Firm Sorting, Ownership and Product Scope: Evidence from Chinese Enterprises

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Abstract

This paper features a monopolistic competition model, accounting for multiple products and selection of heterogeneous firms. Firms, upon receiving information on productivity, decide whether to export, and whether to form joint ventures with foreign companies. This selection also affects the number of products a firm introduces. Using microdata for Chinese manufacturing enterprises, we observe sorting and selection patterns consistent with the model. The most productive firms engage in foreign partnership and export. The least productive firms do neither. In between are domestic-owned exporting firms and foreign-owned non-exporting firms. The former display higher efficiency if exporting incurs large upfront fixed costs, and vice versa. More productive firms introduce more varieties. Other things being equal, foreign participation and exporting both promote variety expansion. We also note that the interaction between exporting and foreign participation generates further incentive for expanding product scope.

Keywords: Multiproduct, FDI, Joint Venture, Heterogeneity

JEL Classification: F12, F14, F23

1 Introduction

Recent literature recognizes two stylized facts for firms engaged in international trade. First, firms differ in their productivity levels, which in turn implies sorting and self-selection into different groups, regarding their exporting status and organizational choices. Second, many firms, in particular exporting firms, actually produce multiple products. This paper tries to incorporate these two key ingredients into a simple monopolistic competition model. The aim is to shed light on firms' export and organizational decisions based on productivity, and the impact of the decisions on product scope expansion. Using micro-level data from 2,000 Chinese firms, we apply the model to empirical tests. We find empirical evidence on Chinese firms' specific sorting and selection patterns, and the impact of their selections on the expansion of product range.

The seminal paper by Helpman, Melitz and Yeaple (2004) observes interesting sorting patterns across heterogeneous firms. In particular, the most productive firms serve foreign market through FDI, while less productive firms export, and the least productive firms are not engaged in international business. Examining the U.S. firms' export relative to affiliate sales with respect to firm size dispersion, they provide some empirical evidence. Pursuing the same question, Head and Ries (2003) look at Japanese firms' decision on export versus investment abroad and the range of destination countries' income levels. Aw and Lee (2008) examine Taiwanese multinational firms' location of production under a three-country setting. Buch et al. (2008) build a model of multinationals facing financial constraints and apply it to German firms.

With few exceptions, empirical studies on heterogeneous firms' export and investment decisions focus on industrial economies. However, when we apply the same approach to an emerging economy such as China, two important features have to be recognized. First, until very recently, few Chinese firms had subsidiary affiliates abroad[1]. Therefore the proximity-concentration trade-off as in Brainard (1997) does not apply. Second, the last two decades have seen the growing importance of multinationals investing in China. As documented by Amiti and Javorcik (2008), foreign investment enterprises (FIEs) ac-

[1] See Cheng and Ma (2007) for an analysis of China's outward FDI.

counted for nearly a third of industrial output in China in 2001. But until 2001, wholly foreign-owned enterprises were not permitted unless they either adopted advanced technology and equipment or exported a majority of their products[2]. Instead, local chinese firms are encouraged to seek foreign partnership and form joint ventures. This is shown in Figure 1. Though the total share of FIEs in Chinese exports reachs nearly 50 percent in 2000, half of it is attributed to joint ventures. This has important implications for the sorting and selection of firms in China, because from a Chinese firm's point of view, realizing its productivity after entry, it will decide whether to export and whether to introduce foreign partnership.

This paper contributes to the fast growing literature that builds on the Melitz model of heterogeneous firms (Melitz 2003). The superior performance of exporters has been noted by Clerides, Lach and Tybout (1998) and Bernard and Jensen (1999), who argue that only productive firms are most likely to become exporters. This evidence provides empirical support for the connection between productivity advantage and exporting decisions[3]. We follow this causality argument and further investigate firm's exporting and organizational decisions when they are able to produce multiple products.

Our theoretical model implies that firms, based on their productivities, self-select into four categories. The most productive firms choose to form joint ventures with foreign partners and export. The least productive firms choose to serve only the domestic market but do not welcome foreign partnership. In between are the domestic-owned exporting firms and the foreign-owned non-exporting firms, whose ranking by productivity depends on the fixed costs of exports and relative size of foreign market. When exporting incurs large upfront fixed costs and foreign market is relatively large, domestic-owned exporters

[2] See the 1990 and 2001 Detailed Implementing Rules for the Law of the People's Republic of China on Wholly Foreign-owned Enterprises. The reader is directed to Lardy (1992, 1998) and Naughton (1995) for comprehensive descriptions on the evolution of China's policy toward FDI.

[3] There is another strand of literatue arguing that firms benefit from their exporting experience. Because firms "learn from exporting", those who export gain higher technology of production. For example, De Loecker (2007) finds that for Slovenian manufacturing firms, new exporters become more productive once they start exporting.

are on average more productive than the non-exporters with foreign partnership. However, the productivity ranking is reversed if exporting incurs lower overhead costs and foreign market is small. This ambiguity is reconciled when we examine 2,000 Chinese enterprises from a World Bank survey. The evidence suports the first case, which is consistent with the relative high trade barrier and large exporting volume for China.

The paper also contributes to the emerging theoretical and empirical literature on multiproduct firms. Multiproduct firms have played a phenomenal role in, not only advanced economies[4], but also many developing countries. As for the Chinese firms we examine, 769 out of 1020 manufacturing firms surveyed in 2001 produce more than 2 products. The fact is also evident for other nations, especially in their exporting sectors. For example, Arkolakis and Muendler (2008) find that multiproduct firms dominate in a large sample of Brazilian exporters, accounting for over 90 percent of all exports, with an average of 5.3 products per firm. Similarly, Martincus and Carballo (2008) document that the average Peruvian exporter sells 7.5 products to 2.6 countries. Though less impressive than the US firms, Iacovone and Javorcik (2008) find that multiproduct firms account for over a half of Mexican exports, with a stable average 2.1 products per firm over 1994-2003. In short, numerous country studies all point to the importance of the extensive margin of introducing (and dropping) varieties along firms' product range.

Instead of focusing on exporting firms only, this paper examines all firms that produce at home, exporting or not. In a world with herterogenous firms, more productive firms introduce more varieties into domestic and exporting markets. However, further complication occurs because the firm's scope expansion interacts with its exporting/ownership choice.

To capture the idea, this paper combines Melitz (2003) with Allanson and Montagna (2005)[5] in a partial equilibrium setting: firms enter the market once and for all, with all

[4]As documented in Bernard, Redding and Schott (2006a), 41% of U.S. manufacturing firms produce in multiple 5-digit SIC industries, accounting for 91% of total sales. The importance becomes even more apparent when it comes to exports: firms exporting five or more products account for 98% of total exports. See also Baldwin and Gu (2005) for further evidence from Canadian firms.

[5]Similar nested CES models are also used in Agur(2007), and Arkolakis and Muendler (2008).

feedback effects in wages and market enviroment neglected. To be concrete, upon paying the sunk costs of entry and knowing productivity, firms produce horizontally differentiated products in a monopolistic competitive market. The heterogeneity in productivity leads to (1) heterogeneity in selections of exporting / ownership decisions, and (2) heterogeneity in the number of varieties each firm introduces. That is, given *ex expost* productivity, firms self-select into different exporting/ownership groups, and optimize on prices and product scope. Barriers to exporting and to forming joint ventures are modeled as extra fixed costs[6]. Thus exporting or forming joint venture requires a higher productivity and hence higher profitability. This selection, however, provides positive feedback to firm's scope of products. Exporting firms face larger market than local sellers, while forming joint venture with a foreign interest helps a firm reduce its variety-level developing costs.

This is not the first paper investigating multiproduct firms with productivity heterogeneity. Previous theoretical work has established various predictions on the intensive margin (scale) and the extensive margin (scope) of the firm. Among others, Bernard, Redding and Schott (2006b) propose a multi-product-multi-industry model with heterogeneity between and within firms. They show a positive correlation between firm's intensive margin and extensive margin[7]. Brambilla (2006) investigates the introduction of new varieties by multiproduct firms, with an empirical application to multinationals in China. However, she ignores firms' endogenous sorting and selection patterns, and the interaction between product scope and exporting/ownership selection, which we will address in this paper.

Overall, the paper attempts to provide a complementary extension to the literature on the sorting and selection of heterogeneous firms, and on product scope expansion as well. Section 2 presents the model of multiproduct firms. Section 3 introduces a brief decription of the dataset and the summary statistics of key variables. Section 4 provides the empirical evidence for firm's selection on exporting and ownership, according to their levels of productivity. Section 5 then examines the impact of this selection on firm's choice

[6] Exporting, of course, also incurs transport costs, adding to the marginal costs of production.

[7] The prediction is, however, reversed by assuming that marginal cost rises when scope expands, as in Nocke and Yeaple (2006).

of product scope, using information on the number of new products introduced from 2,000 Chinese enterprises. We conclude in Section 6.

2 The Model

2.1 Exporting Status

We focus on a home country H (China) trading with the rest of the world F. The utility function takes the usual CES form over a continuum of products:

$$U^H = \left(\int_{i=0}^{N^d} q^d(i)^{\frac{\eta-1}{\eta}} di + \int_{i=0}^{N^f} q^f(i)^{\frac{\eta-1}{\eta}} di + \int_{i=0}^{N^m} q^m(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}, \eta > 1. \tag{1}$$

where N^l denotes the number of firms owned by type l firms. There are three types of firms by ownership: domestic (d), foreign (f), and multinational firms operating in the host country (m). Each firm i is atomic relative to the large population of firms (N^l), while each produces a limited number of varieties (n_i^l). The aggregate quantity $q^l(i)$ for firm i is expressed as:

$$q^l(i) = \left(\sum_{j=1}^{n_i^l} q_i^l(j)^{(\sigma-1)/\sigma} di \right)^{\sigma/(\sigma-1)}, \sigma > 1, l = d, f, m \tag{2}$$

where $\sigma > \eta$. The two-tier nested CES utility function captures the idea that varieties are more substitutable within a firm than between firms. Because of the homotheticity of the preference, we solve the utility maximization problem by two-stage budgeting, which gives the demand for each variety:

$$q_i^l(j) = A^H P^l(i)^{\sigma-\eta} p_i(j)^{-\sigma} \tag{3}$$

where $A^H = Y^H P^{\eta-1}$ represents the aggregate market condition faced by all firms, which is assumed to be taken as given. The aggregate price index P is defined by $P^{1-\eta} = \int_{i=0}^{N^d} P^d(i)^{1-\eta} di + \int_{i=0}^{N^f} P^f(i) di + \int_{i=0}^{N^m} P^m(i) di$, and the firm level price index $P(i)$ is defined as $P(i)^{1-\sigma} = \sum_{j=1}^{n_i} p_i(j)^{1-\sigma} dj = n_i p_i^{1-\sigma}$, where the last equality is because of the symmetry across varieties within a firm.

If the manager of each variety acts independently, takes as exogenous the prices of all other varieties, including those belonging to the same firm, as in the Dixit-Stiglitz monopolistic competition model (Dixit and Stiglitz, 1977), the optimal price is then a constant markup $\frac{\sigma}{\sigma-1}$ over the marginal cost, depending solely on the within-firm elasticity of substitution. However, this simplification neglects the demand linkages within a firm. The firm, when dropping the price of one variety, sees the demand for other varieties of its own distracted[8]. Thus, taking into account the "*cannibalization effect*" within a firm, we find:

Lemma 1 *Taking into account the impact of the price change in one variety on its other varieties (through the impact on $P(i)$), the firm charges a higher markup $\frac{\eta}{\eta-1}$,* as long as *it neglects the impact through the aggregate price index P.*

Proof. See the Appendix. ■

Since there are many firms, each firm takes the aggregate market price index P as given. But each firm produces a limited number of varieties, so each firm sets up its prices on each variety, accounting for the within-firm competition. In this case, the markup is solely determined the across-firm substitutability η, instead of within-firm substitutability σ. That is, denoting the markup as $\frac{1}{\rho} = \frac{\eta}{\eta-1}$, and assuming labor wage is w, then for a domestic firm with productivity level φ, the price is $p_i(j) = p(\varphi) = \frac{w}{\rho\varphi}$.

As we are interested in firms producing in China, we will focus on domestic firms and multinationals in the model. Hereafter, we use superscripts d and m to denote the firm's ownership (domestic or multinational). And we use subscripts h and x to denote the firm's export status (selling at home or exporting).

