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Ownership and Control in Outsourcing to China:

Estimating the Property-Rights Theory of the Firm

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Abstract. In this paper, we examine the organization of export processing operations in China. During the 1990s, export processing accounted for over 50% of China's total exports. We observe China's processing exports broken down by whether the factory is Chinese or foreign owned and by whether control over the inputs that the factory processes is in Chinese or foreign hands. To account for how parties organize export processing in China, we build and estimate a property-rights model of the firm. Multinational firms and the Chinese factory managers with whom they contract divide the surplus associated with export processing by Nash bargaining. Threat-point payoffs are subject to a loss in human capital, depending on which party owns the factory and which party controls input purchases. We show that if this human-capital specificity is not too large, it is optimal to give factory ownership and input control to different parties. In the empirical analysis, we find that multinational firms engaged in export processing in China tend to split factory ownership and input control with managers in China: the most common outcome is to have foreign factory ownership but Chinese control over the inputs. We estimate the parameters of the property-rights model that are consistent with this outcome.

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1. Introduction

Over the last several decades, much of the developing world has adopted trade policies that favor export production. Typically, the early periods of export-led development involve *export processing*. In this arrangement, firms import parts and components from abroad, process these inputs into finished goods, and then export the final products. In the 1970s, Hong Kong, Singapore, and Taiwan assembled and exported footwear, clothing, and other consumer goods (Findlay and Wellisz, 1993). In the 1980s, China, Mexico, and much of Southeast Asia developed extensive export processing operations (Grunwald and Flam, 1985; Yeats, 2001). And in the 1990s, Central America, Eastern Europe, and South Asia joined the fray.

Multinational enterprises mediate a substantial amount of processing trade involving developing countries (Barba et al., 2002; Borga and Zeile, 2002; Feenstra and Hanson, 2002). These firms design the goods to be produced and distribute final outputs. Where multinationals differ is in how much control they exert over actual processing activities. One source of variation is in terms of who owns the processing factory. While Dell subcontracts the assembly of its personal computers to independent firms in many locations, Intel uses wholly-owned subsidiaries in China, Costa Rica, and elsewhere, to assemble its microchips. Another source of variation is in terms of who controls processing decisions. Dell maintains tight control over who buys what from whom along its PC supply chain. Mattel, in contrast, grants the subcontractors that make its plastic dolls latitude in choosing from whom to purchase raw materials.

In this paper, we examine the organization of export processing operations in China. During the 1990s, processing exports accounted for over 50% of China's total exports. By virtue of the country's trade regulations, we have unusually detailed data on trade flows under different contractual arrangements, as described in section 2. We observe China's processing exports broken down by *who owns the plant* and by *who controls the inputs* that plants process. 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.

To account for how export processing is organized in China, we appeal to the property-rights (PR) model of Grossman and Hart (1986) and Hart and Moore (1990), as presented in section 3. In this framework, parties use control rights over productive assets to ameliorate hold-up problems created by incomplete contracts. Contractual incompleteness requires parties to divide gains from trade by Nash bargaining, where threat-point payoffs involve some loss in investments in human capital. Threat-point payoffs also depend on who has the relevant control rights (i.e., ownership of the factory or control over input decisions). Whether ownership and control should be given to the same or to different parties will turn out to depend on two parameters of the model: the specificity of human-capital investments in the project and value-added in the processing factory. When human-capital specificity is low, or when value-added is high, then the multinational can ameliorate the potential hold-up problem by transferring control of the input purchases to the manager. This will improve her incentive to invest in projects that are specific to the multinational even when she does not own the factory, so that ownership and control are given to different parties. When value-added is low, however, or human-capital specificity is high, then we find that ownership and control should be given to the same party.

Previewing our empirical results in section 4, 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 inputs purchases. This is consistent with moderate or low human-capital specificity, and we estimate this parameter of the property-rights model. There is some interesting variation, however, in the pattern of ownership/control across types of firms, industries, and regions within China, as we shall investigate.

Our findings are relevant to several bodies of literature. One is work on the role of exports in industrialization (Amsden, 1989; Wade, 1992). In the 1980s, Hong Kong, Singapore, and Taiwan graduated from export processing to original equipment manufacture (OEM) by backward integrating into the production of parts and components (Gereffi and Korzeniewicz, 1994; Orru et al., 1997). In the 1990s, some firms then graduated to own-brand production by forward integrating into marketing and sales (Chiu, et al., 1997; Hamilton, 1999). The expansion of East Asian firms up and down the supply chain helped their economies industrialize. Moving beyond simple export assembly to other activities is often linked to the accumulation of human and physical capital. Little is known about whether the contractual environment also influences organization changes during export-led development.

A second body of literature to which our work relates is empirical work on modern theories of the firm. Despite intense theoretical interest in the PR and other models, few papers have tested them.[1] A notable exception is Baker and Hubbard (2000a,b) who examine contractual arrangements in U.S. trucking. They exploit the introduction of on-board computers in trucks, which changed the costs of monitoring truck drivers, to sharpen predictions from

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[1] 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).

theory and to surmount the lack of data on key determinants of organizational choice. They find evidence consistent with the PR model, but also with the alternative "incentive systems" (IS) model due to Holmstrom and Milgrom (1994).[2]

A third body of literature to which our work relates is theories of ownership decisions in global-production arrangements. Several recent papers build general equilibrium models of trade around specific theories of the firm. Grossman and Helpman (2002a, 2002b) and Antras (2001) use the PR approach to develop general-equilibrium models of global outsourcing and intra-firm trade, while Grossman and Helpman (2002c) apply the IS framework to model managerial compensation in global production. Marin and Verdier (2001) and Puga and Trefler (2002) extend the Aghion and Tirole (1997) theory of delegating authority in organizations to general equilibrium contexts. While we do not examine the general-equilibrium implications of these models, our results are relevant for assessing which underlying framework best describes how parties organize global production.

