OWNERSHIP AND CONTROL IN OUTSOURCING TO CHINA: ESTIMATING THE PROPERTY-RIGHTS THEORY OF THE FIRM*

by

Robert C. Feenstra and Gordon H. Hanson

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Abstract

We develop a simple model of international outsourcing and apply it to processing trade in China. Export processing involves a foreign firm contracting with a Chinese factory manager to assemble intermediate inputs into a final product. Whether the same or different parties should have ownership of the processing factory and control over input purchases depends on parameters of the model, which we estimate. We find that multinational firms engaged in export processing in China tend to split factory ownership and input control with local managers: the most common outcome is to have foreign factory ownership but Chinese control over input purchases. Our model estimates indicate that this pattern is especially prevalent in the southern coastal provinces, where export markets are thickest and contracting costs are lowest.

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Corresponding author: Gordon H. Hanson, Graduate School of International Relations and Pacific Studies, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0519.

I. Introduction

Global production is a common feature of the modern firm. Businesses as diverse as Mattel, which makes plastic dolls, Dell, which sells personal computers, and Intel, which makes semiconductors, operate supply chains that span multiple countries. Typically, multinational firms produce components in one location, process components into final goods in another location, and manage these operations from headquarters in yet another location. While trade theory has used general-equilibrium models to examine location decisions by multinational firms,[1] the literature has tended to abstract away from how multinationals set firm boundaries within global supply chains. Until recently, trade theory has not sought to explain why Intel would use wholly-owned subsidiaries in China and Costa Rica to assemble its microchips, while Dell and Mattel subcontract production to outside firms in many countries. Nor has it tried to account for why Dell would control who buys what from whom along its PC supply chain, while Mattel grants the suppliers that make its dolls latitude in finding sources for materials.

In recent work, trade theorists bring modern theories of the firm into trade models.[2] Building on Grossman and Helpman [2002a, 2002b], Antràs [2003] and Antràs and Helpman [2004] use the property-rights theory of Grossman and Hart [1986] and Hart and Moore [1990] to model global outsourcing and intra-firm trade. Grossman and Helpman [2004] apply the incentive-systems framework of Holmstrom and Milgrom [1994] to managerial compensation in global production, and Marin and Verdier [2001, 2003] and Puga and Trefler [2002] extend the Aghion and Tirole [1997] theory of delegating authority to general equilibrium.

In this paper, we build a simple model of international outsourcing and apply this model to China. We consider a multinational firm that has decided to set up an *export processing* plant in a low-wage country. In this arrangement, the firm sends intermediate inputs to a processing factory, which converts the inputs into finished goods and then exports the final output. The decisions facing the multinational include who should own the processing factory and who should control input-purchase decisions the factory makes. Following recent trade literature, we use the Grossman-Hart-Moore property-rights (PR) theory as the basis for our model. In this framework, parties use control rights over productive assets to ameliorate hold-up problems created by incomplete contracts. Our model is general enough, however, to allow for results in the spirit of the Holmstrom-Milgrom incentive-systems (IS) framework.

The application to China is motivated by the importance of export processing to global trade and by the availability of detailed trade data on China. As described in section II, we observe China's processing exports broken down by *who owns the plant* and by *who controls the inputs* the plant processes. Since the early 1980s, China has permitted foreign ownership of export processing plants. It stipulates that all processing plants (whether Chinese or foreign owned) operate according to one of two regimes: a *pure-assembly* regime, in which a foreign buyer supplies a plant in China with inputs and hires the plant to process them into finished goods, all the while retaining ownership over the inputs; and an *import-and-assembly* regime, in which a plant in China imports inputs of its own accord, processes them, and sells the processed goods to a foreign buyer. This level of contractual detail is rarely observed in international trade.

In our model of export processing, presented in section III, contracts are incomplete and parties divide gains from trade by Nash bargaining. The threat-point payoffs associated with bargaining do not fully compensate parties for their investments in human capital and depend, in standard fashion, on who has the relevant control rights (i.e., ownership of the factory or control over input decisions). The essential tradeoff of the model comes because investments in *input search* are at their first-best level when that *same* party has ownership and control (similar to the

IS framework). But investments in *processing* (by the manager) and *marketing* (by the foreign firm) are closest to their first-best when *different* parties have ownership and control. This occurs because when the foreign firm owns the factory, its outside options and incentives to invest in marketing are strong; but in this case, we argue that the manager's outside options are improved if she searches for the input. Thus, whether ownership and control should be given to the same or different parties depends on parameters of the model, such as the specificity of human-capital investments and value-added in processing versus that in input search. When input search matters more, concentrated ownership and control is optimal, but when processing matters more, then divided ownership and control is optimal.[3]

Previewing the empirical results in sections IV and V, we find that multinational firms engaged in export processing in China tend to split factory ownership and input control with factory managers in China: the most common outcome is to have foreign factory ownership but Chinese control over input purchases. This is consistent with moderate or low human-capital specificity, which our parameter estimates confirm. In our benchmarks results, the project specificity of human-capital investments is 28 to 51 percent in interior and northern provinces but only 22 percent in the more export-oriented southern coastal provinces. Thus, investment specificity is lowest where export markets are thickest. The parameter for specificity can also be interpreted as the cost of resolving commercial disputes, and consistent with our results, these costs are lowest in the southern coastal provinces and highest in the interior and north [Dollar et al. 2003]. Our preferred estimate of the Nash bargaining weight for multinational firms is 0.7, but the confidence interval includes the value 0.5, which corresponds to simple Nash bargaining.

Our findings are relevant to several bodies of literature. Incomplete contracts are a common feature of recent trade models, but there is little empirical work on contracting costs in international trade.[4] Our contribution is to estimate sources of contractual incompleteness in global production. While estimated for China, export-processing activities are widespread in Central America, Eastern Europe, and South and East Asia [Yeats 2001]. This suggests our results may be widely applicable, as discussed in section V. A second body of literature to which our work relates is empirical research on modern theories of the firm. Despite intense theoretical interest in the PR and IS models, few papers have tested them.[5] A notable exception is Baker and Hubbard [2003, 2004] who examine contractual arrangements in U.S. trucking.[6] They exploit the introduction of on-board computers in trucks, which changed the costs of monitoring drivers. They find evidence consistent with the PR and IS models. Our work, which exploits the interaction between choices over ownership and input-purchase regimes, is similar in spirit to theirs. We extend the literature by estimating contracting costs in a developing-country context, where contractual incompleteness is thought to be severe but is rarely estimated empirically.

II. Export Processing in China

Export processing plays a major role in China's foreign trade, accounting for 55.6 percent of the country's total exports over our sample period of 1997 to 2002 (Table I). The activity involves a firm in China importing intermediate inputs, processing the inputs, and then exporting the finished goods. Inputs are imported duty-free as long as these goods are only used to produce exports. China has two regulatory regimes for export processing.

<u>The Pure-Assembly Regime</u>. In this arrangement, a foreign firm supplies a factory in China with materials from abroad [Naughton 1996]. The factory in China, whose role is relatively passive, receives orders from and delivers processed goods to the foreign client, who

then sells the goods outside China. While the factory takes possession of the imported materials during processing, the foreign firm retains ownership over them. The foreign firm pays the factory in China a fee for its processing services. To obtain clearance from Chinese customs to import materials and to export processed goods, the terms of the transaction between the Chinese factory and the foreign firm must be stipulated in a written contract and presented in advance to Chinese customs officials for approval.[7] Legally, the processing factory may use imported materials for the sole purpose of meeting its obligations to the foreign client.

The Import-and-Assembly Regime. In this arrangement, the processing factory in China plays a more active role. Table I shows that this regime is the more common form of export processing, accounting for 70.7 percent of processing exports over the 1997-2002 period. The factory imports materials of its own accord and takes ownership of these materials during processing. It may broker deals to process goods for multiple foreign firms [World Bank 1994]. Thus, the factory in China controls both the import of inputs and the export of processed goods (though usually not the marketing and sale of the good to end users). Legally, Chinese customs treats processing plants under this regime as bonded warehouses – facilities that are permitted to import inputs duty free under the proviso that they export all output. Bonded goods cannot be transferred to another party without the approval of Chinese customs. To become a bonded warehouse, a plant must apply to the Chinese government and have warehouse facilities and accounting personnel that meet government standards.[8] Under either regime, exporters are required to submit monthly reports on the status of their contracts and to verify that the contract has been completed within a month of having exported the finished goods.

There are several important distinctions between the two processing regimes. One relates to the responsibilities of the factory manager in China. Under pure-assembly, the manager appears to play a small role in searching for inputs or in other activities that precede input processing. Under import-and assembly, the factory manager has greater responsibility. A second distinction has to do with to controls rights over imported materials. Under pure-assembly, the foreign buyer of the processed goods owns the materials used in processing. Without this buyer's consent, the factory in China cannot legally use the imported materials to process goods for another client. Under import-and-assembly, in contrast, the processing factory owns the imported materials. It may use them to produce for the foreign buyer of its choice, so long as the goods are exported. A third distinction between the two regimes is that they are subject to different approval processes and regulations. In particular, import-and-assembly factories are required to make greater investments in inventory storage and management. This suggests that a processing plant cannot costlessly or quickly change from one regime to another.