Putting firm ownership aside, let's first explore its exporting decision and optimal scope. If a firm only sells domestically, output quantity, revenue, and profits from domestic sales of *one* variety for a firm with productivity φ are, respectively,

$$q_h^d(\varphi) = A^H n^{\frac{\sigma-\eta}{1-\sigma}} (\frac{w}{\rho\varphi})^{-\eta}, \quad r_h^d(\varphi) = A^H n^{\frac{\sigma-\eta}{1-\sigma}} (\frac{w}{\rho\varphi})^{1-\eta}, \ \pi_h^d(\varphi) = \frac{1}{\eta} r_d(\varphi) - f_h,$$

[8] Eckel and Neary (2006) and Ju (2003) consider demand linkages among products within a firm, under oligopoly market. Using CES preference, Feenstra and Ma (2008) extend the monopolistic competition model to incorporate endogeneous markup.

where n denotes the number of varieties produced by a single firm.

Multiproduct firms not only make price decisions, but also need to choose the optimal product scope. The total operating profit for domestic sales is therefore $\Pi_h^d(\varphi) = n(\frac{1}{\eta}r_h^d(\varphi) - f_h) - \alpha_h$, where f_h denotes the fixed costs associated with developing each specific variety, while α_h denotes the overall fixed costs in order to manage all product lines within the firm's boundary. Distinguishing the variety level fixed costs and firm level fixed costs introduces economy of scope to the multiproduct firm. Then maximizing profit with respect to the number of products gives the optimal scope:

$$n_h^d = \left(\frac{\eta-1}{\eta(\sigma-1)}\frac{A^H}{f_h}(\frac{w}{\rho\varphi})^{1-\eta}\right)^{(\sigma-1)/(\sigma-\eta)}. \tag{4}$$

Thus, each active firm's profit from domestic sales depends on its productivity level φ and the market size parameter A^H:

$$\widehat{\Pi}_h^d(\varphi) = \kappa\left[A^H\right]^{(\sigma-1)/(\sigma-\eta)} f_h^{-(\eta-1)/(\sigma-\eta)}(\frac{w}{\rho\varphi})^{-(\eta-1)(\sigma-1)/(\sigma-\eta)} - \alpha_h,$$

where $\kappa = (\sigma-\eta)[\eta(\sigma-1)]^{-(\sigma-1)/(\sigma-\eta)}(\eta-1)^{(\eta-1)/(\sigma-\eta)}$ is a constant.

A firm's product scope, as well as its profit, are increasing in its producitivity level. More productive firms produce a greater range of products and make more profits than less productive rivals, while some firms with very low productivity levels cannot break even so they will exit the market immediately. The least productive firm who survives the market have zero profit from serving the domestic market. Thus, equalizing the optimized profit to zero for the boundary firm gives *the zero-profit-cutoff condition* for scope:

$$n_h^{*d} = n_h^d(\varphi_h^d) = \frac{\eta-1}{\sigma-\eta}\frac{\alpha_h}{f_h}, \tag{5}$$

where φ_h^d represents the zero-cutoff-profit firm's marginal cost. The borderline firm's scope expands with the firm-level fixed cost relative to the variety-level fixed cost (i.e., α_h/f_h). Since product scope is monotonically increasing in productivity, more productive firms produce a greater range of varieties. For any surviving firm with productivity φ, the number of products it produces relative to that of the borderline firm is:

$$\frac{n_h^d(\varphi)}{n_h^{*d}} = \left(\frac{\varphi}{\varphi_h^d}\right)^{(\eta-1)(\sigma-1)/(\sigma-\eta)}. \tag{6}$$

Furthermore, firms may not just sell products in the domestic market. They self-select into exporters and non-exporters. If a firm decides to export, it charges $p_{xi}(j) = p_x(\varphi) = \frac{\tau w}{\rho\varphi}$ for the foreign market, where τ denotes the *ad valorem* trade costs (including tariff and transportation costs). The quantity, revenue and operating profit for exporting *one* variety to the foreign market are, respectively:

$$q_x^d(\varphi) = A^F n^{(\sigma-\eta)/(1-\sigma)} (\frac{\tau w}{\rho\varphi})^{-\eta}, \quad r_x^d(\varphi) = A^F n^{(\sigma-\eta)/(1-\sigma)} (\frac{\tau w}{\rho\varphi})^{1-\eta}, \pi_x^d(\varphi) = \frac{1}{\eta} r_x.$$

To export an existing variety abroad, we assume that no additional variety level fixed costs is necessary. Therefore, due to the property of monopolistic competition, no firm will develop new varieties solely for the foreign market. However, to export, there is an additional firm level upfront fixed cost, which we label as α_x. The upfront fixed costs for an exporting firm include setting up exporting facilities, collecting information on foreign markets, costs of advertisement, market relationship maintanence, training on international trade, and others. The fixed cost of exporting has been recognized in empirical work of trade (see, for example, Roberts and Tybout 1997b, Bernard and Wagner 2001). Since a firm exports all its domestic varieties if it chooses to export, the combined profits from both domestic and foreign markets is $\Pi_x^d(\varphi) = n\pi_x^d - \alpha_h - \alpha_x = n\left(\frac{r_h^d}{\eta} + \frac{r_x^d}{\eta} - f_h\right) - \alpha_h - \alpha_x$.

Solving an exporting firm's profit maximization (optimal scope) problem, we then have,

$$n_x^d = \left(\frac{\eta - 1}{\eta(\sigma-1)} \frac{A^H + A^F \tau^{1-\eta}}{f_h} (\frac{w}{\rho\varphi})^{1-\eta} \right)^{(\sigma-1)/(\sigma-\eta)}, \tag{7}$$

where $A^F \tau^{1-\eta}$ can be seen as foreign market condition discounted by the trade cost.

Plugging the optimal scope back to the exporting firm's profit function gives:

$$\widehat{\Pi}_x^d(\varphi) = \kappa \left[A^H + A^F \tau^{1-\eta}\right]^{(\sigma-1)/(\sigma-\eta)} f_h^{-(\eta-1)/(\sigma-\eta)} (\frac{w}{\rho\varphi})^{-(\eta-1)(\sigma-1)/(\sigma-\eta)} - (\alpha_h + \alpha_x),$$

To simplify the notation, let's define $A_1 = \left(A^H\right)^{\frac{(\sigma-1)}{(\sigma-\eta)}}$, $A_2 = \left[A^H + A^F\tau^{1-\eta}\right]^{\frac{(\sigma-1)}{(\sigma-\eta)}}$, $F = f_h^{\frac{(\eta-1)}{(\sigma-\eta)}}$. Hereafter we use A_1, A_2 to denote the modified market size for non-exporters and exporters, respectively; and use F to denote the modified fixed costs of introducing new varieties. Thus, nonexporting and exporting firm's optimal profit can be simplified as,

$$\widehat{\Pi}_h^d(\varphi) = \kappa \frac{A_1}{F} (\frac{w}{\rho\varphi})^{-(\eta-1)(\sigma-1)/(\sigma-\eta)} - \alpha_h, \tag{8}$$

and,

$$\widehat{\Pi}_x^d(\varphi) = \kappa \frac{A_2}{F} (\frac{w}{\rho\varphi})^{-(\eta-1)(\sigma-1)/(\sigma-\eta)} - (\alpha_h + \alpha_x), \tag{9}$$

Whether the firm chooses to export depends on whether the profits are greater if the firm sells in both markets than in domestic market only. That is: $\widehat{\Pi}_x^d(\varphi) \geqslant \widehat{\Pi}_h^d(\varphi))$.Thus, the borderline exporting firm (with cutoff productivity φ_x^d) must satisfy:

$$\kappa \frac{A_2 - A_1}{F} (\frac{w}{\rho\varphi_x^d})^{-\frac{(\eta-1)(\sigma-1)}{(\sigma-\eta)}} = \alpha_x. \tag{10}$$

We are interested in the case where some firms do not export, which is consistent with the previous empirical evidence and also our firm-level data. In paricular, firms draw randomly from a productivity distribution upon entry and decide whether to stay and produce or exit, and if a firm stays, whether to export or serve only dometically. Firms[9] with productivity draw within the range $\varphi \in \left[\underline{\varphi}, \varphi_h^d\right]$ exit immedately without production, firms with $\varphi \in \left[\varphi_h^d, \varphi_x^d\right]$ are domestic firms who sell only at home, and the more productive firms with $\varphi \in [\varphi_x^d, \infty)$ find that it's optimal to serve both domestic and foreign market. The left panel of Figure 2 depicts this relationship between nonexporters and exporters. The steeper exporting firm's profit curve implies larger market for firms involved in both local and foreign markets.

To ensure $\varphi_x^d > \varphi_h^d$, we must then have

$$\frac{A_2}{A_1} = \left(1 + \frac{A^F}{A^H} \tau^{1-\eta}\right)^{(\sigma-1)/(\sigma-\eta)} < \frac{\alpha_h + \alpha_x}{\alpha_h} \tag{11}$$

as a assumed condition. That is, the home market can not be too small, such that all existing firms find exporting profitable, and/or the trade costs of exporting (the marginal trade cost τ as well as the benchhead exporting cost α_x) must be large enough.

[9] We assume firms draw their productivity from an exogenous distribution $G(\cdot)$, with support $[\underline{\varphi}, \infty]$.

Comparing the product scope of exporting firms with the cutoff domestic selling firm who is just indifferent about producing or exiting, their scope ratio is

$$\frac{n_x(\varphi)}{n_h^{*d}} = \frac{A_2}{A_1}\left(\frac{\varphi}{\varphi_h^d}\right)^{(\eta-1)(\sigma-1)/(\sigma-\eta)}. \tag{12}$$

Summarizing, we have the following propositions:

Proposition 1 *More productive firms not only produce in larger scale, they also supply a greater range of varieties.*

Proposition 2 *Exporting firms produce more varieties than firms serving only the local market. Having a relatively larger foreign market or lower trade cost leads to an expansion in the product range of exporting firms.*

2.2 Introducing Foreign Partnership

Besides the self-selection of exporting status, firms may also choose foreign partnership and form joint ventures with foreign investors if it is more profitable. Since foreign investors may bring in more advanced technology and new know-how, it helps the domestic firm to reduce its fixed costs of expanding product scope (i.e., f_h). However, to form a solid relationship with a foreign investor, the firm needs to pay additional general monitoring costs or relationship maintanence costs. In addition, a joint venture means the local firm has to share profits with foreign investors.

As assumed, with foreign partnership, a firm becomes more experienced in developing new varieties. If the foreign parent has other affiliates producing similar products, the firm could of course benefit from that experience. This could be embodied by lower costs in R&D, or less expensive purchase of blueprints, licenses and patents. For this reason, we assume foreign partnership reduces the variety-level fixed cost to $f_m < f_h$, or by a factor $\lambda = f_h/f_m > 1$. On the other hand, the firm-level fixed cost is increased by a factor $\delta > 1$[10]. This is because more sophisticated hierarchy causes more friction. To

[10]That is, for non-exporting joint ventures, the firm-level fixed cost is now $\delta \cdot \alpha_h$, while for exporting joint ventures, the firm-level fixed cost is now $\delta \cdot (\alpha_h + \alpha_x)$.

negotiate and maintain the partnership also means higher operating costs. And because of the partial ownership arrangement, only a proportion β of the final operating profits is attributed to the local firm[11]. Thus, for a firm who only serves the domestic market, its profit from choosing foreign partnership is:

$$\Pi_h^m = \beta n \left[\frac{1}{\eta} A^H n^{(\sigma-\eta)/(1-\sigma)} (\frac{w}{\rho\varphi})^{1-\eta} - f_m \right] - \delta\alpha_h.$$

Solving for the optimal scope,

$$n_h^m = \left(\frac{(\eta-1)\lambda}{\eta(\sigma-1)} \frac{A^H}{f_h} (\frac{w}{\rho\varphi})^{1-\eta} \right)^{(\sigma-1)/(\sigma-\eta)} \tag{13}$$

Notice $\lambda > 1$, so given productivity draw φ, a firm with foreign partnership produces more varities than without foreign investment. Defining $\theta \equiv \beta\lambda^{(\eta-1)/(\sigma-\eta)}$ and plugging the optimal scope back into firm's profit we have

$$\widehat{\Pi}_h^m = \kappa\theta \frac{A_1}{F} (\frac{w}{\rho\varphi})^{-(\eta-1)(\sigma-1)/(\sigma-\eta)} - \delta\alpha_h. \tag{14}$$

A firm prefers inviting foreign investment to producing solely by it own if and only if $\widehat{\Pi}_h^m(\varphi) \geqslant \widehat{\Pi}_h^d(\varphi)$.That is:

$$\kappa \left[\theta - 1\right] \frac{A_1}{F} (\frac{w}{\rho\varphi})^{-(\eta-1)(\sigma-1)/(\sigma-\eta)} \geqslant (\delta - 1)\alpha_h,$$

where taking equality gives the cutoff productivity φ_h^m for nonexporting firms that invite foreign cooperation rather than being solely owned by domestic investors. To guarantee the existence of a solution, we assume $\theta \equiv \beta\lambda^{(\eta-1)/(\sigma-\eta)} > 1$.