2. Export Processing in China

Export processing plays a major role in China's foreign trade. Table 1 shows that over the years 1997-1999, which spans our sample period, processing exports accounted for 53.7% of China's total exports. Export processing in China is broadly similar to that in other countries. It involves a firm in China importing intermediate inputs, processing the inputs, and then exporting the finished goods. The inputs are imported duty-free (as are any investment goods used in

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[2] In the incentive-systems (IS) model of Holmstrom and Milgrom (1994) a principal designs a contract to influence an agent's effort supply choice, subject to uncertainty in the principal's observation of the agent's effort. Under some assumptions, Holmstrom and Milgrom argue that the contractual instruments the principal uses to influence the agent's effort level are *complementary*. In our context, this means that factory ownership and input control tend to be concentrated in the hands of a single party. Our results are inconsistent with this prediction, suggesting that the incomplete-contracts approach of the PR model is more appropriate to the weak legal system in China.

export processing) as long as these goods are only used to produce exports. As discussed in the previous section, China has two regulatory regimes for export processing.

The Pure-Assembly Regime.[3] 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.[4] 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 1 shows that this regime is the more common form of export processing, accounting for 68.5% of processing exports over the 1997-1999 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

[3] The pure-assembly arrangement is translated as either "processing and assembling" or "processing with supplied materials" in Chinese statistics. The import-and-assembly arrangement is translated as "processing with imported materials." We use our own terms for these arrangements in order to define them more clearly.

[4] 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.

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.[5] 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 controls rights over imported materials. Under pure-assembly, the foreign buyer of the processed goods owns the materials used in processing. Without the consent of this buyer, 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 second 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 1 shows that FIEs accounted for 56.5% of China's processing exports over the years 1997-1999. 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% ownership stake. One issue is whether a 25% ownership share gives a foreign party effective control over a processing factory.

[5] 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.

Standard definitions of whether an enterprise is foreign controlled set a lower ownership threshold. The U.S. government, for instance, defines as foreign-controlled any enterprise in which the ownership stake of a foreign interest is at least 10%. Following this precedent, we treat as foreign controlled both wholly owned factories and equity joint ventures.[6]

Export processing began to take off in China in the late 1980s. Among the pioneers in the sector were Hong Kong trading companies that set up processing plants across the border in Guangdong Province and used Hong Kong as a base from which to manage their operations (Sung, 1991). Hong Kong continues to mediate a large fraction of China's processing trade. Table 1 shows that from 1997 to 1999, 54.7% of China's processing exports were re-exported through Hong Kong. Hong Kong traders provide a range of intermediation services, including finding foreign buyers, sorting and grading goods according to quality, labeling and packaging, and coordinating processing in China with processing in other countries (Naughton, 1997; Feenstra and Hanson, 2002). We shall examine whether processing exports re-exported through Hong Kong differ systematically from those shipped directly to destination markets.

3. 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 factory. The formulation of our model follows closely the PR approach of Grossman and Hart (1986) and Hart and Moore (1990), but as we shall see, the results can also be similar to the IS framework of Holmstrom and Milgrom (1994).

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[6] The government also recognizes cooperative joint ventures as a mode of inward foreign investment (Sung, 1998). These are often non-equity arrangements between a foreign firm and a domestic partner that account for a small fraction of exports. Since these arrangements may not involve foreign investment, we exclude them from our definition of foreign-owned plants. Counting them as foreign-owned plants does not affect the results.

Consider a principal denoted by f (the foreign firm) transacting with an agent in China denoted by g (the factory manager). 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 to market and to 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. All actions are observable to the two parties but not verifiable to a third party.

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 preparing the factory, by the *factor manager* g; e_3 = effort devoted to marketing the final good, by the *foreign firm* f. The subscripts on these effort levels denote the stages of production rather than the timing, since all efforts are undertaken in period 1, before production and sale. 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 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 preparation effort lowers processing costs in period 2. 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 preparation and 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 revenue, with effort e_2 by the factory manager affecting both. It is perhaps obvious that effort by the manager can reduce factory costs, and an example (taken from Grossman and

Helpman, 2002c) where such effort also affects final sales is when the project is "successful" (leading to positive sales) with some probability that is increasing in e_2. Joint production means that it will be difficult to compensate the manager at the first-best level, reflecting the marginal contributions of her effort to both processing costs and final sales.

The period 1 effort investments, e_i, i=1,2,3, impose a cost on the parties involved. The variable $\delta_1 \in \{0,1\}$ indicates 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*. The costs to the foreign firm are given by $C_f[(1-\delta_2)e_1, e_3] = \frac{\gamma_f}{2}[(1-\delta_1)e_1^2 + e_3^2]$, and the costs to the manager are given by $C_g(\delta_1 e_1, e_2) = \frac{\gamma_g}{2}(\delta_1 e_1^2 + e_2^2)$, where γ_f and γ_g are the disutility of effort for each party. The total surplus from the project is then,

$$W = \pi - C_h[(1-\delta_1)e_1, e_3] - C_f(\delta_1 e_1, e_2), \tag{2}$$

where first-best effort levels are $e_1^* = \max\{P/\gamma_f, P/\gamma_g\}$, $e_2^* = (\lambda B + A)/\gamma_g$, and $e_3^* = B/\gamma_f$.

In addition to input control, δ_1, we introduce 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 factory used to process the input. While this indicator variable does not appear in the profits (1) or surplus (2), ownership of the factory certainly affects the effort levels of f and g, as will be made clear below. With the effort levels depending on δ_1 and δ_2, the surplus in (2) also depends on these, which we write as $W(\delta_1, \delta_2)$. The goal of our analysis is to see how W varies with δ_1 and δ_2. In particular, if $W(0,0) + W(1,1) > W(0,1) + W(1,0)$ then W is strictly *supermodular,* so the highest values for W are obtained when δ_1 and δ_2 take on the *same* values. Then it is optimal for the same party to control the inputs and to own the factory (factory ownership and input control are "concentrated"). This is the case on which the IS literature focuses. Conversely, when W(0,0) + W(1,1) < W(0,1) + W(1,0) 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 the input purchases and the other owns the factory (factory ownership and input control are "dispersed"). We will argue that PR model can lead to either of these outcomes, depending on parameter values. To establish this, we need to solve for effort levels under incomplete contracting.