Processing factories may be owned by either Chinese or foreign interests. Foreign-invested enterprises (FIEs) play a major role in China's trade. Table I shows that over the period 1997-2002 FIEs accounted for 62.8 percent of China's processing exports. The Chinese government recognizes two categories of FIEs, wholly foreign-owned enterprises and equity joint ventures in which a foreign interest has at least a 25 percent ownership stake. We shall refer to both of these as "foreign owned." It is important to recognize, however, that foreign ownership in our model is not equivalent to foreign control. Rather, we will assume that control over input-processing always resides with a local (Chinese) manager, while control over input sourcing will reside with the foreign firm or local manager, depending on whether the pure-assembly or import-and-assembly regime is being used. Foreign ownership simply means that the foreign firm has property rights over the residual profits of the plant, as described next in our model.

III. The Model

We begin by describing the problem faced by a foreign firm wanting to locate export processing operations in China. The parties choose who should own the factory used in production and who should control the purchase of inputs processed by this plant. Our model follows closely the PR approach of Grossman and Hart [1986] and Hart and Moore [1990].

Consider a foreign firm, denoted by f, transacting with a factory manager in China, denoted by g. The project requires the parties to purchase one unit of an input, to use a factory to process the input into one unit of a final product, and then to market and sell the final product. Timing is as follows: In period 0 the parties choose who should own the factory and who should control input purchases; in period 1 the parties simultaneously make effort investments; and in period 2 the parties undertake input purchases, input processing, and final sales.

The efforts undertaken in period 1 are as follows: e_1 = effort devoted to searching for a low-priced input, by *either* party f or g; e_2 = effort devoted to processing the input, by the *factory manager* g; e_3 = effort devoted to marketing the final good, by the *foreign firm* f. The price of the input in period 2 is given by the linear function $P\cdot(1-e_1)$, $P > 0$, $0 \le e_1 \le 1$, so that more search effort e_1 lowers the input price. The cost of input processing in period 2 is given by $A\cdot(1-e_2)$, $A > 0$, $0 \le e_2 \le 1$, so that effort e_2 devoted to processing lowers costs. Revenues from final sales in period 2 are given by $B\cdot(1+\lambda e_2+e_3)$, where $0 < \lambda \le 1$, $0 \le e_3 \le 1$ and $B > (A+P) > 0$, so that more marketing effort raises sales revenue. Combined period 2 profits are then

$$\pi = B(1+\lambda e_2+e_3) - A(1-e_2) - P(1-e_1) > 0. \tag{1}$$

Notice that we have introduced an element of *joint production* between input processing and sales, with effort e_2 by the manager affecting both. Preparing the factory for production may enhance plant efficiency (lowering processing costs) *and* product quality (raising sales revenues).[9] Joint production means that it may be difficult to fully compensate the manager, reflecting the marginal contributions of her effort to both input processing and final sales.

Let the variable $\delta_1 \in \{0,1\}$ indicate whether the foreign firm f ($\delta_1 = 0$) or the manager g ($\delta_1 = 1$) expends search effort e_1. We refer to this indicator variable as *control over input purchases*. In addition, we use the *ownership variable* $\delta_2 \in \{0,1\}$ to indicate whether the foreign firm f ($\delta_2 = 0$) or whether the Chinese manager g ($\delta_2 = 1$) owns the processing factory.

The period 1 effort investments, e_i, i=1,2,3, impose a cost on the parties involved. The costs of supplying effort for the foreign firm are $C_f[(1-\delta_2)e_1, e_3] = \frac{\gamma_f}{2}[(1-\delta_1)e_1^2 + e_3^2]$, and the costs to the manager are $C_g(\delta_1 e_1, e_2) = \frac{\gamma_g}{2}(\delta_1 e_1^2 + e_2^2)$, where γ_f and γ_g are the disutility of effort for each party. The total surplus from the project is then

(2) $$W(\delta_1, \delta_2) = \pi - C_h[(1-\delta_1)e_1, e_3] - C_f(\delta_1 e_1, e_2).$$

Note that the effort levels in (2) will depend on the ownership and control variables δ_1 and δ_2. This occurs because we assume that it is difficult to write contracts to compensate effort, so the parties Nash bargain instead. But for reference, we note that with perfect contracts the first-best effort levels that maximize (2) are: $e_1^* = \max\{P/\gamma_f, P/\gamma_g\}$ $e_2^* = (A+\lambda B)/\gamma_g$, and $e_3^* = B/\gamma_f$.

III.A Nash Bargaining

We will allow for generalized Nash bargaining where the foreign firm has bargaining weight θ and the Chinese manager has weight $(1 - \theta)$. The *status quo* or threat-point payoffs for the two parties will be denoted by $\hat{\pi}_f$ and $\hat{\pi}_g$ (as specified below). Total *ex post* profits are given by (1), and the profits π_f and π_g earned by each party are then

(3) Party f receives: $\pi_f = \hat{\pi}_f + \theta(\pi - \hat{\pi}_g - \hat{\pi}_f) = \theta(\pi - \hat{\pi}_g) + (1-\theta)\hat{\pi}_f$

(4) Party g receives: $\pi_g = \hat{\pi}_g + (1-\theta)(\pi - \hat{\pi}_f - \hat{\pi}_g) = (1-\theta)(\pi - \hat{\pi}_f) + \theta\hat{\pi}_g$.

Thus, each party will choose their effort levels to maximize the difference between these payoffs and the costs of supplying effort:

(5) Party f solves: $\max\limits_{(1-\delta_1)e_1, e_3} \pi_f - C_f[(1-\delta_1)e_1, e_3]$,

(6) Party g solves: $\max\limits_{\delta_1 e_1, e_2} \pi_g - C_g(\delta_1 e_1, e_2)$,

where the foreign firm f chooses e_1 when $\delta_1=0$, while the manager g chooses e_1 when $\delta_1=1$.

In order to solve these problems, we need to be more specific about the threat-point payoffs available to each party. We make three interrelated assumptions:

(A.1) When Nash bargaining breaks down, the party owning the factory is entitled to the residual profits and completes the project by contracting for the services of another party on the spot market (i.e., the foreign firm hires another factory manager or the factory manager contracts with another foreign buyer).

(A.2) Under the spot contracts in (A.1), the parties earn only a fraction of their marginal products. In particular, the marginal product of their period 1 effort investments are reduced by ψ, with $0 \leq \psi \leq 1$, so the payoffs are $(1 - \psi)$ times the first-best level.

(A.3) In the case where the foreign firm owns the factory, and Nash bargaining breaks down, the manager seeks a job elsewhere. But her prior effort investments are valued *if and only if* she has searched for the inputs (that is, if and only if $\delta_1 = 1$).

These three assumptions generate all our results, so it is important to understand them. The first two assumptions are standard in PR-type models. (A.1) clarifies that ownership of the factory confers the right to residual profits, which guarantees the owner full marginal incentives on investments in *non-joint-production* activities. On the spot market, the effort investments of the party not owning the factory are not as highly valued: in (A.2), ψ can be interpreted as the *human-capital specificity* of these investments, or alternatively, as the *ability to contract* over these investments. Under the latter interpretation, we are allowing for imperfect contracts in the threat points, but both parties still prefer to Nash bargain over the project at hand, because then they earn their threat-point payoffs *plus* a share of the remaining profits $(\pi - \hat{\pi}_g - \hat{\pi}_f) > 0$.[10]

In the case where the manager owns the factory (δ_2=1), then (A.1) and (A.2) imply:

(7) $$\text{When } \delta_2 = 1: \quad \partial\hat{\pi}_f / \partial e_3 = (1-\psi)B, \text{ and } \begin{cases} \partial\hat{\pi}_f / \partial e_1 = (1-\psi)P & \text{if } \delta_1 = 0 \\ \partial\hat{\pi}_g / \partial e_1 = P & \text{if } \delta_1 = 1 \end{cases}.$$

The foreign firm f earns a fraction of its marginal product from effort investments in input search (P) or marketing (B), whereas the manager g earns her full marginal product in input search (P). In addition, because she is entitled to the residual profits, the manager earns her full marginal product of effort in input processing (A), but a fraction of her marginal product in sales (λB):

(8) $$\text{When } \delta_2 = 1: \quad \partial\hat{\pi}_g / \partial e_2 = A + (1-\psi)\lambda B.$$

Even when the manager owns the factory, she must contract with a foreign firm on the spot market *to sell* the final good, implying her returns on this activity are reduced by ψ, from (A.2).

When the foreign firm owns the factory ($\delta_2 = 0$), then (A.1) and (A.2) become:

(9) $$\text{When } \delta_2 = 0: \quad \partial\hat{\pi}_f / \partial e_3 = B, \text{ and } \begin{cases} \partial\hat{\pi}_f / \partial e_1 = P & \text{if } \delta_1 = 0 \\ \partial\hat{\pi}_g / \partial e_1 = (1-\psi)P & \text{if } \delta_1 = 1 \end{cases}.$$

The foreign firm f has full marginal investment incentives in marketing (B) and input search (P). But the marginal incentive of the manager g to engage in input search is reduced by ψ when she does not own the factory: in the event that bargaining breaks down, she must hire herself out to another factory for whom her search investments presumably won't be as valuable.

What about the manager's incentive to make effort investment towards processing the input? Our final assumption is that effort in input processing is more highly valued by other firms if the manager has *also* searched for the input. For example, input search can lead to knowledge of the characteristics and availability of foreign inputs, which may raise the returns to the manager's processing ability in other plants. Formally, we state (A.3) as:

(10) $$\text{When } \delta_2 = 0: \quad \partial\hat{\pi}_g / \partial e_2 = \delta_1(1-\psi)(A + \lambda B).$$

The manager's effort investments are valued *if and only if* she searched for the inputs ($\delta_1 = 1$).