We are interested in the case where not all local firms find raising technology of production through foreign partnership worthwhile, that is, $\varphi_h^d < \varphi_h^m$. This requires:

$$\delta > \theta = \beta\lambda^{(\eta-1)/(\sigma-\eta)} > 1. \tag{15}$$

This condition ensures that there are some low-productivity domestic firms that find the cost-reducing benefit from introducing foreign partnership does not outweigh the

[11] The Grossman-Hart-Moore property-rights theory points out that because of incomplete contracts, the control over residual rights should be assigned to the party who contribute more to alleviate the hold-up problem. For simplicity, here the share of profit is taken as exogenous.

increase in the setup cost δ. Those firms with productivity draw within the range $\left[\varphi_h^d,\, \varphi_h^m\right]$ would rather use their less productive technology and sell only in the domestic market.

Again, firms may decide to export also. Following the analysis in the previous section, if a firm decides to export, and if it also has foreign partnership, then:

$$\widehat{\Pi}_x^m(\varphi) = \kappa\theta\frac{A_2}{F}(\frac{w}{\rho\varphi})^{-\frac{(\eta-1)(\sigma-1)}{(\sigma-\eta)}} - \delta(\alpha_h + \alpha_x), \tag{16}$$

And the optimal scope for such firms is:

$$n_x^m = \left[\frac{(\eta-1)\lambda}{\eta(\sigma-1)}\frac{A^H + A^F\tau^{1-\eta}}{f_h}(\frac{w}{\rho\varphi})^{1-\eta}\right]^{(\sigma-1)/(\sigma-\eta)} \tag{17}$$

Thus, for a larger foreign market, exporting firms produce a larger number of varieties; while for lower variety development costs, firms with foreign partnership further expand their range of varieties. A foreign-owned exporting firm therefore benefits twofold.

A firm with foreign partnership prefers exporting rather than local-sales only, if $\widehat{\Pi}_x^m(\varphi) \geqslant \widehat{\Pi}_h^m(\varphi)$. This is equivalent to

$$\kappa\theta\frac{A_2 - A_1}{F}(\frac{w}{\rho\varphi})^{-\frac{(\eta-1)(\sigma-1)}{(\sigma-\eta)}} \geqslant \delta\alpha_x \tag{18}$$

and an equality gives the cutoff productivity φ_x^m. Inequality (11) again guarantees that after a range of positive profit, the foreign-owned nonexporter will be dominated by the foreign-owned exporter. This sorting of exporting and nonexporting firms with foreign partnership is illustrated in the right panel of Figure 2. Given exporting firms' lower (negative) intercept and steeper slope, for all firms that have foreign shares, more productive firms are those who actually sell in both markets. This is analogous to the left panel of the same Figure, where we plot the sorting pattern of purely locally-owned firms.

Concerning product scope of foreign owned firms, Proposition 2 still holds. That is, foreign-owned exporting firms produce more varieties than foreign-owned nonexporting firms. Given productivity level, foreign-owned exporting firms produce the largest number of varieties, while the local-owned non-exporting firms produce the least. Yet the comparison of scope between firms with different ownership arrangements depends on firms' sorting and selection, which we will explore below.

2.3 Firm's Selection on Exporting and Ownership

Before making decisions on the number of varieties to develop and quantities of each variety, firms active in the market decide on their strategies over two dimensions: whether to export, and whether to choose foreign partnership. Those strategies, as shown in previous subsections, depend on firms' productivity and market conditions. To be clear, we define choice variables (E, I) to represent each firm's status, where

$$E = \begin{cases} h & \text{if not export} \\ x & \text{if export} \end{cases}, \text{ and } I = \begin{cases} d & \text{without foreign share} \\ m & \text{with foreign share} \end{cases}. \tag{19}$$

Thus we have four types of firms in the market, respectively: firms that do not export and do not have foreign share in ownership (h, d), firms that do not export but have foreign partnership (h, m), firms that export but owned solely by local investors (x, d), and firms that export and have foreign partnership (x, m). Recall we use superscript to denote ownership, and subscript to denote exporting status. The distribution of firms' productivity draw, as well as other parameters, helps sorting out different types of firms. Because we observe all four types of firms in our Chinese firm-level dataset, we should make appropriate assumptions to ensure their coexistence.

Let $\Psi = (\frac{w}{\rho\varphi})^{-\frac{(\eta-1)(\sigma-1)}{(\sigma-\eta)}}$ represent the adjusted productivity index (note that this is a monotonic transformation). First of all, we notice that from (11) and (15), firms who either export or have foreign partnership are more productive than firms that do neither. Secondly, with foreign partnership, firms that export are more productive than firms that do not export. Those have been plotted in Figure 2. Indicated by their lowest intercept, exporting firms with foreign partnership are the most productive ones so as to compensate the highest fixed costs.

Thus, Figure 2 illustrates the sorting patterns stated in Proposition 2. However, it remains unclear when it comes to the comparison between local-owned exporting firms and foreign-owned non-exporting firms. In combining exporting status and ownership status depicted in the two graphs of Figure 2, we have to further examine the market conditions and cost parameters, which turns out to be two cases. Before a further exploration, we present the following proposition:

Proposition 3 *Given an exogenous productivity distribution, the most productive firms engage in foreign partnership and also export. The least productive firms do neither. In between are domestic-owned exporting firms and foreign-owned non-exporting firms. The former display higher efficiency if exporting incurs large upfront fixed costs, and vice versa. Formally, (1).* $\overline{\varphi}_h^d < \overline{\varphi}_h^m < \overline{\varphi}_x^d < \overline{\varphi}_x^m$ *if assumptions (15) and (20) holds; Or, (2).* $\overline{\varphi}_h^d < \overline{\varphi}_x^d < \overline{\varphi}_h^m < \overline{\varphi}_x^m$ *if assumptions (15) and (21) holds; where* $\overline{\varphi}_E^I$ *refers to the productivity of a representative firm in group* (E, I)*, which is defined in (19), and (20), (21) are defined as below.*

Proof. See the Appendix. ■

The above Proposition comes from comparing the profit functions of different types of firms, such as equations (8), (9), (14) and (16). To combine the two panels of Figure 2, we first compare the intercepts between profit functions Π_h^m and Π_x^d. If to enter foreign market is relatively costly, such that $\alpha_x > (\delta - 1)\alpha_h$, then in order to ensure the coexistence of all 4 types of firms, it must be true that Π_x^d increases faster than Π_h^m. In other words, profit line for domestic-owned exporting firms should be steeper than that for foreign-owned non-exporting firms. Otherwise, it won't be the optimal choice for any firm. This situation is plotted in Figure 3. As proved in the Appendix, it requires inequality (15), and,

$$\frac{\alpha_h + \alpha_x}{\alpha_h + \frac{\delta - \theta}{\theta(\delta - 1)}\alpha_x} < \frac{A_2}{A_1} < \frac{\theta - 1}{\delta - 1}\frac{\alpha_x}{\alpha_h} + 1, \tag{20}$$

In this case, exporting requires high upfront costs and a relatively large foreign market. Only very productive firms will choose to export. That is, for all Chinese firms active in the market, firms of the lowest productivity keep their business within the border. The less productive firms still only sell to the home market, but they may still engage in foreign partnership, in order to reduce variety developing costs and focus on the domestic market. As productivity grows, firms of intermediate productive not only sell their products to the home consumers but also export. However, they do not seek foreign partnership because of the additional relationship-maintanence costs and share of profits cannot be compensated by either lower trade costs or lower variety fixed costs. Finally, the most productive firms benefit from foreign partnership, and they serve both home and foreign markets.

On the other hand, if $\alpha_x < (\delta - 1)\alpha_h$, Π_h^m must increase faster than Π_x^d to retain coexistence of different firm types. To ensure coexistence, we need (15), and,

$$\frac{\alpha_h + \alpha_x}{\alpha_h + \frac{\delta-\theta}{\theta(\delta-1)}\alpha_x} > \frac{A_2}{A_1} > \frac{\theta-1}{\delta-1}\frac{\alpha_x}{\alpha_h} + 1, \tag{21}$$

In this case, exporting is less costly than introducing foreign partnership (in terms of firm-level fixed costs), and foreign market is relatively small. The comparison between foreign-owned non-exporters and local-owned exporters is reversed: relatively less productive firms export but do not have foreign partnership, while relatively more productive firms have foreign partnership but do not export. It is also true that the lowest productive firms do neither while the most productive firms do both. Thus the sorting and selection of firms with different productivities is summarized in Figure 4.

To conclude the model, following Melitz (2003), in equilibrium, each potential firm pays an sunk entry cost f_e to enter the market, the lowest productive firms find production not profitable and exit immediately, while the survivors, according to their productivity draw, will choose different strategies on export / ownership choices, and then optimize their prices and product scope. Free entry into the market leads to zero expected profit in equilibrium.

In this context, we test the implication using accounting data from about 2,000 Chinese enterprises, as shown in the following sections. Using MNL regressions, we find that more productive Chinese firms are more likely to choose export without foreign partnership, rather than to form joint venture serving local market only. This reflects the relatively high barrier to trade in China[12].

Furthermore, starting from Propositions 1 and 2, and given the sorting pattern of firms as in Propostition 3, the ordering of firms by their product scope follows:

Corollary 1 *Regarding the average number of varieties developed, foreign-owned exporting firms produce the largest number of varieties, and local-owned non-exporting*

[12] For example, China hasn't been a member of WTO until the end of 2001.

firms produce the least. The comparison of the number of varieties produced by local-owned exporting firms and foreign-owned nonexporting firms depends on the the relative foreign market size A_2/A_1 and the product expansion advantage λ of foreign-owned firms.

3 Data Description

We are interested in analyzing Chinese firms' sorting pattern and optimal product scope with different exporting and ownership choices. Our firm-level data come from a combined sample of firms from the World Bank's 2001 and 2003 Investment Climate Surveys[13]. The surveys were run in collaboration with the Chinese National Bureau of Statistics and is part of a World Bank's larger project (the World Business Environment Survey, or WBES) to study the business environment at the firm-level in Africa, Latin America, and South and East Asia. A total of 1,548 firms were interviewed in 2001 in five major cities of China - Beijing, Tianjin, Shanghai, Guangzhou and Chengdu (nearly 300 from each of five cities). About two-thirds of the firms are in manufacturing sectors, which can be categorized into 5 broad sectors: apparel and textiles, household appliances, vehicles and vehicle parts, electronic equipment, and electronic components. Approximately two hundred firms were surveyed in each of these sectors. Then in 2003 the WBES project continued the survey, but to other 18 cities, mainly province capitols or important manufacturing cities[14]. This time a total of 2,400 firms were interviewed. Two-thirds

[13] There is an emerging empirical literature utilizing this dataset to analyze Chinese firms' performance and ownership. See, for example, Brambilla (2006) on impact of multinationals on product scope, Fan and Hu (2007) on the effect of FDI on indigenous technological efforts, Hale and Long (2006) on FDI spillover, Hallward-Driemeier et al. (2006) on firm performance, and Xu and Li (2008) on wage inequality. All the above research ultilize only the first phase of the survey. One exception is Dong and Xu (2008), who examine China's millennium labour restructuring program and its impact on employee earnings. In particular, Dollar et al. (2004) provide a detailed description of the survey.