3.1 Incomplete Contracting

Essential to modern theories of the firm is that idea that contracts are incomplete, so that the first-best effort levels cannot necessarily be obtained. In Grossman and Hart (1988), the surplus of the firms is divided by Nash bargaining. If bargaining breaks down, the *status quo* or threat point payoffs for the two parties are 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 under Nash bargaining are then:

$$\text{Party f receives:} \quad \pi_f = \hat{\pi}_f + \tfrac{1}{2}(\pi - \hat{\pi}_g - \hat{\pi}_f) = \tfrac{1}{2}(\pi - \hat{\pi}_g) + \tfrac{1}{2}\hat{\pi}_f \tag{3}$$

$$\text{Party g receives:} \quad \pi_g = \hat{\pi}_g + \tfrac{1}{2}(\pi - \hat{\pi}_f - \hat{\pi}_g) = \tfrac{1}{2}(\pi - \hat{\pi}_f) + \tfrac{1}{2}\hat{\pi}_g . \tag{4}$$

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

$$\text{Party f solves:} \qquad \max_{(1-\delta_1)e_1, e_3} \pi_f - C_f[(1-\delta_1)e_1, e_3]\,, \tag{5}$$

$$\text{Party g solves:} \qquad \max_{\delta_1 e_1, e_2} \pi_g - C_g(\delta_1 e_1, e_2)\,, \tag{6}$$

where the foreign firm f chooses e_1 when δ_1=0, while the manager g chooses e_1 when δ_1=1.

In order to solve these problems, we need to be more specific about the threat point payoffs received by each party. Our general assumption is that when Nash bargaining breaks down, the party not owning the factory can still make an arrangement with another factory. But in that case, the marginal product of his or her effort investment are reduced by ψ, so the payoffs are $(1 - \psi)$ times their first-best level. Thus, ψ measures the specificity of human-capital investments by either party in the project. For example, when the *Chinese manager owns the factory* ($\delta_2 = 1$) and Nash bargaining breaks down, then the foreign firm will seek out another factory to work with. In that case, the threat-point payoff to the foreign firm is:

$$\text{Party f threat-point when } \delta_2 = 1: \qquad \hat{\pi}_f = (1-\psi)[Be_3 + (1-\delta_1)Pe_1]\,. \tag{7}$$

Meanwhile, the manager can still use the factory to process the input for another firm. We suppose that the transfer price received depends imperfectly on the marketing effort of the manager, $\hat{T} = T + \lambda(1 - \psi)Be_2$, but otherwise the manager has property rights over the residual profits of the firm. Her threat-point payoff is then:

$$\text{Party g threat-point when } \delta_2 = 1: \qquad \hat{\pi}_g = \hat{T} - A(1-e_2) - P(1-\delta_1 e_1)\,. \tag{8}$$

Next, suppose that the *foreign firm owns the factory* ($\delta_2 = 0$). In the case of disagreement over the *ex post* division of profits, the foreign firm retains ownership of the factory and hires another manager. There is no reason to expect that a new manager would have made prior effort investments, so in that event the profits of the foreign firm should be computed with e_2=0. Thus, the threat-point payoff of the foreign firm is:

$$\text{Party f threat point when } \delta_2 = 0: \qquad \hat{\pi}_f = B(1+e_3) - A - P[1-(1-\delta_1)e_1]. \qquad (9)$$

The ex-manager must now find another factory to work with, and the amount that she earns from her effort investments is again reduced by ψ. However, in this case we make the further assumption that *the manager's effort investments are valued with another factory if and only if she also searches for the input.* In other words, a manager who is separated from a foreign firm can be hired by *another foreign firm* only if she brings with her the knowledge of input control; otherwise, she become part of the general labor pool, where her prior effort investments are not valued. Normalizing the wage in the general labor pool at zero, then the threat point payoff to the manager when she does not own the factory is:

$$\text{Party g threat point when } \delta_2 = 0: \qquad \hat{\pi}_g = \delta_1(1-\psi)[(A+\lambda B)e_2 + Pe_1]. \qquad (10)$$

Substituting (7)-(10) into the objective functions (6) and (7), we can determine the optimal effort investments, as discussed in the next section.

3.3 Solutions for Effort Investments

Let us first consider that case where the foreign firm owns the factory, and also controls the input, so that $(\delta_1,\delta_2) = (0,0)$ in the upper-left cell of Table 2. In the disagreement point the foreign firm receives the full marginal value from it's own effort investments, as shown in (9), since it continues to own the factory. It follows that the foreign firm's effort levels are at their first-best levels of $e_1 = P/\gamma_f$ and $e_3 = B/\gamma_f$. The manager, on the other hand, has the threat-point payoffs in (10). When $\delta_1 = 0$, the manager's effort investments have no value in outside work. Since the threat-point payoff has weight 1/2 in (4), then $e_2 = (A + \lambda B)/2\gamma_g$ is *below* its first-best level.

The case $(\delta_1,\delta_2) = (0,0)$ is particularly simple because the foreign firm retains ownership of the factory, and since it also made the input decision, the manager has no property rights. To discuss other cases in Table 3, recall our general assumption that the *party controlling the input decision loses $0 \leq \psi \leq 1$ times their marginal product if they work with another factory.* In particular, consider the case $(\delta_1,\delta_2) = (1,0)$ in the lower-left cell of Table 2, so the foreign firm retains ownership of the factory but the Chinese manager now controls the input decision. In that case, if the manager goes to another factory then she loses ψ times the marginal product of her effort investments. So the optimal investment towards processing the inputs is now $e_2 = [1-(\psi/2)](A + \lambda B)/\gamma_g$, and provided $\psi < 1$, this *exceeds* $e_2 = (A + \lambda B)/2\gamma_g$ as applies when the foreign firm has both ownership and control. Thus, giving the manager control over input-search improves her incentive to make investments in processing the input. This is because the threat-point earnings from outside employment in (10) are *conditional on* having control over the input, δ_1=1. However, her optimal effort in input-search becomes $e_1 = [1-(\psi/2)]P/\gamma_g$, which is less than the first-best level for $\psi > 0$. In this case, the foreign firm still chooses the first-best effort investment $e_3 = B/\gamma_f$ in marketing the finished good.

