpman, 2005), except that firms in their framework differ in their marginal cost of production. In our framework, by contrast, firms differ in the productivity of RSI. Part (b) of Figure 5 shows how the critical values between the various contractual forms shift due to changes in parameters, as we examine next.

B. Comparative static effects

In Corollary 3, we extend Proposition 2 to examine the effects of the parameters, y, δ and q, taking into account the option that the buyer in country H may contract with a multinational supplier of type M that produces in the low-wage country. We restrict attention to the cases satisfying $\underline{L} < \underline{M} < \underline{H}$ so as to ensure that contractual exporting involves both type L and type M suppliers.[22]

Corollary 3. *Assume $\underline{L} < \underline{M} < \underline{H}$, (8) and (16).*

(A) An increase in output, y, reduces $\underline{L}$, $\underline{M}$, $\underline{H}$, and I^{MH} and hence reduces the range of generic exports from country L and raises the range of parts produced under contractual outsourcing in country H. Since $\underline{M}$ falls by more than $\underline{L}$, fewer varieties are exported by suppliers of type L.

(B) Hold y fixed. (i) An increase in the cost advantage, δ, has no effect on $\underline{L}$ or $\underline{M}$, but $\underline{H}$ and I^{MH} are increased, with the result that the range of parts exported from country L by multinationals is increased at the expense of contractual outsourcing in country H. There is no change in the range of parts exported by contractual suppliers of type L or exported as generics. (ii) An improvement in the quality, q, of manufacturing in country L reduces $\underline{L}$ and $\underline{M}$, but H is unchanged and I^{MH} rises. There is an increase in the range of contractual exports from country L due to an increase in the range of parts exported by

[22] From Proposition 3, $\underline{L} < \underline{M} < \underline{H}$ iff $F/y\delta < 1/4$, $F/y\delta < (\beta^{q}/2 - \underline{k}/y\delta)/(1 + \beta^{q})$ and $F/\underline{k} > 1/\beta^{\lambda}$.

multinationals and a reduction in the range of generic exports. Since $\underline{M}$ *falls by more than* $\underline{L}$ *,fewer varieties are exported by suppliers of type L. If* $k/y\delta < (\beta^{\lambda q} -1)/4$*, then the fall in the buyer's preference for type H suppliers narrows the range of parts produced through domestic contractual outsourcing.*

Proof: (A) If $\underline{L} < \underline{M}$, then $d\rho(\underline{M})/dy = - \rho(\underline{M})/y < d\rho(\underline{L})/dy = - \rho(\underline{L})/y$ and hence that the range of parts produced by M expands more than the range of parts produced by L. The remaining results in (A) and (B) follow directly from the expressions for $\underline{L}$, $\underline{M}$, $\underline{H}$, I^{MH} (see (7), (14) and (15)) and Proposition 2. □

This corollary is illustrated in Figure 5(b), where we show how the critical values between the outsourcing regions are affected by an increase in the cost advantage of the low-wage country, δ, or in the quality of that workforce, q, or in the scale of the buyer, y. Holding the buyer scale fixed for a moment, these results provide us with the following testable hypotheses:

(I′) An increase in the cost advantage, δ, of the low-wage country raises the range of contractual exports by multinationals, with no change in the range of contractual exports by unaffiliated firms or in the range of generic exports;

(II′) An increase in the quality, q, of the foreign workforce raises the range of contractual exports by multinationals, and lowers the range of contractual exports by unaffiliated firms and the range of generic exports.

Similar to hypotheses (I) and (II), hypotheses (I′) and (II′) are derived while holding constant the scale of the buyer, y, but in principle this scale can change. So we next state an extension that allows for the endogenous increase in scale, y, due to a rise in cost advantage or workforce quality in the low-wage country. In this result we define ψ^M and ψ^L to represent the proportion of varieties that are exported by contractual suppliers of type M and L respectively. The sum, $\psi^M + \psi^L$, analogous to ω in Corollary 2, represents the proportion of exported varieties that are of the contractual rather than the generic type:

Corollary 4. *Assume* $\underline{L} < \underline{M} < \underline{H}$ *, (8) and (16).*

In response to an increase in the cost advantage, δ, of country L, the quality, q, of manufacturing in country

L or the scale, y, of the buyer, there is an increase in the proportion ψ^M of varieties that are exported by multinational firms of type M and a reduction in the proportion, ψ^L, of varieties that are exported by contractual suppliers of type L. Overall, a greater variety of parts is produced through international contractual outsourcing at the expense of generic exports.

Proof: For the case $I^{MH} \leq \underline{H}$, the results follow from $\psi^M \equiv 1 - \rho(\underline{M})/\rho(\underline{H}) = 1 - (\underline{k} + F)^{1/2}/q(\underline{k} + y\delta/2)^{1/2}$ and $\psi^L \equiv (\rho(\underline{M}) - \rho(\underline{L}))/\rho(\underline{H}) = (\underline{k} + F)^{1/2}/q(\underline{k} + y\delta/2)^{1/2}$. Similarly for $\underline{H} < I^{MH}$ the results follow from using $\psi^M \equiv 1 - \rho(\underline{M})/\rho(I^{MH})$ and $\psi^L \equiv (\rho(\underline{M}) - \rho(\underline{L}))/\rho(I^{MH})$. □

Thus, by considering the proportion of varieties exported by multinationals or unaffiliated contractual suppliers this Corollary shows that we obtain the following hypothesis:

(III′) Increases in the cost-advantage of the low-wage country or the quality of its workforce (with any induced increase in buyer scale) will raise the proportion ψ^M of varieties that are exported by multinational firms, lower the proportion ψ^L of varieties that are exported by contractual suppliers in the low-wage country, and also lower the proportion and range of generic exports.