While we use a strong form of (A.3) for convenience, the key feature requires that:

$$\frac{\partial\hat{\pi}_g(1,0)}{\partial e_2} - \frac{\partial\hat{\pi}_g(0,0)}{\partial e_2} > \frac{\partial\hat{\pi}_g(1,1)}{\partial e_2} - \frac{\partial\hat{\pi}_g(0,1)}{\partial e_2}.$$

That is, the increase in returns on processing effort from giving the manager control over input purchases (going from $(0,\delta_2)$ to $(1,\delta_2)$) is larger when she *does not* own the factory ($\delta_2 = 0$, on the left of the inequality) than when she does ($\delta_2 = 1$, on the right of the inequality). This condition is satisfied so long as giving the factory manager control over input purchases matters more (in terms of improving her outside options) when she is in a weaker bargaining position (as applies when she does not own the factory). We assume an analogous asymmetry does not apply to the foreign firm. Since the foreign firm may engage in many projects, acquiring control over input purchases in just one project is likely to have a relatively small impact on its outside options.

III.B Solutions for Effort Investments

Using the specifications of the marginal threat-point payoffs in (7)-(10), we can solve for the effort investments from (5) and (6). These are shown in Table II and have the following general features. First, on the diagonal of Table II, the efforts e_1 devoted to input search are at their *first-best* levels. This result follows from assumption (A.1), whereby the party owning the plant earns the residual profits. If they also control the input decisions then there is every incentive to engage in first-best search. This result suggests that ownership and control should be given to the same party, illustrating the general finding of Holmstrom and Milgrom [1994], but obtained here in a PR model.

Second, the effort investment e_3 by the foreign firm towards marketing the final good is at its first-best level when the foreign firm owns the factory (the first column of Table II), since then it is entitled to the residual profits. But in this case, it is most difficult to obtain good effort e_2 by the manager towards processing the input. She receives a share of the profits in the Nash bargain, of course, but if bargaining breaks downs then she is not entitled to the residual profits, which puts her in a particularly weak bargaining position. This creates a disincentive for her to put any effort into input-processing in the first place. A solution to this holdup problem is to give her control over input search, which by (A.3) will improve her outside option and therefore her *ex post* bargaining power. In the first column of Table II, the effort e_2 in input processing is closer to its first-best when the manager controls the input decision (the lower-left cell) than not (the upper-left cell).

Using the effort levels in Table II, the value of surplus in each case can be computed. A convenient summary statistic is the *modularity* of the surplus function, defined by

$$V \equiv W(0,0) + W(1,1) - W(0,1) - W(1,0). \tag{11}$$

If $V > 0$ then W is strictly supermodular, so the highest values for W are obtained when δ_1 and δ_2 take on the *same* values. In our model, it means that it will be optimal for the same party to control the inputs and to own the factory.[11] This is the general finding in the IS framework of Holmstrom and Milgrom [1994]. Conversely, when $V < 0$ then W is strictly *submodular*, so it is optimal for δ_1 and δ_2 to take on *different* values, meaning that one party controls input purchases and the other owns the factory.

Using the effort levels in Table II, we obtain (see the Appendix for details)

$$V = P^2\left[\frac{(1-\theta)^2\psi^2}{2\gamma_f} + \frac{\theta^2\psi^2}{2\gamma_g}\right] - \frac{(A+\lambda B)^2(1-\psi^2)\theta^2}{2\gamma_g}. \tag{12}$$

It is apparent that (12) can be positive or negative, so that the surplus function can be either supermodular or submodular. Furthermore, we can readily see that

$$\frac{\partial V}{\partial (A+\lambda B)} < 0, \quad \frac{\partial V}{\partial P} > 0 \quad \text{and} \quad \frac{\partial V}{\partial \psi} > 0. \tag{13}$$

To interpret condition (13), recall that $(A+\lambda B)$ is the marginal product of the manager's processing effort e_2. When this marginal product is high, it is particularly important to obtain good effort investments e_2 from the manager. To ameliorate that holdup problem when the foreign firm owns the factory, we have argued that the manager should be given control over input sourcing. This means that giving ownership and control to different parties is more likely when $(A+\lambda B)$ rises, so the surplus function is more submodular.

Conversely, P is the marginal product of the manager's or the foreign firm's effort investment in input search. As P rises, then it becomes particularly important to obtain good effort investments e_1 in search. That outcome is obtained by giving ownership and control to the same party – either the manager or the foreign firm. Thus, as P rises then the surplus function is more supermodular, which is the second inequality in (13).

Finally, as human capital is more specific or contracts are increasingly difficult to write then ψ rises, making it harder to elicit good effort from the party not owning the factory. As $\psi \rightarrow 1$ it will become impossible to obtain any effort investment e_2 from the manager if she does not own the factory, so the surplus of the project is maximized by getting the best effort possible on input search, as obtained when the same party has ownership and control. Thus, higher values of ψ correspond to more supermodular surplus, which is the final result in (13). We can think of a high value of ψ as indicating "thin" labor markets or high contracting costs, as may occur in inland regions of China. We see, therefore, that the modularity of the surplus function may well differ over regions of China, as we investigate next.

IV. Data and Nonparametric Results

IV.A Data

The data we use to measure processing trade are from the Customs General Administration of the People's Republic of China, and show processing exports by year (1997-

2002), 8-digit harmonized system (HS) product, origin city-districts in China (including trade zone status), destination country (including whether goods are exported directly or through Hong Kong), customs regime (pure-assembly or import-and-assembly), and ownership type (foreign or Chinese-owned), yielding approximately 170,000 observations per year.[12] Summary values from these data were reported in Table I.

The detail in these data approach that which might be available from a firm level dataset, even though the fundamental observation available to us is the 8-digit HS product, Chinese city-district, and destination market. For example, if there is a single factory processing "women's or girl's suit-type jackets of wool" in Pudong, Shanghai, operating in a SEZ, and exporting goods directly to the United States, then the Chinese data would show its ownership and control regime along with its export value. However, if there are several such processing factories in Pudong (located in the same economic zone and exporting the same product directly to the United States), then the exports of *each* ownership and control regime represented there would be listed. Thus, a given city-economic zone-product-destination market cell might show positive exports for more than one type of contractual arrangement, though this is the exception.[13]

In this section we sum over observations to report the aggregate export shares by type of ownership and control, and in the next section we shall make use of the disaggregate data. As explained in the next section, we also make use of import and re-export data for Hong Kong by year (1997-2001), source and destination country, and 8-digit HS product. An Appendix to this paper provides more information on the data used; a more detailed version of that Appendix is available on our home pages.

IV.B Modularity

The modularity of the surplus function cannot be tested directly, because we do not observe the value of surplus from outsourcing activity; instead, we observe the processing exports accounted for by each ownership and control regime. To move from the value of surplus in (12) to the frequency of contractual regimes in our data, we adopt a simple stochastic specification. In particular, we suppose that ownership and control in our data are chosen to maximize $W(\delta_1, \delta_2)$ *plus* an i.i.d. extreme value random error that varies across contractual types.[14] Then it is well known [Train 1986] that the probabilities of observing each contractual type take on the logit form:

$$\text{(14)} \qquad \Pr(i, j) = \frac{\exp[W(i, j)]}{\sum_{i,j=0,1} \exp[W(i, j)]}, \quad i,j \in \{0,1\}.$$

To measure the probabilities on the left of (14), we shall use the *share of processing trade accounted for by each contractual type.* Denoting these export shares by S(i, j), our measure of the modularity of the welfare function is then:

$$\text{(15)} \qquad \begin{aligned} V &\equiv [W(0,0) + W(1,1) - W(1,0) - W(0,1)] \\ &= [\ln S(0,0) + \ln S(1,1) - \ln S(1,0) - \ln S(0,1)] , \end{aligned}$$

where the second line follows from replacing Pr(i, j) by S(i, j) in (14). We assess the modularity of the welfare function in Chinese export processing by calculating the expression for the sum of log export shares in the first line of equation (15). We then see how this expression varies across Chinese regions and trade policy regimes.

In Table III, the first two columns show export shares in the total sample, and the second two columns show export shares for all provinces *except* those on the southern coast (i.e., excluding Shanghai, Zhejiang, Fujian, Guangdong, and Hainan).[15] Reading down the diagonal of the first matrix, foreign control of the inputs (the pure-assembly regime) combined with foreign ownership of the factory accounts for an average of 8.3 percent of processing exports, while Chinese ownership of the factory and control of the inputs accounts for 14.6 percent of processing exports. Much more weight occurs on the off-diagonal, where Chinese control of the inputs (the import-and-assembly regime) combined with foreign ownership of the factory accounts for 49.6 percent of exports, and foreign control of the inputs combined with Chinese ownership of the factory accounts for 27.1 percent of processing exports. Computing modularity V as in (15), this is highly negative. Thus, the full sample support the submodularity of the surplus function.

From (13), we expect the welfare function to be less submodular where value-added in processing is lower or the parameter ψ – representing human capital specificity or contractual incompleteness – is higher. In China, export processing activities are highly concentrated in southern coastal provinces, suggesting thicker labor markets and less human capital specificity. In addition, it turns out that contracting costs (the time taken to complete court cases) are lower in the southern coastal provinces, as we discuss later. For both reasons, we expect ψ to be higher in the interior and northern regions than on the southern coast. In the second two columns of Table III, we separate out processing exports for the northern and interior provinces (i.e. excluding Shanghai, Zhejiang, Fujian, Guangdong, and Hainan). For those provinces we find that the V measure is positive rather than negative, indicating supermodular welfare. This is consistent with the last inequality in (13).