In order to compute the levels of surplus $W(\delta_1, \delta_2)$, we use the following result:

Lemma

Suppose the efforts levels are $e_1 = (1-\Delta_1)P/\gamma_h$, $h = f, g$, $e_2 = [(1-\Delta_{2a})A + (1-\Delta_{2b})\lambda B]/\gamma_g$, and $e_3 = (1-\Delta_3)B/\gamma_f$. Then surplus is:

$$\begin{aligned} W = (B-A-P) + \tfrac{1}{2\gamma_h}(1-\Delta_1^2)P^2 + \tfrac{1}{2\gamma_f}(1-\Delta_3^2)B^2 \\ + \tfrac{1}{2\gamma_g}[(1-\Delta_{2a}^2)A^2 + (1-\Delta_{2a}\Delta_{2b})2\lambda AB + (1-\Delta_{2b}^2)\lambda^2 B^2]. \end{aligned} \tag{11}$$

This result follows by straightforward computation, and shows that the welfare loss is proportional to the *square* of the deviation of each effort level from its first-best value. Making use of (11) and the efforts shown in the first column of Table 2, it is readily shown that W(0,0) cannot be ranked in general with W(1,0): effort e_1 is higher when the foreign firm searches for the input, but effort e_2 in processing the input is higher when the manager searches for it, since this improves the manager's threat-point payoff.

Now consider the situation where the manager owns the processing factory (δ_2=1). The solutions for the effort investment are shown in the second column of Table 2. When $\delta_1 = 0$, the foreign firm controls input purchases. As summarized in the upper-right cell of Table 2, all effort investments are below their first-best level. For the foreign firm, the marginal value of its investments are reduced by ψ in its threat-point payoff, and since this has weight 1/2 in (3), its optimal efforts levels are $e_1=[1-(\psi/2)]P/\gamma_f$ and $e_3=[1-(\psi/2)]B/\gamma_f$. The manager chooses e_2, which has marginal value ($A+\psi\lambda B$) in her threat-point payoff (8), as compared with ($A+\lambda B$) in overall profits π. Since the threat-point has weight 1/2 in (4), it follows that $e_2 = (A/\gamma_g) + [1-(\psi/2)]\lambda B/\gamma_g$, which is below the first-best level.

Suppose now that the manager controls input purchases, $\delta_1 = 1$. In that case, she receives full marginal value of P from search effort in *both* her threat-point payoff (8) and in total profits π. It follows that her optimal search investment is at her own first-best level, $e_1 = P/\gamma_g$. The other efforts levels are unchanged from when the foreign firm controls the input decision. So under the outsourcing contract, the only difference between having each party control the input decision is in their search efforts. With differing disutility of efforts, we cannot rank welfares W(0,1) and W(1,1) obtained under outsourcing. If $\gamma_f = \gamma_g$, however, then it is clearly better to have the manager search for the input, since she undertakes this activity at her first-best level. So $W(1,1) > W(0,1)$ if $\gamma_f = \gamma_g$.

Using the effort levels in Table 2, the value of surplus in each case is computed as in (11). Then a convenient summary statistic is the *modularity* of the surplus function, computed by taking the sum of its values using the diagonal elements of Table 2, minus the sum of its value using the off-diagonal elements. We obtain:

$$W(0,0) + W(1,1) - W(0,1) - W(1,0) = \frac{P^2\psi^2}{8}\left(\frac{1}{\gamma_f} + \frac{1}{\gamma_g}\right) - \frac{(A+\lambda B)^2(1-\psi^2)}{8\gamma_g}. \qquad (12)$$

It is apparent that (12) can be positive or negative. In the former case the surplus function is strictly supermodular, meaning that the highest values tend to occur when $\delta_1=\delta_2$, so that ownership and control go to the *same* party; in the latter case, the surplus function is strictly submodular so that the highest values tend to occur when $\delta_1\neq\delta_2$, so that ownership and control go to *different* parties. These results are summarized with:

Proposition 1

The surplus function is strictly supermodular, so (12) is positive, if and only if,

$$\left(\frac{A+\lambda B}{P}\right)^2 < \left(\frac{\psi^2}{1-\psi^2}\right)\left[1+\left(\frac{\gamma_g}{\gamma_f}\right)\right] \quad . \tag{13}$$

To interpret the ratio on the left of (13), 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 that P is the marginal product of her effort e_1, and $e_1^* = P/\gamma_g$ is the first-best effort levels, so that P^2/γ_g would be the labor income or value-added in the search activity. It follows that $[(A+\lambda B)/P]^2$ is interpreted as the *ratio of value-added in the factory relative to that in input search,* or simply the *value-added ratio,* in the first-best.

Then (13) shows that if the value-added ratio is low, or the parameter ψ measuring the specificity of human-capital investments is high, then supermodularity of the surplus function is obtained. The reason for this is that low value-added means the incentive problem occurs in *input search* rather than processing. From Table 2, the first-best levels of input search are obtained along the diagonal, when the *same party* has ownership of the factory and control over input sourcing. This occurs because ownership of the factory brings with it property rights over the residual profits, so a party that has both ownership and control will make the first-best effort in input search. Similarly, when ψ is high (say, $\psi = 1$) then the outside options are irrelevant and the disincentive for the manager to engage in processing effort e_2 is the same in all cells of Table 2: $e_2 = (A+\lambda B)/2\gamma_g$ when $\psi=1$, which is one-half of its first-best level. Then again, the relevant incentive problem occurs in *input search* rather than processing, which obtains its first-best along the diagonal, when ownership and control is given to the same party. This is the case on which the IS framework focuses, and also arises in the PR model for low value-added or high ψ.

When value-added is high, however, or human-capital specificity is low, then surplus depends more on ameliorating the incentive problem in processing. In these cases, the manager's effort is improved by giving her better outside options. In particular, when the foreign firm owns the firm then the manager's outside options are improved by giving her control over the inputs. Because ownership and control are given to opposite parties, this means that the surplus function is *submodular*, contrary to the IS result.