The implications for the range of generic exports from the low-wage country are very similar to what we found without multinationals, so in our testing we will not repeat the regressions related to Chinese ordinary exports (shown in Table 1). Rather, we will focus on processing exports and the range of varieties exported by multinationals versus Chinese-owned firms.

C. Estimation

To test the model predictions for FDI, we re-calculate the extensive margins separately for the processing exports of foreign-owned firms and the processing exports of domestic Chinese firms. The extensive margins for 2003, averaged across regions in China and destination countries, are illustrated in Figure 6. Both forms of processing trade have extensive margins near 1 in Guangdong, but the extensive margin for foreign-owned firms is reduced below 0.05 in the North West, while the extensive margin for domestic firms does not fall quite as far. Estimates of the gravity equation with the extensive margin as the dependent variable are shown in Table 4, regressions (1)-(3), and with the intensive margin as the dependent variable in regressions (4)-(5). As in Table 1, the regressions are pooled across the years 1988-2003, while allowing interaction with a time trend for those coefficients that change significantly in the yearly regressions. Fixed effects for year are included as well as random effects for provinces, and the standard errors are also clustered by provinces.

Once again, our primary interest is in the effect of distance on the external margins. In Table 4, the effect of internal distance is substantially more negative for the foreign-owned firm (regression 2) than for the domestic enterprises (regression 1), and this effect is statistically significant (regression 3). Surprisingly, external distance has a positive coefficient on the extensive margin for either type of firm, but it is very small in magnitude. Infrastructure shows up as having a larger positive impact on the extensive margin of foreign-owned firms, but the difference with domestic firms is not significant. Labor skill also has a substantially more positive effect for the foreign-owned firms than for the domestic enterprises, and that effect is statistically significant. So these results support the hypothesis (III′) that the variety of components produced through offshore production by FDI subsidiaries is more sensitive to transport costs and also labor quality than is the variety of contractual exports from domestic Chinese firms. Thus, as one moves towards inland provinces, the variety of processing goods produced by foreign-owned firms becomes sparse more rapidly than the variety of processing goods produced by domestic firms.

We again check the robustness of these results by including the other investment climate measures from Dollar *et al* (2004). The resulting coefficients on interior distance and on labor skill are shown in Table 2, part C. The coefficient on interior distance for the extensive margin of foreign-owned firms is always substantially more negative than the coefficient on the extensive margin of domestic firms. In addition, labor skill has a significantly more positive effect on foreign-owned rather than domestic firms.

5. Conclusions

This paper examines the determinants of the organizational form and location of suppliers at home or abroad in outsourcing relationships. The buyer requires a continuum of parts which vary based on the effectiveness of relationship-specific investment in creating rent for the buyer. Assuming this effectiveness is increasing in the technological sophistication of parts, we obtain the following ranking. The range or variety of parts with the highest technological sophistication are produced in the high wage country; as technological sophistication falls, parts are produced in turn, by contractual outsourcing to multinationals in the low-wage country, contractual outsourcing to purely domestic firms in the low-wage country and the arms length purchase of generic (non-specialized) parts from the low-wage country.

Due to the buyer's outside option of importing generic parts, an important implication of the model is that countries that are closer in physical distance to a low-wage country should benefit from lower trade costs leading to an increase in the variety or range of parts that are imported through contractual rather than generic outsourcing. The model also predicts that as physical distance falls, a greater proportion of imports should be mediated through multinationals rather than direct contractual outsourcing to the low-wage country or through the import of generic parts.

We use a gravity specification based on Chinese export data by province to a large number of destination countries to test these and other predictions. Assuming that contractual exports are represented by processing exports and ordinary manufactures by "generics", the data identifies three organizational forms: foreign-owned enterprises (multinational firms), Chinese contractual exporters, and exporters of generic products. For a subset of years, we also examine two types of processing trade based on whether the foreign buyer or the Chinese producer controls the imported input. Since we are interested in effects on the variety of exports associated with each organizational form, the relevant dependent variable is the "extensive margin" of exports rather than the value of exports traditionally used in gravity equation estimations.

We examine the effects of distance in two dimensions: the internal distance from each province to the closest port or border crossing, and then the subsequent external distance to the destination country. Although external distance tends to have only a very small impact on the extensive margin of either ordinary or processing exports, in most cases internal distance is significant in ways that support our model. First, internal distance has a substantially greater negative impact on the extensive margin processing exports than ordinary exports. Second, a larger impact on processing exports is also found (albeit more weakly) for an infrastructure variable, which measures the probability of theft along the road. Third, within the processing category, there is a significantly greater decrease in the variety of exports supplied by foreign-owned firms as one moves inland relative to the variety of exports supplied by Chinese-owned firms. In sum, these results demonstrate a substantial role for proximity (especially internal distance in China) in shaping the organizational form of outsourcing.