Another explanation for differing modularity of surplus over the regions of China is the industry mix. In Table IV we report modularity measures for a low value-added industry (apparel) with a high value-added industry (office machines). Interior provinces are relatively specialized in low value-added industries.[16] Rather than report the entire matrix of export shares by ownership and control type, we report just the key off-diagonal cell (foreign ownership and Chinese control), and the overall modularity measure.[17] We see that apparel has a much lower export share in the foreign ownership/Chinese control regime, and also much lower modularity. This is consistent with the first inequalities in (13), whereby lower value-added in processing, or higher value-added from input search, leads to lower modularity of the surplus function.

Next, we consider whether the processing activity in China takes place with Special Economic Zones (SEZ) or not. In the early stage of China's economic opening, the government permitted foreign trade and investment only in SEZs located in the southern coastal provinces of Guangdong and Fujian. In the mid to late 1980s, the government expanded the number of regions where such activities were permitted, and by the 1990s, foreign trade and investment were allowed (subject to government approval) throughout the country [Demurger *et al*. 2002]. Among other advantages, the SEZs operate separate court system set up to handle civil and commercial cases [Wang 2000].[18] Since we also expect thicker labor markets in those areas, we predict lower ψ and more submodular surplus in the SEZ. From Table IV, we see that the export share subject to foreign ownership/Chinese control is higher in the SEZ, and that the overall modularity measure is slightly lower, so we obtain support for the hypothesis that human-capital specificity and contracting costs are lower in SEZs.

Finally, we check whether the modularity of the surplus function depends on whether or not the final processed good is re-exported through Hong Kong. The share of processing trade re-exported though Hong Kong has fallen from 55 percent to 44 percent over 1997-2002. Re-exports are not simply goods transshipped through Hong Kong; rather, they clear customs in Hong Kong where traders grade them according to quality, package and label them, and arrange for their shipment to consumers [Sung 1991]. As compared to direct exports from China, we conjecture that Hong Kong firms have a relatively high marginal productivity of investment (B) in export processing activities and relatively low human-capital-specificity or contracting costs (low ψ). From (13), we then expect export processing involving Hong Kong to exhibit more submodular surplus. This conjecture is confirmed in Table IV, where re-exports through Hong Kong have modularity of -4.1 as compared to -1.0 for processed goods exported directly from China.

The discussion in this section has demonstrated interesting cross-sectional differences in the modularity of the surplus function over sub-samples of the data, which reflects differences in the ownership/control regimes used in these sub-samples. Our goal in the next section is to use this variation to identify the parameters of our model, θ and ψ. Before turning to that, we briefly consider alternative variations to our model described in section III.

One simple alternative model is where contracts are complete, implying that efforts levels are at their first best. In this case, the choice of organizational form would be dictated by comparative advantage in input search. With first-best effort levels, so $\psi = 0$, then ownership of the factory is irrelevant (i.e., the two columns of Table II would be identical) and $V = 0$.[19] The choice would be between the two rows of Table II, depending on which party has lowest disutility of effort γ_f or γ_g. This is clearly contradicted by the data in Tables III and IV. Under first-best contracts, input search should be done by the party with comparative advantage (lowest disutility of effort γ_f or γ_g), but then ownership of the factory does not matter at all. So that model predicts roughly equal shares across the columns, but higher shares in the row where the party has with lowest γ_f or γ_g. It is therefore impossible to find high exports in the off-diagonal cell with foreign ownership and Chinese control, as actually occurs.

At the other extreme, we might suppose that contracts are entirely incomplete, so $\psi = 1$, and provincial policy makers in China influence organizational design. Suppose, for instance, that policy makers set the value of the Nash bargaining weight θ, with provincial governments more in favor of foreign investment choosing higher values and those less in favor of foreign firms choosing lower values. With $\psi = 1$, then $V > 0$ from (12). In this case the incentives for the manager to make effort investment in processing are very low, so surplus is maximized by choosing the best efforts in input search, as occurs when the same party has ownership and control and surplus is super-modular. Again, that contradicts our finding than the most likely outcome is foreign ownership and Chinese control of inputs.

V. Parametric Estimation Results

V.A Multinomial Logit

To apply multinomial logit to our model, we measure welfare for a given ownership/control regime choice relative to welfare for some base choice, which we select to be W(0,0) (foreign ownership and foreign input control). For convenience, we shall weight welfare by the inverse of $\sigma(A+\lambda B)^2/\gamma_g$, where $(A+\lambda B)^2/\gamma_g$ is the (first-best) value-added in the processing factory, and σ is a parameter related to the variance of the extreme value error.[20] The reduced form of the multinomial logit equations can then be written as:

(16a) $$\left[\frac{W(1,0)-W(0,0)}{\sigma(A+\gamma B)^2/\gamma_g}\right] = a_1 - b_1\left(\frac{P}{A+\lambda B}\right)^2,$$

(16b) $$\left[\frac{W(0,1)-W(0,0)}{\sigma(A+\gamma B)^2/\gamma_g}\right] = a_2 - b_2\left(\frac{P}{A+\lambda B}\right)^2 - c_2\left[\frac{B^2/\gamma_g}{(A+\lambda B)^2/\gamma_f}\right],$$

(16c) $$\left[\frac{W(1,1)-W(0,0)}{\sigma(A+\gamma B)^2/\gamma_g}\right]=a_3-b_3\left(\frac{P}{A+\lambda B}\right)^2-c_3\left[\frac{B^2/\gamma_g}{(A+\lambda B)^2/\gamma_f}\right],$$

where a_i, b_i and c_i are nonlinear functions of the parameters θ , ψ and σ (see the Appendix).

The various terms appearing on the right of (16) depend on two ratios: $[P/(A+\lambda B)]^2$ and $(B^2/\gamma_f)/[(A+\lambda B)^2/\gamma_g]$. To interpret these, recall that recall that $(A+\lambda B)$ is the marginal product of the manager's effort e_2, while $e_2^* = (A+\lambda B)/\gamma_g$ is the first-best effort level, so that $(A+\lambda B)^2/\gamma_g$ would be the labor income received by the manager or value-added in the first-best. Similarly, if the manager controls the input decision, then P is the marginal product of her effort e_1 and $e_1^* = P/\gamma_g$ is the first-best effort level, so P^2/γ_g would be the labor income or value-added in the search activity. It follows that $[P/(A+\lambda B)]^2$ is interpreted as the ratio of value-added in input search relative to processing, or simply the *value-added ratio.* Similarly, $[(B^2/\gamma_f)/(A+\lambda B)^2/\gamma_g]$ is the ratio of first-best value-added in marketing the final good relative to processing (where the former is done by the foreign firm and the latter by the Chinese manager).

From equation (13), the larger are the returns to input search (i.e., the higher is P), the greater are the gains from concentrating ownership and control in the hands of one party. This implies the reduced-form coefficients b_1 and b_2 in (16a) and (16b) should be negative, since they reflect how an increase in the relative productivity of input search affects the likelihood of preferring dispersed to concentrated ownership and control. By the same logic, the coefficient b_3 in (16c) is of indeterminate sign. How the productivity of input search affects the likelihood of giving either the foreign firm or the factory manager both factory ownership and input control depends on which party has the lower disutility of effort.

We estimate equation (16) using the data on Chinese processing exports by year, 8-digit HS product, Chinese city, economic zone, destination country, customs regime, and ownership type.[21] To implement this specification, we need data on the two value-added ratios. We measure value-added in processing trade *within* China using an input-output table that differs across provinces, and we measure the value-added in *input search* by the markups charged on goods re-exported from Hong Kong to China (see the Appendix for details). From these two sources we construct the ratio $[P/(A+\lambda B)]^2$, which we refer to as the *inbound value-added ratio,* since it depends on effort devoted to bringing inputs into China. It is more difficult to measure the value-added in *marketing* the final good, but we attempt to do so using the markup on goods leaving China and re-exported through Hong Kong. The ratio of this to the value-added in processing within China is used to (imperfectly) measure $(B^2/\gamma_f)/[(A+\lambda B)^2/\gamma_g]$, which we refer to as the *outbound value-added ratio,* since it depends on the effort in marketing the final good exported from China.

Because of the errors involved in estimating the Hong-Kong markup and the input-output table for processing trade within China, both the value-added ratios are measured at the 1-digit SITC level rather than the 8-digit HS level, used for the Chinese trade data; these ratios also vary across years, across provinces (since the processing input-output table differs across provinces), and across destination markets (for the outbound ratio).

V.B Estimation

We turn now to the estimation of the model parameters: ψ, the specificity of human capital or a measure of contractual incompleteness; and θ, the bargaining weight for foreign firms.[22] The ratio γ_g/γ_f also appears in the reduced form coefficients in (16), but we can cannot reject that hypothesis that $\gamma_g/\gamma_f = 1$, and impose this in subsequent estimation.[23]

In Table V, we report the results from MNL estimation of the three equations in (16). With six years of data (1999–2002) and thirty Chinese provinces, we can allow parameters to differ over time and across regions. We adopt a parsimonious specification whereby the coefficients of the two valued-added ratios on the right of (16) have constant coefficients, whereas the intercept terms vary across regions and years. In addition, we allow for interaction terms between the four coastal regions (northern provinces; those around Beijing; those around Shanghai; and southern provinces) and two time periods 1997-1999 and 2000-2002. The usefulness

of this fixed-effect specification will be apparent when we discuss the parameter estimates.