We can think of having a low value of ψ as indicating "thick labor markets" for the manager, since her outside options are improved. We might expect this to occur in regions of China where there is an agglomeration of processing activity, and less restrictive rules governing new firms and hiring. A lower value of ψ, or higher productivity in processing as measured by $(A+\lambda B)$, both give *more submodular* values of the surplus function. This results follows directly from the measure of modularity in (12):

Proposition 2

Define $V \equiv W(0,0) + W(1,1) - W(0,1) - W(1,0)$. Then:

$$\frac{\partial V}{\partial A} < 0, \; \frac{\partial V}{\partial B} < 0, \; \frac{\partial V}{\partial \lambda} < 0, \text{ and } \frac{\partial V}{\partial \psi} > 0. \qquad (14)$$

To motivate this result, consider comparing the contracts used in, say, state-owned enterprises versus private enterprises in China. We expect managers in state-owned enterprises to be less productive (lower A), so (15) says that by excluding these enterprises from the dataset we should observe *lower* values of V. Likewise, consider factories in China that use agents in Hong Kong to arrange the marketing of their goods. As we discuss below, we expect these Hong Kong traders to have higher downstream productivity (higher B), so when focusing on trade through Hong Kong, we again expect to see *lower* values of V. Essentially, moving towards more efficient environments has the effect of increasing the relative frequency of observations where ownership and control of the inputs are given to different parties. We will refer to lower values of $V < 0$ as having more *dispersed* ownership and control, while $V > 0$ has *concentrated* ownership and control, i.e. given to the same party. The goals of our empirical analysis will be to assess the modularity of the surplus function, as well as estimate ψ and other parameters.

4. Empirical Results

In this section we test the empirical predictions of from our model. Data are from the Customs General Administration of the People's Republic of China and show processing exports by year (1997-1999), destination country, four-digit SITC product, origin province in China (including trade zone status), customs regime (pure-assembly or import-and-assembly), firm type (foreign or Chinese-owned), and export status (direct export or re-export through Hong Kong). We have roughly 64,000 observations per year.

4.1 Stochastic Specification

The modularity of the surplus function cannot be tested directly, because we do not observe the value of surplus from outsourcing activity; instead, we will observe the *proportion of 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 will suppose that ownership and control in our data are chosen to maximize $W(\delta_1, \delta_2)$ *plus* a random error that varies across contractual types.[7] Denoting these random errors by ε_{ij}, $i,j \in \{0,1\}$, the probabilities that each control/ownership pair (δ_1, δ_2) is chosen are:

$$\begin{aligned}\Pr(i,j) &= \text{Prob}[\, W(i,j) + \varepsilon_{ij} \geq W(i',j') + \varepsilon_{i'j'},\ i'j' \in \{0,1\}\,] \\ &= \text{Prob}[\, \varepsilon_{i'j'} - \varepsilon_{ij} \leq W(i,j) - W(i',j'),\ i'j' \in \{0,1\}\,] \\ &= \int_{\varepsilon_{i'j'} - \varepsilon_{ij} \leq W(i,j) - W(i',j')} dF(\varepsilon)\ , \end{aligned} \tag{15}$$

where $F(\varepsilon)$ is the joint distribution function of ε. The random errors ε_{ij}, $i,j \in \{0,1\}$ represent unobserved (to the researcher) cost factors associated with ownership and input control. These include the cost of incorporating a domestic or foreign-owned firm in China, the cost of setting up a specific type of processing plant (pure assembly versus important and assembly), or other fixed costs associated with establishing an export processing operation. It is appropriate to think of each (f,g) pair as having a different draw of ε_{ij}, $i,j \in \{0,1\}$, which influences their optimal choice over ownership and control.

Let us further assume that ε_{ij}, $i,j \in \{0,1\}$, are distributed as i.i.d. extreme value. Then it is well known (see e.g. Anderson *et al,* 1992, p. 39) that the probabilities in (15) take on the logit form:

$$\Pr(i,j) = \frac{\exp[W(i,j)/\mu]}{\sum_{i,j=0,1} \exp[W(i,j)/\mu]}, \quad i,j \in \{0,1\}. \tag{16}$$

In this formula, the parameter μ is related to the variance of the extreme value distribution.[8] It

[7] A stochastic specification of this type is suggested by Whinston (2001).
[8] The variance of the extreme value distribution is $\pi^2\mu^2/6$.

will be convenient to choose this parameter as $\mu = \sigma(A+\lambda B)^2/\gamma_g$, so that the variance is related to the (first-best) value-added in the processing factory.

A problem we encounter is that we do not have firm-level data on factory ownership and control of inputs, but rather, have Chinese trade data on *exports by ownership and contractual types*. To make the connection between these data and (15) or (16), let $x(\varepsilon)$ be exports of each factory (i.e., with the unobserved cost vector ε), so that total exports are $X = \int x(\varepsilon)dF(\varepsilon)$. Then instead of (16) we observe:

$$S(i,j) \equiv \int_{\varepsilon_{i'j'}-\varepsilon_{ij} \leq W(i,j)-W(i',j')} [x(\varepsilon)/X]dF(\varepsilon)\,. \tag{17}$$

That is, we observe the *market share* of exports accounted for by each control/ownership regime, which depends on the relative exports $[x(\omega)/X]$ from each plant. We do not have plant-level data to construct these magnitudes, and so shall assume that the export shares in (17) differ from the probabilities in (18) by a random error. Specifically, we assume that:

$$\ln S(i,j) = \ln \Pr(i,j) + u_{ij} \tag{18}$$

where u_{ij} are normally distributed measurement errors.

To re-write (18) in terms of our actual estimating equations, let us now introduce the subscript k to denote product/province/year observations in our sample. While the value-added ratio $(A+\lambda B)_k^2 / P_k^2$ can be measured with our data, as described above, we do not presume to know the value of final sales B_k for each product: this would require data from the partner countries using China for input processing. Because we do not observe B_k, we cannot estimate all of the export share equation in (18). However, it turns out that we can estimate two equations in difference form.