[14] The 18 cities surveyed in the second phase are Benxi, Changchun, Changsha, Chongqing, Dalian, Guiyang, Haerbin, Hangzhou, Jiangmen, Kunming, Lanzhou, Nanchang, Nanning, Shenzhen, Wenzhou, Wuhan, Xian, Zhengzhou. Also see Figure A1 in the Appendix for the location of cities of the two phases of survey.

of them (1609 firms) are manufacturing firms, around 66 to 109 for each city. Besides the five industries surveyed in 2001, five other industries are included: food processing, biotech products & Chinese medicine, chemical products & medicine, metallurgical products, transportation equipments. Consistent through both surveys, the surveyed unit is the main production facility of a firm. The Chinese firm survey data include accounting information on sales, material inputs, employment, capital stock, investment and R&D expenditures, and broader information such as location, ownership structure, share of exports, relations with competitors, clients and suppliers, innovation, and market environment, etc. Table 1 gives the distribution of firms by industry, year of survey, or by location.

Though the firms are only interviewed once, respectively in 2001 or 2003, the accounting data on sales and inputs span over 3 years prior to the year of each survey. Since we are interested in firms' productivity, we use the 3-year panel to estimate firms' total factor productivity (TFP). Firms were inquired about their ownership and whether they undertook ownership restructuring during the 3 years. Exporters were also asked about their exporting sales of each year. On the other hand, the question on how many varieties and new varieties produced was only answered once for the whole 3 years period, but available for both surveys. And information on the total number of varieties is only reported in the 2001 survey.

Discarding firms that were established less than 4 years ago when interviewed, and those firms without information on ownership and exporting status, and some outliers[15], we are left with an unbalanced sample of nearly 2000 firms. Out of the whole sample, 228 firms (or about 12 percent) are foreign owned, while 154 firms (or about 7 percent) are exporting firms, and 162 firms (or about 8 percent) are foreign owned and exporting. A firm is regarded as exporting when the value of its total exports exceeds 10 percent of its total sales. And we define a firm as foreign-owned when the share of foreign investors takes at least 10 percent. Since we are mostly interested in firms that are at least partly owned by the local, we also discard firms that are wholly owned by foreign investors.

[15] The outliers include those firms with nonpostitive sales or value-added.

Including fully foreign-owned firms won't qualitatively affect our empirical results.

Table 2 presents some summary statistics of the variables involved in our analysis. Column 2 gives the average total factor productivity (TFP) in logarithm for each firm type[16]. Consistent with what the theory predicts, foreign-owned exporting firms are the most productive, local-owned exporting firms come next in productivity, then foreign-owned nonexporting firms, and local-owned nonexporting firms have the lowest productivity level. This provides some nonparametric support to our theory. Column 3 reports the average R&D expenditure intensity, defined as the annual R&D expenditure[17] including purchase of outside technology over sales. It seems that firms aiming at the domestic market are more likely to spend in research and development, probably because many exporting firms are engaged in processing trade which by its nature does not require much effort in R&D activities.

Beginning from column 3 we also display the (log) value of firm's capital stock, employment, value-added (defined as sales minus total material costs) and sales. One concern in practice is that firm's scale may vary systematically across industries as a result of differences in minimum efficient scale. To control for those concerns, we substract the industry mean for each series. As expected, foreign-owned exporters are largest in capital stock, value-added and revenue, while domestic-owned non-exporters are smallest, and foreign-owned non-exporters and local-owned exporters are in between. Measuring employment, local exporters on average hire the largest number of workers and nonexporters are usually the smallest. This is partly due to China's comparative advantage in labor-intensive industries. Finally, local firms are on average twice as old as firms with foreign share. This is true because private firms emerge only since the 1980s in China. And foreign invested enterprises (FIEs) became significant even much later[18].

[16] Estimation of TFP will be explained in the next section.

[17] Unfortunately, information on firm level R&D investment stock is not available.

[18] As documented by Feenstra and Lee (2002, Figure 2), FIEs' output share increases the most in 1990s, but still remains relatively small.

4 Empirical Test I: Productivity Sorting and Exporting / Ownership Decisions

4.1 Model Specification

To start with, we analyze the effect of firms' productivity draws on firms' choices of exporting and ownership. We could first specify each individual firm's operating profit as:

$$\pi_{is} = \alpha_s + \beta_s \cdot \varphi_i + Z_i' \gamma_s + \varepsilon_{is} \tag{22}$$

where s indicate firm i's selection over two status variables (E, I). Here we take firms' choice variable $s = 1$ for local-owned nonexporters (i.e., $(E, I) = (h, d)$), $s = 2$ for foreign-owned nonexporters (so $(E, I) = (h, m)$), $s = 3$ for local-owned exporters ($(E, I) = (x, d)$), and finally $s = 4$ for foreign-owned exporters ($(E, I) = (x, m)$). The explanatory variables include firm's productivity (φ) and other firm level characteristics (vector Z) such as capital stock, firm age, and R&D expenditure.

We do not observe firms' economic profit from different choices, but we do observe each firm's exporting status and ownership structure. More importantly, in the theorectical part of this paper, we've constructed a connection between firms' productivity levels and the exporting / ownership choices they make. So we are able to use a multinomial logit (MNL) model to explore how changes in firm's pre-choice productivity (and other firm level characteristics) affect the response probability of each choice group. We take domestic-owned non-exporters as the base group, and the probabilities for a firm to choose alternatives $s = 2, 3, 4$ is[19]:

$$\Pr(s) = \frac{\exp[\alpha_s + \beta_s \cdot \varphi_i + Z_i' \gamma_s]}{1 + \sum_{k=2}^{4} \exp[\alpha_k + \beta_k \cdot \varphi_i + Z_i' \gamma_k]} \tag{23}$$

Taking the ratio between probabilities of two groups j and k (j and $k = 1, 2, 3, 4$), and taking log gives the log-odds ratio $\ln(\Pr(j)/\Pr(k)) = (\alpha_j - \alpha_k) + (\beta_j - \beta_k) \cdot \varphi_i + Z_i'(\gamma_j - \gamma_k)$. Thus the difference between coefficients of two groups reveals the semi-elasticities of odds

[19] And the probability for a firm to be a domestic-owned non-exporter is, $\text{Prob}(s = 1) = 1/\left[1 + \sum_{k=2}^{4} \exp(\alpha_k + \beta_k \cdot productivity_i + Z_i' \gamma_k)\right]$.

ratio between two groups with respect to firm's differences in productivity, and other control variables[20]. We expect to see β_s increases in s.

First notice that the constant term in each choice applies to all firms within the group, so it captures the group-specific costs: in our theoretical model, it is the firm level fixed costs incurred in producing, exporting and introducing foreign partnership, respectively.

To start the MNL experiment, a good measure of productivity is necessary. Here we adopt total factor productivity (TFP). A typical measure of TFP uses the residual from an OLS regression of the production function. As is well known, this measure subjects to serious endogeneity of input choices (Olley and Pakes, 1996). To fix this estimation bias, Olley and Pakes suggest a multi-step method using a third-order polynomial approximation to back out the unobserved productivity shocks from the firm's investment decisions[21]. In the same spirit, Levinsohn and Petrin (2003) propose using intermediate inputs as proxy to estimate firms' production function. One main advantage of the Levinsohn-Petrin method over Olley and Pakes' original work is that using material instead as proxy avoids the inaccuracy caused by the large amount of missing values or "zeros" of investment. This is what exactly occurs in our data, of which over a quarter of firms do not report investment each year. Thus following the steps suggested in Petrin et al. (2004), we estimate the production function[22] using a three-year panel of firms, separately for each sector. We then measure TFP as the first year regression residual associated with each firm.

Finally, larger firms are more likely to overcome the investment barrier to export or coordinate with multinationals, so we include the log value of the capital stock as a control of firm scale. Other control variables include R&D expenditure intensity as well as firm's age.

[20] For the details on the properties of multinomial logit specifications, see Wooldridge (2002), Chapter 15.

[21] For an application in international trade, see Pavcnik (2002).

[22] That is, we regress value-added on employment, capital and material, where value-added is sales minus material costs, capital is measured as the stock of depreciable assets (buildings, machinery, and equipment).

4.2 Estimation Results

Results from the MNL regression based on (23) are presented in Table 3. In this table, we work on a 3-year short panel to estimate TFP. As discussed above, we use estimated TFP values of the *first* year as the key explanatory variable, and use exporting / ownership decisions of the *last* year as the dependent variable. The first three columns show the effect of each explanatory variable on the likelihood of a firm belonging to that group relative to the base group of local-owned non-exporting firms. The estimation results are encouraging. First, the negative constant terms in column (1) to (3) indicate that exporting and introducing foreign partnership incur higher fixed costs than purly domestic production. Second, the coefficients on TFP are all positive and significant, implying more productive firm is more likely to export or form parterships with foreign investors. Estimates on the capital stock, R&D expenditure intensity and firm's age are also significant mostly, with signs consistent with our intuition.

More importantly, we are intestested in the ordering of the relative change in odds ratio when productivity increases, holding other explanatory variables constant. This is done by taking differences between the coefficients of each column, as shown in the last three columns of Table 3. Column (4) gives the difference in coefficients between columns (2) and (1), reflecting the relative odds ratio change between local-owned exporting firms relative to foreign-owned non-exporting firms, when firm's characteristics change. Similarly, column (5), the difference between columns (3) and (1), reflects the change in relative odds ratio between foreign-owned exporting firms and non-exporting firms. The last column shows the change between foreign- and local-owned exporting firms. The ordering of coefficient estimates are in general consistent with our theory. In particular, the coefficient on TFP is highest for firms that export and have foreign share, followed by local firms that export, and finally foreign firms that do not export. That means, relative to local nonexporting firms, the most productive firms are more likely to choose both foreign ownership and export rather than just export or just have foreign ownership. For example, raising log TFP by one standard deviation (2.25) increases the odds of local firms become exporters 48% (from column 2), and increases the odds of foreign-owned firms become exporters by 43% (from column 5)[23]. Or, since we measure TFP in log value, the coefficients can also be read as the elasticity of odds ratio between two groups with respect to productivity change. Thus increasing TFP by 1% raises the likelihood ratio of exporting firms to be foreign owned rather than local owned by 9.9% (from column 6), etc.

In Table 3, we use the number of total employment as a free variable in estimating TFP. This neglects the heterogeneity across workers within a firm. Instead, we could decompose firm's employment by workers' skill type, but only for two years. Here we define skilled workers as non-production workers, which equals the sum of engineering and technical personnel and managerial personnel. On the other hand, production workers are used as a proxy for unskilled workers, including basic production workers, auxiliary production workers and service personnel. We reestimate firm TFP and then report a new MNL regression in Table 4. Again, we get supportive evidence for our theory. From columns (1) to (3), the constant terms remain negative and significant, and increasing in absolute value. The TFP coefficients stay positive and significant, and increasing along groups. Note that MNL regression assumes independence of irrelevant alternatives (IIA), which means that the probability of any two alternatives is independent from the number and characteristics of other alternatives. A Hausman test cannot reject the IIA assumption in both datasets.

4.3 Robustness and Extension

In this section we further examine the sensitivity of the estimates. The first concern is the limited number of firms in some industries. Table 1 has given a general distribution of firms across 10 manufacturing industries. However, firms in the last five industries listed there were only interviewed in the second survey and are relatively small in number of observations. Table 5 takes a closer look at firms by further tabulating their exporting and ownership choices. Not surprisingly, out of the five small industries, three do not have firms of type (h, d), two do not have firms of type (x, m). To see whether this

[23] That is: $[exp(2.25 \times 0.174) - 1] \times 100\% = 48\%$, and $[exp(2.25 \times 0.159) - 1] \times 100\% = 43\%$.

raises serious bias to our estimation, we resample the data by only using the five largest industries. We find qualitatively similar patterns to those shown by earlier regressions, which still support our ranking of firms by their choices of categories. This is shown in the left panel of Table 6.

Our second sensitivity test is what defines a firm with foreign partnership. One important feature of our theory is that Chinese firms can turn to foreign investors for joint venture. So our previous regressions excluded firms that are solely owned by foreign investors (such as greenfield FDI). However it is reasonable that if the foreign share is sufficiently large (say over 80 percent), it might be more appropriate to regard the firm as foreign dominated instead of Chinese firm with foreign partnership. Thus in the right panel of Table 6, we further restrict the sample to firms that are either fully domestic or with foreign share less than 80 percent. Still, we have the correct ordering of TFP coefficients across different groups of firms. And the coefficients are also close to previous estimates in magnitude.