In Table V, the sign pattern of the coefficients in the three MNL equations meets our expectations in most cases.[24] Most importantly, the *inbound value-added ratio* has a negative coefficient in estimated equations (16a) and (16b). The variation in the data that identifies these coefficients is primarily the *province-industry variation* in processing value-added. As we have already seen from the nonparametric results in Table IV, high-value-added industries have greater exports with dispersed ownership and control, and especially foreign ownership/Chinese input control. This means there is a higher frequency of observations with $(\delta_1, \delta_2) = (1,0)$ when value-added $(A+\lambda B)^2$ is high, leading to a negative coefficient b_2 in (16a); similar reasoning applies to (16b). This effect is particularly pronounced in the coastal provinces, where more exports have dispersed ownership and control and also higher processing value-added. Thus, variation in processing value-added at the 1-digit SITC level and across provinces, combined with the higher frequency of dispersed ownership and control in high-value-added industries and coastal regions, identifies the negative coefficients for b_1 and b_2 in (16a) and (16b).

The intercept a_1 in (16a) is identified through the large mass of exports with foreign ownership and Chinese control, independent of processing value-added. Our inclusion of Hong-Kong and SEZ indicator variables, as well as the regional indicator variables, clearly affects the estimate of this and other intercept terms in Table V and therefore affects the implied structural parameters. Using the reduced-form estimates from Table V, the implied structural parameters ψ and θ can be obtained (see the Appendix), and are reported in Table VI.[25]

From Table VI, we see that the estimates of ψ, the degree of human-capital specificity, are highest in Beijing, the Interior and the North, and lowest in the South Coast. Since this parameter reflects the *loss* in the return to human-capital investments when bargaining breaks down, lower values of ψ may indicate a "thicker" labor market and stronger outside options for the Chinese managers. Just below the estimates of ψ for each time period, we report the range of these parameters across regions. Generally, these ranges are *reduced* in the 2000-02 period as compared to 1997-1999. These results are suggestive of managerial labor markets that are becoming more integrated within and across regions over time.

The estimates of ψ also depend on whether the goods are processed in SEZ or not, and whether they are re-exported through Hong Kong or not. Comparing the estimates in the first two columns of Table VI with those in the second two columns, we see that *direct* exports have slightly *higher* estimates of ψ than do re-exports through Hong-Kong. That is, by *not* using Hong-Kong traders to handle processed exports, parties face slightly higher project specificity of human-capital investments (presumably because the Hong Kong traders can help arrange a new match). This human-capital specificity is increased further when processing occurs outside of

SEZ. An exception to this rule occurs for the South Coast, where the loss in returns to human-capital investments are close to 0.22 (or 22 percent) regardless of whether processing occurs in SEZ or whether the goods are re-exported through Hong Kong. That estimate of 0.22 for Fujian, Guangdong and Hainan compares with the range 0.28 – 0.51 for the other regions.

We find it highly plausible that human-capital specificity is lowest in the southern coastal provinces due to the concentration of international commercial activity in the region. To examine this interpretation, Figure I plots the estimates of ψ in Table VI against each region's share of total processing exports, averaged over the time periods 1997-1999 and 2000-2002. A higher regional share of national export processing activity is one indication of thicker regional markets. Estimates of ψ are clearly decreasing in the regional processing export share, suggesting that human-capital specificity is lower in regions with more developed export industries.

We have also discussed an interpretation of ψ as a measure of the ability of parties to contract over investments, with lower values of ψ indicating greater ease of contracting. We find it plausible that contracting costs would also be lower in the southern coastal provinces, which have a longer history of dealing with foreign investors and stronger commercial institutions. Figure II plots estimates of ψ against the average time in months needed to resolve commercial court cases (averaged over cities in each Chinese region). The court data, reported in Dollar, Shi, Wang, and Xu [2003], are based on a survey of business executives conducted China's major cities in 2001. The estimates of ψ are higher in regions in which it takes more time to resolve commercial disputes. The time needed to resolve court cases is substantially lower in China's South Coast, consistent with our lower estimates of ψ in that region.

Lastly in Table VI we report the estimate of θ, the Nash bargaining weight for foreign firms, which is 0.69 (standard error of 0.12) across all regions and time periods. It turns out that θ depends only on the slope coefficients of the inbound and outbound value-added ratios, so in our specification it does not vary with region or time period, as does ψ. Our estimate of θ is insignificantly different from 0.5, which corresponds to simple Nash bargaining.[26]

In unreported estimation exercises, we have examined the plausibility of alternative hypotheses for parties' ownership and control decisions. One hypothesis, discussed at the end of section IV, involves complete contracts ($\psi = 0$), in which the choice of organizational form is dictated by comparative advantage in input search. To obtain an empirical specification for this model, we re-derive equation (16) with investments set at first-best levels, which produces an alternative set of estimating equations.[27] The key parameter in the ownership/control choice becomes the relative disutility of effort, γ_g/γ_f. To further enrich the model we allow the disutility of effort to vary across industrial sectors. If we imagine that foreign firms have a stronger comparative advantage in more capital-intensive sectors, then γ_g/γ_f will be increasing in capital intensity such that the parties will be less likely to give the Chinese factory manager input control in more capital-intensive industries. In unreported regressions, we reject the parameter restrictions implied by the comparative-advantage model and find that the estimated value of γ_g/γ_f is lower, rather than higher, in more capital-intensive industries. Consistent with the results in Table IV, the estimation yields little evidence that comparative advantage in input search can account for organization structure in the Chinese export processing industry.[28]

VI. Conclusions

This paper reports a new empirical finding: that the allocation of ownership and control in China's export processing tends to be shared between foreign and local parties, with foreign firms likely to have ownership of the Chinese plant, but the Chinese parties having control over input-purchase decisions. A goal of our paper has been to reconcile this finding with available theories of the ownership/control structure within a firm. We have drawn on the property-rights model due to Grossman and Hart [1986] and Hart and Moore [1990], while also allowing for results in the spirit of the Holmstrom-Milgrom incentive-systems framework.

In our model, giving the same party ownership and control is optimal when investment specificity is high or when value added in processing activities is low. In either case, there are relatively large gains to giving one party strong investment incentives in searching for inputs. Consistent with this prediction, concentrated ownership and control is more common in interior and northern provinces of China, where export markets are thin and the costs of using courts are high (either of which imply high investment specificity).

The more common arrangement of divided ownership and control is more likely to be optimal when investment specificity is low, such that hold-up costs are small. Southern coastal provinces, with their thick export markets and relatively efficient courts, are where this arrangement is most common. Divided ownership and control is also more likely where both parties' investments matter to the value of the project. Following PR logic, giving the foreign firm factory ownership improves its outside options and strengthens its investment incentives. In a similar manner, granting the Chinese factory manager control over input purchases enhances her outside options and investment incentives. Thus, divided ownership and control makes sense when it is optimal to provide balanced investment incentives to the two parties, as is the case where value added in processing activities is high. In the data, foreign factory ownership and

Chinese input control is more common in high-value-added office machines than in low-value-added apparel. This finding is in line with Hart and Moore [1990], who show that disintegrated ownership (giving each party ownership of an asset) is optimal where both parties make investments that are important to the value of the relationship. Our contribution is to suggest that control over input decisions, by affecting parties' outside options, provides an additional instrument through which parties can influence investment incentives.

There are a variety of other contexts in which our framework may be relevant. One is, obviously, export processing in other countries. In the last two decades, export processing has grown rapidly throughout the developing world [Yeats 2001]. As suggested in the introduction, there appears to be a great deal of variation in how multinational companies organize export processing: Nike (like Dell) controls input purchases but rarely owns production facilities; Plantronics (the leading global producer of headsets) owns factories but cedes control over input purchases to factory managers; and Samsung (like Intel) tends to retain both factory ownership and input control. A related form of outsourcing occurs in services. In a recent development, U.S. companies are designing software and hiring firms in India to write the code. By retaining the copyright on the software, U.S. firms control the key "input" in production, and by owning the facility in which the code is written, Indian firms own the "factory" in which the software is produced. This is another example of divided factory ownership and input control, though one in which the roles of the foreign and local parties are reversed from the Chinese case. An important question for further research is to see how contracting costs, factor intensity, and other features of production and exchange affect organizational choices in these settings.

Data Appendix

A. Chinese Trade Data

Chinese import and export data are 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, 1981- 2003.) These data are purchased from Mr. George Chen, China Customs Statistics Information Center, Economic Information Agency, Hong Kong; EIAET@PACIFIC.NET.HK . Note that only the data in 1997 and later years distinguish the pure-assembly regime from the import-and-assembly regime in processing trade.[29]

B. Estimating Value-Added in Chinese Export Processing

To construct the value-added ratios used in the multinomial logit estimation, we need estimates of value-added in Chinese processing exports. An initial measure is obtained as the difference between the value of processing exports and processing imports (relative to processing exports), which is 36 percent over all products and years, 1997-2002. In order to obtain the value-added for particular products and provinces, we estimated an input-output table between SITC industries for processing trade at the provincial level. Details are provided in the Appendix available on our home pages.