Appendix A - Proofs of Propositions

Proof of Proposition 1: From (6) and (7), we first derive some basic relationships:

$\rho(\underline{L}) \geq \rho(\underline{H})$ iff $\underline{k}/y\delta \geq \beta^{\lambda q}/2$;

$\rho(\underline{H}) \geq \rho(I^{LH})$ iff $\underline{k}/y\delta \geq (\beta^{\lambda q} - 1)/4$

$\rho(\underline{L}) \leq \rho(I^{LH})$ iff $\underline{k}/y\delta \leq \beta^{\lambda q}/4$. (A1)

(A) If $\beta^{\lambda q}/2 \leq \underline{k}/y\delta < y/16\delta - ½$ then from (A1) and (8), we obtain $\underline{H} \leq \underline{L}$ and $I^{LH} < \underline{H} < \check{Z}$. Thus the buyer prefers i = H over i = L for the range of z under which suppliers of type L would potentially enter and suppliers of type H are willing to produce whenever suppliers of type L would enter. Consequently, no contracts i = L are awarded. Suppliers of type i = H undertake RSI and accept contracts for $z \in [\underline{H}, \check{Z}]$ and generic parts are imported for $z \in [0, \underline{H})$.

(B)(i) If $(\beta^{\lambda q} - 1)/4 < \underline{k}/y\delta < \beta^{\lambda q}/2$, then $\underline{L} < \underline{H}$ and $I^{LH} < \underline{H} < \check{Z}$ from (A1) and (8). For both of the possible orderings: $I^{LH} < \underline{L} < \underline{H}$ and $\underline{L} < I^{LH} \leq \underline{H}$, the buyer prefers i = H relative to i = L. Thus type H suppliers produce parts $z \in [\underline{H}, \check{Z})$ and type L produce parts $z \in [\underline{L}, \underline{H})$ that suppliers of type H are not willing to produce. Generic parts are imported for $z \in [0, \underline{L})$. (B)(ii) If $\underline{k}/y\delta < (\beta^{\lambda q} - 1)/4$, then $\underline{L} < \underline{H} < I^{LH}$ from (A1) and $I^{LH} < \check{Z}$ from (8). We have $\beta^{\lambda q} > 1$ due to $\underline{k}/y\delta > 0$. The buyer chooses type H for $z \in [I^{LH}, \check{Z}]$ and type L for $z \in [\underline{L}, I^{LH})$. Generic parts are imported for $z \in [0, \underline{L})$. □

Proof of Proposition 2: From (7), (14) and (15), we obtain

$\rho(\underline{M}) \geq \rho(I^{MH})$ iff $(\underline{k} + F)/y\delta \geq \beta^{q}/4$.

$\rho(\underline{M}) \geq \rho(\underline{H})$ iff $F/y\delta \geq [\beta^{q}/2 - \underline{k}/y\delta]/(1+\beta^{q})$

$\rho(\underline{H}) \geq \rho(I^{MH})$ iff $\underline{k}/y\delta \geq (\beta^{q} - 1)/4$

$\rho(\underline{L}) < \rho(\underline{M})$ iff $F > \underline{k}(1 - (\lambda)^2)/(\lambda)^2 = \underline{k}/\beta^{\lambda}$. (A2)

A further useful relationship is

$\underline{k}/y\delta \geq (\beta^{q} - 1)/4$ iff $(\beta^{q}/2 - \underline{k}/y\delta)/(1 + \beta^{q}) \leq 1/4$. (A3)

(A) Since $(\beta^{q}/2 - \underline{k}/y\delta)/(1+ \beta^{q}) \leq F/y\delta < 1/4$, we obtain $\underline{k}/y\delta \geq (\beta^{q} - 1)/4$ from (A3) and it follows from (A2) that $I^{MH} \leq \underline{H} \leq \underline{M}$. The buyer chooses H for $z \in [\underline{H}, \check{Z}]$ and there is no FDI. Proposition 1, parts (A) and (B)(i) then apply, but since $\beta^{\lambda q} < \beta^q$ and $\underline{k}/y\delta \geq (\beta^q - 1)/4$, we have $\underline{k}/y\delta > (\beta^{\lambda q} - 1)/4$ ruling out part B(ii).

(B)(i)(a) From $F/y\delta < (\beta^q/2 - \underline{k}/y\delta)/(1 + \beta^q)$, $\underline{k}/y\delta \geq (\beta^q - 1)/4$ and (A2), we obtain $\underline{M} < \underline{H}$ and $I^{MH} < \underline{H}$.

(b) From $F/y\delta < (\beta^q/2 - \underline{k}/y\delta)/(1 + \beta^q)$, $\underline{k}/y\delta < (\beta^q - 1)/4$ and (A2), we obtain $\underline{M} < \underline{H} < I^{MH}$.

(B)(ii) From (A2), $\underline{L} < \underline{M}$ iff $F > \underline{k}(1 - (\lambda)^2)/(\lambda)^2 = \underline{k}/\beta^\lambda$. Since $r^L = (\lambda)^2 r^M$ where $\lambda < 1$, the buyer prefers M over L and chooses L only for parts $z \in [\underline{L}, \underline{M})$. □

Appendix B - Data Sources

Chinese export data at the SITC 4-digit level are obtained from the Customs General Administration of the People's Republic of China (China. Customs General Administration, Statistics Department. "China Trade Information." Hong Kong: Economic Information Agency). These data are purchased from Mr. George Chen, China Customs Statistics Information Center, Economic Information Agency, Hong Kong, EIAET@PACIFIC.NET.HK , and are used to construct the extensive margins used as the dependent variables in Tables 1 - 4. The independent variables are obtained from various sources:

1) *China's Regional Economy After Seventeen Years Reform and Open*, Xinjiang Statistical Bureau, 1998, which is a collection of data from the provincial statistic yearbooks for 1978-1995.

2) *China's Statistic Yearbook,* 1989-2004: used for provincial GDP, population and wages.

3) *Chinese railroad timetable*: used for the Internal distance: measured by train hours.

The external distance is taken from Lin (2001) and Ma (2004), and is the external shipping distance between Chinese ports and the international ports, which is obtained from a special world map designed for sketching ocean transportation.

