An Application of theMelitz Model to Chinese Firms

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When Pareto Meets Melitz*

the Inapplicability of the Melitz-Pareto Model for Chinese Firms

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Abstract

This paper realizes the Melitz-Pareto model using firm-level data from 40 Chinese manufacturing industries from 1998 and 2007. Under the hypothesis that the productivity of firms in each industry follows a Pareto distribution, we show that the domestic sales of non-exporters and the foreign sales of exporters in each industry also follow a Pareto distribution, respectively. We then estimate industrial productivity Pareto distributions, and cut-offs of domestic sales of non-exporters and foreign sales of exporters for each industry. Together this yields all the parameters of the Melitz-Pareto model. Our result shows that the Melitz-Pareto model may not fully apply to Chinese firms.

Keywords: Melitz-Pareto model, Pareto distribution, productivity heterogeneity, export

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Abstract

This paper realizes the Melitz-Pareto model using firm-level data from 40 Chinese manufacturing industries from 1998 and 2007. Under the hypothesis that the productivity of firms in each industry follows a Pareto distribution, we show that the domestic sales of non-exporters and the foreign sales of exporters in each industry also follow a Pareto distribution, respectively. We then estimate industrial productivity Pareto distributions, and cut-offs of domestic sales of non-exporters and foreign sales of exporters for each industry. Together this yields all the parameters of the Melitz-Pareto model. Our result shows that the Melitz-Pareto model may not fully apply to Chinese firms.

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1. Introduction

The Melitz model (developed first by Jean (2000), and later advanced by Melitz (2003), but known as the Melitz model) incorporating heterogenous firms into the international trade model developed respectively by Jean (2000) and Melitz (2003) have become a stepstone in the so-called ”new” new trade theory and many other fields. The syllogism of this model is summarized as follows. In each industry l, a firm must pay a fixed entry cost F_l to enter the market before it observes its productivity θ, which is randomly drawn from an industry-specific cumulative probability function G_l, and thus is heterogenous across firms. After that, the firm decides whether or not to start production. In the former case another fixed production cost f_l is incurred; In the latter case the fixed entry cost F_l is sunk. An incumbent can decide whether or not export. In the former case another fixed exporting cost κ_l is incurred. At each period, the entry-exit condition for the domestic market yields the productivity cutoff of entry into the domestic market, and that for the foreign market yields the productivity cut-off of entry into the foreign market. In the stationary equilibrium, the zero-profit condition that the sum of an incumbent's expected profit at all periods equals the industrial fixed entry cost determines the equilibrium number of firms in the industry. This model successfully explains why various firms in the same industry have different exporting behaviors. After this pioneered work, many literatures applied various versions of this model to investigate different firm-level trade phenomena.

Among the many versions of the Melitz model is one that assumes that industrial productivity follows a Pareto distribution (**the Melitz-Pareto model**), as follows

$$G_l(\theta) = \begin{cases} 1 - \left(\frac{b_l}{\theta}\right)^{k_l} & \theta \geq b_l, \\ 0 & \text{else}, \end{cases} \tag{1}$$

where k_l is the concentration degree, and $b_l > 0$ is the lower bound of productivity distribution. This version is applied in many classic literatures, such as Antras and Helpman (2004, 2006), di Giovanni et al. (2010), Ottaviano (2011), etc. In this version, an assumption that $k_l + 1 > \sigma_l$ is made,[1] where σ_l is the substitution elasticity among varieties in industry l. However, no one questions whether this

[1] In fact, this assumption is implicitly made in the above-mentioned literatures. Their explicit assumption is $k_l > 2$, while the former is critical and the latter is not.

assumption holds in practice. This paper focuses on the realization of the Melitz-Pareto model, and shows that the practical data set does not support its syllogism. This implies that the Melitz-Pareto model is inconsistent with Pareto distribution in practice, and thus we shall consider other distributions of industrial productivity. According to the authors' knowledge, this is the first piece of research that investigates the practical applicability of the Melitz-Pareto model.

Our strategy of realizing the Melitz-Pareto model is as follows. First, we estimate the production function of each industry (using four micro-econometric approaches, namely the pooled ordinary least square (OLS), Olley-Pakes (OP), Levinsohn-Petrin (LP), and firm fixed-effect model (FE)) based on the Annual Survey of Industrial Firms (**ASIF**) cross-sectional data collected by China National Bureau of Statistics from 1998 to 2007. Second, we compute each firm's productivity, and then estimate industrial productivity Pareto distribution, accordingly. Third, we derive size distributions of both non-exporting and exporting firms based on the Melitz-Pareto model, which are also Pareto ones, whose parameters are functions of parameters of those of industrial productivity distribution. Fourth, we estimate parameters of these size distributions. Comparing these estimations with the parameters of the Pareto distribution of industrial productivity yields the substitution elasticities of varieties, fixed production cost, domestic sale cut-off and productivity cut-off level, below which firms exit the industry. Finally, we calculate industrial productivity cut-offs of entering into the industry and the foreign market from these results. Combing the results obtained above yields all the parameters and variables in the Melitz-Pareto model. However, we will show that $k_l + 1 < \sigma_l$ for all industries.

The structure of the paper is as follows. We review the Melitz-Pareto model in Section 2 and derive the relationship between the parameters of Pareto distribution of industrial productivity and those of size distribution of non-exporters and exporters for each industry. In Section 3 we describe the econometric approach and we briefly describe the data set and our manipulation strategies in Section 4. We then estimate industrial production functions, calculate firms' productivity in each year, estimate industrial productivity Pareto distributions, size distributions of non-exporters and exporters, and calculate cut-offs of domestic sales of non-exporters and foreign sales of exporters for each industry, based on **ASIF**. Estimation results are described in Section 5. Our result shows that the critical assumption $k_l + 1 > \sigma_l$ in the Melitz-Pareto model does not hold for Chinese firms.

As a result, its successive deduction can not be carried out. We also shows that the assumption $\tau_l^{1-\sigma_l} f_l > \kappa_l$ does not hold for most Chinese industries, where τ_l is the exporting transportation cost in industry l. Section 6 ends up with conclusions.

2. The Melitz-Pareto framework

I this section we introduce the basic idea of the Melitz-Pareto model for multiple industries in this section. Suppose there are only two countries (i.e., the home country and the foreign country (denoted by H and F)) in the economy. In the sequel, we denote the variable of the foreign country corresponding to that of the home country by adding a superscript "$*$". There are two factors (labor and capital) and M industries in each country, where in industry l are there N_l firms, with each producing a heterogeneous variety. Consumers in both countries are homogenous and the utility function of a representative consumer is $U = \prod_l \left(\int_0^{N_l} x_{li}^{\frac{\sigma_l - 1}{\sigma_l}} di \right)^{\frac{\beta_l \sigma_l}{\sigma_l - 1}}$, where β_l is the expenditure share of consumption, σ_l is the substitution elasticity between varieties in industry l, and x_{li} is the consumption of variety i in industry l for the consumer. If one lets the total expenditure be Y, then it is easy to find that the demand for variety i in industry l is

$$x_{li} = A_l p_{li}^{-\frac{1}{1-\rho_l}}, \tag{2}$$

where $\rho_l = \frac{\sigma_l - 1}{\sigma_l}$, $A_l = \beta_l Y P_l^{-\frac{\rho_l}{1-\rho_l}}$, and $P_l = \left(\int_0^{N_l} p_{li}^{\frac{\rho_l}{1-\rho_l}} di \right)^{\frac{1-\rho_l}{\rho_l}}$ is the ideal price index of industry l. We assume that firms in each industry in each country compete monopolistically. A potential firm must pay a fixed entry cost F_l to enter industry l before observing its productivity θ, which follows a Pareto distribution $G_l(\theta)$. After it enters the industry, it needs to decide whether or not to start production in each period; this brings the firm another fixed production cost f_l. Hence, the profit of firm i in industry l in each period is

$$\pi_{li} = A_l^{1-\rho_l} \theta_{li}^{\rho_l} K_{li}^{\rho_l \alpha_l} L_{li}^{\rho_l (1-\alpha_l)} - r K_{li} - w L_{li} - f_l, \tag{3}$$

where θ_{li} is its productivity, K_{li} and L_{li} are the capital and labor hired, and r and w are prices of capital and labor in the economy. Here we assume that the production technologies in both countries are of a constant return to scale, and the capital production elasticity is α_l. Plugging (2) into (3), solving the firm's profit maximization problem, and substituting its optimal pricing rule and output into $D_{li} = p_{li}x_{li}$ yields the firm's maximal domestic sale as

$$D_{li} \;=\; \rho_l^{\frac{\rho_l}{1-\rho_l}} A_l^{\frac{1}{1-\rho_l}} \omega_l^{-\frac{\rho_l}{1-\rho_l}} \theta_{li}^{\frac{\rho_l}{1-\rho_l}} = M_{jl}\Theta_{li}, \tag{4}$$

where

$$\omega_l = \left(\frac{r}{\alpha_l}\right)^{\alpha_l}\left(\frac{w}{1-\alpha_l}\right)^{1-\alpha_{jl}}, M_l = \rho_l^{\frac{\rho_l}{1-\rho_l}} A_l^{\frac{1}{1-\rho_l}} \omega_l^{-\frac{\rho_l}{1-\rho_l}},$$

are respectively the unit production cost and the measure of the domestic demand size in industry l, which is the same across all firms for each industry, and $\Theta_{li} = \theta_{li}^{\frac{\rho_l}{1-\rho_l}}$ measures the firm-specific productivity term. Following the same deduction procedures as those in Melitz (2003), we can show that A_l is independent from θ_{li} in equilibrium. Moreover, the firm's maximal profit is

$$\pi_{li} = (1-\rho_l)D_{li} - f_l, \tag{5}$$

The firm enters the industry only if $\pi_{li} \geq 0$, which defines the minimum domestic sale $\underline{D}_l$ of the firm observed in the economy, as well as the productivity cut-off $\underline{\theta}_l$

$$\underline{D}_l = \frac{f_l}{1-\rho_l}, \underline{\theta}_l = \left(\frac{f_l}{(1-\rho_l)M_l}\right)^{\frac{1-\rho_l}{\rho_l}}. \tag{6}$$

Suppose firm i in industry l in the home country must pay a fixed cost κ_{li} before exporting to the foreign country. Moreover, there is an iceberg per-unit cost of $\tau_l > 1$ for export. Let the iceberg cost of domestic sales be normalized to be 1. Then it is easy to verify that foreign sales of firm i in industry l is $X_{li} = M_l^*\Theta_{li}$, where $M_l^* = \rho_l^{\frac{\rho_l}{1-\rho_l}} A_l^{*\frac{1}{1-\rho_l}} \omega_l^{*-\frac{\rho_l}{1-\rho_l}} \tau_l^{\frac{\rho_l}{1-\rho_l}}$ measures the foreign country's market size in industry l. Similarly, the export condition of firm i in industry l is $(1-\rho_l)M_l^*\Theta_{li} \geq \kappa_{li}$. Following Jean (2000) and Melitz (2003), we assume that κ_{li} is constant across firms in each industry l. Then there is a single exporting productivity cut-off above which all firms export and below which none export.

2.1. Pareto distribution of firms' domestic sales

Suppose now G_l is a Pareto distribution of the form (1), where $b_l > 0$ is the lower bound, and $k_l > 0$ is the concentration degree of the productivity distribution, which vary with l. We use the firms' sales to represent their sizes. Then in autarky, the probability that the domestic sale of firm i in industry l is larger than a given quantity s is

$$\mathsf{Pr}(D_{li} > s) \;=\; \mathsf{Pr}\left(\theta_{li} > \left(\frac{s}{M_l}\right)^{\frac{1-\rho_l}{\rho_l}}\right) = \begin{cases} C_l s^{-\zeta_l} & D_{li} \geq \underline{D}_l, \\ 0 & D_{li} < \underline{D}_l. \end{cases} \tag{7}$$

where $C_l = \left(M_l^{\frac{1-\rho_l}{\rho_l}} b_l\right)^{k_l}$, $\zeta_l = \frac{(1-\rho_l)k_l}{\rho_l}$. (7) implies that the domestic sale D_{li} of firm i in industry l in the home country follows a Pareto distribution with exponent ζ_l. Moreover, the Pareto exponents ζ_l varies by industry.

2.2. Pareto distribution of firms' exports

The distribution of foreign sales for exporting firms is different from Equation (7). The mechanism is the firm selection effect (i.e., some low-productivity firms are selected out of the market because of their negative profits due to a low productivity). To see this, we only consider industry l according to symmetry. For simplification, we assume that there is $\kappa_{li} = \kappa_l$ for all firms in industry l. Then the profit of firm i in industry l under openness is

$$\pi_{li} \;=\; \pi_{li}^D + \pi_{li}^X,$$

where π_{li}^D is its profit from domestic sale, and π_{li}^X is its profit from exporting to the foreign country. Obviously, there is $\pi_{li}^X = \max\{0, (1-\rho_l)M_l^*\Theta_{li} - \kappa_l\}$. Then firm i exports to the foreign country only if $(1-\rho_l)M_l^*\Theta_{li} \geq \kappa_l$, or $X_{li} = M_l^*\Theta_{li} \geq \frac{\kappa_l}{1-\rho_l} = \underline{X}_l$. This implies the probability that the foreign sale of firm i in industry l is larger than a given quantity s is that

$$\mathsf{Pr}(X_{li} \geq s) \;=\; \begin{cases} C_l^* s^{-\zeta_l} & s \geq \underline{X}_l, \\ 1 & s < \underline{X}_l. \end{cases} \tag{8}$$

where $C_l^* = \left((M_l^*)^{\frac{1-\rho_l}{\rho_l}} b_l\right)^{k_l}$ and ζ_l is defined above as $\frac{(1-\rho_l)k_l}{\rho_l}$. Moreover, the export productivity cutoff is $\underline{\theta}_{Xl} = \left(\frac{\kappa_l}{(1-\rho_l)M_l^*}\right)^{\frac{1-\rho_l}{\rho_l}}$.