Furthermore, there also exists endogeneity between TFP and firm's exporting / ownership decisions: one might be more productive because its foreign partner brings in new know-how to reduce marginal costs; furthermore, literature on learning from exporting argues that firms who export will improve performance during the exporting process. One way to inspect those alternative explanations is to look at the "switchers". Those switchers include those who did not export previously, but began to export, and those who did not have foreign ownership previously, but undertook ownership restructuring during the latest three years prior to the interview. Thus, switchers in our practice are defined as firms that exported less than 10 percent of sales in 1998 but the exporting share exceeded 10 percent in 2000, and firms that had zero or less than 10 percent of foreign share in 1998 but became foreign owned in 2000[24]. Thus our samples are now all domestic nonexporters plus those switchers. We then use each firm's TFP and other characteristics in 1998 as explanatory variable in the new MNL regression. Regressing choice variables in 2000 on

[24] Recall that we define exporters as those who export at least 10 percent of total sales, and define foreign-owned firms as those whose share of foreign companies or investors takes 10 percent or more.

1998 firm characteristics can largely control the experience accumulation from exporting activities and the productivity premia from foreign investment since now firm's exporting / ownership choices are "exogenous" to firm's productivity. The result of regression is reported in Table 7. First, the sign predictions on TFP coefficients and constant terms are the same as before. Second, the ranking of different groups still follows the theory, but is somewhat less significant, probably because of much smaller sample we now use. There are also some changes on the ordering of constant terms and other explanatory variables, but our basic prediction holds.

In summary, we uncovered supportive empirical evidence for the theoretical predictions stated. As in section 2, we relate firm's decision on exporting and ownership to their productivity. The most productive firms are exporting firms who have foreign ownership. The least productive firms are those local firms without substantial export share. The theory points to two possibilities on ranking local-owned exporters and foreign-owned non-exporters. If exporting requires large upfront fixed costs of exporting and foreign market is relatively large, more productive firms are more likely to be exporters. If on the other hand exporting barrier is relatively low and foreign market is relatively small, foreign-owned firms are on average more productive than local firms, no matter whether they export or not. Our empirical tests examining firms across sectors lend its support to the case of large exporting fixed cost in Proposition 3.

5 Empirical Test II: Estimating Product Scope with Exporting and Ownership Decisions

5.1 Model Specification

Propositions 1 and 2 state that more productive firms in general introduce more varieties than less productive firms, and exporting firms on average produce more varieties than nonexporters. Corollary 1 then states that foreign-owned exporting firms produce the largest number of varieties, while local-owned non-exporters produce the least. Examining equations (4), (7), (13), (17), it clearly suggests that we could incorporate all four equations of optimal scope into one, and take the log. Then the number of varieties produced by a firm with productivity φ can be written as,

$$\ln n_{(\varphi \mid E,I)} = C + FOR \cdot \frac{(\sigma-1)}{(\sigma-\eta)} \ln \lambda + EXP \cdot \ln(A_2/A_1) + \frac{(\sigma-1)(\eta-1)}{(\sigma-\eta)} \ln \varphi \tag{24}$$

where C is a constant[25] over different categories (E, I) defined by (19). FOR and EXP are two indicator variables, where $FOR = 1$ if the firm introduces foreign partnership, and $= 0$ otherwise; $EXP = 1$ if the firm exports, and $= 0$ otherwise. λ refers to the reduction in the variety-level fixed costs due to internal technology transfer among foreign-owned affiliates; A_2/A_1 refer to the market size raio of exporters relative to non-exporters. Immediately, it suggests that foreign ownership or exporting status both promote variety expansion.

In addition, λ does not vary across firms who belong to group $FOR = 1$; and the market size ratio A_2/A_1 does not vary across firms belonging to group $EXP = 1$. Therefore, letting $\beta_1 = \ln(A_2/A_1)$, and $\beta_2 = \frac{(\sigma-1)}{(\sigma-\eta)} \ln \lambda$, the structural empircal model is specified as,

$$\ln(n_i) = C + \beta_1 \cdot EXP_i + \beta_2 \cdot FOR_i + \beta_3 \ln \varphi_i + X_i'\Gamma + \epsilon_i \tag{25}$$

An exporter produces more varieties than a local nonexporter since it faces a larger market ($A_2 > A_1$), while a foreign-owned firm also produces more varieties than a local nonexporter since it have improved technology on expanding product scope ($\lambda = f_h/f_m > 1$). This implies positive estimates for β_1 and β_2. More productive firms produce more varieties, thus we expect a positive β_3.

Though it's not formalized in the model, a set of control variables (X_i) is utilized to capture the effect of firm characteristics other than productivity. It is argued that the SOEs (State Owned Enterprises) and Cooperative/Collective firms may not perform competitively. So indicators for SOEs and Cooperative/Collective firms are included. Thus, the baseline group in the estimation is local private firms that do not export. Secondly, R&D expenditure promotes innovation and is expected to increase the number

[25] $C = \ln A_1 + \frac{(\sigma-1)}{(\sigma-\eta)} \left[\ln \left(\frac{(\eta-1)}{\sigma(\sigma-1)} \right) - (\eta-1) \ln \frac{w}{\rho} - \ln f_h \right]$

of new varieties. Furthermore, notice that the constant term C includes $\ln w$, which refers to local labor costs, which in fact vary across industries and production locations. To capture this heterogeneity, we include industry and city fixed effects in all our estimation.

5.2 Estimation Results

The left part of Table 8 presents the estimation results. The first column of Table 8 displays the results of a simple OLS, using (log) number of products as the dependent variable. As expected, TFP has a positive and significant impact on product innovation. Exporting / ownership choices, however, do not play significant role. This is probably due to the fact that we are using ordinary regression on count data which only take nonnegative integers. So to account for the count data property of our dependent variable, we experiment poisson regression. That is, we implicitly assume the conditional probability for the number of varieties is $\Pr(n_i|\omega_i) = \omega_i^{n_i} e^{-\omega_i}/n_i!$, where ω_i is the mean and variance of number of products, which is specific to firm i and depends on a log-linear specification:

$$\omega_i = \exp\left(C + \beta_1 \cdot EXP_i + \beta_2 \cdot FOR_i + \beta_3 \ln \varphi_i + X_i'\Gamma\right) \tag{26}$$

Therefore, column (2) presents the results based on a truncated poisson distribution. Foreign partnership, exporting status, as well as productivity, all have positive and significant effects on product scope. To interpret the estimated coefficients, we need to calculate the incident ratio, which equals $exp(\beta_k \triangle x_k)$ for variable x_k. The incidence ratio gives the expected proportional change in the number of varieties[26]. We report this ratio for key variables below each coefficient estimate. Other things equal, firms with foreign participation produce 57 percent more than domestic private firms[27], while firms that export produce 5 percent more, relative to domestic private firms. So a firm having foreign partnership and exporting produce a total of 62 percent more than a domestic private firm without foreign partnership. As expected, TFP promotes product range expansion.

[26] For indicator variables, for example for foreign partnership, the expected proportional difference relative to the base group is simply $exp(\beta_2)$. For TFP, notice the regressor is in log value, so 1 percentage increase in TFP will lead to $exp(\beta_3) - 1$ percentage increase in number of varieties.

[27] Using the incidence ratio, exp(0.450) - 1 $\simeq$ 0.57.

1 percent increase in productivity raises number of products by 14 percent. Moreover, Collective firms and state-owned enterprises (SOEs), produce much less than their private rivals. If a firm established early produces more varieties than others, reflecting importance of experience accumulation. Surprisingly, R&D expenditure intensity reduces number of products. Recall we are using the current R&D expenditure, so more productive firms should spend less in R&D. In addition, indicator for Firms that were newly set up has a positive and significant coefficent, which will be controlled when we control over-dispersion problem of the poisson regression. As well known, poisson distribution imposes strict assumption that mean equals variance, which may not be the case for many applications. So in column (3), results from a truncated negative binomial regression are displayed. Now foreign ownership / exporting has a smaller impact on product scope. While the impact of productivity becomes stronger. New firm's effect vanishes.

In the theoretical model, we assume a static partial equilibium and prove the positive impact of firms' ownership/exporting decisions on the scope of varieties. However, to capture firms' ability to expand variety range, we could instead use the number of new varieties. This is because: firstly firms' number of varieties might not depend on its current productivity level, R&D expenditure, and export/ownership choices, but instead on historic factors such as technology background in previous years; secondly we only have limited observations of firms who reported their number of prouduct in the first survey, but instead we have observations on how many new varieties were introduced during the most recent 3 years in both surveys; finally using new varieties, we follow Brambilla (2006) and could provide close comparison with her findings.

We start with similar estimations using the sampe sample as previous regressions, with the number of new varieties as dependent variable, instead of total varieties. Column (4) of Table 8 gives the results using OLS, in which no significant impacts of ownership/exporting are found. Columns (5) and (6) give more precise results based on poisson and negative binomial. As expected, more productive firms introduce more new varieties. Foreign participation or exporting also significantly enhances firm's ability to expand product range. It also worths noting that collective firms, instead of SOEs, are those performing worst.

Then in Table 9, we expand our sample to include those firms in the second survey, in which only the number of new products are reported. The first three columns repeat what we have done in the right panel of Table 8, but using the full sample with all firms in two surveys. All regressions confirm that product scope expands with productivity, foreign participation, and exporting status. Collective firms underperform private rivals, while SOEs somewhat do better. R&D expenditure and experience (age) help variety expansion. New firms produce smaller amount of new varieties.

Furthermore, a firm gains new advantage if it exports and allow foreign participation at the same time. As documented by Feenstra and Hanson (2005), over the period 1997-2002 FIEs accounted for 62.8 percent of China's processing exports. Those processing factories are granted privilege of importing inputs duty-free as long as those inputs are only used to produce exports. Also, foreign partnership could probably bring exporting firms lower transport costs, faster custom clearing, or favoring tariff terms by the multinational's home country. Thus, to capture any extra impact by such interaction between exporting and foreign share, we add an additional indicator term $(FOR_i \cdot EXP_i)$, and its coefficient, β_4, is expected to be positive.

Column (4) to (6) of Table 9 present the results with this addtional interation term, using OLS, poisson and negative binomial regressions. Taking column (5) for example, foreign-owned firms produce 7 percent more varieties than baseline nonexporting local-owned firms, other things equal; while exporting firms have 18 percent more varieties than the baseline firms. For a foreign-owned exporting firm, *ceteris paribus*, its product range is $(7 + 18 + 16) = 41$ percent larger than the baseline firms. This implies the importance of the interaction between foreign partnership and exporting activities.

Finally, using the number of new varieties as an indicator for firm's ability of product expansion raises a concern that it does not capture consumers' valuation of the new products. As a robustness check, following Brambilla (2006), we run a OLS regression of sales of new varieties (in log value) on the same set of independent variables. This is reported in the last column of Table 9. Having foreign participation more than doubles new product sales since $\exp(0.948) - 1 = 1.58$, while exporters have three quarters higher sales in new products than local-owned private nonexporters. If a firm fits in both groups, it further increases sales on new varieties by even larger percentage!

Using the same data of Chinese firms but limited to the first survey, Brambilla constructs reduced form regressions investigating the impact of foreign ownership on firm's introduction of new products. She concludes that foreign ownership significantly improves firm efficiency by raising productivity and lowering R&D costs. In comparison, the paper draws on both phases of the surveys, which includes more cities, from both inland and coastal provinces, and more firms in each sector. Therefore we have more variations in the sample, which hopefully provides further insights on firm's scope strategy. Our structural model divides firms by their ownership / exporting choics, showing that besides productivity, foreign partnership and exporting activity both encourage firm to expand in product range. And the interaction between the two might create further important incentives.

6 Concluding Remarks

This paper proposes a simple monopolistic competition model, accounting for multiple products and selections of heterogeneous firms into different ownership/exporting choices. To capture the idea of heterogenous multiproduct firms, we add the Melitz (2003) style firm heterogeneity into a symmetric two-tier CES preference used by Allanson and Montagna (2005). Firms, upon paying entry costs and knowing their productivity levels, decide whether to export, and whether to form joint ventures with foreign companies. Having full knowledge of the market and the productivity distribution, they then decide what prices to charge and how long the product range should be. More productive firms produce more varieties. But the ownership / exporting selections also have important impacts on the number of products that a firm introduces.