4) *Major figures of the Fourth National Population Census of China*, 1991, China Statistics Publisher House: used for the percentages of the population with primary, junior, senior and university education. Later years are obtained from *China's Statistic Yearbook*.

5) GDP and population of the destination markets are taken from the Penn World Tables.

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Table 1: Ordinary versus Processing Trade

	Dependent Variable and Sample Used:				
	Extensive Margin			Intensive Margin	
	(1) Ordinary	(2) Processing	(3) = (1) - (2)	(2) Processing	(1) Ordinary
GDP per capita (province)	0.017	0.238	-0.213	1.235**	1.771**
	(0.031)	(0.183)	(0.169)	(0.313)	(0.445)
GDP per capita (destination country)	-0.0005**	-0.0008	0.0003	0.220**	0.217**
	(0.0001)	(0.002)	(0.002)	(0.006)	(0.019)
Population (province)	0.102**	0.543**	-0.445**	0.820**	0.350~
	(0.020)	(0.090)	(0.080)	(0.091)	(0.195)
Population (destination country)	-0.001**	-0.009**	0.008**	0.774**	0.645**
	(0.000)	(0.003)	(0.003)	(0.014)	(0.034)
Skill (education)	0.305**	1.374**	-1.089**	0.619	-2.263*
	(0.094)	(0.424)	(0.375)	(0.780)	(0.926)
External Distance	0.002**	0.006	-0.004	-1.112**	-1.175**
	(0.001)	(0.012)	(0.012)	(0.047)	(0.059)
Internal Distance	-0.037**	-0.221**	0.187**	-0.224**	-0.067
	(0.009)	(0.054)	(0.050)	(0.073)	(0.110)
GDP per capita (province)*time	-0.002	0.023~	-0.025*	-0.004	-0.037
	(0.003)	(0.013)	(0.012)	(0.035)	(0.043)
Population (province)*time	-0.006**	0.016*	-0.023**	0.031*	-0.017
	(0.002)	(0.006)	(0.006)	(0.013)	(0.014)
Skill*time	-0.034*	-0.064	0.030	0.041	0.163~
	(0.016)	(0.049)	(0.045)	(0.086)	(0.095)
Internal Distance*time	0.003**	-0.006*	0.009**	-0.012	0.009
	(0.001)	(0.003)	(0.003)	(0.008)	(0.009)
Infrastructure = A	0.008	0.180	-0.172	-0.083	-0.104
	(0.019)	(0.130)	(0.116)	(0.193)	(0.345)
Infrastructure = B	0.021	0.259~	-0.238~	-0.124	-0.522
	(0.023)	(0.139)	(0.125)	(0.150)	(0.345)
Observations	44,368	40,734	40,715	44,368	40,734
Number of provinces	29	29	29	29	29

Notes:
All regression include fixed effects by year and random effects by province. Robust standard errors are in parentheses are clustered by province.
~ significant at 10%; * significant at 5%; ** significant at 1%

Table 2: Robustness of Estimates on Internal Distance and Labor Quality

	Dependent Variable: Extensive Margin					
Indicator Variables included:	**Coefficients on Internal Distance:**			**Coefficients on Labor Skill:**		
Part A	**(1) Ordinary**	**(2) Processing**	**(3) = (1) – (2)**	**(1) Ordinary**	**(2) Processing**	**(3) = (1) – (2)**
Infrastructure	-0.037**	-0.221**	0.187**	0.305**	1.374**	-1.089**
	(0.009)	(0.054)	(0.050)	(0.094)	(0.424)	(0.375)
***Also:* Court time**	-0.039**	-0.231**	0.195**	0.316**	1.408**	-1.109**
	(0.009)	(0.058)	(0.053)	(0.089)	(0.461)	(0.415)
Ease of entry/exit	-0.037**	-0.234**	0.200**	0.309**	1.055*	-0.762~
	(0.009)	(0.054)	(0.050)	(0.095)	(0.446)	(0.393)
Labor market flex	-0.038**	-0.225**	0.189**	0.231*	1.031*	-0.822~
	(0.009)	(0.059)	(0.055)	(0.094)	(0.490)	(0.437)
Skill-technology	-0.039**	-0.243**	0.207**	0.298**	1.333**	-1.053**
	(0.009)	(0.058)	(0.053)	(0.095)	(0.458)	(0.407)
Part B	**(1) Import & Assembly**	**(2) Pure Assembly**	**(3) = (1) – (2)**	**(1) Import & Assembly**	**(2) Pure Assembly**	**(3) = (1) – (2)**
Infrastructure	-0.357*	-0.398**	0.059	0.146	-0.126	0.132
	(0.168)	(0.133)	(0.150)	(0.218)	(0.138)	(0.182)
***Also:* Court time**	-0.336*	-0.392**	0.074	0.143	-0.124	0.140
	(0.169)	(0.129)	(0.141)	(0.218)	(0.138)	(0.183)
Ease of entry/exit	-0.350*	-0.397**	0.052	0.148	-0.128	0.128
	(0.165)	(0.129)	(0.154)	(0.218)	(0.139)	(0.182)
Labor market flex	-0.362*	-0.401**	0.077	0.150	-0.129	0.141
	(0.155)	(0.135)	(0.143)	(0.218)	(0.139)	(0.183)
Skill-technology	-0.343*	-0.384**	0.053	0.143	-0.128	0.133
	(0.167)	(0.127)	(0.150)	(0.218)	(0.141)	(0.183)
Part C	**(1) Domestic**	**(2) Foreign**	**(3) = (1) – (2)**	**(1) Domestic**	**(2) Foreign**	**(3) = (1) – (2)**
Infrastructure	-0.141**	-0.316**	0.186**	0.853**	2.068**	-1.360*
	(0.037)	(0.069)	(0.054)	(0.299)	(0.634)	(0.588)
***Also:* Court time**	-0.143**	-0.349**	0.215**	0.824**	2.318**	-1.616**
	(0.039)	(0.075)	(0.055)	(0.318)	(0.633)	(0.549)
Ease of entry/exit	-0.156**	-0.334**	0.191**	0.743*	1.765**	-1.168*
	(0.040)	(0.071)	(0.051)	(0.314)	(0.610)	(0.580)
Labor market flex	-0.146**	-0.320**	0.183**	0.658*	1.948**	-1.437*
	(0.044)	(0.078)	(0.056)	(0.326)	(0.671)	(0.588)
Skill-technology	-0.154**	-0.326**	0.188**	0.847**	1.865**	-1.191*
	(0.041)	(0.077)	(0.058)	(0.313)	(0.673)	(0.600)