The industries with the greatest processing exports are SITC 6 (manufactured goods), 7 (machinery and transport equipment) and 8 (miscellaneous manufactured goods). We estimate relatively low value-added of 16 percent in SITC 6 and 8, and higher value-added of 55 percent in SITC 7. As described by Yeats (2001), SITC 7 includes a number of individual products and their parts, such as: automobiles and their parts; computers and their parts; various types of machinery and their parts; etc. So as a rough check on our value-added estimate of 55 percent from the input-output table, we can compare this to value of processing exports and processing imports (relative to processing exports), obtaining 50 percent. This is quite close to our input-output estimate of 55 percent for this industry, giving us confidence in the estimated input-output table.

C. Measurement of Hong Kong Markups

For the multinomial estimation we also need estimates of the value-added in marketing, and for this purpose we use the Hong Kong markups on various 1-digit SITC goods, by destination country. The measurement of these Hong Kong markups is discussed in Feenstra *et al* [1999], and is based on a comparison of unit-values for Hong Kong imports and re-exports of disaggregate commodities (at the 8-digit HS level). This comparison is complicated, however, because when a good is imported into Hong Kong, it is not known whether it is intended for the domestic market or for re-export to some destination market. So comparing the import unit-value to the unit-value for re-exports involves some error, and sometimes the computed Hong Kong markups can be negative rather than positive. When averaging across the 8-digit HS products to the 1-digit SITC level, in most cases the negative values disappear. But in cases where we still obtain negative markups for the 1-digit SITC categories, these products are omitted from the calculation of the value-added ratios and from the multinomial logit estimation.

University of California, Davis, and National Bureau of Economic Research

University of California, San Diego, and National Bureau of Economic Research

References

Aghion, Phillipe, and Jean Tirole, "Formal and Real Authority in Organizations," Journal of Political Economy, CV (1997), 1-29.

Anderson, Simon P., Andre de Palma, and Jacques-Francois Thisse, Discrete Choice Theory of Product Differentiation, (Cambridge, MA: MIT Press, 1992).

Antràs, Pol, "Firms, Contracts, and Trade Structure," Quarterly Journal of Economics, CXVIII (2003), 1375-1418.

Antràs, Pol, and Elhanan Helpman, "Global Sourcing," Journal of Political Economy, CXII (2004), 552-580.

Baker, George P., and Thomas N. Hubbard, "Empirical Strategies in Contract Economics: Information and the Boundary of the Firm," American Economic Review, XCI (2001), 189-194.

Baker, George P., and Thomas N. Hubbard, "Make versus Buy in Trucking: Asset Ownership, Job Design, and Information," American Economic Review, XCIII (2003), 551-572.

Baker, George P., and Thomas N. Hubbard, "Contractibility and Asset Ownership: On-Board Computers and Governance in U.S. Trucking," Quarterly Journal of Economics, CXIX (2004), 1443-1479.

Chiu, Stephen W.K., K.C. Ho, and Tai-Lok Lui, City-States and the Global Economy: Industrial Restructuring in Hong Kong and Singapore, (Boulder, CO: Westview Press, 1997).

Demurger, Sylvie, Jeffrey D. Sachs, Wing Thye Woo, Shuming Bao, Gene Chang, and Andrew Mellinger, "Geography, Economic Policy, and Regional Development in China," Asian Economic Papers, I (2002), 146-197.

Dollar, David, Anqing Shi, Shuilin Wang, and Lixin Colin Xu, "Improving City Competitiveness through the Investment Climate," mimeo, The World Bank, 2003.

Ethier, Wilfred J., and James R. Markusen, "Multinational Firms, Technology Diffusion, and Trade," Journal of International Economics, XLI (1996), 1-28.

Feenstra, Robert C., Wen Hai, Wing T. Woo, and Shunli Yao, "Discrepancies in International Data: An Application to China-Hong Kong Entrepôt Trade," American Economic Review, (1999), 338-343.

Feenstra, Robert C., and Gordon H. Hanson, "Ownership and Control in Outsourcing to China: Estimating the Property Rights Theory of the Firm," National Bureau of Economic Research Working Paper Number 10198, 2004.

Grossman, Sanford J., and Oliver D. Hart, "Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," Journal of Political Economy, XCIV (1986), 691-719.

Grossman, Gene, and Elhanan Helpman, "Integration versus Outsourcing in Industry Equilibrium," Quarterly Journal of Economics, CXVII (2002a), 85-120.

Grossman, Gene, and Elhanan Helpman, "Outsourcing in a Global Economy," National Bureau of Economic Research Working Paper Number 8728, 2002b.

Grossman, Gene, and Elhanan Helpman, "Managerial Incentives and the International Organization of Production," Journal of International Econoimcs, LXIV (2004), 237-262.

Hanson, Gordon H., "Incomplete Contracts, Risk, and Ownership," International Economic Review, XXXVI (1995), 341-63.

Hart, Oliver D., and John Moore, "Property Rights and the Nature of the Firm," Journal of Political Economy, XCVIII (1990), 1119-1158.

Hart, Oliver D., Firms, Contracts, and Financial Structure, (Oxford: Oxford University Press, 1995).

Holmstrom, Bengt, and Paul Milgrom, "The Firm as an Incentive System," American Economic Review, XXCIV (1994), 972-991.

Marin, Dalia, and Thierry Verdier, "Power Inside the Firm and the Market: A General Equilibrium Approach," Centre for Economic Policy Research Discussion Paper Number 3526, 2001.

Marin, Dalia, and Thierry Verdier, "Globalization and the Empowerment of Talent," Centre for Economic Policy Research Discussion Paper Number 4129, 2003.

Markusen, James R., Multinational Firms and the Theory of International Trade, (Cambridge, MA: MIT Press, 2002).

Markusen, James R. and Keith E. Maskus, "Discriminating among Alternative Theories of the Multinational Enterprise," Handbook of International Trade, James Harrigan and Kwan Choi, eds. (Oxford: Basel Blackwell, 2003).

McLaren, John, "Globalization and Vertical Structure," American Economic Review, XC (2000): 1239-1254.

Naughton, Barry, "China's Emergence and Prospects as a Trading Nation," Brookings Papers on Economic Activity, II (1996), 273-343.

Naughton, Barry, The China Circle, (Washington, DC: Brookings Institution Press, 1997).

Puga, Diego, and Daniel Trefler, "Knowledge Creation and Control in Organizations," National Bureau of Economic Research Working Paper Number 9121, 2002.

Rauch, James E., "Networks versus Markets in International Trade," Journal of International Economics, XLVIII (1999), 7-37.

Rauch, James E., and Alessandra Casella, 2003, "Overcoming Informational Barriers to International Resource Allocation: Prices and Group Ties," Economic Journal, CXIII (2003), 21-42.

Sung, Yun-Wing, The China-Hong Kong Connection, (Cambridge: Cambridge University Press, 1991).

Sung, Yun-Wing, Hong Kong and South China: The Economic Synergy, (Hong Kong: City University of Hong Kong Press, 1998).

Tirole, Jean, "Incomplete Contracts: Where Do We Stand?" Econometrica, 67 (1999), 741-781.

Train, Kenneth, Qualitative Choice Analysis, (Cambridge: MIT Press, 1986).

Wang, Kui Hua, Chinese Commercial Law, (Oxford: Oxford University Press, 2000).

Whinston, Michael, "Assessing the Property-Rights and Transaction Cost Theories of Firm Scope," American Economic Review, XCI (2001), 184-188.

World Bank, China: Foreign Trade Reform, (Washington, DC.: The World Bank, 1994).

Yeats, Alexander J., "Just How Big is Global Production Sharing?" Fragmentation: New Production Patterns in the World Economy, Sven W. Arndt and Henryk Kierzkowski, eds. (Oxford: Oxford University Press, 2001).

Notes

1. See Markusen [2002] and Markusen and Maskus [2003] for surveys.

2. For early work on firm boundaries in international trade, see Ethier and Markusen [1996] and McLaren [2000].

3. Our emphasis on how ownership depends on the intensity of different stages in production is consistent with the Antrás-Helpman [2004] model of outsourcing.

4. See Rauch [1999] and Rauch and Casella [2000] on networks and information costs in international trade.

5. For surveys of the theoretical literature, see Hart [1995] and Tirole [1999] and for surveys of the empirical literature, see Baker and Hubbard [2001] and Whinston [2001].

6. See Hanson [1995] for a test of an extended PR model.

7. The contract must specify the materials (and any equipment) to be imported, the processing activities to be performed, the fees to be paid, and the ports of entry and exit, among other items. See "Regulations Concerning Customs Supervision and Control over the Inward Processing and Assembling Operation (Amended)," Customs General Administration, October 5, 1990, http://www.moftec.gov.cn.

8. See "Measures on the Administration of the Customs of the People's Republic of China for Bonded Warehouse Factory Engaged in Processing Trade," Customs General Administration, April 6, 1988, http://www.moftec.gov.cn.

9. An example of this interaction, taken from Grossman and Helpman [2004], is when the project is "successful" (leading to positive sales) with some probability that is increasing in e_2.

10. That is, even if all parties were paid their first-best, there would still be additional profits of (B-A-P) > 0 to be allocated. Therefore, not matter how close to first-best are the *status quo* payoffs, the parties will want to Nash bargain over the outsourcing project so that these additional profits are allocated.

11. More precisely, when W is supermodular then changes in exogenous parameters tend to increase the optimal ownership and control regimes in the same direction: if the optimal δ_1 increases from 0 to 1, this will lower the opportunity cost of also increasing δ_2 from 0 to 1. This follows from the results in Holmstrom and Milgrom [1994], whereby a strictly supermodular function that is differentiable has a positive cross-derivative, $\partial^2 W / \partial\delta_1 \partial\delta_2 > 0$.