We then apply this model to two empirical tests, using firm-level data for Chinese enterprises. The experiment of Chinese firms is relevant, because China gets most of the FDI among developing countries. And Chinese firms often form joint ventures with foreign companies in order to improve technology or enlarge the foreign market. So it is important to take a close look at their ownership/exporting status and product scope.

First, using multinomial logit estimations, we observe sorting and selection patterns consistent with the model. The most productive firms engage in foreign partnership and also participate in exporting. The least productive firms do neither. In between are domestic-owned exporting firms and foreign-owned non-exporting firms. In the case of China, exporting incurs large upfront fixed costs, then more productive firms are more likely to be domestic-owned exporting firms, rather than the latter. While if exporting involves less frictions, such as in many developed economies, foreign-owned nonexporting firms may display higher productivity than local-owned exporting firms.

In the second empirical test, we further explore the impact of firm's selections on product scope. More productive firms introduce more varieties. Foreign participation and exporting both enhance variety expansion, because exporting firms have larger markets, and foreign-invested firms have lower product developing costs. We confirm the model prediction in the empirical applications. Overall, foreign partnership increases the number of new varieties by 2-24 percent, while exporting status increases the number of new varieties by 7-18 percent. Moreover, we find the interaction between exporting and foreign participation generates substantial incentives for expanding product scope. SOEs and collective firms usually underperform.

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Appendix

Appendix A. Lemma 1: the cannibalization effect

Proof. First, since firm's country origin does not matter, we suppress the country superscripts in equation (1) and rewrite it as:

$$U^H = \left\{ \int_{i=0}^{N} \left[\left(\sum_{j=1}^{n_i} q_i(j)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \right]^{\frac{\eta-1}{\eta}} di \right\}^{\frac{\eta}{\eta-1}}, \sigma > \eta > 1. \tag{A1}$$

Thus we are assuming each firm is atomic relative to the large population of firms (N), while each firm i produces a limited number of varieties (n_i). All other notations follow section 2. Maximizing utility gives the demand for each variety k by firm i:

$$q_i(k) = A^H P(i)^{\sigma-\eta} p_i(k)^{-\sigma} \tag{A2}$$

where, as described in section 2, $A^H = Y^H P^{\eta-1}$ represents the aggregate market condition, $P = \left(\int_{i=0}^{N} P(i)^{1-\eta} di\right)^{\frac{1}{1-\eta}}$, and $P(i) = \left(\sum_{j=1}^{n_i} p_i(j)^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}}$ gives unit price of firm i's aggregate product. As assumed, firms are atomless, and take A^H as given, while each firm realize that a price change in variety k will affect the firm aggregate price $P(i)$. Taking log of (A2) and taking derivative with respect to variety k''s log price $\ln p_i(k')$, we get the elasticities:

$$\varepsilon_{ikk'} = \frac{\partial \ln q_i(k)}{\partial \ln p_i(k')} = \begin{cases} -\sigma + (\sigma - \eta)\frac{p_i(k)^{1-\sigma}}{P(i)^{1-\sigma}} \text{if } k' = k \\ (\sigma - \eta)\frac{p_i(k)^{1-\sigma}}{P(i)^{1-\sigma}} \text{if } k' \neq k \end{cases} \tag{A3}$$

Thus a drop in price of variety $k\prime$ decreases demand for varity k produced by the same firm. This is recognized as the "*cannibalization effect*" within a firm. Maximizing firm i's profit $\Pi(\varphi_i) = \sum_{j=1}^{n_i} \left[(p_i(j) - \frac{w}{\varphi_i}) q_i(j) - f \right] - \alpha$, where $\frac{w}{\varphi_i}$ gives marginal cost which is constant within a firm, we have:

$$\begin{aligned} \frac{\partial \Pi_i}{\partial p_i(k')} &= \sum_{k=1}^{n_i} (p_i(k) - \frac{w}{\varphi_i}) \frac{\partial q_i(k)}{\partial p_i(k')} + q_i(k') \\ &= \sum_{k=1}^{n_i} \frac{(p_i(k) - \frac{w}{\varphi_i}) q_i(k)}{p_i(k')} \varepsilon_{ikk'} + q_i(k') = 0 \end{aligned} \tag{A4}$$

Using (A3) and the symmetry between varieties within a firm, we get:

$$p_i(k) = \frac{\eta}{\eta - 1} \frac{w}{\varphi_i} \tag{A5}$$

Thus taking "cannibalization effect" into account, the price of each variety is still a constant markup over marginal cost, but the markup depends solely on the across firm substitutability η. QED. ■

Appendix B. Proposition 3: sorting the cutoff conditions.

Figure 3 and Figure 4 depict the two possible solutions for the co-existence of all four types of firms.

First, the cutoff conditions specifying Figure 3 could be summarized as below:

(1). cutoff for entering the domestic market:

$$kA_1 \Psi_h^d / F = \alpha_h \tag{A6}$$

(2). cutoff between local- and foreign-owned nonexporting firms:

$$k(\theta - 1) A_1 \Psi_h^m / F = (\delta - 1)\alpha_h \tag{A7}$$

(3). cutoff between foreign-owned nonexporting firms and local-owned exporting firms:

$$k(A_2 - \theta A_1)\Psi_x^d/F = \alpha_x - (\delta - 1)\alpha_h \tag{A8}$$

(4). cutoff between local- and foreign-owned exporting firms:

$$k(\theta - 1)A_2\Psi_x^m/F = (\delta - 1)(\alpha_h + \alpha_x) \tag{A9}$$

We aim to make $\Psi_h^d < \Psi_h^m < \Psi_x^d < \Psi_x^m$, this requires:

$\Psi_h^d < \Psi_h^m \Leftrightarrow \delta > \theta > 1$, which is assumption (15);

$\Psi_h^m < \Psi_x^d \Leftrightarrow \frac{A_2}{A_1} < 1 + \frac{\theta-1}{\delta-1}\frac{\alpha_x}{\alpha_h}$, which dominates (11);

$\Psi_x^d < \Psi_x^m \Leftrightarrow \frac{A_2}{A_1} > \frac{\alpha_h+\alpha_x}{\alpha_h+\frac{\delta-\theta}{\theta(\delta-1)}\alpha_x}$;

Combining all conditions, we have $\delta > \theta > 1$ and $1 + \frac{\theta-1}{\delta-1}\frac{\alpha_x}{\alpha_h} > \frac{A_2}{A_1} > \frac{\alpha_h+\alpha_x}{\alpha_h+\frac{\delta-\theta}{\theta(\delta-1)}\alpha_x}$,which are expressed in (15) and (20).

To confirm, examining equations (8), (9), (14) and (16), Figure 3 is realized when the intercepts follow $\alpha_h < \delta\alpha_h < \alpha_h + \alpha_x < \delta(\alpha_h + \alpha_x)$, and slopes follow $A_1 < \theta A_1 < A_2 < \theta A_2$, and finally the horizontal intercepts that each profit line crosses the horizontal axis from below follow $\alpha_h/A_1 < \delta\alpha_h/\theta A_1 < (\alpha_h + \alpha_x)/A_2 < \delta(\alpha_h + \alpha_x)/\theta A_2$. All those conditions are satisfied given $\delta/\theta > 1$, $A_2/A_1 > \theta$ and $\alpha_x/\alpha_h > (\delta - 1)$. The latter two are implicitly embodied in (20).

On the other hand, the cutoff conditions specifying Figure 4 could be summarized as (A6), and,

(5). cutoff between local-owned non-exporting firms and exporting firms:

$$k(A_2 - A_1)\Psi_x^d/F = \alpha_x \tag{A10}$$

(6). cutoff between local-owned exporting firms and foreign-owned non-exporting firms:

$$k(\theta A_1 - A_2)\Psi_h^m/F = (\delta - 1)\alpha_h - \alpha_x \tag{A11}$$

(7). cutoff between foreign-owned non-exporting and exporting firms:

$$\kappa\theta(A_2 - A_1)\Psi_x^m/F = \delta\alpha_x \tag{A12}$$

We aim to make $\Psi_h^d < \Psi_x^d < \Psi_h^m < \Psi_x^m$, this requires:

$\Psi_h^d < \Psi_x^d \Leftrightarrow \frac{A_2}{A_1} < 1 + \frac{\alpha_x}{\alpha_h}$;

$\Psi_x^d < \Psi_h^m \Leftrightarrow \frac{A_2}{A_1} > 1 + \frac{\theta-1}{\delta-1}\frac{\alpha_x}{\alpha_h}$;

$\Psi_h^m < \Psi_x^m \Leftrightarrow \frac{A_2}{A_1} < \frac{\alpha_h+\alpha_x}{\alpha_h+\frac{\delta-\theta}{\theta(\delta-1)}\alpha_x}$;

Combining all conditions, we have $\delta > \theta > 1$ and $1 + \frac{\theta-1}{\delta-1}\frac{\alpha_x}{\alpha_h} < \frac{A_2}{A_1} < \frac{\alpha_h+\alpha_x}{\alpha_h+\frac{\delta-\theta}{\theta(\delta-1)}\alpha_x}$,which are expressed in (15) and (21).

Implicitly (21) implies $A_2/A_1 < \theta$ and $\alpha_x/\alpha_h < (\delta - 1)$, which, together with (15) guarantee the intercepts and slopes of four profit lines follow Figure 4.