Notes:
The coefficients in the first row are from Table 1, where indicator variables for infrastructure are included. The following rows in part A shows the coefficients obtained on internal distance and labor quality when alternative indicator variables are *also* included. Part B shows the results from including alternative indicator variables in Table 3, and part C shows the results from including alternative indicator variables in Table 4. The notes from those tables also apply.

Table 3: Types of Processing Trade

	Dependent Variable and Sample Used:				
	Extensive Margin			Intensive Margin	
	(1) Import & Assembly	(2) Pure Assembly	(3) = (1) - (2)	(2) Pure Assembly	(1) Import & Assembly
GDP per capita	0.284	0.762*	-0.348	0.812*	0.827
(province)	(0.613)	(0.369)	(0.441)	(0.396)	(0.661)
GDP per capita	0.0002	-0.0006	0.0005	0.303**	0.355**
(destination country)	(0.0003)	(0.0006)	(0.0007)	(0.031)	(0.038)
Population	-0.336	0.473**	-0.376	0.174	0.098
(province)	(0.468)	(0.127)	(0.292)	(0.202)	(0.246)
Population	0.000	-0.000	0.001	0.720**	0.725**
(destination country)	(0.000)	(0.001)	(0.001)	(0.045)	(0.060)
Skill (education)	0.146	-0.126	0.132	-0.355	-0.798~
	(0.218)	(0.138)	(0.182)	(0.336)	(0.461)
External Distance	0.003~	0.003	-0.002	-1.084**	-1.326**
	(0.002)	(0.002)	(0.003)	(0.063)	(0.068)
Internal Distance	-0.357*	-0.398**	0.059	-0.088	0.057
	(0.168)	(0.133)	(0.150)	(0.130)	(0.226)
GDP per capita	0.050	0.002	0.059	0.028	0.160~
(province)*time	(0.040)	(0.030)	(0.043)	(0.054)	(0.084)
Population	0.018	0.016~	0.007	-0.027	0.033
(province)*time	(0.022)	(0.009)	(0.012)	(0.028)	(0.032)
Skill*time	0.004	0.009	-0.014	-0.132	-0.062
	(0.083)	(0.051)	(0.066)	(0.124)	(0.150)
Internal Distance*time	-0.012	-0.016*	0.005	0.024~	0.021
	(0.008)	(0.006)	(0.007)	(0.012)	(0.016)
Infrastructure = A	-0.389	0.021	-0.213	0.216	-0.283
	(0.393)	(0.478)	(0.394)	(0.330)	(0.578)
Infrastructure = B	0.250	0.289	-0.096	-0.375	-0.907
	(0.366)	(0.483)	(0.362)	(0.356)	(0.608)
Observations	14,005	6,902	6,902	14,005	6,902
Number of provinces	29	29	29	29	29

Notes:
All regression include fixed effects by year and random effects by province. Robust standard errors are in parentheses are clustered by province.
~ significant at 10%; * significant at 5%; ** significant at 1%

Table 4: Domestic versus Foreign Firms

	Dependent Variable and Sample Used:				
	Extensive Margin			Intensive Margin	
	(1) Domestic	(2) Foreign	(3) = (1) - (2)	(2) Foreign	(1) Domestic
GDP per capita	0.346**	0.316	0.028	1.301**	1.744**
(province)	(0.131)	(0.247)	(0.212)	(0.318)	(0.414)
GDP per capita	-0.002	-0.0005	-0.0007	0.200**	0.283**
(destination country)	(0.001)	(0.003)	(0.002)	(0.017)	(0.023)
Population	0.415**	0.771**	-0.387**	0.422**	-0.144
(province)	(0.065)	(0.158)	(0.132)	(0.129)	(0.238)
Population	-0.005~	-0.005	0.001	0.604**	0.623**
(destination country)	(0.003)	(0.005)	(0.005)	(0.030)	(0.049)
Skill (education)	0.853**	2.068**	-1.360*	-1.057~	-4.295**
	(0.299)	(0.634)	(0.588)	(0.619)	(0.975)
External Distance	0.014*	0.044**	-0.029**	-1.152**	-1.085**
	(0.007)	(0.011)	(0.009)	(0.055)	(0.071)
Internal Distance	-0.141**	-0.316**	0.186**	-0.051	-0.080
	(0.037)	(0.069)	(0.054)	(0.072)	(0.109)
GDP per capita	0.050**	0.011	0.033	-0.086*	0.083~
(province)*time	(0.017)	(0.017)	(0.022)	(0.034)	(0.043)
Population	0.025*	0.035**	-0.004	0.002	-0.031
(province)*time	(0.011)	(0.012)	(0.016)	(0.017)	(0.027)
Skill*time	-0.067	-0.017	-0.010	0.159~	0.159
	(0.050)	(0.055)	(0.053)	(0.093)	(0.103)
Internal Distance*time	-0.009*	-0.005	-0.006	0.015~	0.018
	(0.005)	(0.005)	(0.006)	(0.009)	(0.012)
Infrastructure = A	0.132	0.310*	-0.200	-0.258	-0.363
	(0.090)	(0.154)	(0.123)	(0.285)	(0.372)
Infrastructure = B	0.147~	0.315	-0.215	-0.469~	-0.804*
	(0.087)	(0.196)	(0.150)	(0.266)	(0.365)
Observations	27,376	25,203	24,985	27,376	25,203
Number of provinces	29	29	29	29	29