First, consider [ln $S_k(0,0)$ – ln $S_k(0,1)$], which is the log difference between the export shares in the upper-left and lower-left cells of Table 2. Conditional on *foreign ownership*, this shows the difference in export share when the foreign firm versus the Chinese manager have input control. Using (18), (16) with $\mu = \sigma(A_k + \lambda B_k)^2 / \gamma_g$, the general formula for welfare in (11) and the effort levels in Table 2, we obtain:

$$\ln S_k(0,0) - \ln S_k(1,0) = -\frac{(1-\psi^2)}{8\sigma} + \left[\frac{1}{2\sigma}\left(\frac{\gamma_g}{\gamma_f} - 1\right) + \frac{\psi^2}{8\sigma}\right]\left(\frac{P_k}{A_k + \lambda B_k}\right)^2 + (u_{00k} - u_{10k}). \quad (19)$$

This equation is a simple regression of the log-difference in export shares on a constant and the inverse value-added ratio, where the constant is predicted to be negative.

Alternatively, we can take the log difference between the export shares in the upper-right and lower-right cells of Table 2. Conditional on *Chinese ownership*, this again shows the difference in export share when the foreign firm versus the Chinese manager have input control. Using (18), (16), (11) and Table 2, this magnitude is,

$$\ln S_k(0,1) - \ln S_k(1,1) = \left[\frac{1}{2\sigma}\left(\frac{\gamma_g}{\gamma_f} - 1\right) - \frac{\psi^2 \gamma_g}{8\sigma\gamma_f}\right]\left(\frac{P_k}{A_k + \lambda B_k}\right)^2 + (u_{01k} - u_{11k}). \quad (20)$$

This is a regression of the log-difference in export shares with Chinese ownership on the inverse value-added ratio, where the constant is predicted to be zero.

We can also take the difference between (19) and (20) to obtain:

$$CVD_k \equiv \ln S_k(0,0) + \ln S_k(1,1) - \ln S_k(1,0) - \ln S_k(0,1)$$

$$= -\frac{(1-\psi^2)}{8\sigma} + \left[\frac{\psi^2}{8\sigma}\left(\frac{\gamma_g}{\gamma_f}+1\right)\right]\left(\frac{P_k}{A_k+\lambda B_k}\right)^2 + u_k, \qquad (21)$$

where $u_k \equiv (u_{00k} + u_{11k} - u_{01k} - u_{10k})$ is a random error. We shall refer to CVD_k as *concentrated versus dispersed* ownership/control. It is evident that this serves as a stochastic measure of the modularity of the surplus function for each observation k.

Notice that all the coefficients in (19)-(21) depend on σ, which is related to the variance of the extreme-value distribution. We are not interested in this parameter, and it is eliminated by dividing the slope coefficient by the constant in (19) and (21), obtaining:

$$\ln S_k(0,0) - \ln S_k(1,0) = -a + b\left(\frac{P_k}{A_k+\lambda B_k}\right)^2 \Rightarrow \left(\frac{b}{a}\right) = \frac{\psi^2}{(1-\psi^2)}\left(\frac{\gamma_g}{\gamma_f}+1\right), \qquad (22)$$

$$CVD_k = -a + c\left(\frac{P_k}{A_k+\lambda B_k}\right)^2 \Rightarrow \left(\frac{c}{a}\right) = \frac{\psi^2}{(1-\psi^2)}\left[1+\frac{4}{\psi^2}\left(\frac{\gamma_g}{\gamma_f}-1\right)\right]. \qquad (23)$$

These two regressions shall serve as our estimating equations. We shall test the hypothesis that their constant terms are the same, and obtain ψ and γ_g/γ_f from equations (22) and (23).

4.2 Export Shares

We first report the average values of export-shares for various samples. In Table 3, the first two columns show the total sample, and the second two columns show the sample with state-owned enterprises excluded. Reading down the first column, foreign-buyer control of the inputs (the pure-assembly regime) combined with foreign ownership of the factory accounts for an average of 6.8% of processing exports, while Chinese control of the inputs (the import-and-assembly regime) combined with foreign ownership of the factory accounts for 49.8%. The difference in these two probability masses is much greater than in the second column, where foreign control of the inputs combined with Chinese ownership of the factory accounts for 24.8% of processing exports, while factory control of the inputs combined with Chinese ownership of the factory accounts for 18.7% of processing exports. Computing CVD as in (21), this is negative and highly statistically significant, confirming that dispersed control/ownership is more likely than concentrated control/ ownership. In the full sample, the data support the submodularity of the surplus function. In unreported results, we performed similar calculations separately by year and found CVD to be stable over time.

We now extend our full-sample results to account for variation in the ownership types of Chinese firms, in how processing exports are delivered to destination markets, and whether exports are produced in one of China's special economic zones. So far, we have treated all Chinese firms as being of a common ownership type. In reality, the data distinguish between four types of Chinese owned-firms: private enterprises, collectives, Sino-foreign contractual joint ventures, and state-owned enterprises (SOEs). Collectives include town-and-village enterprises (TVEs) and urban collectives that are owned by communities or groups of households. They constitute a hybrid ownership form, somewhere between a public and private enterprise. In terms of management structure and performance, they share many features in common with private firms (Chen, 2000). A Sino-foreign contractual joint venture is a Chinese firm created in conjunction with a foreign firm, usually with majority Chinese ownership (Lin and Png, 2001).[9] In the case of export processing, this means that the foreign client with whom

[9] A Sino-foreign contractual joint venture may or may not involve foreign equity participation. We treat these firms as Chinese owned, but their ownership status is difficult to determine. While Chinese commercial law dictates that foreign equity joint ventures (discussed in section 2) must distribute profits according to the ownership share that each equity holder has in the concern, contractual joint ventures exercise considerable flexibility in how they

the Chinese firm will transact is designated at the time the firm is created. SOEs are wholly owned by government entities.

While SOEs may operate under either input-control regime, they are by definition Chinese owned (and so not subject to foreign ownership). Still, there is no *a priori* reason to exclude them from the analysis. A foreign firm engaged in export processing in China that chooses to contract with a Chinese owned firm (rather than use one of its own subsidiaries), may just as well choose an SOE as a private enterprise or a collective. Many SOEs have the flexibility to offer managers incentive pay schemes (Naughton, 1995), and use of these schemes appears to affect SOE performance (Groves et al., 1994 and 1995).[10] Still, it is natural to imagine that SOEs might differ from other Chinese-owned firms. In particular, the productivity of investments (A) might be weaker or the specificity of investments (ψ) might be greater in SOEs than in other Chinese firms. According to Proposition 2, this would suggest that the share of outcomes with concentrated versus dispersed control/ownership would *fall* once SOEs were dropped from the sample (i.e., dispersed control/ownership regimes would become relatively more common in the data). To see how inclusion of SOEs affects our results, we drop them from the analysis in the second two columns of Table 3.