2.3. Fixed entry costs with international trade

The Melitz-Pareto model considers only steady equilibria in which the aggregate variables remain constant over time. In the steady equilibria, each firm's productivity level does not change over time, and thus its per-period profit level (excluding F_l) will also remain constant. Let the equilibrium distribution of incumbents' productivity be $\mu_l(\theta)$ and that of exporters be $\mu_{Xl}(\theta)$. Then there are

$$\mu_l(\theta) = \begin{cases} \frac{g_l(\theta)}{1-G_l(\underline{\theta}_l)} & \theta \geq \underline{\theta}_l, \\ 0 & \text{else}, \end{cases} \quad \mu_{Xl}(\theta) = \begin{cases} \frac{g_l(\theta)}{1-G_l(\underline{\theta}_{Xl})} & \theta \geq \max\{\underline{\theta}_l, \underline{\theta}_{Xl}\}, \\ 0 & \text{else}. \end{cases}$$

Here is made the following implicit hypothesis.

Hypothesis 1 $k_l + 1 > \sigma_l$ *for each industry* l.

If **Hypothesis 1** holds, the average productivity level $\tilde{\theta}_l$ of incumbents in industry l is a function of the cut-off productivity level $\underline{\theta}_l$ according to $\mu_l(\theta)$, and the one $\tilde{\theta}_{Xl}$ of exporters is a function of $\underline{\theta}_{Xl}$ according to $\mu_{Xl}(\theta)$:

$$\tilde{\theta}_l(\underline{\theta}_l) = \left(\frac{k_l}{k_l + 1 - \sigma_l}\right)^{\frac{1-\rho_l}{\rho_l}} \underline{\theta}_l, \quad \tilde{\theta}_{Xl}(\underline{\theta}_{Xl}) = \left(\frac{k_l}{k_l + 1 - \sigma_l}\right)^{\frac{1-\rho_l}{\rho_l}} \underline{\theta}_{Xl}, \tag{9}$$

where $\sigma_l = \frac{1}{1-\rho_l}$ is the substitution elasticity of varieties in industry l. If this hypothesis is broken, then the average industrial productivity $\tilde{\theta}_l(\theta_l) = +\infty$, and thus industrial average net profit and finally industrial fixed entry cost, are all infinite, which implies that the successive deduction of the Melitz-Pareto model can not be carried out. In the sequel, we will estimate both k_l and σ_l for each industry l using Chinese firm-level data set, and we will show that **Hypothesis 1** does not hold for Chinese firms and that, therefore, *the Melitz-Pareto model is not applicable to Chinese firms with assumption of industrial productivity Pareto distribution.*

Underlying **Hypothesis 1**, the average profit in industry l is $\bar{\pi}_l = \pi_{Dl}(\tilde{\theta}_l) + \varsigma_l \pi_{Xl}(\tilde{\theta}_{Xl})$, where $\pi_{Dl}(\tilde{\theta}_l)$ is the average profit selling domestically, $\pi_{Xl}(\tilde{\theta}_{Xl})$ is the one exporting to the foreign country and ς_l is the exporting probability of a firm in industry l. Thus we have

$$\bar{\pi}_l = \frac{\sigma_l - 1}{k_l + 1 - \sigma_l} \left[f_l + \kappa_l \varsigma_l\right], \tag{10}$$

where $\varsigma_l = \left(\frac{\underline{\theta}_l}{\underline{\theta}_{Xl}}\right)^{k_l}$. The present value of $\bar{\pi}_l$ is $\sum_{t=0}^{+\infty}(1-\delta_l)^t\bar{\pi}_l = \bar{\pi}_l/\delta_l$, where δ_l is the probability that an incumbent exits the market at each period in industry l. Here δ_l is assumed to be constant over all periods. Upon successful entry probability $1 - G_l(\underline{\theta}_l)$, the expected net value v_{lE} of entry for firms in industry l is then

$$v_{lE} = \frac{1 - G_l(\underline{\theta}_l)}{\delta_l}\bar{\pi}_l - F_l.$$

In any steady equilibrium where entry is unrestricted, v_{lE} defined above shall be 0. This together with (10) concludes the expression of the fixed entry cost in industry l in country j

$$F_l = \frac{\sigma_l - 1}{k_l + 1 - \sigma_l}\frac{f_l + \varsigma_l\kappa_l}{\delta_l}\left(\frac{b_l}{\underline{\theta}_l}\right)^{k_l}. \tag{11}$$

Summarizing the above discussions, we see that **Hypothesis 1** is important for the successive deduction in the Melitz-Pareto model. If it holds, (11) implies that we can find the fixed entry cost of any industry l if only we can estimate $b_l, k_l, \rho_l, f_l, \kappa_l, \underline{D}_l$ and $\underline{X}_l$. As will be shown in the sequel, they can be estimated from the power law distributions of domestic sales of non-exporters and foreign sales of exporters. Otherwise, the syllogism of the model can not be carried on. However, this important hypothesis does not hold for Chinese firms.

3. Econometric approach

3.1. Estimation of productivity distributions of industries

We introduce the estimation approach of industrial productivity distributions in this section.

There production function for firm i in industry l in year t is $Y_{lit} = \theta_{li}K_{lit}^{\alpha_l}\mathcal{M}_{lit}^{\gamma_l}L_{lit}^{\varrho_l}$, where θ_{li} is the productivity level observed after it pays the industry-specific fixed entry cost F_l, which follows a Pareto distribution of the form (1), where L_{lit}, K_{lit} and $\mathcal{M}_{lit}$ are labor, capital and intermediate input used in production and Y_{lit} is the output. [2] Suppose $\alpha_l, \gamma_l, \varrho_l$ are estimated for each industry l, then each firm's productivity level is $\theta_{li} = \frac{Y_{lit}}{K_{lit}^{\alpha_l}\mathcal{M}_{lit}^{\gamma_l}L_{lit}^{\varrho_l}}$. This implies that we can estimate the productivity distribution $G_l(\theta)$ for each industry l. Let the vector sorted from

[2] According to Melitz (2003), the productivity of each firm in every industry does not vary with time. Moreover, the productivity distribution of each industry does not vary with time.

the productivity vector $\theta_l^t = (\theta_{l1}^t, \cdots, \theta_{lN_l^t}^t)^T$ in year t in descending order be $\tilde{\theta}_l^t = (\tilde{\theta}_{l1}^t, \cdots, \tilde{\theta}_{lN_l^t}^t)^T$, where θ_{lk}^t is the productivity level of firm k in industry l. Denote the number of firms whose productivity is larger than $\tilde{\theta}_{lk}^t$ by N_{lk}^t. Then we can approximate $1 - G_l(\tilde{\theta}_{lk})$ by $\frac{N_{lk}^t}{N_l^t}$, where N_l^t is the number of incumbents in industry l. We thus have

$$\ln \frac{N_{lk}^t}{N_l^t} = \xi_l - k_l \ln \tilde{\theta}_{lk}^t, \forall t, \tag{12}$$

where $\xi_l = k_l \ln b_l$. The effects are included in the estimation of (12).[3] This method makes use of the definition of a Pareto distribution, and it is applied by Axtell (2001) and Giovianni et al. (2010). We follow Gabaix and Ibragimov (2011)'s estimation strategy in practical operations.

3.2. Estimation of the distributions of firms' domestic sales and exporting sales

We first illustrate the estimation approach for domestic sales of non-exporters in industry l. Let $D_l = (D_{l1}, \cdots, D_{lM_l})^T$ be the vector of domestic sales of the M_l firms in industry l. Note that the distribution of D_{li} without international trade is Pareto with cumulative distribution function $\Phi(D) = 1 - C_l D^{-\zeta_l}$, where $\zeta_l = \frac{(1-\rho_l)k_l}{\rho_l}$. Then we can estimate ζ_l as follows. First we sort the vector $D_l^t = (D_{l1}^t, \cdots, D_{lM_l^t}^t)$ in year t in descending order to yield the new vector $\tilde{D}_l^t = (\tilde{D}_{l1}^t, \cdots, \tilde{D}_{lM_l^t}^t)^T$, where D_{lk}^t is the domestic sale value of firm k in industry l. Denote the number of firms whose sales are larger than D_{lk}^t by N_{lk}^t. Then we can apply $\frac{N_{lk}^t}{M_l^t}$ to approximate $1 - \Phi(\tilde{D}_{lk}^t)$. We thus have

$$\ln \frac{N_{lk}^t}{M_l^t} = \chi_l - \zeta_l \ln \tilde{D}_{lk}^t, \tag{13}$$

where $\chi_l = \ln C_l$, i.e, $C_l = e^{\chi_l}$.

For estimation of the distribution of foreign sales of exporting firms, we let the vector of their foreign sales in year t in industry l be $X_l^{Xt} = (X_{l1}^{Xt}, \cdots, X_{lK_l^t}^{Xt})^T$, where K_l^t is the number of incumbent exporters in year t in industry l and X_{lk}^{Xt} is

[3] In Giovianni et al. (2010), two other methods are applied to estimate a Pareto distribution. One is to estimate its density function; the other is to estimate a similar equation $\ln\left(N_{lk} - \frac{1}{2}\right) = \varrho_l + k_l \ln \theta_{lk}$ like (12), which is proposed by Gabaix and Ibragimov (2011). Gabaix and Ibragimov (2011) also prove that k_l has a standard error of $|k_l|(N_l)^{-1/2}$ for this method. Generally, the three methods yield very similar results when the sample scale is sufficiently large.

the sale of exporter k. Note that X_{lk}^{Xt} follows the Pareto distribution with cumulative distribution function $\Psi(X) = 1 - C_l^* X^{-\zeta_l}$ from (7), where $C_l^* = ((M_l^*)^{\frac{1-\rho_l}{\rho_l}} b_l)^{k_l}$. Let the vector sorted in decending order from X_l^{Xt} be $\tilde{X}_l^{Xt} = (\tilde{X}_{l1}^{Xt}, \cdots, \tilde{X}_{lK_l}^{Xt})^T$. Then, in a similar way, we know that we can estimate C_l^* and ζ_l by regressing the following equation:

$$\ln \frac{N_{lk}^t}{K_l^t} = \psi_l - \zeta_l \ln \tilde{X}_{lk}^{Xt}, \tag{14}$$

where N_{lk}^t is the number of firms whose sales are larger than $\tilde{X}_{lk}^{Xt}$ and $\psi_l = \ln C_l^*$ or $C_l^* = e^{\psi_l}$.

Note that (13) and (14) are different only in the intercepts. Therefore, we can regress them simultaneously for each industry, controlling the time fixed effects.

3.3. Cut-offs of domestic sales of non-exporters and foreign sales of exporters

We estimate cut-offs of domestic sales of non-exporters and foreign sales of exporters as follows. We find the minimum domestic sales and foreign sales of non-exporters and exporters respectively in each year for this industry and then calculate their means over all periods. These estimators are unbiased from the true values as the data set covers the population of all firms.

3.4. Computation of other variables

Suppose we have estimated $\xi_l, k_l, \chi_l, \psi_l$, ζ_l, $\underline{D}_l$ and $\underline{X}_l$. Then the other parameters are calculated as follows:

$$b_l = e^{\frac{\xi_l}{k_l}}, \rho_l = \frac{k_l}{k_l + \zeta_l}, C_l = e^{\chi_l}, C_l^* = e^{\psi_l}, \tag{15}$$

and

$$f_l = (1-\rho_l)\underline{D}_l, \kappa_l = (1-\rho_l)\underline{X}_l, M_l = \left(\frac{C_l^{1/k_l}}{b_l}\right)^{\frac{\rho_l}{1-\rho_l}}, M_l^* = \left(\frac{(C_l^*)^{1/k_l}}{b_l}\right)^{\frac{\rho_l}{1-\rho_l}}, \tag{16}$$

as well as

$$\underline{\theta}_l = \left(\frac{f_l}{(1-\rho_l)M_l}\right)^{\frac{1-\rho_l}{\rho_l}}, \underline{\theta}_{Xl} = \left(\frac{\kappa_l}{(1-\rho_l)M_l^*}\right)^{\frac{1-\rho_l}{\rho_l}}, \varsigma_l = \left(\frac{\underline{\theta}_l}{\underline{\theta}_{Xl}}\right)^{k_l}. \tag{17}$$

Finally, according to (11), the industrial fixed entry cost F_l can be achieved as follows

$$F_l = \frac{\sigma_l - 1}{k_l + 1 - \sigma_l} \frac{f_l + \varsigma_l \kappa_l}{\delta_l} \left(\frac{b_l}{\underline{\theta}_l}\right)^{k_l}. \tag{18}$$

4. Data descriptions

4.1. Data set and Coverage

This paper employs plant-level data from the Annual Survey of Industrial Firms (**ASIF**) cross-sectional data collected by the National Bureau of Statistics of China between 1998 and 2007. The data set contains detailed information (including more than 100 financial variables listed in the main accounting sheets of these firms) for all state-owned and non-state firms above a designated scale (above 5 million RMB) in (1) mining, (2) manufacturing, and (3) production and distribution of electricity, gas and water, with 40 industries indexed from 6 to 46, with industry 38 vacant (see Table 1 for the industry codes, industry names and their abbreviations). The number of firms covered by this data set is 161,000 in 1998 and 336,768 in 2007, respectively. The industry section of the China Statistical Yearbook and reports in the China Markets Yearbook are compiled and based on this data set (Lin et al. 2009; Lu and Tao 2009; Brandt et al. 2011). The duration of this data set includes the WTO entry year 2001 and a new industrial information calculation in year 2004, which is sensitive to the impact and fluctuations of structural change. The data set explored in this paper covers every firm's output value, value added, capital stock, labor hired, intermediate input, domestic sale value, exporting sale, scale type, exporting status, operational status, ownership, age, etc., between 1998 and 2007, in each industry.