12. The source for these data is provided in the Appendix.

13. In our data 82.7 percent of observations have positive exports in one ownership/control regime, 13.4 percent have positive exports in two regimes, 3.4 percent have positive exports in three regimes, and 0.5 percent have positive exports in four regimes.

14. A stochastic specification of this type is suggested by Whinston [2001].

15. Standard errors for the modularity measures in Tables III and IV are obtained using bootstrap methods.

16. Using the 1-digit Standard Industrial Trade Classification (SITC), the coastal provinces have roughly equal processing exports within SITC 7 (which includes office machines and electrical machinery) and outside of SITC 7, whereas the interior provinces have four times more exports *outside* of SITC 7, and especially within SITC 8 (which includes apparel, footwear, and toys).

17. The complete matrices of export shares are reported in Feenstra and Hanson [2004].

18. Advantages to being in a zone may include expedited treatment by customs of imported inputs and exported outputs, greater opportunities to retain foreign exchange earnings, and access to various types of tax incentives. SEZs and related economic zones are managed by provincial governments and so may exhibit regional variation in their organization and effectiveness [Demurger *et al.* 2002].

19. Notice that complete contracts, with $\psi = 0$, is not nested within our model of section III, because we then also need to dispense with assumption (A.3). Under complete contracts, all efforts are at their first-best levels, so $e_1^* = \max\{P/\gamma_f, P/\gamma_g\}$ $e_2^* = (A+\lambda B)/\gamma_g$, and $e_3^* = B/\gamma_f$. Then the two columns of Table II are identical, so that V=0.

20. The variance of an extreme-value distribution is $\mu^2\pi^2/6$ [Anderson, De Palma and Thisse 1992, p. 40], whereas the MNL specification in (14) assumes that the variance is $\pi^2/6$, so that $\mu = 1$. Our assumption is that the variance parameter μ equals $\sigma(A+\lambda B)^2/\gamma_g$, so that by dividing each observation by this, we effectively obtain $\mu = 1$.

21. As discussed in note 13, some observations (for a Chinese city, type of economic zone, product, and destination market) have more than one positive choice of ownership/control regime. In this case, we can presume this means that more than one factory was operating in that city, product, etc. In the multinomial logit estimation, we split such an observation into two or more observations, corresponding to the ownership/control regimes of each type of factory. Disaggregating the trade data in this way, we obtain a standard multinomial logit dataset (with a unique ownership/control choice for each observation).

22. We apply bootstrap methods to obtain standard errors for the structural parameter estimates reported in this section.

23. Because we do not accurately measure the ratio $(B^2/\gamma_f)/[(A+\lambda B)^2/\gamma_g]$ appearing in (16b) and (16c), we do not expect to identify those coefficients or the intercepts in those equations. So we rely on the single intercept term of (16a), together with the three coefficients of $[P/(A+\lambda B)]^2$, to measure the four parameters σ, θ, ψ, and (γ_g/γ_f). The coefficient $b_3 = [(\gamma_g/\gamma_f) - 1]/\sigma$ is insignificantly different from zero, from which we conclude that $(\gamma_g/\gamma_f)=1$, and then we use the remaining coefficients a_1, b_1 and b_2 to solve for σ, θ, ψ. See the Appendix for details.

24. The *outbound value-added ratio* does not appear at all in (16a), and its estimated coefficient in Table V is very small. However, the coefficients on the outbound value-added ratio in (16b) and (16c) are predicted to be negative (see the Appendix), whereas in Table V they are positive. We do not use these estimates, however, because of the error in estimating the outbound value-added ratio; see note 19.

25. We compute standard errors by bootstrapping the regression with 100 replications.

26. In unreported results, we re-estimated (16) applying two alternative methods to compute the markups used to construct the value added ratios [Feenstra and Hanson 2004]. These results are very similar to those in Table VI.

27. This specification differs from (16) in that the inbound value-added ratio does not appear in the second equation and the outbound value added ratio appears in no equation.

28. The second alternative model from section IV involved entirely incomplete contracts (ψ=1), in which provincial policy makers influenced organizational design by affecting the value of the Nash bargaining weight, θ. In further unreported results, we re-estimated (16), setting ψ=1 and allowing θ to vary across provinces according to their observed policies towards foreign

investment, using the index from Demurger *et al.* [2002]. Inconsistent with the policy-preference model, estimated values of θ were not higher in provinces with more friendly investment policies. Forcing the human-capital specificity parameter, ψ, to equal unity yields estimates of θ that are undefined.

29. In Chinese trade statistics, the pure-assembly arrangement is called “processing and assembling” or “processing with supplied materials,” and the import-and-assembly arrangement is called “processing with imported materials.”

Table I: Foreign Ownership, Export Processing, and Trade in China

Year	Processing exports/ Total exports	FIE exports/ Total exports	Share in total processing exports of: Import-and-assembly	FIE exports
1997	0.545	0.361	0.704	0.561
1998	0.568	0.393	0.705	0.587
1999	0.568	0.413	0.677	0.609
2000	0.552	0.439	0.701	0.646
2001	0.554	0.462	0.714	0.669
2002	0.550	0.484	0.741	0.697

Columns (1) and (2) show processing exports and exports by foreign-invested enterprises, respectively, as a share of total China exports; columns (3)-(4) show as a share of total China processing exports, processing exports under the import-and-assembly regime, and processing exports by foreign-invested enterprises (FIEs). Source: Chinese export data from the Customs General Administration of the People's Republic of China.

Table II: Optimal Effort Levels

Control of the Inputs	Ownership of the Factory: $\delta_2 = 0$, Foreign firm f owns	Ownership of the Factory: $\delta_2 = 1$, Chinese manager g owns
$\delta_1 = 0$,	$e_1 = P/\gamma_f$ (first-best for f)	$e_1 = [1-(1-\theta)\psi]P/\gamma_f$
Foreign firm	$e_2 = (1-\theta)(A+\lambda B)/\gamma_g$	$e_2 = [A+(1-\theta\psi)\lambda B]/\gamma_g$
f controls inputs	$e_3 = B/\gamma_f$ (first-best)	$e_3 = [1-(1-\theta)\psi]B/\gamma_f$
$\delta_1 = 1$,	$e_1 = (1-\theta\psi)P/\gamma_g$	$e_1 = P/\gamma_g$ (first-best for g)
Chinese manager	$e_2 = (1-\theta\psi)(A+\lambda B)/\gamma_g$	$e_2 = [A+(1-\theta\psi)\lambda B]/\gamma_g$
g controls inputs	$e_3 = B/\gamma_f$ (first-best)	$e_3 = [1-(1-\theta)\psi]B/\gamma_f$

Table III: Processing Exports by Input Control and Factory Ownership Regime

	All provinces *Ownership of factory:*		**Interior and northern provinces** *Ownership of factory:*	
Control over inputs:	Foreign	Chinese	Foreign	Chinese
	S(0,0)	S(0,1)	S(0,0)	S(0,1)
Foreign buyer	0.083	0.271	0.177	0.110
(pure-assembly)	(0.001)	(0.003)	(0.007)	(0.004)
	S(1,0)	S(1,1)	S(1,0)	S(1,1)
Chinese factory	0.496	0.146	0.416	0.297
(import-and-assembly)	(0.003)	(0.002)	(0.011)	(0.009)
Modularity	-2.417		0.141	
	(0.026)		(0.064)	

This table shows: (i) mean shares of Chinese processing exports by factory ownership (foreign versus Chinese) and input-control regime (pure-assembly versus import-and-assembly); (ii) modularity, defined by $V = [\ln S(0,0)+\ln S(1,1)] - [\ln S(1,0)+\ln S(0,1)]$. The first two columns show results for all provinces; the second two columns show results for interior and northern provinces (i.e. excluding Shanghai, Zhejiang, Fujian, Guangdong, and Hainan). Standard errors for mean shares (in parentheses) are computed over observations by year, industry, destination country, origin province, and trade zone status, while standard errors for the modularity measure are obtained by bootstrapping with 100 replications.

Table IV: Modularity of the Surplus Function for Sub-samples

		Export Share in Chinese control and foreign ownership	Modularity
Industries	*Apparel*	0.302	-0.716
		(0.003)	(0.020)
	Office Machines	0.693	-4.265
		(0.016)	(0.223)
Location	*Inside SEZ*	0.745	-1.967
		(0.006)	(0.069)
	Outside SEZ	0.442	-2.367
		(0.003)	(0.025)
Trade Route	*Through Hong Kong*	0.490	-4.142
		(0.004)	(0.040)
	Export directly	0.504	-0.984
		(0.005)	(0.031)

This table shows for various sub-samples of the data: (i) mean shares of processing exports subject to Chinese control of inputs (import-and-assembly regime) and foreign ownership, (ii) modularity, defined by $V = [\ln S(0,0)+\ln S(1,1)] - [\ln S(1,0)+\ln S(0,1)]$. Standard errors for mean shares (in parentheses) are computed over observations by year, industry, destination country, origin province, and trade zone status, while standard errors for the modularity measure are obtained by bootstrapping with 100 replications.