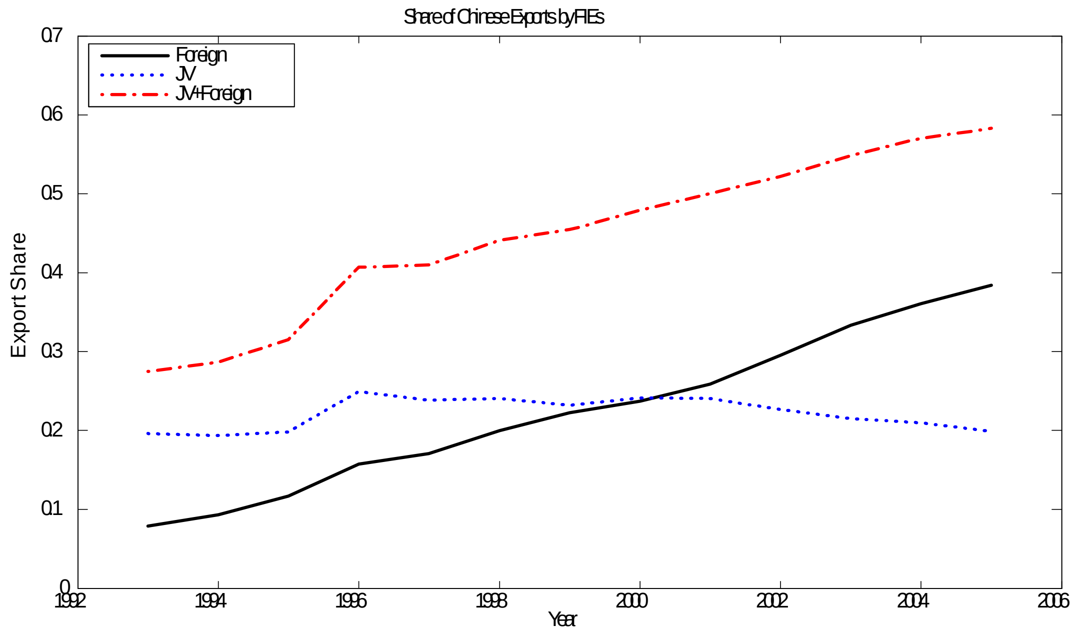

FIGURE 1: Export Share by FIEs

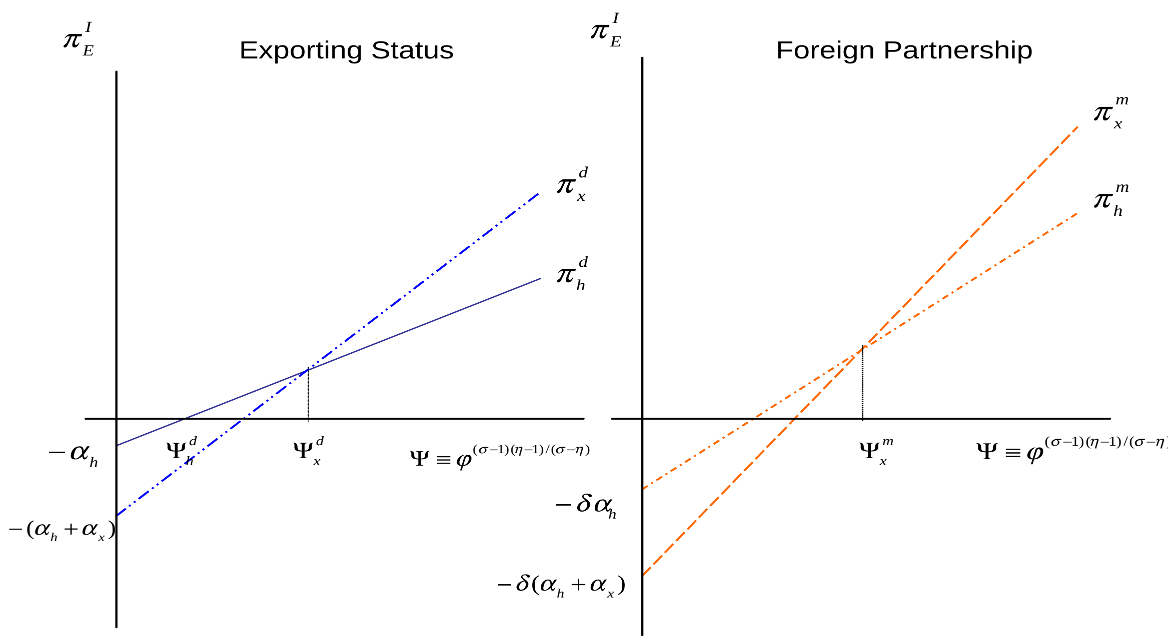

Figure 2: Selection of Firms by Exporting/Ownership. [Notes: Each line gives the profit function π_E^I, where (E, I) defines the exporting/ownership categories that firms belong to. $E = x$ if the firm exports; $= h$ if only sells to home; $I = m$ if the firm has foreign participation; $= d$ if purely local-owned. $\Psi = \varphi^{\frac{(\eta-1)(\sigma-1)}{\sigma-\eta}}$ proxies for productivity.]

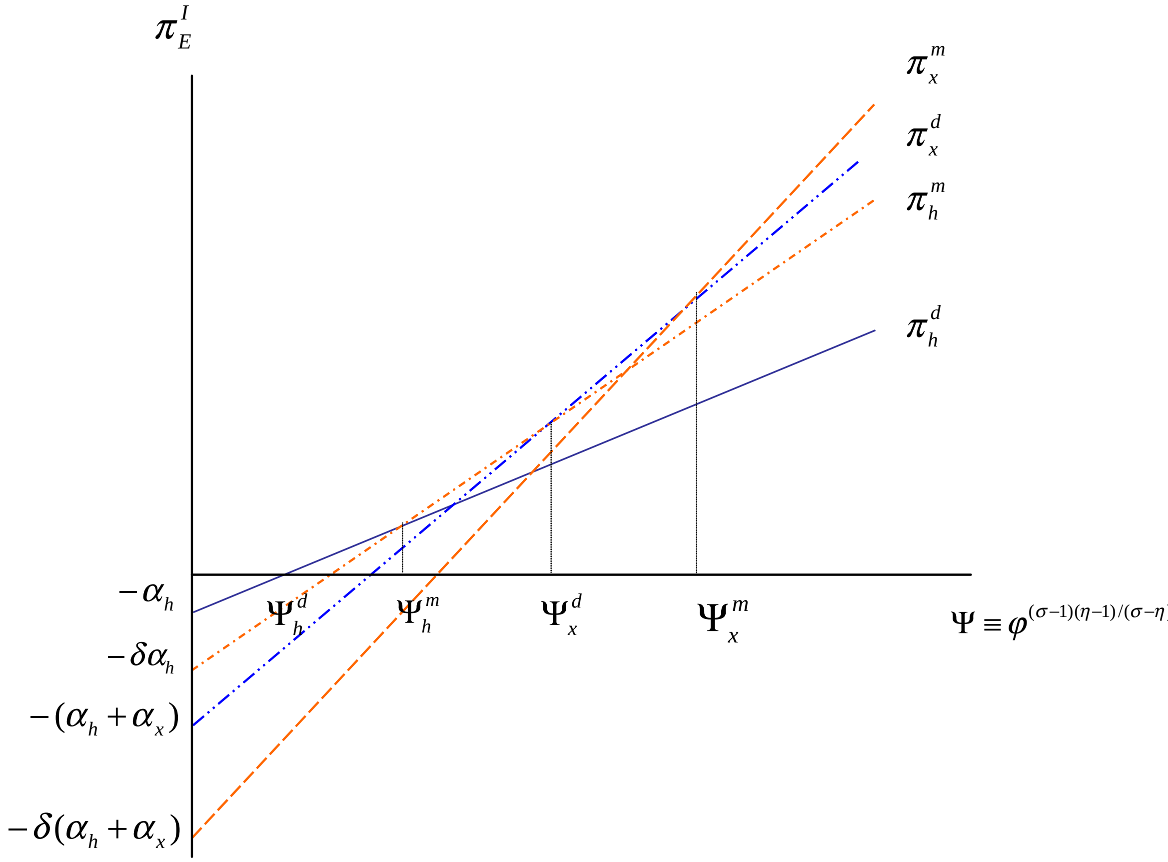

Figure 3: Selection of Firms: High Export Costs, Large Foreign Market [Notes: Each line gives the profit function π_E^I, where (E, I) defines the exporting / ownership category that the firm belongs to. $E = x$ if the firm exports; $= h$ if it only sells to home; $I = m$ if the firm has foreign participation; $= d$ if it's purely local-owned. $\Psi = \varphi^{(\eta-1)(\sigma-1)/(\sigma-\eta)}$ is a proxy for productivity.]

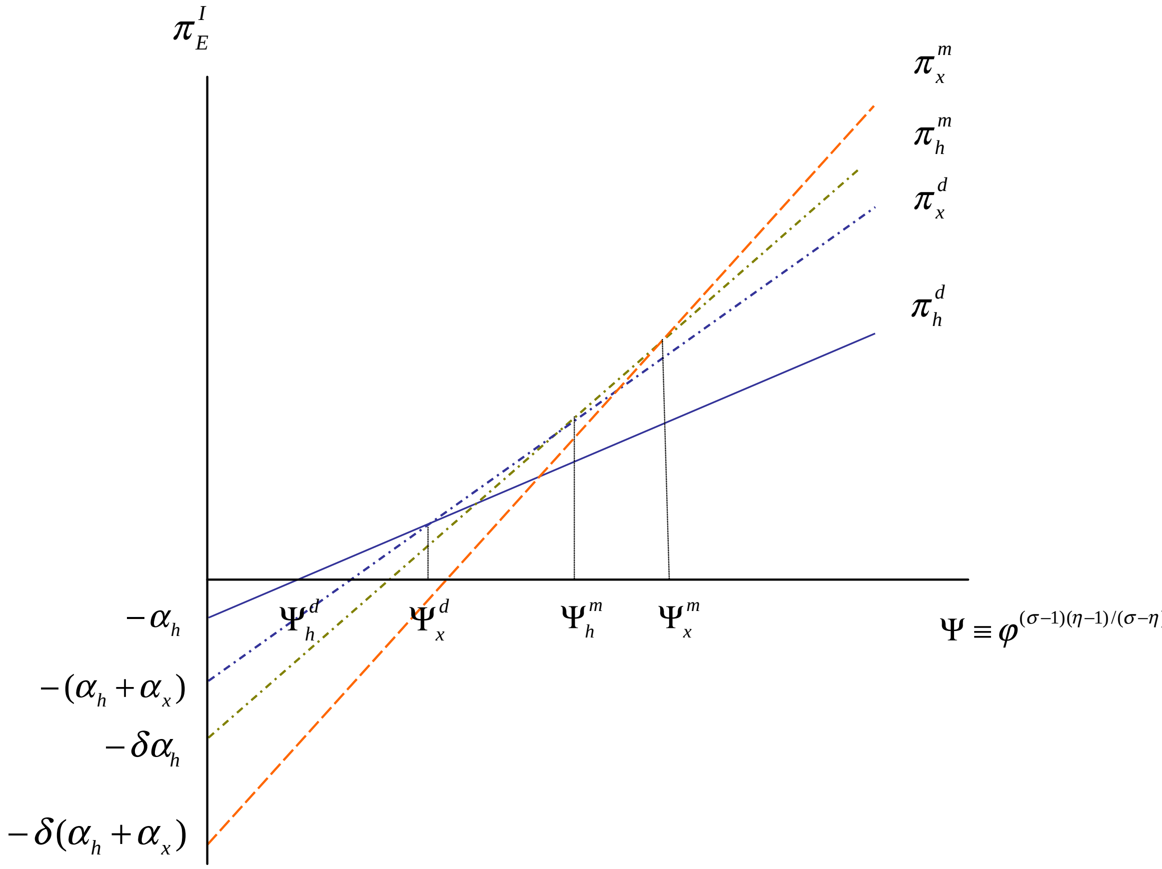

Figure 4: Selection of Firms: Low Export Costs, Small Foreign Market [Notes: Each line gives the profit function π_E^I, where (E, I) defines the exporting / ownership category that the firm belongs to. $E = x$ if the firm exports; $= h$ if it only sells to home; $I = m$ if the firm has foreign participation; $= d$ if it's purely local-owned. $\Psi = \varphi^{(\eta-1)(\sigma-1)/(\sigma-\eta)}$ is a proxy for productivity.]

Table 1: Firms Distribution by Sector, Year, and Location

Sector	Total	2002	2003	Coastal	Inland
Garment & leather products	558	206	352	263	295
Electronic equipment	357	172	185	208	149
Electronic parts making	461	187	274	224	237
Household electronics	213	150	63	156	57
Auto & auto parts	558	201	357	214	344
Food processing	69		69	8	61
Chemical products & medicine	66		66	7	59
Biotech products & Chinese medicine	35		35	3	32
Metallurgical products (manuf.&tools)	157		157	42	115
Transportation equipment	43		43	5	38
Total	2,517	916	1,601	1,130	1,387

Notes: Transportation equipment includes telecommunication and shipbuilding.

Table 2: Summary Statistics of Firms by Different Exporting and Ownership Decisions

Firm Type	Firms	TFP	R&D Intensity	Capital	Employment	VA	Sales	Age
Domestic only (h, d)	1429	2.74	0.03	-0.37	-0.16	-0.44	-0.45	19.74
Foreign owned, non-export (h, m)	228	3.41	0.06	0.97	0.17	1.20	1.18	8.93
Domestic owned, export (x, d)	154	3.67	0.02	1.12	0.87	1.05	1.06	20.49
Foreign owned, export (x, m)	162	4.20	0.01	1.46	0.52	1.53	1.62	9.93

Notes: Samples include all firms except wholly foreign owned. Capital, employment, value-added, sales are mean corrected average over all firms. R&D intensity is the R&D expenditure over sales. All are in log value except number and age of firms .

Table 3: Firm's Sorting by Exporting and Ownership Choices: 3-Year Panel

Independent Variables	(Exporting, Ownership) (h,m) (1)	(x,d) (2)	(x,m) (3)	Difference in Coefficients (4)=(2)-(1)	(5)=(3)-(1)	(6)=(3)-(2)
Constant	-4.512***	-5.454***	-6.151***	-0.942	-1.639	-0.697
	(0.393)	(0.452)	(0.483)			
TFP	0.114***	0.174***	0.273***	0.061	0.159***	0.099**
	(0.035)	(0.039)	(0.041)	(0.048)	(0.046)	(0.051)
Capital Stock	0.412***	0.310***	0.471***	-0.102*	0.060	0.161***
	(0.038)	(0.045)	(0.046)	(0.053)	(0.050)	(0.058)
R&D expenditure	0.043	-1.327	-6.898**	-1.371	-6.942**	-5.571
intensity	(0.223)	(1.627)	(2.936)	(1.633)	(2.939)	(3.264)
Age	-0.118***	-0.006	-0.090***	0.112***	0.028	-0.084***
	(0.013)	(0.006)	(0.013)	(0.014)	(0.017)	(0.013)
Group Obs.	221	146	153			
Sample Obs.	1885					
Likelihood	-1403.33					

Notes: Standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. R&D intensity is the R&D expenditure over sales. TFP is estimated from 3 years panel. Hausman test does not reject IIA.