The ASIF data set provides us with a unique opportunity to observe Chinese enterprises performance with s large and comprehensive sample. The time duration also enables us to avoid some radical economic policy changes in the early and middle 1990s (structural change, SOE reform, etc.). China has undertaken a series of economic policy reformd since 1978, and such structural adjustments stabilized in the later years. Especially in the late 1990s, more and more domestic firms and plants are emerging and competing with their foreign counterparts for the unconditional government fiscal loans, abolishing industrial licensing, equalizing foreign direct investment opportunities, cutting import duties, deregulating capital markets and reducing tax rates. Therefore, the time period of this data set–with relatively stable price indices and deflators for all variables–is suitable to indicate the firm performance with specific effects.

Some noteworthy drawbacks in the ASIF data set need further discussions. We believe these characteristics are partially responsible for causing the estimates' standard errors to be comparatively large and result in less convergence in our later empirical tests. The first is that the number of manufacturing firms covered in the sample period increased dramatically since 2004. Apart from more and more firms having annual sales reaching the official statistical category, the year 2004 was an industry census year and there was more comprehensive survey coverage in that year, which may explain the jump in the number of firms from 2003 to 2004 (Lu and Tao 2009). The second is that the ASIF does not cover small non-state-owned firms with annual sales of less than five million yuan, which could cause the sample estimation to be upwardly biased. The third and most challenging problem is that the ASIF does not provide organization relation information among multi-plant firms. We could only recognize the individual plants and had to ignore the situation that saw enterprises having more than one plant in different regions. The disaggregate composition of plant total productivity did not allow for a review of some multi-plant firms real performance.

As the data set contains some noisy and misleading samples, and also because of our special research objectives, we deal with the data set in the following way. (1) Following Jefferson et al. (2008), we drop those observations whose key financial variables (such as total assets, net value of fixed assets, sales and gross value of industrial output) are missing and have fewer than 10 employees. (2) Following Cai and Liu (2009) and guided by the General Accepted Accounting Principles, we drop those observations whose total assets are less than their liquid assets, those whose total assets are less than the net value of their fixed assets, those whose identification numbers are missing or not unique and those whose establishment time is invalid. (In particular, the establishment time shall not be earlier than 1840 and shall not be later than 2007.) (3) We drop those observations whose sales, total assets and values of fixed assets are less than 5 million yuan. (4) As intermediate inputs are important for firms' production, and also because we apply the OP approach and the LP approach to compute firms' productivity, we drop those observations whose investments or intermediate inputs are zero. After the above rigorous filter, we finally obtain a total of 407,919 observations from the original sample of 2,400,000. All nominal terms are originally measured in current Chinese yuan. We thus use the GDP deflator to convert the nominal terms (gross output value, net sales of the plants, investment, middle inputs and all other monetary variables) into real ones by choosing 1978 as the base year.

Apart from above treatment, we are facing one critical problem regarding the endogeneity issue of firm behavior. Previous studies using the **ASIF** data set all include observations with negative or zero investment and middle input values, and their total observations are over 2,400,000 (we have 169,902 firms and 407,919 observations in our 10-year data set, which is one-sixth of untrimmed ASIF data set). We are arguing that if researchers need to observe firms' endogenous behavior, henceforth they should estimate their self-adjustments in capital and labor investment and yearly middle inputs from year to year, and that zero investments or middle inputs are intolerable. Since we assume that firms are aware of their productivity changes, as well as their profitability, there is less solid ground to assume they have static decision making in each year's production decision making. Though Levinsohn and Petrin (2003)'s proposed method on firm-level productivity estimation only requires middle input information, we still need to compare different estimation methods of firm productivity in order to establish our robust results. Such trade-offs lead to a large quantity of data loss in our actual empirical test (OLS, FE, OP and LP methods accordingly), while, on the other hand, it enables us to compare different methods with the same background. The samples with/without investments and middle inputs are summarized in Table 2 in the **Appendix**.

4.2. Variable definitions

The variables we use in this paper are, respectively, value-added, total sales, labor hired, capital stock, intermediate input and exporting sales. The data of each firm in each industry from 1998 to 2007 is obtained after being dropped. A firm's domestic sales is measured as the difference between the firm's total sales and its foreign sales. Its capital stock is measured as the net value of fixed assets at the end of each year, and its quantity of labor hired is measured as that of its average employees within a year. A firm's productivity is measured by total productivity . In this paper, we apply four methods (i.e., OP, LP, OLS and FE) to compute each firm's productivity using 10-year of non-balanced panel data.

The measure of capital stock here is different from the commonly used Perpetual Inventory Method. In the interest of uniformity, and for obtaining comparable results, Olley and Pakes (1996) and Levinsohn and Petrin (2003) proposed some alternative methods for estimating capital stock (capital stock of current year is defined as the gross fixed assets of the last year minus the depreciation over the last year). Due to variation in the capital stock measurements, and the fact that some required information for the early years (industrial price depreciation rate, investment and middle input level, and industrial gross fixed assets) are not available, this paper uses the net sum of fixed capital (in the data set, it is defined as the previous year's fixed capital minus current year investment and other middle inputs) deflated by the price deflators.

The descriptive statistics for all variables, for all industries and for the whole time period are provided in Table 3 in the **Appendix**.

5. Estimation results

5.1. Productivity distribution

As intermediate inputs are important for practical production, we adjust the industrial production function as $Y_{lit} = \theta_{lit} K_{lit}^{\alpha_l} \mathcal{M}_{lit}^{\gamma_l} L_{lit}^{\varrho_l}$ for each l, where $\mathcal{M}_{lit}$ is the intermediate input used for production, and α_l, γ_l and ϱ_l are output elasticities of capital, intermediate input and labor in industry l. We apply four approaches (i.e., OLS, FE, OP, and LP), to estimate the industrial production functions (see the **Appendix** for a description of these methods). The estimation results of industrial production functions for 40 manufacturing industries based on FE, LP, OLS and OP are shown in Table 4, Table 5 , Table 6 and Table 7 in the Appendix. In these tables, the variable "age" and "t" represent firms' ages and the time variable (from 1998 to 2007), respectively. In the tables, "Xl" implies the regression equation of industry l using "X" method ($X \in \{FE, OP, LP, OLS\}$. We see from these four tables that the three inputs–labor, intermediate input and labor–are almost significant at the 10 percent level for all industries. As well, the null hypothesis

$H_0 : \alpha_l + \gamma_l + \varrho_l = 1$ holds significantly at 10 percent for almost all industries.

After α_l, γ_l and ϱ_l have been obtained, we solve θ_{lit} for each firm in each industry in each period t from the result of production function estimated using each approach. We then estimate industrial productivity distributions by regressing (12) using the method proposed in Subsection 3.1., controlling the time fixed effects. As the results obtained by OLS are biased according to Olley and Pakes (1996), we only present the result achieved by FE and LP.

Table 8, Table 9, Table 10 and Table 11 show, respectively, the parameter estimation results of k_l and ξ_l of industrial productivity distributions in each industry l based on the estimated productivity using FE, LP, OLS and OP, respectively. We can calculate b_l by e^{ξ_l/k_l}. The results based on the estimated productivity using FE and LP are somewhat similar. The correlation coefficient between $k_l(b_l)$ estimated based on FE and LP is 0.84 (0.58). However, the results estimated using FE/LP and OLS/OP are much different. The correlation coefficient between $k_l(b_l)$ estimated based on FE and OLS is 0.12 (-0.13). That between $k_l(b_l)$ estimated based on FE and OP is 0.43 (0.12). This implies that different approaches yield different productivity distribution results. In the following discussion, we only apply the result estimated using FE to realize the Melitz-Pareto model. Our rationale is as follows. First, OLS is biased because of simultaneity and endogeneity (Olley and Pakes 1996). Second, the ideas of LP and OP are not consistent with the Melitz model that assumes that a firm's productivity, if it is in the market,remains constant in the stationary dynamics, even though it may exit the market at a constant probability. The idea of FE essentially assumes that the logarithm of productivity θ of a firm in the stationary equilibrium follows a random walk (i.e., $\ln \theta_{t+1} = \ln \theta_t + \varepsilon_{t+1}$, where ε_t are i.i.d. random variables and t represents period). From this point of view, FE is the most consistent with the thought in the Melitz model.

5.2. Distribution of domestic sales of all the incumbents and non-exporting firms

Table 12 shows the estimation result of the distribution of domestic sales of non-exporters while Table 13 shows that of exporters in each industry. According to the theoretical result given in Section 3., the two ζ_ls estimated applying data of non-exporting firms and exporters in each industry shall be the same. However, the correlation coefficient between these two estimation results for all the industries is only 0.43, which implies their large difference. Further tests show that the absolute value of ζ for non-exporters is strictly larger than that for exporters. One reason is that we ignore the influences of the regions where the firms are located, as well as many other complicated economic and non-economic factors on the distribution of domestic sales of firms.[4] One is that industrial exporting fixed cost is heterogeneous across firms, as shown in di Giovanni et al. (2010). Another is that productivity distributions of non-exporters and exporters are different, as shown in Zhang and Sun (2011). This result implies that we need to change either the assumptions of homogeneous fixed exporting costs across firms or the same productivity distribution between non-exporters and exporters in the same industry when applying the Melitz model. In this paper, to keep consistent with the former sections, we still maintain these assumptions. Thus, we make the regressions for non-exporters' domestic sales and exporters' foreign sales proposed in 3. and get the same ζ_l for both types of firms. The result is shown in Table 14. It shows that Pareto distribution parameters change in this case, which further indicates that the above-mentioned explanations may hold in practice.

The only remaining work is to estimate cut-offs of domestic sales and foreign sales for each industry. The results are shown in Table 15. It shows that industry 40 is the one whose domestic sale cut-off $\underline{D}_l$ is the smallest, while industry 7 is the one whose domestic sale cut-off is the largest. For exporters, the largest foreign sale cut-off is in industry 7, while the smallest one is in industries 13, 26, 34, 35, 36, 37, and 41.

5.3. Productivity cut-offs, domestic sale cut-offs and heterogeneity preferences

According to the above estimation results, we can compute the relevant parameters ρ_l, f_l, M_l and $\underline{\theta}_l$ from Table 8, 14 and 15 for each industry, as shown in Table 16, where ρ_l, f_l and $\underline{\theta}_l$ measure, respectively, the heterogeneity preferences, the fixed entry costs and the productivity cut-offs, and $M_l = \left(\frac{C_l^{1/k_l}}{b_l}\right)^{\frac{\rho_l}{1-\rho_l}}$ is a transitional parameter. We can see from this table that Hypothesis 1 does not hold for each industry l (i.e., $k_l + 1 > \sigma_l$). This implies that the deduction process of the Melitz-Pareto framework are not applicable to Chinese firms (while the Melitz model is),

[4] di Giovanni et al. (2010) explains this difference by firms' heterogeneous fixed exporting costs.

as the average industrial productivity is not finite. The results of industrial fixed entry costs ($\delta_l F_l$)–which are all negative –confirm this assertion. A possible way to remedy this is to assume that firms' productivity follows a probability distribution with both lower and upper productivity bounds. A possible distribution is

$$G(\theta) = \begin{cases} d - \left(\frac{b}{\theta}\right)^k & d^{-1/k} f \le \theta \le (d-1)b^{-k}, \\ 0 & \theta \le d^{-1/k} f, \\ 1 & \theta \ge (d-1)b^{-k}, \end{cases} \tag{19}$$

where $d > 1$, $b, k > 0$.

One interesting thing in Table 16 is that $\underline{\theta}_l > \underline{\theta}_{Xl}$, *which implies that the assumption* $\tau_l^{1-\sigma_l} f_l < \kappa_l$ *made in the standard Melitz model (Melitz 2003) does not hold in Chinese firm-level data (for all industries except for industries 11, 12 and 45).*

6. Conclusion

We estimate the Melitz-Pareto model based on the statistical database of Chinese industrial enterprises above the designated size in 40 manufacturing industries between 1998 and 2007, including heterogeneity preferences, industrial fixed entry costs, domestic sale cut-offs, productivity cut-offs, concentration degrees and lower productivity bounds of industrial productivity distribution. It shows that the Melitz-Pareto framework is not applicable to this data set. Two points are found. First, Hypothesis 1 does not hold, which leads to an inconvergent average industrial productivity level and, thus, the successive deduction of the Melitz-Pareto model does not hold. Second, the assumption that $\tau_l^{1-\sigma_l} f_l > \kappa_l$ does not hold in this Chinese data set. This implies that the Melitz-Pareto model may not apply to the Chinese data.

More results on industrial price indices, consumption elasticities among products of various industries and numbers of industrial equilibrium firms can be obtained if we apply equilibrium analysis to the framework applied in this paper, using only limited firm-level data, including firms' labor hired, capitals, wages, outputs, export sales and domestic sales. Moreover, if we have firm-level data on export sales to various countries, industrial exporting entry costs to each country can be estimated. We leave this to future work.