Table V: MNL Estimates of the Property Rights Model

	Foreign ownership & Chinese control Equation (16a)		Chinese ownership & foreign control Equation (16b)		Chinese ownership & Chinese control Equation (16c)	
Intercept	0.74		-0.47		1.24	
(Year = 2002)	(0.15)		(0.16)		(0.14)	
Inbound	-0.34		-0.036		-0.17	
value-added ratio	(0.054)		(0.072)		(0.050)	
Outbound	-0.007		0.013		0.035	
value-added ratio	(0.014)		(0.021)		(0.017)	
Years:	*1997-99*	*2000-02*	*1997-99*	*2000-02*	*1997-99*	*2000-02*
Hong-Kong	-0.061	0.24	0.16	0.59	0.001	0.26
	(0.20)	(0.15)	(0.23)	(0.16)	(0.22)	(0.16)
SEZ	-0.21	0.47	0.19	-0.90	0.12	-0.48
	(0.15)	(0.11)	(0.31)	(0.20)	(0.24)	(0.16)
North coast	0.32	-0.18	-0.25	-0.018	0.54	-1.53
	(0.21)	(0.16)	(0.24)	(0.15)	(0.24)	(0.18)
Beijing area	0.11	-0.21	-0.12	-0.040	0.32	-1.18
	(0.20)	(0.15)	(0.20)	(0.12)	(0.22)	(0.16)
Shanghai area	-0.14	0.57	-0.56	0.72	0.027	-0.48
	(0.19)	(0.14)	(0.22)	(0.12)	(0.20)	(0.14)
South coast	0.75	1.94	0.25	2.42	1.10	-0.14
	(0.29)	(0.20)	(0.37)	(0.24)	(0.30)	(0.21)

N = 1,118,883, across 8-digit harmonized system (HS) products, provinces, years, and destination markets. Each column shows the estimates for choosing an ownership/control regime relative to foreign ownership and foreign control of inputs. The inbound (outbound) value-added ratio equals the markup on Hong Kong re-exports entering (leaving) China, divided by the value-added in processing trade within China. These ratios are measured at the 1-digit SITC industry rather than 8-digit HS product, so the standard errors (in parentheses) are corrected for correlation of errors across observations in the same one-digit industry and year. The variable SEZ equals one if the HS products are produced in a Special Economic Zone (including high-technology development zones), and Hong-Kong equals one if the good is re-exported through Hong Kong. All regressions include indicator variables for the year (with 2002 excluded). The northern coast consists of Heilongjiang, Jilin and Lioning; the area around Beijing includes Beijing/Tianjin, Hebei and Shandong; the area around Shanghai includes Shanghai, Jiangsu and Zhejing; and the southern coastal provinces consist of Fujian, Guangdong, and Hainan Island.

Table VI: Parameter Estimates

		SEZ, HK Re-exports		SEZ, Direct exports		No SEZ, Direct exports	
		1997-99	*2000-02*	*1997-99*	*2000-02*	*1997-99*	*2000-02*
	Region:						
ψ	Interior	0.38	0.33	0.41	0.35	0.48	0.43
		(0.05)	(0.04)	(0.06)	(0.04)	(0.06)	(0.05)
	North coast	0.36	0.34	0.39	0.38	0.44	0.48
		(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.06)
	Beijing area	0.40	0.35	0.43	0.38	0.51	0.50
		(0.06)	(0.04)	(0.06)	(0.05)	(0.06)	(0.07)
	Shanghai area	0.33	0.28	0.34	0.30	0.38	0.34
		(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)
	South coast	0.21	0.22	0.21	0.23	0.22	0.24
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
	Range	*0.19*	*0.13*	*0.22*	*0.15*	*0.29*	*0.26*
θ	Any region	0.69	0.69	0.69	0.69	0.69	0.69
		(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)

Parameters estimates are calculated from the coefficients in Table 6 and equation (16). The parameter ψ is the degree of human-capital specificity, and θ is bargaining weight of the foreign firm. Standard errors are obtained by bootstrapping (16) using 100 replications. The range indicates the difference between the maximum and minimum estimates across regions.

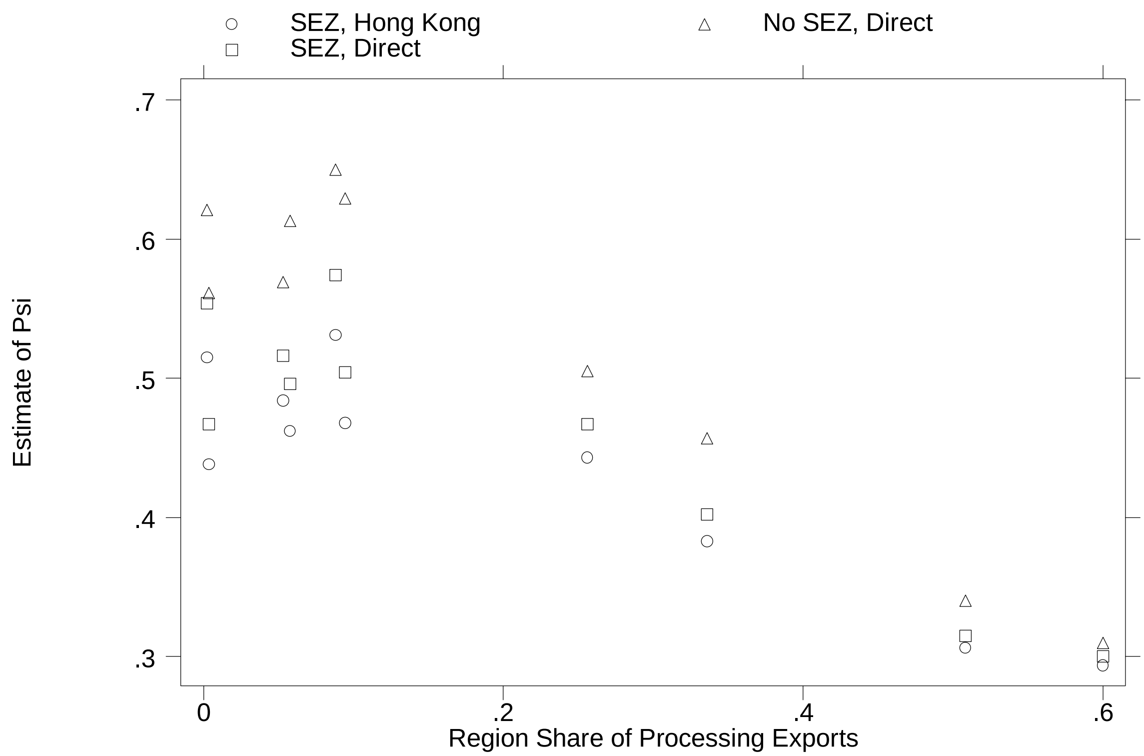

Figure I: Human-Capital Specificity (ψ) and Regional Export Activity

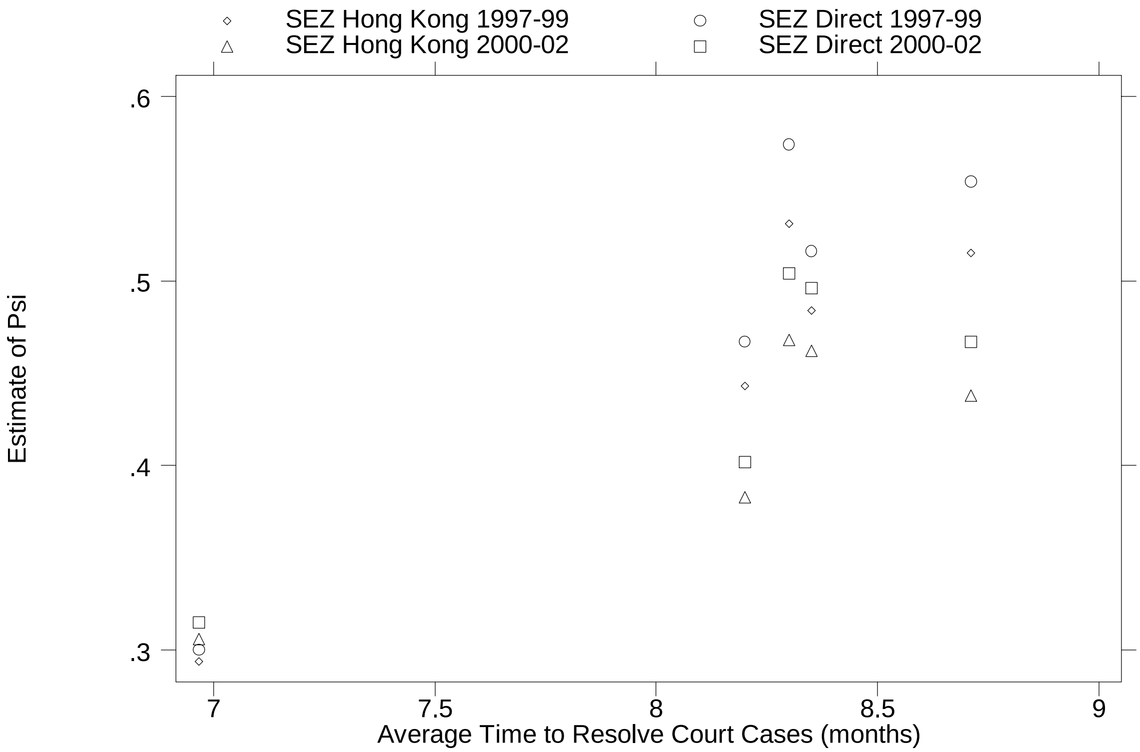

Figure II: Human-Capital Specificity (ψ) and Court Costs