Notes:
All regression include fixed effects by year and random effects by province. Robust standard errors are in parentheses are clustered by province.
~ significant at 10%; * significant at 5%; ** significant at 1%

Figure 1(A): Chinese Manufacturing Exports 2003, By Destination, billion $

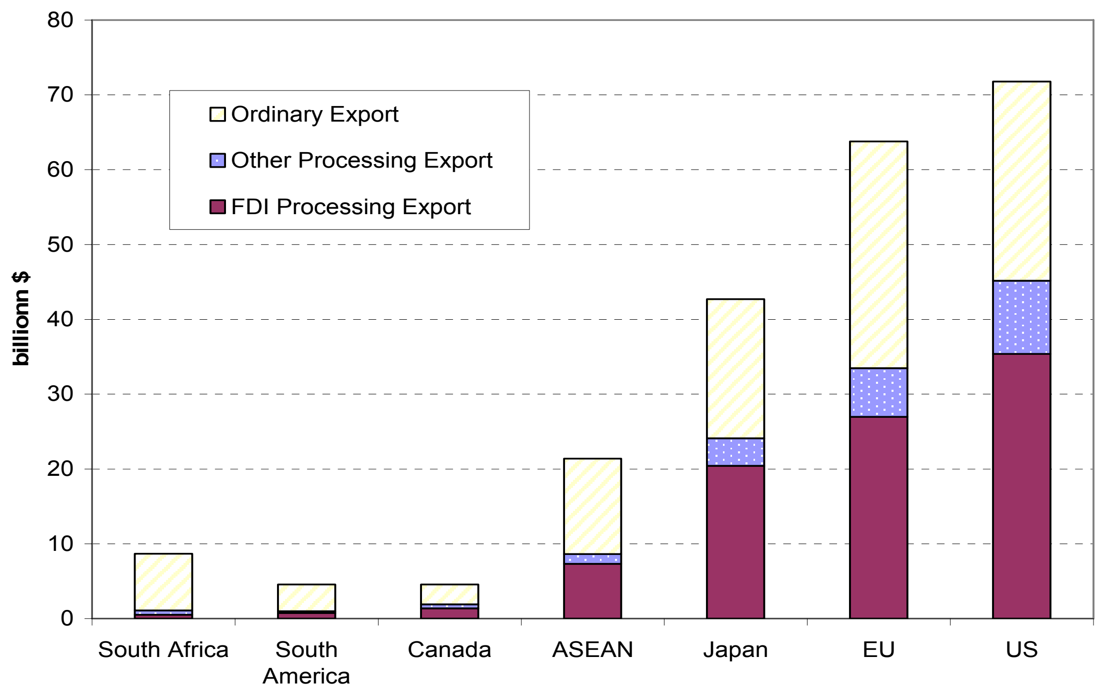