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Appendix

Methods of Estimating TFP

There are different methods to measure productivity. In this paper, the plant-level estimates of TFP are computed using the ordinary least squares, plant individual fixed effects, Olley-Pakes(1996) and Levinsohn-Petrin (2003) methodologies. In these approaches, the assumption of constant returns to scale of production technologies is not required.

The OLS Approach

The OLS technique entails estimating output as a function of the inputs and then subtracting the estimated output from actual output to capture productivity as the residual. However, this traditional estimation technique may suffer from simultaneity and selection bias. If we estimate the Cobb-Douglas production function in logs, we would have the following:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \theta_{it} + \mu_{it},$$

where y is the logarithm of value-added output, i is the index of the firm, l is the log of labor, k is the log of capital and m is the log of middle inputs. θ_i refers to the productivity shock known to the firm but unobserved by the econometrician. μ_i refers to all other disturbances such as measurement error, omitted variables, functional form discrepancies and any other shocks affecting output that are unknown to the firm when making input decisions. The basic computation methodology used for measuring TFP is as follows:

$$\ln TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it}.$$

Firms' inputs are based on their optimizing behavior on the input quantity l_i and k_i that is endogenous in the estimation equation, and the productivity could be both contemporaneously and serially correlated with inputs, which would cause the OLS estimations to be biased and inconsistent. Contemporaneous correlation will occur if the firm hires more workers based on its current productivity in anticipation of future profitability. Serial correlation between productivity and hiring decisions will lead to an upward bias in the coefficient, in the case of a single-input production process, but the direction of bias is less obvious in a multivariate setting.

Regarding the selection bias, we can see that firms stay in the market in each year. A firm's decision to stay in the market is contingent upon its productivity and expected future profitability. If there is a positive correlation between greater capital stocks and future profitability, then firms with higher capital stock, at any productivity level, will have a higher survival rate in the market. The expectation of productivity, contingent upon a firm's survival, would then be decreasing in capital. The OLS estimators of the production would thus lead to a negative bias in the capital coefficient.

The Olley-Pakes Method

Since the firm's asymmetry knowledge of its productivity is unavailable to the econometrician, the problem of simultaneity will affect a firm's endogenous decision on hiring and investment factor inputs. This will lead the OLS estimation of a production function to estimates of the coefficients of exogenous inputs that are biased upwards.

The OP approach developed in Olley and Pakes (1996) assumes that incumbent firms decide at the beginning of each year whether to continue participating in the market. If the firm exits, it receives a liquidation value of Φ dollars; if it does not, it chooses variable inputs with an anticipating level of investment I_{it}. Firms realize their conditional profits on the beginning years' state variables: productivity indicator or shock, Ω_{it}, capital stock, K_{it}, and the age of the firm. Therefore, the expected productivity is a function of current productivity and capital, $\mathsf{E}[\Omega_{i,t+1} \mid \Omega_{it}, K_{it}]$, and the profit is a function of Ω_{it} and K_{it}.

Firm i's decision to maximize the expected discounted value of net future profits is characterized by the Bellman equation, as follows:

$$V_{it}(K_{it}, a_{it}, \Omega_{it}) = \max \left[\Phi, \sup_{I_{it} \geq 0} \Pi_{it}(K_{it}, a_{it}, \Omega_{it}) - C(I_{it}) + \rho \mathsf{E} \left\{ V_{i,t+1}(K_{i,t+1}, a_{i,t+1}, \Omega_{i,t+1}) \mid J_{it} \right\} \right],$$

where $\Pi_{it}(\cdot)$ is the profit function (current profit as a function of the state variables), $C(\cdot)$ is the cost of current investment, ρ is the discount factor, and $\mathsf{E}[\cdot \mid J_{it}]$ is the firm's expectations operator conditional on information J_{it} at time t. The Bellman equation implies that a firm exits the market if its liquidation value, Φ exceeds its expected discounted returns.

Firm i decides to stay in the market $(\chi_{it} = 1)$ or exit the market $(\chi_{it} = 0)$ if its productivity is greater than or less than some threshold subject to the firm's current capital stock and age, K_{it} and a_{it}. This exit rule is:

$$\chi_{it} = \begin{cases} 1 & \Omega_{it} \geq \Omega_{it}(K_{it}, a_{it}), \\ 0 & \text{else}, \end{cases} \tag{20}$$

where the state variable Ω_{it} follows a first-order Markov process.

The firm's decision to invest further capital, I_{it}, depends on Ω_{it}, K_{it} and a_{it}.

$$I_{it} = I(\Omega_{it}, K_{it}, a_{it}). \tag{21}$$

This investment decision equation implies that future productivity is increasing in the current productivity shock, so firms that experience a large positive productivity shock in period t will invest more in period $t+1$.

Based on the above exit and investment decision rules, Olley and Pakes (1996) assumes that production technology can be represented as productivity residual or shock in production function:

$$Y_{it} = F(L_{it}, M_{it}, K_{it}, a_{it}, \Omega_{it}).$$

For estimation purposes, it can be assumed as Cobb-Douglas technology

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + \beta_a a_{it} + u_{it}, \tag{22}$$

$$u_{it} = \Omega_{it} + \eta_{it}, \tag{23}$$

where y_{it} is the log output of firm i in period t; l_{it}, m_{it}, k_{it} are the log values of labor, material, and capital inputs; a_{it} is the age of the firm; Ω_{it} is the productivity shock that is observed by the decision maker in the firm but not by the econometrician; and η_{it} is an unexpected productivity shock that is unobserved by both the decision maker and the econometrician. Thus η_{it} has no effect on the firm's decisions, but Ω_{it} is s state variable that does affect the firm's decision-making process.

Given the standard econometric model (22), it provides biased and inconsistent estimates for two reasons: simultaneity between output and variable inputs, and selection bias resulting from the exit of inefficient firms. The productivity shock Ω_{it} seen by the firm but not by the econometrician implies that inputs are correlated with firms' input decisions. Firms of higher variable inputs result from a positive productivity shock. As such, the OLS estimates for inputs will be biased upward due to simultaneity issue. If the profitability is positively related to K_{it}, higher capital stock will expect larger future profitability at current productivity levels, which will survive lower productivity realizations that cause small firms to exit the market. The selection bias will cause expected future productivity to be negatively related to K_{it} and biased downward.

To tackle these issues, the OP method uses the investment decision rule (21) to control for the correlation between the error term and the inputs. Provided that I_{it} is strictly positive[5] (that is also the reason we previously argued that ASIF data set variables cannot tolerate negative or zero investment values), the inverse function for the unobserved productivity shock Ω_{it} is

$$\Omega_{it} = I^{-1}(I_{it}, K_{it}, a_{it}) = h(I_{it}, K_{it}, a_{it}), \tag{24}$$

which is strictly increasing in I_{it}.

The inverse function can thus be used to control for the simultaneity problem by substituting equation (23) and (24) into (22) to yield

$$y_{it} = \beta_l l_{it} + \beta_m m_{it} + \phi(i_{it}, k_{it}, a_{it}) + \eta_{it}, \tag{25}$$

(6) where $\phi(i_{it}, k_{it}, a_{it}) = \beta_0 + \beta_k k_{it} + \beta_a a_{it} + h(i_{it}, k_{it}, a_{it})$ and $\phi(\cdot)$ is approximated with a second-order polynomial series in age, capital and investment. The partially linear equation (25) can be estimated by OLS. The coefficient estimates for variable inputs (labor and material) will be consistent because $\phi(\cdot)$ controls for unobserved productivity, and thus the error term is no longer correlated with inputs.

Equation (25) does not identify β_k and β_a, so the effects of capital and age on the investment decision need to be estimated. The second step is to estimate survival probabilities that allows us to control for selection bias. According to the exit rule (20), a firm will choose to stay in the market if its productivity is greater than some threshold Ω_{it} that depends on K_{it} and a_{it}. The probability of survival in peri-

[5] Both the OLS estimation and OP method are based on the assumption that future productivity is strictly increasing with respect to Ω. The only difference is that OP assumes that firms that observe a positive productivity shock in period t will invest more in that period, for any K_{it} and a_{it}.

od t thus depends on $\Omega_{i,t-1}$ and $\underline{\Omega}_{i,t-1}$, and in turn on age, capital and investment at time $t-1$. The probability of survival is determined by fitting a probit model of χ_{it} on $I_{i,t-1}$, $K_{i,t-1}$ and $a_{i,t-1}$, as well as on their squares and cross products.

$$\mathsf{Pr}(\chi_{it} = 1 \mid J_{i,t-1}) = \mathsf{Pr}(\chi_{i,t} = 1 \mid \Omega_{i,t-1}, \underline{\Omega}_{i,t}(k_{i,t+1})) = \phi(i_{i,t-1}, k_{i,t-1}). \tag{26}$$

Call the predicted probabilities from this model $\hat{P}_{it}$.

In the third step, we fit the following equation by nonlinear least squares:

$$y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} = \beta_k k_{it} + \beta_a a_{it} + g(\hat{\phi}_{t-1} - \beta_k k_{i,t-1} - \beta_a a_{i,t-1}, \hat{P}_{it}) + \xi_{it} + \eta_{it},$$

where the unknown function $g(\cdot)$ is approximated by a second-order polynomial in $\hat{\phi}_{t-1} - \beta_k k_{i,t-1} - \beta_a a_{i,t-1}$ and $\hat{P}_{it}$.

The Levinsohn and Petrin Approach

The LP method proposed an alternative for firm-level data estimation that requires no further information about input values and does not require us to nor subtract them from the gross-output number to get the value added. Since the investment proxy is only valid for plants reporting non-zero investment, firms with ”zero investment” are likely to be dropped in the previous approach. Instead, the LP method uses intermediate input proxies to avoid truncating all the zero investment firms. In many empirical studies (as in our ASIF data set), firms always report a positive use of intermediate inputs like electricity or materials.

Start with the Cobb-Douglas production technology

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t + \eta_t,$$

where y_t is the logarithm of the firms' output, such as value added; l_t and m_t are the logarithm of the freely variable inputs labor and the intermediate input; and k_t is the logarithm of the state variable capital.

The error has two components: the transmitted productivity component given as ω_t and η_t, as well as an error term that is uncorrelated with input choices. They key difference between ω_t and η_t is that the former is a state variable and impacts on the firm's decision rules. It is not observed by the econometrician and it can affect the choices of inputs, leading to the simultaneity problem in production function estimation.

Demand for the intermediate input m_t is assumed to depend on the firm's state variables k_t and ω_t:

$$m_t = m_t(k_t, \omega_t).$$

In the LP assumption, demand function is monotonically increasing in ω_t. This allows inversion of the intermediate demand function, and thus ω_t can be written as a function of k_t and m_t:

$$\omega_t = \omega_t(k_t, m_t).$$

The unobservable productivity term is now expressed solely as a function of two observed inputs.

A final identification restriction follows Olley and Pakes (1996), in which productivity is governed by a first-order Markov process

$$\omega_t = \mathsf{E}[\omega_t \mid \omega_{t-1}] + \xi_t,$$

where ξ_t is an innovation to productivity that is uncorrelated with k_t, but not necessarily with l_t.

For the value-added production function, it can be written as

$$v_t = \beta_0 + \beta_l l_t + \beta_k k_t + \omega_t + \eta_t = \beta_l l_t + \phi_t(k_t, m_t) + \eta_t,$$

where

$$\phi_t(k_t, m_t) = \beta_0 + \beta_k k_t + \omega_t(k_t, m_t).$$

Substituting a third-order polynomial approximation in k_t and m_t in place of $\phi_t(k_t, m_t)$, makes it possible to consistently estimate parameters of the value-added equation using OLS as

$$v_t = \delta_0 + \beta_l l_t + \sum_{i=0}^{3} \sum_{j=0}^{3-i} \delta_{ij} k_t^i m_t^j + \eta_t,$$

where β_0 is not separately identified from the intercept of $\phi_t(k_t, m_t)$. As the first stage of estimation routine from Levinsohn and Petrin (2003), estimates of β_l and ϕ_t are available.

The second stage of the routine identifies the coefficient β_k. It begins by computing the estimated value for ϕ_t using

$$\widehat{\phi}_t = \widehat{v}_t - \widehat{\beta}_l l_t = \widehat{\delta}_0 + \sum_{i=0}^{3} \sum_{j=0}^{3-i} \widehat{\delta}_{ij} k_t^i m_t^j - \widehat{\beta}_l l_t.$$

For any candidate value β_k^*, a prediction for ω_t of all periods t can be computed by

$$\widehat{\omega}_t = \widehat{\phi}_t - \beta_k^* k_t.$$

Using these values, a consistent (nonparametric) approximation to $\mathsf{E}[\omega_t \mid \omega_{t-1}]$ is given by the predicted values from the regression

$$\widehat{\omega}_t = \gamma_0 + \gamma_1 \omega_{t-1} + \gamma_2 \omega_{t-1}^2 + \gamma_3 \omega_{t-1}^3 + \epsilon_t,$$

which LP call $\mathsf{E}[\widehat{\omega_t \mid \omega_{t-1}}]$.

$$\widehat{\eta_t + \xi_t} = v_t - \widehat{\beta}_l l_t - \beta_k^* k_t - \mathsf{E}[\widehat{\omega_t \mid \omega_{t-1}}].$$

The estimate $\widehat{\beta}_k$ of β_k is defined as the solution to

$$\min_{\beta_k^*} \sum \left(v_t - \widehat{\beta}_l l_t - \beta_k^* k_t - \mathsf{E}[\widehat{\omega_t \mid \omega_{t-1}}] \right)^2.$$

Tables and Figures

For readers' convenience, we show in Table 1 the industry codes (ID in short), industry names and their abbreviations. In the statements we only use the abbreviations to denote the corresponding industries.