The distribution of exports across control/ownership regimes is qualitatively similar with or without SOEs in the sample. Naturally, excluding SOEs from the sample moves mass from the Chinese ownership column to the foreign ownership column. The share of processing

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distribute profits (Wang, 2000). In practice, contractual joint ventures appear to involve small foreign firms that have family ties or other links to the parties in China with whom they transact. Even where a contractual joint venture involves some foreign ownership, it may be, in effect, a Chinese family-owned enterprise. Most foreign firms that use contractual joint ventures appear to be based in Hong Kong or Taiwan or to be owned by a Chinese national (who may use the joint venture as a vehicle to transfer profits abroad). Our results are robust to either defining contractual joint ventures as foreign-owned firms or to excluding them from the analysis.

[10] Some exports reported to be associated with SOEs may in fact be produced by other types of Chinese firms. During the 1980's and early 1990's, in many industries Chinese-owned firms (but not foreign-owned firms) were required to export goods through state-owned foreign trading companies (Naughton, 1996). While the government has since relaxed this restriction, some SOE exports in our sample may be produced by other Chinese firms.

exports associated with foreign input control and foreign factory ownership rises to 9.3% and the share associated with Chinese input control and foreign factory ownership (which IS predicts should be small) rises to 73.4%.[11] Consistent with Proposition 2, excluding SOEs lowers the value of CVD, implying that outside of SOEs input control and factory ownership is more likely to be dispersed.

As reported in Table 1, slightly over half of processing exports from China are re-exported through Hong Kong. Re-exports are not simply goods transshipped through Hong Kong. They are goods that clear customs in Hong Kong and that are taken into possession (and subject to intermediation services) by firms based in Hong Kong. In the case of re-exports, Hong Kong traders typically grade them according to quality, package and label them, and arrange for their shipment to final destination markets (Sung, 1991).

With regards to Chinese processing trade, contracting costs might differ for firms in Hong Kong relative to firms based in other countries. Due to their long history of entrepôt trade, Hong Kong firms may have a competitive advantage in export processing. Compared to firms in other countries, Hong Kong traders may be better positioned to select inputs, identify reliable suppliers in China, and market final goods. In such a case, Hong Kong firms would tend to have a relatively high marginal productivity of investment (B) in export processing activities and relatively low specificity of human-capital investments (ψ). By the logic of Proposition 2, we would expect export processing involving Hong Kong to exhibit more dispersed input control and factory ownership.

Table 4 replicates the results in Table 3 separating Chinese processing exports into those shipped directly to destination markets and those re-exported through Hong Kong. For Hong

[11] For SOEs a higher share of exports have foreign input control (70.4%) than Chinese input control (29.6%).

Kong re-exports, there is more mass along the off-diagonal cells among dispersed input-control and factory-ownership regimes. Thus, for re-exports through Hong Kong, CVD is more negative, as is consistent with the PR model and Proposition 2. These results include exports associated with SOEs, but excluding them does not change the findings.

Over the last two decades, trade policies in China have varied substantially across regions of the country. In the early stage of China's economic opening, the government permitted foreign trade and investment only in Special Economic Zones (SEZs) located in the southern coastal provinces of Guangdong and Fujian. In the mid to late 1980s, after the spectacular growth of export production in the first SEZs, the government steadily expanded the number of regions in which foreign trade and investment were permitted. By the early 1990s, foreign trade and investment were allowed (subject to government approval) throughout the country (Demurger et al, 2001). Still, much export activity continued to be concentrated in SEZs and other trade zones. Advantages to being in a zone may include expedited treatment by customs of imported inputs and exported outputs, more freedom to import or export goods directly rather than through state-owned foreign trade corporations, greater opportunities to retain foreign exchange earnings, and access to various types of tax incentives. There are is also a separate court system set up to handle civil and commercial legal cases in trade zones (Wang, 2000). SEZs have been succeeded by second and third generation trade and development zones, including bonded areas, Economic and Technological Development Areas, and Hi-Technology Development Areas, which may target specific industries or activities. At risk of blurring definitions, we refer to all of these zones as SEZs. These zones are managed by provincial governments and so may exhibit regional variation in their organization and effectiveness.

Being in a SEZ may affect the choice of input-control and factory-ownership regime in a variety of ways. If the court system that is specific to trade zones is more efficient and reliable than China's regular court system, then contracting costs might be lower in SEZs. Another possibility is that firms in SEZs have more alternative trading partners. Since SEZs are the center of import and export activities in China, it might be relatively easy for a foreign firm or Chinese factory with a presence in an SEZ to find a new export supplier or foreign buyer. This would tend to lower the specificity of human-capital investments by factory managers and foreign buyers. By Proposition 2, this would tend to make concentrated input-control and factory-ownership less likely inside SEZs than outside SEZs.

To see how presence in a SEZ affects input-control and factory-ownership outcomes, Table 5 replicates the results in Table 3 breaking out processing exports by whether or not they are produced in one of China's Special Economic Zones (SEZs). Inside SEZs, foreign factory ownership is relatively more likely, with 80.9% of processing exports coming from foreign owned factories inside of SEZs compared to only 51.0% outside of SEZs. Also, inside SEZs dispersed input control and factory ownership is relatively more common, such that CVD is lower inside SEZs than outside SEZs. This is again consistent with Proposition 2.

PARAMETER ESTIMATES YET TO BE COMPLETED

5. Conclusions

This paper reports a new empirical finding: that the allocation of ownership and control in processing exports of China tends to be shared between foreign and local parties, with foreign firms likely to have (at least partial) ownership in the Chinese plant, but the Chinese parties having control over input purchase decisions. Based on anecdotal evidence, we expect that this pattern might apply in other developing countries as well, such as India. 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 PR model due to Grossman and Hart (1986) and Hart and Moore (1990), while contrasting this with the IS model due to Holmstrom and Milgrom (1994).