Figure 1(B): Chinese Manufacturing Exports 2003, By Destination, Percent

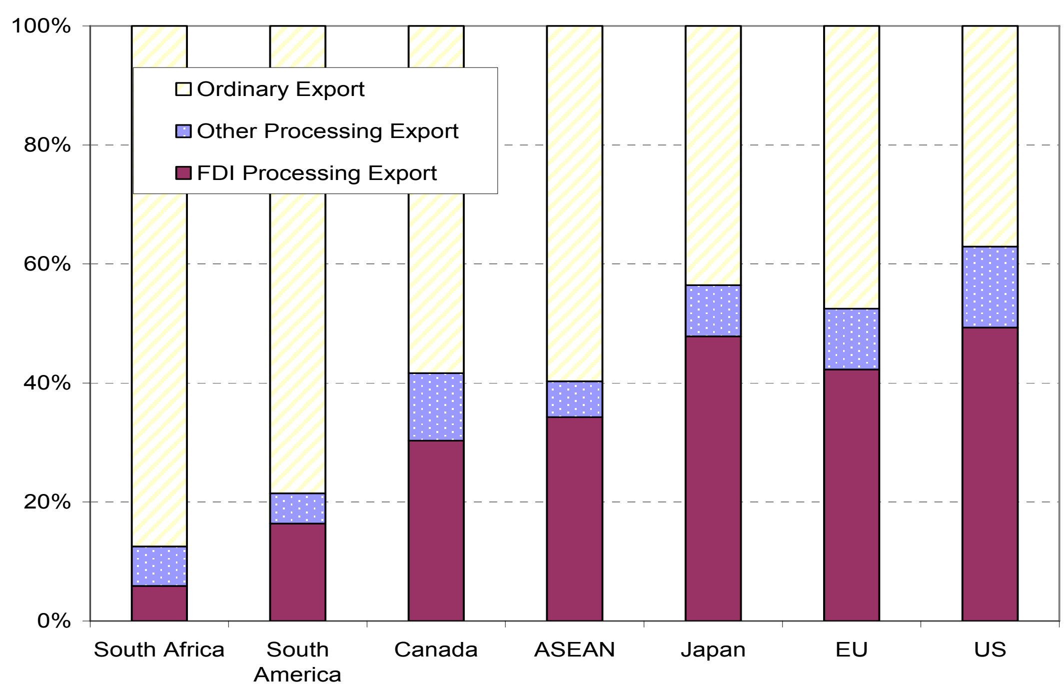

Figure 2(A): China Manufacturing Export 2003, By Source Region, billion$

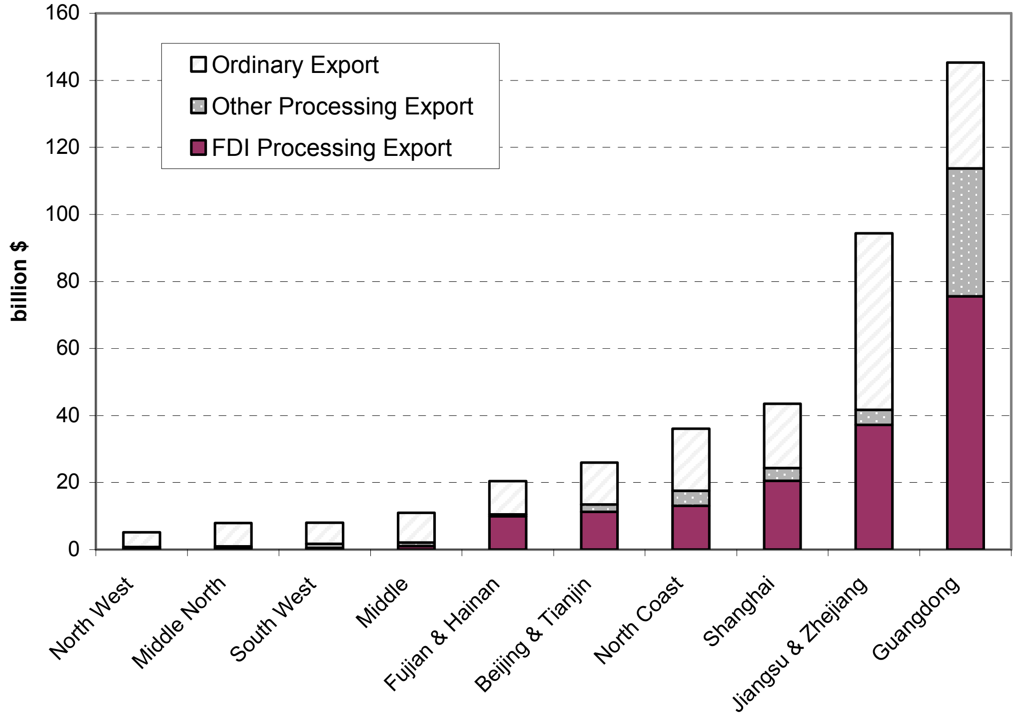

Figure 2(B): China Manufacturing Exports 2003, By Source region, Percent

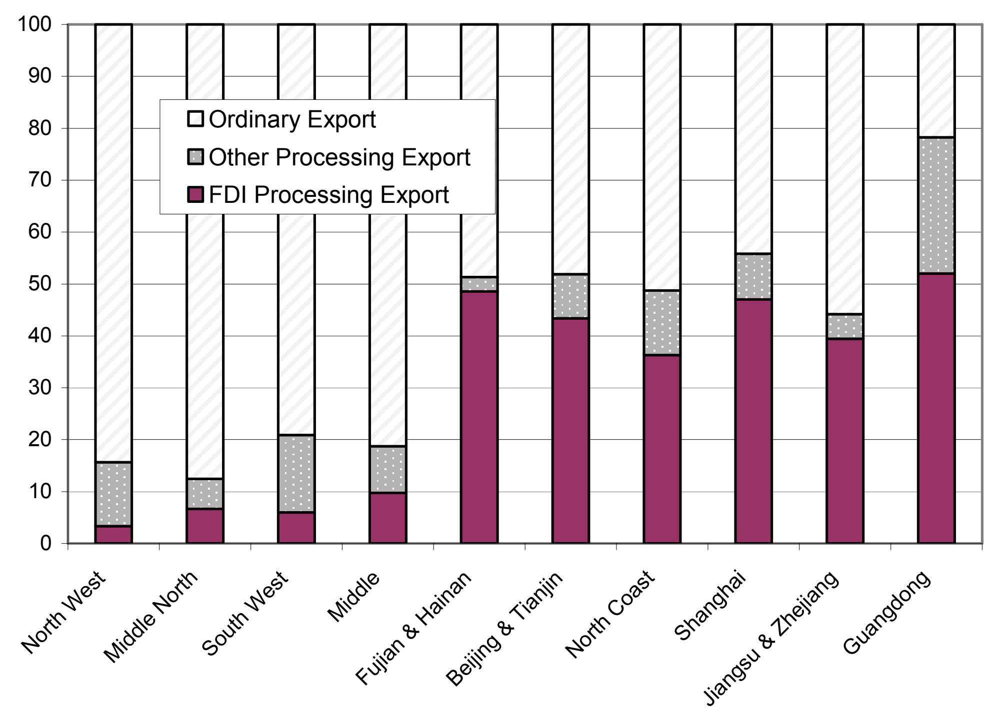

Figure 3: Ranges of Outsourcing (without FDI)