Table 1: **Industry codes, industry names and their abbreviations**

ID	Industry name	Abbreviation
6	Extraction coal	EC
9	Extraction non-ferrous metal	ENM
10	Extraction nonmetallic ore	ENOM

13	Food processing	FP
14	Food manufacturing	FOM
15	Beverage Manufacturing	BM
16	Tobacco processing	TP
17	Textile	T
18	Garments and other Fiber Products manufacturing	GFPM
19	Leather Furs Down and Related Products	LFDRP
20	Timber Processing,Bamboo,Cane, Palm Fiber and Straw Products	TPBCPFSP
21	Furniture Manufacturing	FUM
22	Papermaking and Paper Products	PPP
23	Printing Industry and Recording Media	PRM
24	Cultural Educational and Sports Goods	CESG
25	Petroleum Refining and Cok	PRC
26	Chemical materials and chemical products	CMCP
27	Pharmaceutical manufacturing	PM
28	Chemical Fiber manufacturing	CF
29	Rubber Products	RP
30	Plastic product industry	PP
31	Nonmetal Mineral Products	NMP
32	Ferrous metal smelting and rolling processing	FMSRP
33	Non-Ferrous Metals Smelting and Rolling	NMSR
34	Metal product industry	MP
35	Machine building industry	MB
36	General Equipment manufacturing	GEM

37	Transport Equipment manufacturing	TEM
39	Arms and ammunition manufacturing	AAM
40	Electric Equipment and Machinery manufacturing	EEMM
41	Electronic and Telecommunication Equipment manufacturing	ETEM
42	Instrumentation and culture, office machinery manufacturing	ICOMM
43	Other Manufacturing	OM

Table 2 Annual samples with/without investments and middle inputs

year	Statistic checked observations	Having Investment	Having Middle Input	Having both I & M
1998	132821	42366	132747	42336
1999	142306	41910	142292	41906
2000	144537	38737	144332	38680
2001	152468	35408	152310	35353
2002	163965	34731	163627	34689
2003	183043	34086	183041	34086
2004	216954	36134	216757	36046
2005	257031	37308	256838	37276
2006	286607	38727	286594	38722
2007	321323	68867	321320	68866
total	2,001,055	408,274	1,999,858	**407,960**

Table 3 Descriptive statistics of firms' basic financial variables

Variable		Mean	Std. Dev.	Min	Max	Observations
ln Gross output	overall	8.832185	1.441823	3.680545	12.57972	N = 407919
	between		1.369184	3.705238	12.57972	n = 169902
	within		0.525238	3.076698	13.06407	T-bar = 2.40091
ln Value added	overall	7.445797	1.605989	-1.53839	13.27764	N = 407919
	between		1.493401	-1.39463	13.0022	n = 169902
	within		0.752093	-2.15765	13.01779	T-bar = 2.40091
ln Fix Capital	overall	7.828995	1.703263	-1.53839	14.79171	N = 407919
	between		1.692843	-1.53839	14.41346	n = 169902
	within		0.38811	0.041412	13.49087	T-bar = 2.40091
ln Labor	overall	5.391555	1.180301	2.302585	10.85476	N = 407919
	between		1.138575	2.302585	10.64044	n = 169902
	within		0.278806	0.860467	9.001826	T-bar = 2.40091
ln Middle Input	overall	8.601295	1.454204	-1.53839	13.99317	N = 407919
	between		1.405637	-1.53839	13.99317	n = 169902
	within		0.42944	-1.59255	14.07048	T-bar = 2.40091
ln Export	overall	7.964292	1.865408	-2.08778	13.82362	N = 107833
	between		1.853804	-1.70771	13.04174	n = 48133
	within		0.617398	1.169317	13.31133	T-bar = 2.24031
ln Investment	overall	5.115276	2.613863	-1.53839	15.19863	N = 407919
	between		2.444346	-1.53839	15.19863	n = 169902
	within		0.942194	-4.77117	14.45088	T-bar = 2.40091

Table 4 Estimation results of industrial production functions based on Fixed-effect Model

	FE6	FE7	FE8	FE9	FE10	FE11	FE12	FE13	FE14	FE15
lnL	0.301***	0.606*	0.422***	0.323***	0.357***	-0.140	0.0963	0.275***	0.241***	0.346***
	(6.96)	(2.27)	(5.06)	(4.44)	(4.87)	(-1.32)	(1.39)	(7.23)	(5.47)	(5.73)
lnM	0.557***	0.251	0.458***	0.644***	0.426***	0.895***	0.554***	0.525***	0.570***	0.621***
	(16.49)	(1.42)	(6.79)	(10.93)	(5.18)	(4.86)	(5.84)	(17.43)	(13.13)	(15.05)
lnK	0.119***	0.0588	0.243***	0.118**	0.0828*	0.928	0.00498	0.0990***	0.0725*	0.0903**
	(5.52)	(0.35)	(3.62)	(2.75)	(2.33)	(1.15)	(0.09)	(4.12)	(2.30)	(3.13)
age	0.000893	-0.0331	0.00127	0.000544	-0.00266	-0.0366	-0.0000224	0.00272	0.000761	0.00415*
	(0.56)	(-0.59)	(0.18)	(0.19)	(-1.00)	(-1.30)	(-0.00)	(1.46)	(0.48)	(2.45)
t	0.0688***	0.157	0.143***	0.0580***	0.0420***	0.446	-0.0439*	0.0241***	-0.00584	0.00997
	(10.66)	(1.85)	(8.04)	(5.15)	(3.80)	(1.19)	(-2.26)	(4.02)	(-0.84)	(1.58)
_cons	-0.0607	1.828	-1.217	-0.806	1.121	-6.925	2.440**	0.389	0.606	-0.436
	(-0.20)	(0.99)	(-1.71)	(-1.39)	(1.74)	(-0.94)	(2.69)	(1.36)	(1.62)	(-1.15)
N	9153	259	1875	3078	3843	40	1296	18916	8810	7958

	FE16	FE17	FE18	FE19	FE20	FE21	FE22	FE23	FE24	FE25
lnL	0.0966	0.311***	0.264***	0.339***	0.190*	0.390***	0.313***	0.384***	0.336***	0.336***
	(0.59)	(11.51)	(6.25)	(5.74)	(2.31)	(4.17)	(5.98)	(7.13)	(4.91)	(4.05)
lnM	0.465***	0.577***	0.414***	0.434***	0.658***	0.499***	0.588***	0.376***	0.590***	0.553***
	(5.22)	(21.05)	(7.17)	(6.40)	(11.11)	(5.06)	(14.41)	(9.37)	(8.43)	(9.41)
lnK	0.0178	0.150***	0.193***	0.0887	0.0618	0.129*	0.105**	0.160***	0.00610	0.140**
	(0.20)	(7.83)	(6.45)	(1.93)	(0.92)	(1.99)	(3.22)	(4.63)	(0.12)	(3.24)
age	-0.0267	0.00306*	0.00585*	0.00293	0.00436	0.00913*	0.00277	0.00395*	0.00273	0.0176**
	(-1.91)	(2.56)	(2.35)	(0.73)	(0.90)	(2.29)	(1.41)	(2.25)	(1.07)	(2.97)
t	0.0515*	0.00528	-0.00404	0.0247*	-0.00512	-0.00971	-0.0246***	-0.0264***	-0.00519	0.00434
	(2.47)	(1.40)	(-0.69)	(2.17)	(-0.39)	(-0.70)	(-3.91)	(-4.59)	(-0.51)	(0.32)
_cons	4.376**	-0.684**	0.910*	0.913	0.187	-0.0827	-0.141	0.882*	0.377	-0.327
	(3.18)	(-2.99)	(2.29)	(1.78)	(0.30)	(-0.12)	(-0.41)	(2.46)	(0.71)	(-0.66)
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

Note: *t* statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	FE26	FE27	FE28	FE29	FE30	FE31	FE32	FE33	FE34	FE35
lnL	0.322***	0.278***	0.297*	0.307***	0.278***	0.341***	0.355***	0.255***	0.356***	0.356***
	(11.35)	(6.78)	(2.08)	(4.18)	(6.60)	(12.61)	(5.38)	(4.15)	(8.56)	(13.03)
lnM	0.538***	0.521***	0.522***	0.681***	0.584***	0.429***	0.408***	0.577***	0.429***	0.487***
	(18.27)	(13.29)	(5.77)	(10.52)	(11.45)	(13.25)	(7.13)	(11.64)	(9.02)	(18.30)
lnK	0.140***	0.0662**	0.135	0.0432	0.0576	0.0748***	0.168***	0.129**	0.152***	0.151***
	(8.47)	(2.98)	(1.82)	(0.98)	(1.91)	(4.76)	(3.97)	(2.77)	(6.44)	(8.25)
age	0.00333**	0.00356**	0.00184	0.00391	0.00343	0.00379**	-0.000952	0.00275	0.00239	0.00369***
	(2.82)	(2.66)	(0.30)	(1.48)	(1.17)	(3.25)	(-0.21)	(0.66)	(1.31)	(3.87)
t	0.0126**	0.0124*	-0.0111	-0.0246**	-0.0109	0.00105	0.0741***	0.0411***	0.0232***	0.0328***
	(3.21)	(2.53)	(-0.60)	(-2.68)	(-1.61)	(0.29)	(6.21)	(3.61)	(4.04)	(8.31)
_cons	-0.152	1.120***	0.0930	-0.426	0.372	1.220***	0.245	-0.238	0.420	-0.166
	(-0.75)	(3.90)	(0.09)	(-0.83)	(0.99)	(5.63)	(0.50)	(-0.45)	(1.31)	(-0.80)
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889
	FE36	FE37	FE39	FE40	FE41	FE42	FE43	FE44	FE45	FE46
lnL	0.382***	0.405***	0.488***	0.375***	0.372***	0.540***	0.197**	0.297***	0.657***	0.309***
	(11.50)	(11.62)	(7.72)	(9.52)	(7.46)	(7.73)	(2.91)	(8.43)	(4.98)	(5.35)
lnM	0.443***	0.431***	0.446***	0.488***	0.381***	0.364***	0.439***	0.146***	0.196**	-0.0672
	(16.00)	(13.56)	(7.32)	(12.75)	(8.55)	(5.87)	(7.36)	(9.34)	(2.81)	(-1.87)
lnK	0.136***	0.0910***	0.0861**	0.0904***	0.107***	0.101*	0.0534	0.156***	0.0886	0.0303
	(7.03)	(4.67)	(2.63)	(3.83)	(3.75)	(2.39)	(1.49)	(8.68)	(1.93)	(1.43)
age	0.00256*	-0.000525	0.00293	0.00848***	0.00524	0.00256	0.00539	0.000234	-0.00609	0.000940
	(2.11)	(-0.37)	(0.88)	(4.48)	(1.41)	(0.79)	(1.13)	(0.18)	(-0.88)	(0.54)
t	0.0228***	0.0164***	0.307***	0.0977***	0.103***	0.131***	0.0231	0.0517***	0.0776***	0.0255***
	(4.55)	(3.61)	(27.65)	(14.05)	(10.56)	(9.63)	(1.70)	(11.38)	(4.21)	(5.76)
_cons	0.274	0.695**	-2.241***	-0.0761	0.811*	-0.251	1.936***	3.331***	1.173	5.250***
	(1.11)	(2.94)	(-4.73)	(-0.24)	(2.17)	(-0.45)	(3.48)	(14.89)	(1.40)	(13.18)
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: *t* statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5 Estimation results of industrial production functions based on Levinsohn-Patrin Approach

	LP6	LP7	LP8	LP9	LP10	LP11	LP12	LP13	LP14	LP15
age	-0.00317***	-0.00918	-0.000947	-0.00250	-0.000951	-0.00986	-0.00801**	-0.00234	-0.00110	0.000486
	(-4.08)	(-0.87)	(-0.39)	(-1.77)	(-0.73)	(-0.52)	(-3.05)	(-1.80)	(-1.34)	(0.81)
t	0.0528***	0.0626**	0.0733***	0.0618***	0.0283***	-0.00361	-0.0370*	0.0397***	0.0131**	0.0203***
	(14.32)	(2.89)	(8.01)	(7.96)	(4.83)	(-0.05)	(-2.22)	(10.24)	(3.21)	(5.01)
lnL	0.202***	0.119	0.198***	0.170***	0.235***	-0.125	0.163***	0.254***	0.154***	0.237***
	(13.03)	(1.59)	(6.18)	(5.17)	(8.93)	(-0.40)	(3.36)	(16.54)	(9.82)	(14.32)
lnM	0.678***	0.470***	0.631***	0.698***	0.634***	0.689**	0.666***	0.646***	0.745***	0.773***
	(41.25)	(6.66)	(14.39)	(25.82)	(20.34)	(2.74)	(12.82)	(46.25)	(42.10)	(62.09)
lnK	0.106***	0.420	0.120	0.127**	0.158**	0.212	0.0498	0.0848***	0.0226	0.108***
	(5.65)	(1.84)	(1.94)	(2.73)	(2.94)	(0.17)	(0.68)	(3.41)	(0.90)	(3.80)
N	9153	259	1875	3078	3843	40	1296	18916	8810	7958