Table 4: Firm's Sorting by Exporting and Ownership Choices: 2-Year Panel

Independent Variables	(Exporting, Ownership) (h,m) (1)	(x,d) (2)	(x,m) (3)	Difference in Coefficients (4)=(2)-(1)	(5)=(3)-(1)	(6)=(3)-(2)
Constant	-4.724***	-5.655***	-6.450***	-0.931	-1.726	-0.795
	(0.411)	(0.464)	(0.501)			
TFP	0.106***	0.174***	0.227***	0.068	0.121***	0.053
	(0.033)	(0.036)	(0.037)	(0.044)	(0.041)	(0.046)
Capital Stock	0.427***	0.319***	0.502***	-0.108**	0.076	0.183***
	(0.038)	(0.045)	(0.046)	(0.053)	(0.050)	(0.058)
R&D expenditure	0.069	-0.912	-5.887**	-0.981	-5.956**	-4.975
intensity	(0.227)	(1.523)	(2.792)	(1.532)	(2.795)	(3.092)
Age	-0.119***	-0.006	-0.093***	0.113***	0.026	-0.087***
	(0.014)	(0.006)	(0.013)	(0.014)	(0.018)	(0.014)
Group Obs.	217	148	154			
Sample Obs.	1881					
Likelihood	-1402.54					

Notes: Standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. R&D intensity is the R&D expenditure over sales. TFP is estimated from 2 years panel. Hausman test does not reject IIA.

Table 5: Firms Distribution by Exporting Status and Ownership

	(Exporting, Ownership)				
Sector \ Firm type	(h, d)	(h, m)	(x, d)	(x, m)	Total
Garment & leather products	264	39	68	37	408
Electronic equipment	182	44	19	31	276
Electronic parts making	258	24	35	52	369
Household electronics	114	23	8	18	163
Auto & auto parts	366	82	22	20	490
Food processing	45	6	0	1	52
Chemical products & medicine	44	3	1	1	49
Biotech products & Chinese medicine	20	1	1	0	22
Metallurgical products (manuf.&tools)	120	6	0	2	128
Transportation equipment	16	0	0	0	16
Total	1429	228	154	162	1973

Table 6: MNL Regression on Smaller Samples

	five sectors (Exporting, Ownership)			**foreign share less than 80%** (Exporting, Ownership)		
Independent Variables	(h,m) (1)	(x,d) (2)	(x,m) (3)	(h,m) (1)	(x,d) (2)	(x,m) (3)
Constant	-4.631***	-5.393***	-6.272***	-4.721***	-5.332***	-6.152***
	(0.435)	(0.473)	(0.519)	(0.441)	(0.470)	(0.542)
TFP	0.099***	0.172***	0.218***	0.116***	0.176***	0.240***
	(0.035)	(0.036)	(0.037)	(0.039)	(0.039)	(0.043)
Capital Stock	0.427***	0.308***	0.506***	0.425***	0.304***	0.480***
	(0.040)	(0.046)	(0.047)	(0.040)	(0.045)	(0.049)
R&D expenditure	0.062	-1.517	-10.308***	0.076	-1.539	-10.246***
intensity	(0.238)	(1.807)	(3.700)	(0.240)	(1.809)	(3.975)
Age	-0.119***	-0.005	-0.093***	-0.116***	-0.005	-0.096***
	(0.014)	(0.006)	(0.013)	(0.014)	(0.006)	(0.015)
Group Obs.	205	144	150	195	144	128
Sample Obs.	1634			1602		
Likelihood	-1297.11			-1243.08		

Notes: Left panel includes sample from 5 sectors interviewed in both surveys. Right panel includes firms that are local-owned, or that have foreign share less than 80 percent. Standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. R&D intensity is the R&D expenditure over sales. TFP is estimated from 2 years panel. Hausman test does not reject IIA.

Table 7: Sorting Patterns by Exporting and Ownership Choices: Switching Firms

Independent Variables	(Exporting, Ownership) (h,m) (1)	(x,d) (2)	(x,m) (3)	Difference in Coefficients (4)=(2)-(1)	(5)=(3)-(1)	(6)=(3)-(2)
Constant	-4.009***	-6.633***	-6.264***	-2.624	-2.255	0.369
	(0.541)	(0.839)	(0.678)			
TFP	0.064	0.117*	0.147***	0.052	0.082	0.030
	(0.048)	(0.063)	(0.050)	(0.076)	(0.063)	(0.077)
Capital Stock	0.286***	0.348***	0.477***	0.062	0.191**	0.129
	(0.055)	(0.085)	(0.066)	(0.097)	(0.080)	(0.103)
R&D expenditure	0.223	-1.706	-12.747**	-1.929	-12.970**	-11.041
intensity	(0.270)	(3.560)	(6.065)	(3.566)	(6.069)	(6.909)
Age	-0.105***	-0.017	-0.095***	0.088***	0.010	-0.078***
	(0.018)	(0.011)	(0.017)	(0.021)	(0.025)	(0.020)
Group Obs.	85	38	70			
Sample Obs.	1298					
Likelihood	-623.71					

Notes: Standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. R&D intensity is the R&D expenditure over sales. TFP is estimated from 3 years panel. Hausman test does not reject IIA.

Table 8: Exporting Status, Foreign Partnership, and Number of Varieties

Dependent Variable:	Number of Varieties			Number of New Varieties		
	OLS	TRUNC. POISSON	TRUNC.NEG BINOMIAL	OLS	POISSON	NEG BINOMIAL
	Log(n)	n	n	Log(Δn)	Δn	Δn
Independent Variables:	(1)	(2)	(3)	(4)	(5)	(6)
Log TFP	0.07*	0.131***	0.253***	0.048	0.196***	0.145***
	(0.040)	(0.007)	(0.080)	(0.053)	(0.016)	(0.043)
incidence ratio		*1.14*	*1.29*		*1.22*	*1.16*
Foreign Partnership	0.027	0.450***	0.176	-0.078	0.200***	0.292**
	(0.141)	(0.026)	(0.258)	(0.166)	(0.052)	(0.143)
incidence ratio		*1.57*	*1.19*		*1.22*	*1.34*
Exporter	-0.079	0.053**	0.016	0.264	0.140*	0.149
	(0.125)	(0.021)	(0.227)	(0.237)	(0.073)	(0.200)
incidence ratio		*1.05*	*1.02*		*1.15*	*1.16*
SOE	0.152	-0.352***	0.226	-0.081	-0.034	0.045
	(0.164)	(0.028)	(0.289)	(0.193)	(0.061)	(0.162)
Collective/Cooperative	0.002	-0.315***	0.056	-0.361*	-0.653***	-0.426***
	(0.160)	(0.032)	(0.258)	(0.199)	(0.072)	(0.180)
R&D Intensity	-0.15	-0.666***	-0.605	0.01	0.089***	0.10
	(0.132)	(0.155)	(0.400)	(0.040)	(0.029)	(0.066)
Log Age	0.189**	0.616***	0.258*	-0.086	0.107***	0.212**
	(0.086)	(0.014)	(0.148)	(0.109)	(0.034)	(0.091)
New Firm	-0.147	0.709***	0.134	0.035	0.211***	-0.02
	(0.221)	(0.039)	(0.379)	(0.308)	(0.081)	(0.240)
Observations	765	765	765	376	813	813
R-squared	0.14			0.09		

Notes: Standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. R&D intensity is total R&D expenditure over sales. Dependent variable is Log(number of varieties) in the first columns, and number of total varieties in the second and the third, log(number of new varieties) in the fourth, number of new varieties for the last two columns. All regressions include industry and city fixed effects.

Table 9: Exporting Status, Foreign Partnership, and Number of New Varieties

	OLS	POISSON	NEG BINOMIAL	OLS	POISSON	NEG BINOMIAL	OLS
Dependent Variable:			number of new varieties				Log Sales
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Independent Variables:							
Log TFP	1.057***	0.243***	0.179***	1.050***	0.242***	0.326***	0.802***
	(0.20)	(0.01)	(0.02)	(0.20)	(0.01)	(0.04)	(0.067)
incidence ratio		*1.28*	*1.20*		*1.27*	*1.39*	
Foreign Partnership	0.214	0.034	0.216**	0.354	0.068*	0.022	0.948***
	(1.06)	(0.04)	(0.11)	(1.07)	(0.04)	(0.20)	(0.238)
incidence ratio		*1.03*	*1.24*		*1.07*	*1.02*	
Export	0.455	0.143***	0.113	0.557	0.167***	0.068	0.621**
	(1.03)	(0.05)	(0.14)	(1.03)	(0.05)	(0.21)	(0.267)
incidence ratio		*1.15*	*1.12*		*1.18*	*1.07*	
Foreign * Export				0.566	0.146***	0.048	1.035***
				(1.28)	(0.05)	(0.22)	(0.294)
incidence ratio					*1.16*	*1.05*	
SOE	0.467	0.117***	0.126	0.557	0.138***	0.164	0.145
	(0.98)	(0.04)	(0.10)	(0.99)	(0.04)	(0.17)	(0.215)
Collective/Cooperative	-1.703**	-0.473***	-0.462***	-1.605*	-0.449***	-0.475***	-0.592**
	(0.86)	(0.04)	(0.12)	(0.85)	(0.04)	(0.18)	(0.230)
R&D Intensity	0.443	0.115***	0.084	0.441	0.114***	0.365	-0.315***
	(0.45)	(0.03)	(0.07)	(0.45)	(0.03)	(0.53)	(0.055)
Log Age	0.643	0.138***	0.097*	0.659	0.144***	0.161*	0.561***
	(0.49)	(0.02)	(0.06)	(0.49)	(0.02)	(0.09)	(0.118)
New Firm	-2.004**	-0.560***	-0.243	-1.922**	-0.538***	-0.394	0.514
	(0.98)	(0.07)	(0.16)	(0.97)	(0.07)	(0.25)	(0.348)
Observations	1624	1624	1624	1624	1624	1624	790
R-squared	0.08			0.08			0.47

Notes: Dependent variable is the number of new varieties in the first 6 columns, and log value of new variety sales for the last column. Robust standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. R&D intensity is total R&D expenditure over sales in three years. New Firm is the firms who set up one year earlier than the survy period. All regressions include industry and city fixed effects.

Appedix Table 1: MNL Regression on Sub-Samples

	TFP Coefficient (Exporting, Ownership)			Sample Observations (Exporting, Ownership)			
	(h,m)	(x,d)	(x,m)	(h,d)	(h,m)	(x,d)	(x,m)
Sub-Samples	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Coastal versus Inland:							
Inland Provinces	0.124***	0.194***	0.201***	935	120	70	56
	(0.045)	(0.050)	(0.058)				
Coastal Provinces	0.032	0.007	0.135**	182	68	69	71
	(0.058)	(0.058)	(0.056)				
First versus Second survey:							
First Survey	0.031	0.075	0.062	431	106	71	82
	(0.047)	(0.050)	(0.051)				
Second Survey	0.151**	0.259***	0.407***	686	82	68	45
	(0.055)	(0.055)	(0.065)				
Different Sectors:							
Garment & leather products	0.425*	0.588***	0.639***	251	36	67	35
	(0.181)	(0.145)	(0.189)				
Electronic equipment	0.226	0.079	0.365*	172	40	18	30
	(0.140)	(0.191)	(0.153)				
Electronic parts making	0.849***	0.09	0.390*	247	23	32	50
	(0.240)	(0.200)	(0.197)				
Household electronics	0.16	-0.032	0.619*	110	22	8	17
	(0.204)	(0.284)	(0.261)				
Auto & auto parts	0.388**	0.335	0.354	353	80	21	19
	(0.136)	(0.207)	(0.218)				

Notes: Left panel gives the TFP coefficients estimates from different sub-samples. Right panel gives the observations of differnt types of firms that are estimated. Standard errors in parentheses. *** indicates estimate significant at 1 percent level, ** for significance at 5 percent, while * for significance at 10 percent. TFP is estimated from 2 years panel. Hausman test does not reject IIA.

FIGURE A1: City Location of the Survey [Source: Dollar et al. 2004]