Holmstrom and Milgrom show that the IS model leads to a complementarity in the allocation of ownership/control instruments. In our simple model of outsourcing, we find that the PR model leads to that outcome when value-added in the factory is low or the specificity of human-capital investments is high. But the PR model leads to the alternative arrangement with a *sharing* of the ownership/control instruments between the parties when value-added is high, or human-capital specificity is low. The evidence from China therefore strongly supports the finding that ownership and control is divided between the parties, and more so as we consider subsets of the data that focus on exports through Hong Kong, that exclude the state-owned enterprises, or that limit exports to those from Special Economic Zones: in all three cases, an even greater magnitude of exports occur in the foreign-ownership/local-control regime.

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Table 1: 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	Hong Kong Re-Exports	FIE Exports
1997	0.525	0.342	0.696	0.565	0.545
1998	0.545	0.370	0.694	0.562	0.566
1999	0.542	0.385	0.665	0.516	0.584

Notes: Columns (1) and (2) show processing exports and exports by foreign-invested enterprises, respectively, as a share of total China exports; columns (3)-(6) show as a share of total China processing exports, processing exports under the import-and-assembly regime, processing exports re-exported through Hong Kong, and processing exports by foreign-invested enterprises, respectively.

Table 2: Optimal Effort Levels

	Ownership of the Factory	
	$\delta_2 = 0$, Foreign firm f owns **Employment contract:**	**$\delta_2 = 1$, Chinese Manager g owns** **Outsourcing contract:**
$\delta_1 = 0$, **Foreign firm** **f controls inputs**	$e_1 = P/\gamma_f$ (first-best for f) $e_2 = (A + \lambda B)/2\gamma_g$ $e_3 = B/\gamma_f$ (first-best) $W(0,0) >< W(1,0)$	$e_1 = [1-(\psi/2)]P/\gamma_f$ $e_2 = \left[A + \left(1-\frac{\psi}{2}\right)\lambda B\right]/\gamma_g$ $e_3 = [1-(\psi/2)]B/\gamma_f$ $W(0,1) < W(1,1)$ if $\gamma_f = \gamma_g$
<u>Control of the Inputs</u> **$\delta_1 = 1$,** **Chinese manager** **g controls inputs**	$e_1 = [1-(\psi/2)]P/\gamma_g$ $e_2 = [1-(\psi/2)](A + \lambda B)/\gamma_g$ $e_3 = B/\gamma_f$ (first-best) $W(1,0)$	$e_1 = P/\gamma_g$ (first-best for g) $e_2 = \left[A + \left(1-\frac{\psi}{2}\right)\lambda B\right]/\gamma_g$ $e_3 = [1-(\psi/2)]B/\gamma_f$ $W(1,1)$

Table 3: Processing Exports by Input Control and Factory Ownership Regime

Control over Inputs (processing regime)	All Firms: Ownership of Factory — Foreign	All Firms: Ownership of Factory — Chinese	Excluding SOEs: Ownership of Factory — Foreign	Excluding SOEs: Ownership of Factory — Chinese
	S(0,0)	S(0,1)	S(0,0)	S(0,1)
Foreign Buyer (pure-assembly)	0.068 (0.002)	0.248 (0.006)	0.093 (0.003)	0.036 (0.003)
	S(1,0)	S(1,1)	S(1,0)	S(1,1)
Chinese Factory (import-and-assembly)	0.498 (0.005)	0.187 (0.003)	0.734 (0.004)	0.136 (0.003)
CVD [S(0,0) + S(1,1)] – [S(0,1) + S(1,0)]	-0.490 (0.008)		-0.541 (0.007)	

Notes: This table shows means for shares of processing exports by factory ownership (foreign versus Chinese) and input-control regime (pure-assembly versus import-and-assembly) by year, industry, destination country, origin province, and trade zone. The first two columns show results for 228,760 observations on the sample of all firm types; the second two columns show results for 174,071 observations on the sample of firms excluding state-owned enterprises. Heteroskedasticity-consistent standard errors are in parentheses.

Table 4: Processing Exports by Control/Ownership Regime and Export Route

Control over Inputs (processing regime)	Direct Exports: Ownership of Factory: Foreign	Direct Exports: Ownership of Factory: Chinese	Re-Exports thru Hong Kong: Ownership of Factory: Foreign	Re-Exports thru Hong Kong: Ownership of Factory: Chinese
	S(0,0)	S(0,1)	S(0,0)	S(0,1)
Foreign Buyer (pure-assembly)	0.125 (0.004)	0.131 (0.004)	0.020 (0.001)	0.344 (0.008)
	S(1,0)	S(1,1)	S(1,0)	S(1,1)
Chinese Factory (import-and-assembly)	0.504 (0.006)	0.240 (0.005)	0.492 (0.007)	0.144 (0.003)
CVD [S(0,0) + S(1,1)] – [S(0,1) + S(1,0)]	-0.270 (0.011)		-0.671 (0.007)	

Notes: This tables show mean shares of processing exports by factory ownership and input-control regime for goods shipped directly to destination markets (columns 1 and 2) and goods re-exported through Hong Kong (columns 3 and 4). See Table 3 for more details.

Table 5: Processing Exports by Control/Ownership Regime and Trade Zone

Control over Inputs (processing regime)	Inside SEZs: Ownership of Factory: Foreign	Inside SEZs: Ownership of Factory: Chinese	Outside SEZs: Ownership of Factory: Foreign	Outside SEZs: Ownership of Factory: Chinese
	S(0,0)	S(0,1)	S(0,0)	S(0,1)
Foreign Buyer (pure-assembly)	0.058 (0.003)	0.082 (0.004)	0.070 (0.003)	0.285 (0.006)
	S(1,0)	S(1,1)	S(1,0)	S(1,1)
Chinese Factory (import-and-assembly)	0.751 (0.007)	0.109 (0.004)	0.440 (0.005)	0.205 (0.004)
CVD [S(0,0) + S(1,1)] – [S(0,1) + S(1,0)]	-0.666 (0.011)		-0.451 (0.009)	

Notes: This tables show mean shares of processing exports by factory ownership and input-control regime for goods produced inside Special Economic Zones (columns 1 and 2) and goods produced outside Special Economic Zones (columns 3 and 4). See Table 3 for more details.