	LP16	LP17	LP18	LP19	LP20	LP21	LP22	LP23	LP24	LP25
age	-0.00129	-0.000991*	-0.00234**	-0.00213	-0.00474**	-0.000483	-0.00350***	-0.00217*	-0.000591	-0.00996***
	(-0.45)	(-2.31)	(-3.16)	(-1.46)	(-3.15)	(-0.28)	(-3.60)	(-2.55)	(-0.39)	(-4.83)
t	0.0175	0.00848***	0.0188***	0.0165**	0.0228***	0.000863	-0.00745*	-0.00211	-0.00150	0.0273***
	(1.35)	(4.82)	(6.59)	(3.21)	(4.09)	(0.16)	(-2.20)	(-0.52)	(-0.35)	(4.83)
lnL	0.109	0.241***	0.270***	0.233***	0.192***	0.241***	0.220***	0.220***	0.293***	0.245***
	(1.56)	(24.80)	(16.85)	(12.14)	(6.44)	(7.04)	(11.70)	(11.23)	(11.56)	(9.66)
lnM	0.708***	0.683***	0.610***	0.668***	0.704***	0.706***	0.705***	0.613***	0.627***	0.614***
	(10.97)	(66.01)	(30.11)	(26.31)	(29.41)	(29.51)	(38.10)	(31.45)	(24.91)	(20.72)
lnK	0.170	0.126***	0.177***	0.0293	0.117	0.0786	0.103**	0.123**	0.00965	0.117**
	(1.69)	(5.49)	(3.74)	(0.44)	(1.60)	(1.34)	(2.60)	(2.63)	(0.19)	(2.95)
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

Note: *t* statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	LP26	LP27	LP28	LP29	LP30	LP31	LP32	LP33	LP34	LP35
age	-0.00497***	-0.00239**	-0.00366	-0.00309*	-0.00440***	-0.00330***	-0.00703***	-0.00905***	-0.00480***	-0.00169***
	(-9.26)	(-3.03)	(-1.29)	(-2.47)	(-4.68)	(-6.89)	(-5.99)	(-5.53)	(-6.70)	(-3.61)
t	0.0205***	0.0152***	-0.0100	0.00720	0.00970**	0.00539*	0.0439***	0.0442***	0.0115***	0.0149***
	(8.81)	(4.20)	(-1.00)	(1.45)	(3.03)	(2.45)	(9.06)	(7.80)	(4.18)	(7.10)
lnL	0.167***	0.224***	0.231***	0.211***	0.227***	0.204***	0.291***	0.265***	0.234***	0.211***
	(17.07)	(11.12)	(5.83)	(6.50)	(13.99)	(21.01)	(14.57)	(11.26)	(16.76)	(19.62)
lnM	0.682***	0.691***	0.712***	0.677***	0.667***	0.692***	0.618***	0.649***	0.635***	0.683***
	(67.08)	(33.33)	(20.03)	(20.85)	(41.92)	(53.87)	(33.83)	(35.60)	(35.49)	(57.27)
lnK	0.106***	0.120***	0.0973	0.0511	0.0717*	0.0807***	0.132**	0.114*	0.0965***	0.0943***
	(7.12)	(4.19)	(1.71)	(1.14)	(2.50)	(5.35)	(2.88)	(2.54)	(3.30)	(5.43)
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889

	LP36	LP37	LP39	LP40	LP41	LP42	LP43	LP44	LP45	LP46
age	-0.00418***	-0.00428***	-0.000804	-0.00447***	-0.00796***	-0.00336*	-0.00658***	0.00430***	0.000782	0.00128
	(-7.95)	(-8.72)	(-0.89)	(-6.06)	(-7.58)	(-2.57)	(-5.22)	(8.78)	(0.23)	(1.38)
t	0.0125***	0.0180***	0.226***	0.0202***	0.0181***	-0.00196	0.0355***	-0.000504	0.0505***	-0.0102**
	(4.98)	(7.05)	(31.15)	(7.38)	(4.05)	(-0.40)	(4.20)	(-0.16)	(3.77)	(-2.70)
lnL	0.199***	0.259***	0.248***	0.211***	0.217***	0.243***	0.229***	0.230***	0.117	0.220***
	(15.82)	(21.06)	(20.83)	(16.50)	(13.79)	(9.41)	(9.64)	(16.98)	(1.95)	(9.66)
lnM	0.691***	0.628***	0.636***	0.672***	0.660***	0.647***	0.668***	0.360***	0.410***	0.429***
	(63.88)	(60.45)	(43.25)	(50.31)	(32.91)	(30.93)	(22.59)	(19.63)	(9.02)	(17.36)
lnK	0.0902***	0.100***	0.0882*	0.0794**	0.131***	0.111**	0.0565	0.166***	0.143	0.0897*
	(3.42)	(4.48)	(2.19)	(2.73)	(3.47)	(2.95)	(1.54)	(6.55)	(1.85)	(2.43)
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: *t* statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6　Estimation results of industrial production functions based on OLS Approach

	OLS6	OLS7	OLS8	OLS9	OLS10	OLS11	OLS12	OLS13	OLS14	OLS15
lnL	0.219***	0.133	0.224***	0.184***	0.250***	0.209	0.283***	0.272***	0.163***	0.244***
	(18.22)	(1.91)	(8.20)	(7.88)	(13.64)	(1.63)	(9.99)	(22.49)	(10.55)	(15.86)
lnM	0.699***	0.477***	0.660***	0.725***	0.653***	0.546***	0.687***	0.656***	0.766***	0.783***
	(67.29)	(6.74)	(27.87)	(38.07)	(43.92)	(4.89)	(27.23)	(83.24)	(71.58)	(72.67)
lnK	0.0952***	0.392***	0.127***	0.0760***	0.0800***	0.0738	0.104***	0.0451***	0.0562***	0.0633***
	(10.35)	(7.73)	(6.24)	(4.60)	(6.07)	(0.75)	(4.71)	(5.29)	(5.55)	(6.14)
age	-0.00351***	-0.00935	-0.00165	-0.00307*	-0.00130	-0.0136	-0.00910***	-0.00254***	-0.00151*	0.000233
	(-6.05)	(-1.07)	(-0.88)	(-2.43)	(-1.41)	(-1.39)	(-5.03)	(-5.61)	(-2.28)	(0.37)
t	0.0564***	0.0719**	0.0828***	0.0694***	0.0289***	0.0265	-0.0146	0.0436***	0.0157***	0.0228***
	(16.68)	(3.24)	(10.37)	(11.06)	(5.37)	(0.60)	(-0.88)	(14.43)	(4.08)	(6.03)
_cons	-0.341***	-0.403	-0.533***	-0.374**	-0.0449	1.098	-0.222	-0.355***	-0.579***	-1.042***
	(-6.26)	(-0.94)	(-3.73)	(-3.04)	(-0.48)	(1.32)	(-1.87)	(-6.17)	(-8.67)	(-15.57)
N	9153	259	1875	3078	3843	40	1296	18916	8810	7958

	OLS16	OLS17	OLS18	OLS19	OLS20	OLS21	OLS22	OLS23	OLS24	OLS25
lnL	0.123*	0.245***	0.275***	0.242***	0.195***	0.244***	0.222***	0.233***	0.292***	0.253***
	(2.42)	(32.85)	(20.45)	(14.38)	(9.04)	(9.51)	(14.27)	(13.88)	(13.38)	(10.93)
lnM	0.722***	0.690***	0.623***	0.676***	0.702***	0.714***	0.715***	0.649***	0.632***	0.619***
	(23.60)	(109.70)	(64.17)	(48.69)	(44.17)	(34.72)	(58.90)	(56.90)	(33.34)	(33.28)
lnK	0.307***	0.0490***	0.0930***	0.0677***	0.0506***	0.0484**	0.0510***	0.162***	0.0650***	0.120***
	(9.89)	(9.07)	(10.95)	(5.62)	(4.04)	(3.09)	(5.24)	(14.63)	(4.44)	(6.91)
age	0.00107	-0.000912*	-0.00230**	-0.00204	-0.00487***	-0.000734	-0.00362***	-0.00199**	-0.000423	-0.0105***
	(0.67)	(-2.38)	(-2.97)	(-1.90)	(-3.80)	(-0.50)	(-5.02)	(-3.23)	(-0.40)	(-5.67)
t	0.0203	0.0101***	0.0193***	0.0164***	0.0239***	0.00161	-0.00445	0.00158	-0.00156	0.0284***
	(1.82)	(4.98)	(6.31)	(3.47)	(4.51)	(0.25)	(-1.26)	(0.42)	(-0.29)	(4.23)
_cons	-1.568***	-0.469***	-0.250***	-0.379***	-0.197	-0.493***	-0.349***	-0.540***	-0.124	-0.137
	(-6.86)	(-11.73)	(-3.70)	(-3.85)	(-1.88)	(-3.82)	(-5.20)	(-8.32)	(-1.10)	(-1.16)
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

Note: *t* statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	OLS26	OLS27	OLS28	OLS29	OLS30	OLS31	OLS32	OLS33	OLS34	OLS35
lnL	0.174***	0.221***	0.226***	0.219***	0.233***	0.210***	0.297***	0.272***	0.242***	0.215***
	(21.29)	(14.75)	(6.73)	(9.74)	(19.19)	(29.65)	(17.47)	(14.53)	(23.05)	(25.88)
lnM	0.693***	0.714***	0.711***	0.689***	0.675***	0.708***	0.620***	0.658***	0.646***	0.692***
	(110.35)	(67.23)	(25.62)	(39.45)	(67.80)	(126.89)	(48.25)	(50.34)	(80.10)	(116.29)
lnK	0.0876***	0.0964***	-0.00526	0.0518***	0.0592***	0.0539***	0.0575***	0.0539***	0.0850***	0.0730***
	(15.62)	(9.90)	(-0.26)	(3.51)	(7.26)	(11.95)	(4.63)	(4.38)	(12.35)	(13.19)
age	-0.00517***	-0.00259***	-0.00331	-0.00294**	-0.00448***	-0.00363***	-0.00762***	-0.00912***	-0.00483***	-0.00188***
	(-11.74)	(-4.46)	(-1.34)	(-2.81)	(-5.69)	(-9.70)	(-6.55)	(-8.06)	(-8.38)	(-5.14)
t	0.0241***	0.0198***	-0.00918	0.00820	0.00960**	0.00783***	0.0456***	0.0468***	0.0132***	0.0175***
	(11.49)	(5.87)	(-0.99)	(1.57)	(3.13)	(4.37)	(9.41)	(9.59)	(5.05)	(8.68)
_cons	-0.245***	-0.471***	-0.00766	-0.120	-0.197**	-0.153***	-0.252**	-0.361***	-0.163**	-0.343***
	(-6.43)	(-7.01)	(-0.04)	(-1.17)	(-3.07)	(-4.51)	(-2.92)	(-3.90)	(-3.07)	(-9.26)
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889

	OLS36	OLS37	OLS39	OLS40	OLS41	OLS42	OLS43	OLS44	OLS45	OLS46
lnL	0.205***	0.265***	0.264***	0.219***	0.224***	0.235***	0.230***	0.231***	0.168***	0.232***
	(19.20)	(24.66)	(20.04)	(21.81)	(14.78)	(13.02)	(14.58)	(23.45)	(4.54)	(13.73)
lnM	0.701***	0.638***	0.653***	0.680***	0.675***	0.655***	0.668***	0.395***	0.461***	0.482***
	(99.24)	(86.56)	(62.53)	(93.49)	(69.64)	(50.84)	(54.12)	(59.98)	(19.48)	(34.93)
lnK	0.0473***	0.0655***	0.0919***	0.0598***	0.0630***	0.0713***	0.0807***	0.356***	0.196***	0.301***
	(7.01)	(9.64)	(10.60)	(9.24)	(6.61)	(6.06)	(6.84)	(56.01)	(7.10)	(26.29)
age	-0.00440***	-0.00435***	-0.000740	-0.00440***	-0.00761***	-0.00356***	-0.00666***	0.00318***	0.00186	0.00126
	(-9.36)	(-9.12)	(-0.96)	(-7.65)	(-8.76)	(-3.52)	(-6.58)	(6.82)	(0.91)	(1.69)
t	0.0151***	0.0207***	0.219***	0.0222***	0.0169***	-0.00309	0.0363***	0.00376	0.0542***	-0.00410
	(5.82)	(7.99)	(36.20)	(8.88)	(4.44)	(-0.62)	(5.24)	(1.39)	(4.90)	(-1.10)
_cons	-0.0762	-0.0834	-2.205***	-0.0679	0.109	0.0740	-0.111	-0.0799	0.568**	-0.497***
	(-1.68)	(-1.90)	(-27.66)	(-1.42)	(1.53)	(0.82)	(-1.11)	(-1.67)	(2.96)	(-8.55)
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: *t* statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7 Estimation results of industrial production functions based on Olley-Pakes Approach

	OP6	OP7	OP8	OP9	OP10	OP12	OP13	OP14	OP15
age	-0.005	0.001	0.010	-0.005	-0.004	-0.006	-0.000	-0.002	0.006**
	(-1.911)	(0.007)	(0.829)	(-1.184)	(-1.091)	(-0.540)	(-0.017)	(-0.674)	(2.579)
lnK	0.075**	0.229	0.153	0.095	0.108*	0.103	0.134***	-0.027	0.133***
	(2.666)	(1.102)	(1.774)	(1.386)	(2.313)	(1.246)	(4.409)	(-0.484)	(3.600)
lnL	0.197***	0.159	0.180***	0.170***	0.231***	0.157***	0.263***	0.156***	0.235***
	(12.137)	(1.485)	(5.192)	(4.513)	(10.021)	(3.510)	(16.971)	(7.401)	(12.484)
lnM	0.684***	0.448***	0.614***	0.696***	0.630***	0.669***	0.643***	0.745***	0.771***
	(45.852)	(5.444)	(17.107)	(26.802)	(18.670)	(15.391)	(48.094)	(43.976)	(52.772)
t	0.054***	0.065*	0.082***	0.060***	0.028***	-0.037	0.037***	0.013**	0.020***
	(17.093)	(2.317)	(8.429)	(8.727)	(4.647)	(-1.868)	(12.898)	(2.981)	(5.123)
N	9153	259	1875	3078	3843	1296	18916	8810	7958