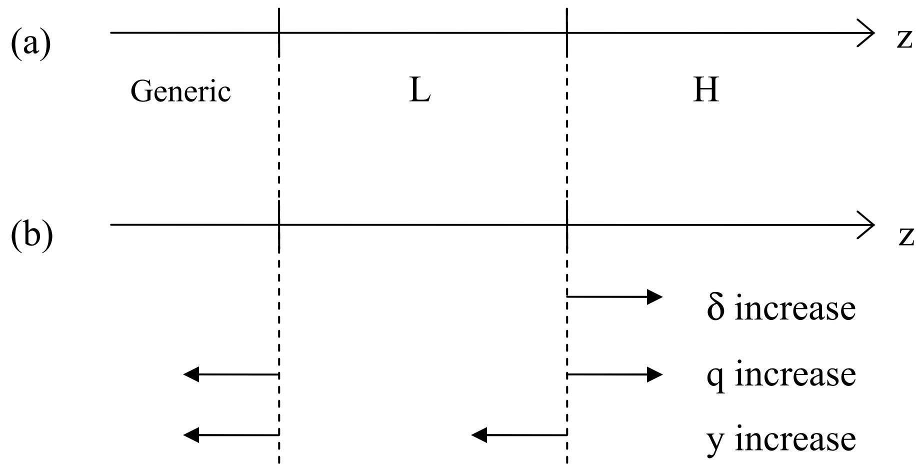

Figure 4: Ordinary and Processing Trade, Extensive Margin, 2003

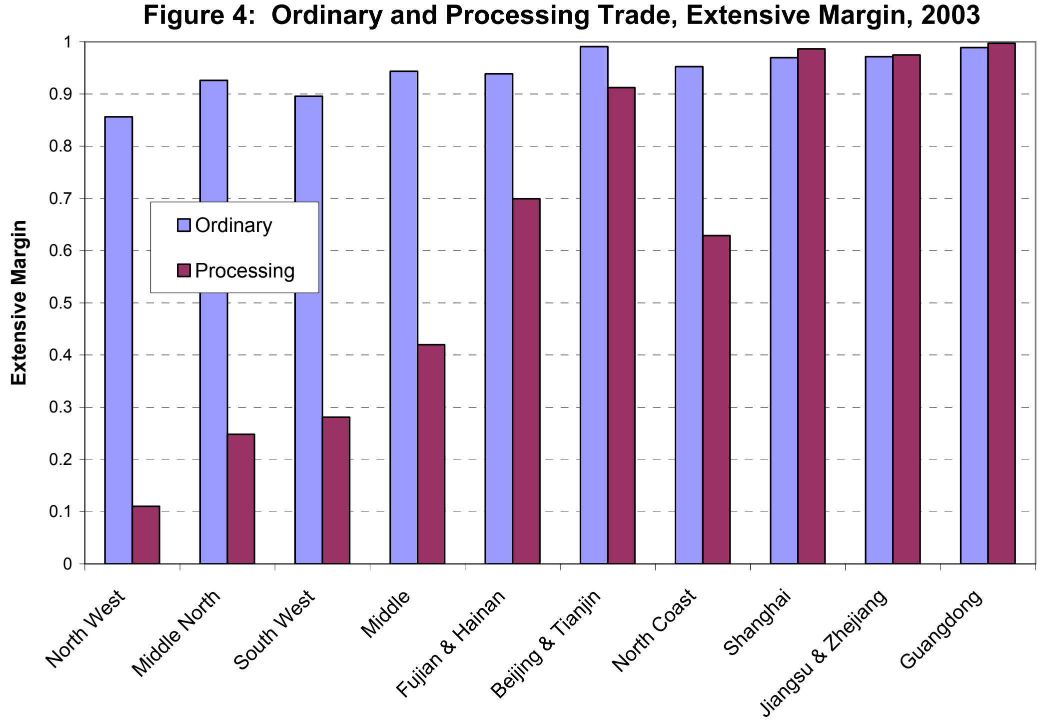

Figure 5: Ranges of Outsourcing (with FDI)

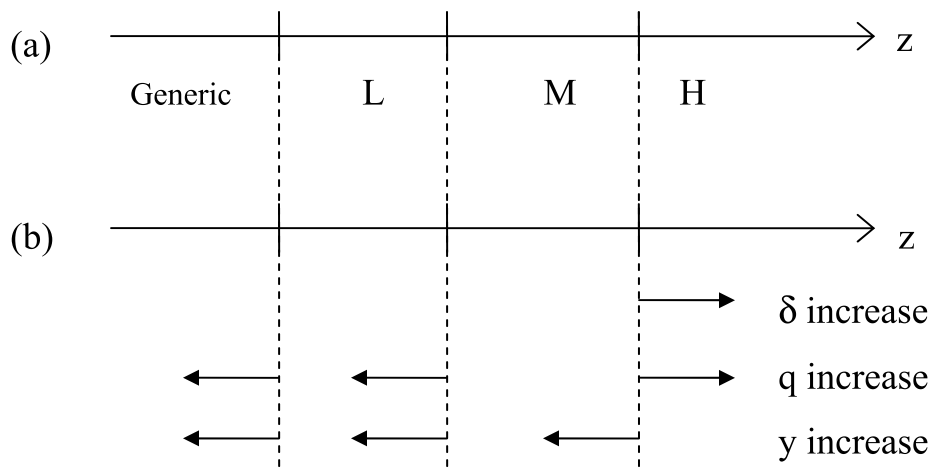

Figure 6: Domestic and Foreign Firms, Extensive Margin, 2003