	OP16	OP17	OP18	OP19	OP20	OP21	OP22	OP23	OP24	OP25
age	-0.016	-0.001	-0.001	-0.005	0.002	0.002	0.001	0.006**	0.002	0.016
	(-0.652)	(-0.333)	(-0.174)	(-0.806)	(0.251)	(0.262)	(0.249)	(2.763)	(0.417)	(1.430)
lnK	0.188	0.166*	0.197***	0.076	0.123	0.037	0.122*	0.133**	0.002	0.096*
	(1.649)	(2.361)	(5.777)	(1.422)	(1.580)	(0.689)	(2.479)	(2.816)	(0.034)	(2.003)
lnL	0.102	0.239***	0.268***	0.236***	0.202***	0.248***	0.218***	0.224***	0.291***	0.249***
	(1.467)	(21.693)	(16.565)	(11.507)	(7.516)	(7.380)	(12.437)	(9.470)	(11.520)	(10.355)
lnM	0.658***	0.680***	0.610***	0.663***	0.699***	0.701***	0.704***	0.605***	0.627***	0.621***
	(10.371)	(57.847)	(32.354)	(25.046)	(27.342)	(28.904)	(42.695)	(31.608)	(21.587)	(21.269)
t	0.024	0.011***	0.019***	0.016**	0.025***	0.003	-0.007*	-0.004	-0.001	0.026***
	(1.794)	(6.789)	(7.109)	(3.157)	(4.267)	(0.424)	(-2.010)	(-0.997)	(-0.147)	(4.338)
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t statistics in parentheses

	OP26	OP27	OP28	OP29	OP30	OP31	OP32	OP33	OP34	OP35
age	0.002	0.002	-0.006	0.002	0.007	0.001	-0.005	-0.003	0.005*	0.001
	(0.672)	(0.969)	(-0.681)	(0.638)	(1.602)	(1.109)	(-1.066)	(-0.441)	(1.972)	(0.650)
lnK	0.157**	0.137***	0.089	0.051	0.071	0.101***	0.116*	0.156*	0.126***	0.123***
	(3.269)	(4.365)	(1.535)	(0.993)	(1.693)	(7.837)	(2.460)	(2.402)	(4.581)	(4.795)
lnL	0.167***	0.229***	0.236***	0.213***	0.225***	0.203***	0.286***	0.264***	0.237***	0.212***
	(15.720)	(12.145)	(5.780)	(7.285)	(14.414)	(24.997)	(14.746)	(11.740)	(16.860)	(18.640)
lnM	0.682***	0.688***	0.706***	0.679***	0.664***	0.692***	0.622***	0.646***	0.629***	0.681***
	(57.813)	(31.587)	(17.881)	(21.438)	(34.535)	(58.987)	(31.758)	(37.315)	(36.912)	(62.131)
t	0.021***	0.015***	-0.010	0.006	0.010***	0.006**	0.045***	0.044***	0.012***	0.015***
	(10.750)	(4.958)	(-0.882)	(0.967)	(3.354)	(3.040)	(7.552)	(9.871)	(4.279)	(6.204)
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889
	OP36	OP37	OP39	OP40	OP41	OP42	OP43	OP44	OP45	OP46
age	0.004	-0.004*	0.003	-0.001	0.002	-0.003	-0.004	0.006***	0.021	0.005
	(1.926)	(-2.272)	(0.768)	(-0.465)	(0.397)	(-1.063)	(-0.877)	(3.393)	(0.968)	(1.892)
lnK	0.107***	0.086***	0.107***	0.159*	0.086*	0.058	0.041	0.148***	0.096	0.076*
	(4.879)	(3.360)	(3.642)	(2.487)	(2.020)	(1.150)	(1.054)	(7.369)	(1.684)	(2.032)
lnL	0.198***	0.262***	0.246***	0.213***	0.224***	0.242***	0.227***	0.237***	0.131*	0.214***
	(15.731)	(14.855)	(16.061)	(15.355)	(11.727)	(10.999)	(8.745)	(17.195)	(2.573)	(10.242)
lnM	0.692***	0.627***	0.633***	0.670***	0.651***	0.648***	0.667***	0.356***	0.410***	0.425***
	(59.580)	(47.434)	(44.948)	(54.201)	(39.199)	(29.145)	(19.107)	(27.798)	(9.020)	(17.482)
t	0.013***	0.018***	0.230***	0.021***	0.017***	0.000	0.037***	-0.001	0.050***	-0.011**
	(4.170)	(6.276)	(33.583)	(8.207)	(4.622)	(0.052)	(3.944)	(-0.364)	(3.731)	(-3.246)
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; *t* statistics in parentheses

Table 8 Estimation results of Pareto distribution of industrial productivity using FE

	FE6P	FE7P	FE8P	FE9P	FE10P	FE11P	FE12P	FE13P	FE14P	FE15P
$\ln\theta$	-1.183***	-0.850***	-1.046***	-0.914***	-0.002***	-0.424***	-0.704***	-0.777***	-0.893***	-0.954***
	(-139.037)	(-29.911)	(-69.797)	(-68.429)	(-110.417)	(-8.154)	(-50.759)	(-179.609)	(-125.877)	(-118.413)
Constant	-0.912***	0.894***	-1.812***	-1.746***	-6.507***	-3.276***	0.724***	-0.813***	-0.642***	-1.543***
	(-54.037)	(6.426)	(-41.642)	(-52.556)	(-121.741)	(-10.314)	(17.029)	(-65.893)	(-36.894)	(-81.922)
R Square	0.7284	0.8518	0.8014	0.6869	0.8008	0.7387	0.7862	0.6718	0.6852	0.6907
N	9153	259	1875	3078	3843	40	1296	18916	8810	7958

	FE16P	FE17P	FE18P	FE19P	FE20P	FE21P	FE22P	FE23P	FE24P	FE25P
$\ln\theta$	-0.603***	-1.082***	-1.024***		-1.036***	-1.043***	-1.056***	-0.939***	-1.076***	-0.964***
	(-39.295)	(-246.240)	(-158.636)	-1.016***	(-94.152)	(-77.144)	(-131.017)	(-126.108)	(-76.096)	(-76.075)
Constant	1.672***	-1.839***	-0.189***	-0.071**	-0.868***	-1.266***	-1.323***	-0.476***	-0.610***	-1.396***
	(22.051)	(-188.420)	(-11.864)	(-2.891)	(-29.493)	(-34.715)	(-74.358)	(-27.446)	(-19.325)	(-41.253)
R Square	0.7667	0.7115	0.7139	0.7444	0.7295	0.7405	0.709	0.7259	0.6723	0.734
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

	FE26P	FE27P	FE28P	FE29P	FE30P	FE31P	FE32P	FE33P	FE34P	FE35P
$\ln\theta$	-0.917***	-0.900***	-0.874***	-1.105***	-1.055***	-1.038***	-0.869***	-0.859***	-1.004***	-1.054***
	(-238.500)	(-151.642)	(-57.952)	(-93.075)	(-170.005)	(-259.788)	(-117.984)	(-110.376)	(-199.492)	(-250.614)
Constant	-1.330***	-0.139***	-1.060***	-1.620***	-0.732***	0.080***	-0.771***	-1.214***	-0.567***	-1.175***
	(-137.012)	(-8.095)	(-27.732)	(-65.146)	(-48.136)	(8.382)	(-37.510)	(-51.852)	(-46.900)	(-124.479)
R Square	0.7206	0.7354	0.668	0.7744	0.7352	0.738	0.6873	0.6979	0.7318	0.7392
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889

	FE36P	FE37P	FE39P	FE40P	FE41P	FE42P	FE43P	FE44P	FE45P	FE46P
$\ln\theta$	-0.927***	-0.944***	-1.012***	-0.923***	-0.839***	-0.851***	-0.944***	-0.797***	-0.718***	-0.630***
	(-201.197)	(-202.393)	(-182.604)	(-198.674)	(-146.491)	(-106.302)	(-83.811)	(-192.263)	(-58.155)	(-146.789)
Constant	-0.878***	-0.406***	-2.112***	-0.875***	-0.131***	-0.891***	0.742***	1.697***	-0.138**	2.176***
	(-79.878)	(-32.099)	(-37.522)	(-79.011)	(-7.992)	(-41.262)	(25.749)	(96.461)	(-2.781)	(90.697)
R Square	0.7487	0.722	0.7601	0.7609	0.7628	0.7478	0.7099	0.7646	0.766	0.8566
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: * p < 0.05, ** p < 0.01, *** p < 0.001; t statistics in parentheses

Table 9 Estimation results of Pareto distribution of industrial productivity using LP

	LP6P	LP7P	LP8P	LP9P	LP10P	LP11P	LP12P	LP13P	LP14P	LP15P
$\ln \theta$	-1.219***	-1.042***	-1.121***	-0.938***	-0.001***	-0.913***	-0.915***	-0.793***	-0.935***	-0.990***
	(-139.027)	(-23.047)	(-68.356)	(-67.654)	(-110.404)	(-7.470)	(-53.026)	(-179.263)	(-129.373)	(-122.419)
Constant	-1.004***	-1.354***	-0.732***	-1.333***	-6.507***	-0.294	0.052	-1.350***	-1.055***	-2.257***
	(-58.407)	(-9.392)	(-16.199)	(-40.555)	(-121.728)	(-1.720)	(1.476)	(-107.882)	(-62.058)	(-108.680)
R-squared	0.7054	0.7372	0.7724	0.6628	0.8008	0.6742	0.7841	0.6686	0.6895	0.7026
N	9153	259	1875	3078	3843	40	1296	18916	8810	7958
	LP16P	LP17P	LP18P	LP19P	LP20P	LP21P	LP22P	LP23P	LP24P	LP25P
$\ln \theta$	-1.042***	-1.112***	-1.076***	-1.090***	-1.044***	-1.113***	-1.090***	-1.052***	-1.085***	-1.042***
	(-37.474)	(-251.710)	(-167.076)	(-107.873)	(-93.333)	(-76.365)	(-134.601)	(-132.923)	(-76.899)	(-73.305)
Constant	-0.950***	-2.096***	-1.694***	-0.895***	-1.531***	-1.522***	-1.669***	-0.857***	-0.631***	-0.915***
	(-18.430)	(-207.717)	(-110.385)	(-39.440)	(-50.439)	(-40.337)	(-92.331)	(-51.149)	(-20.172)	(-25.696)
R-squared	0.6767	0.7129	0.7352	0.7409	0.7288	0.7164	0.7099	0.7338	0.6741	0.7027
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701
	LP26P	LP27P	LP28P	LP29P	LP30P	LP31P	LP32P	LP33P	LP34P	LP35P
$\ln \theta$	-0.960***	-0.953***	-0.897***	-1.123***	-1.076***	-1.135***	-0.904***	-0.870***	-1.062***	-1.126***
	(-237.366)	(-156.698)	(-58.499)	(-91.470)	(-171.346)	(-259.331)	(-117.757)	(-109.998)	(-203.802)	(-256.349)
Constant	-1.204***	-1.469***	-1.899***	-0.870***	-1.152***	-1.207***	-1.697***	-1.539***	-1.026***	-1.356***
	(-121.758)	(-89.705)	(-46.047)	(-35.674)	(-76.190)	(-135.238)	(-78.878)	(-64.195)	(-86.105)	(-141.012)
R-squared	0.6993	0.7425	0.6682	0.7547	0.7339	0.721	0.6844	0.6882	0.7276	0.7294
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889
	LP36P	LP37P	LP39P	LP40P	LP41P	LP42P	LP43P	LP44P	LP45P	LP46P
$\ln \theta$	-1.024***	-0.983***	-1.052***	-0.993***	-0.939***	-0.961***	-1.070***	-0.956***	-0.783***	-1.058***
	(-212.388)	(-206.519)	(-175.862)	(-201.079)	(-160.812)	(-108.595)	(-88.030)	(-204.987)	(-61.410)	(-145.036)
Constant	-1.253***	-1.130***	-1.885***	-1.072***	-1.235***	-1.180***	-0.917***	0.885***	0.555***	0.776***
	(-114.016)	(-92.267)	(-32.368)	(-95.332)	(-83.537)	(-52.715)	(-45.834)	(60.710)	(10.260)	(40.372)
R-squared	0.7528	0.7143	0.7371	0.7507	0.7757	0.7255	0.7103	0.7786	0.7668	0.8011
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; *t* statistics in parentheses

Table 10 Estimation results of Pareto distribution of industrial productivity using OLS

	OLS6P	OLS7P	OLS8P	OLS9P	OLS10P	OLS11P	OLS12P	OLS13P	OLS14P	OLS15P
$\ln\theta$	-1.224***	-1.046***	-1.131***	-0.947***	-1.091***	-1.087***	-1.042***	-0.794***	-0.944***	-0.990***
	(-140.676)	(-23.392)	(-68.793)	(-68.805)	(-100.266)	(-10.588)	(-58.382)	(-179.357)	(-130.490)	(-121.903)
Constant	-1.321***	-1.218***	-1.225***	-1.219***	-0.998***	0.295	-1.152***	-1.248***	-1.476***	-2.012***
	(-76.739)	(-8.442)	(-27.075)	(-37.575)	(-44.042)	(1.659)	(-39.254)	(-100.266)	(-85.346)	(-100.821)
R-squared	0.7148	0.7433	0.7773	0.667	0.7664	0.8032	0.8088	0.6671	0.6927	0.6961
N	9153	259	1875	3078	3843	40	1296	18916	8810	7958

	OLS16P	OLS17P	OLS18P	OLS19P	OLS20P	OLS21P	OLS22P	OLS23P	OLS24P	OLS25P
$\ln\theta$	-1.110***	-1.124***	-1.085***	-1.091***	-1.060***	-1.117***	-1.097***	-1.074***	-1.087***	-1.045***
	(-41.454)	(-248.090)	(-165.774)	(-106.950)	(-95.519)	(-76.942)	(-134.502)	(-136.391)	(-75.386)	(-73.827)
Constant	-2.675***	-1.498***	-1.187***	-1.332***	-1.028***	-1.484***	-1.328***	-1.526***	-1.100***	-1.026***
	(-42.522)	(-157.798)	(-79.542)	(-57.668)	(-35.113)	(-39.538)	(-75.309)	(-89.950)	(-34.731)	(-28.943)
R-squared	0.7297	0.6967	0.7221	0.744	0.7311	0.7187	0.7048	0.7482	0.6698	0.7065
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

	OLS26P	OLS27P	OLS28P	OLS29P	OLS30P	OLS31P	OLS32P	OLS33P	OLS34P	OLS35P
$\ln\theta$	-0.961***	-0.954***	-0.926***	-1.123***	-1.077***	-1.137***	-0.915***	-0.874***	-1.064***	-1.129***
	(-237.767)	(-157.179)	(-60.508)	(-91.617)	(-171.991)	(-260.279)	(-116.916)	(-109.374)	(-204.601)	(-257.150)
Constant	-1.191***	-1.462***	-1.023***	-1.051***	-1.154***	-1.146***	-1.177***	-1.221***	-1.079***	-1.276***
	(-120.532)	(-89.468)	(-27.145)	(-43.135)	(-76.539)	(-128.908)	(-55.976)	(-51.515)	(-90.710)	(-133.449)
R-squared	0.6992	0.7419	0.6684	0.7566	0.735	0.7206	0.6741	0.6765	0.7291	0.7289
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889

	OLS36P	OLS37P	OLS39P	OLS40P	OLS41P	OLS42P	OLS43P	OLS44P	OLS45P	OLS46P
$\ln\theta$	-1.029***	-0.705***	-1.051***	-0.994***	-0.947***	-0.966***	-1.071***	-1.061***	-0.807***	-1.252***
	(-213.455)	(-117.806)	(-177.116)	(-201.603)	(-160.159)	(-108.960)	(-87.954)	(-217.421)	(-61.935)	(-147.530)
Constant	-1.027***	-0.831***	-2.217***	-1.039***	-0.887***	-0.897***	-1.100***	-0.958***	-0.359***	-1.549***
	(-94.173)	(-58.284)	(-38.159)	(-92.560)	(-59.774)	(-40.207)	(-54.838)	(-83.674)	(-7.228)	(-91.329)
R-squared	0.7511	0.4908	0.7413	0.7511	0.7694	0.7228	0.7109	0.7905	0.7706	0.7868
N	20375	19219	13180	17899	9060	5664	3368	17973	1643	8224

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11 Estimation results of Pareto distribution of industrial productivity using OP

	OP6P	OP7P	OP8P	OP9P	OP10P	OP12P	OP13P	OP14P	OP15P
$\ln\theta$	-1.209***	-1.000***	-1.107***	-0.942***	-1.085***	-0.968***	-0.789***	-0.936***	-0.984***
	(-139.052)	(-25.537)	(-66.874)	(-68.280)	(-100.162)	(-53.791)	(-180.996)	(-129.285)	(-125.003)
Constant	-0.668***	0.301*	-0.986***	-1.016***	-0.847***	-0.337***	-1.701***	-1.071***	-2.574***
	(-38.632)	(2.027)	(-21.721)	(-31.345)	(-37.428)	(-10.456)	(-132.908)	(-62.991)	(-118.931)
R-squared	0.7022	0.7887	0.7686	0.6617	0.7648	0.7857	0.678	0.6888	0.718
N	9153	259	1875	3078	3843	1296	18916	8810	7958

	OP16P	OP17P	OP18P	OP19P	OP20P	OP21P	OP22P	OP23P	OP24P	OP25P
$\ln\theta$	-0.894***	-1.098***	-1.069***	-1.091***	-1.024***	-1.113***	-1.078***	-1.033***	-1.081***	-0.983***
	(-40.120)	(-255.715)	(-167.709)	(-107.593)	(-92.298)	(-76.539)	(-135.155)	(-133.350)	(-76.626)	(-73.625)
Constant	-0.304***	-2.403***	-1.858***	-1.182***	-1.700***	-1.361***	-1.914***	-1.173***	-0.624***	-1.185***
	(-6.491)	(-229.489)	(-119.421)	(-51.844)	(-55.288)	(-36.350)	(-103.644)	(-70.673)	(-19.855)	(-34.016)
R-squared	0.7273	0.7262	0.7398	0.7438	0.7291	0.7179	0.7189	0.7393	0.6748	0.7197
N	801	29939	11853	4977	4382	2816	9402	8036	3235	2701

	OP26P	OP27P	OP28P	OP29P	OP30P	OP31P	OP32P	OP33P	OP34P	OP35P
$\ln\theta$	-0.945***	-0.951***	-0.902***	-1.120***	-1.056***	-1.128***	-0.905***	-0.859***	-1.041***	-1.117***
	(-241.460)	(-158.939)	(-58.569)	(-91.631)	(-169.775)	(-260.674)	(-117.419)	(-111.602)	(-202.679)	(-257.372)
Constant	-1.741***	-1.703***	-1.776***	-1.035***	-1.334***	-1.492***	-1.619***	-1.892***	-1.435***	-1.675***
	(-172.939)	(-103.660)	(-43.747)	(-42.468)	(-87.471)	(-165.442)	(-75.631)	(-77.696)	(-118.758)	(-170.990)
R-squared	0.7185	0.7508	0.6668	0.761	0.7382	0.7294	0.6818	0.7057	0.7334	0.7365
N	31313	11471	2033	4053	12606	32096	7162	6832	17680	30889

	OP36P	OP37P	OP39P	OP40P	OP41P	OP42P	OP43P	OP44P	OP45P	OP46P
$\ln\theta$	-1.003***	-0.984***	-1.046***	-0.975***	-0.936***	-0.965***	-1.066***	-0.942***	-0.771***	-0.926***
	(-213.717)	(-206.492)	(-176.959)	(-203.558)	(-160.748)	(-108.852)	(-87.418)	(-205.856)	(-61.875)	(-171.873)
Constant	-1.620***	-1.037***	-2.181***	-1.729***	-1.049***	-0.802***	-0.844***	0.961***	0.547***	-4.454***
	(-145.440)	(-84.699)	(-37.570)	(-148.679)	(-71.391)	(-35.851)	(-41.841)	(65.239)	(10.075)	(-185.008)
R-squared	0.7645	0.7135	0.7416	0.7634	0.7792	0.7223	0.7085	0.7822	0.7777	0.8572
N	20375	21028	13180	17899	9060	5664	3368	17973	1643	8224

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12 Estimation results of Pareto distribution of domestic sale of non-exporters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	FEd6P	FEd7P	FEd8P	FEd9P	FEd10P	FEd11P	FEd12P	FEd13P	FEd14P	FEd15P
$\ln D$	-0.630***	-0.656***	-0.651***	-0.612***	-0.355***	-0.528***	-0.436***	-0.461***	-0.463***	-0.473***
	(-179.594)	(-26.319)	(-83.689)	(-82.548)	(-58.914)	(-6.378)	(-48.225)	(-224.397)	(-173.857)	(-136.483)
Constant	4.168***	4.803***	4.587***	4.218***	1.873***	2.891***	2.370***	2.909***	2.648***	3.077***
	(139.567)	(19.668)	(63.521)	(64.391)	(36.446)	(4.687)	(31.760)	(156.276)	(115.362)	(96.881)
R Square	0.8609	0.8152	0.8451	0.7759	0.6082	0.7364	0.7847	0.7984	0.8466	0.8006
N	9148	259	1874	3068	3809	40	1295	18463	8621	7875
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	FEd16P	FEd17P	FEd18P	FEd19P	FEd20P	FEd21P	FEd22P	FEd23P	FEd24P	FEd25P
$\ln D$	-0.507***	-0.385***	-0.219***	-0.221***	-0.416***	-0.327***	-0.572***	-0.581***	-0.230***	-0.551***
	(-26.469)	(-234.525)	(-189.323)	(-118.587)	(-115.940)	(-77.179)	(-168.815)	(-166.330)	(-90.873)	(-70.501)
Constant	4.043***	2.377***	0.900***	1.043***	2.381***	1.716***	3.917***	3.511***	1.029***	4.028***
	(20.566)	(159.507)	(88.685)	(61.711)	(74.498)	(44.561)	(129.047)	(121.024)	(46.888)	(53.528)
R Square	0.6360	0.7487	0.8361	0.8272	0.8092	0.7458	0.8288	0.8398	0.8089	0.7321
N	800	28266	9668	4052	4179	2549	9310	7989	2644	2694
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	FEd26P	FEd27P	FEd28P	FEd29P	FEd30P	FEd31P	FEd32P	FEd33P	FEd34P	FEd35P
$\ln D$	-0.532***	-0.520***	-0.489***	-0.206***	-0.459***	-0.550***	-0.554***	-0.421***	-0.207***	-0.308***
	(-282.188)	(-159.971)	(-54.265)	(-44.473)	(-181.388)	(-304.877)	(-134.216)	(-90.670)	(-98.430)	(-154.581)
Constant	3.698***	3.647***	3.643***	0.821***	2.856***	3.583***	3.992***	2.872***	0.708***	1.598***
	(214.280)	(120.841)	(40.815)	(18.582)	(126.490)	(227.749)	(101.276)	(63.017)	(35.895)	(88.767)
R Square	0.8116	0.7926	0.7157	0.4504	0.7901	0.8184	0.792	0.6501	0.442	0.5447
N	30853	11275	2010	3919	12119	31639	7093	6727	17043	30329
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	FEd36P	FEd37P	FEd39P	FEd40P	FEd41P	FEd42P	FEd43P	FEd44P	FEd45P	FEd46P
$\ln D$	-0.568***	-0.514***	-0.438***	-0.456***	-0.454***	-0.318***	-0.288***	-0.609***	-0.607***	-0.617***
	(-257.213)	(-242.373)	(-197.003)	(-211.592)	(-165.678)	(-93.673)	(-84.152)	(-202.790)	(-69.244)	(-172.241)
Constant	3.728***	3.444***	3.235***	2.969***	2.935***	1.625***	1.415***	4.086***	4.038***	3.505***
	(192.941)	(178.119)	(80.739)	(151.382)	(118.069)	(53.669)	(51.595)	(154.874)	(50.068)	(129.131)
R Square	0.834	0.8068	0.8029	0.7738	0.8186	0.6879	0.7712	0.7776	0.8382	0.8826
N	20150	20737	12624	17280	8749	5086	3013	17968	1640	8221

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t statistics in parentheses

Table 13 Estimation results of Pareto distribution of exporting sale of exporters

	FEx6P	FEx7P	FEx8P	FEx9P	FEx10P	FEx11P	FEx12P	FEx13P	FEx14P	FEx15P
$\ln X$	-0.411***	0.000	-0.512***	-0.552***	-0.468***	-0.349***	-0.364***	-0.437***	-0.412***	-0.412***
	(-19.509)	(.)	(-10.177)	(-18.606)	(-31.252)	(-4.576)	(-6.626)	(-75.440)	(-58.733)	(-48.239)
Constant	1.639***	-0.693	3.672***	3.011***	2.275***	2.132**	1.391**	2.424***	1.854***	1.834***
	(8.787)	(.)	(6.128)	(11.263)	(18.925)	(3.267)	(2.826)	(47.182)	(31.744)	(25.478)
R Square	0.6665		0.7946	0.7341	0.7227	0.7576	0.7878	0.6856	0.7139	0.7356
N	235	3	39	177	585	9	31	3530	2037	1150

	FEx16P	FEx17P	FEx18P	FEx19P	FEx20P	FEx21P	FEx22P	FEx23P	FEx24P	FEx25P
$\ln X$	-0.466***	-0.445***	-0.569***	-0.508***	-0.499***	-0.431***	-0.439***	-0.416***	-0.449***	-0.367***
	(-11.767)	(-141.626)	(-122.390)	(-75.474)	(-43.149)	(-43.531)	(-41.623)	(-39.239)	(-55.851)	(-20.674)
Constant	2.573***	2.721***	3.763***	3.201***	2.702***	2.272***	2.027***	1.760***	2.596***	1.925***
	(7.192)	(96.214)	(91.070)	(52.805)	(27.363)	(24.888)	(23.421)	(19.078)	(36.352)	(11.084)
R Square	0.7724	0.669	0.7203	0.721	0.6703	0.6976	0.6589	0.7535	0.6938	0.7982
N	77	14037	7906	3200	1094	1178	1161	657	2271	189

	FEx26P	FEx27P	FEx28P	FEx29P	FEx30P	FEx31P	FEx32P	FEx33P	FEx34P	FEx35P
$\ln X$	-0.402***	-0.326***	-0.433***	-0.404***	-0.408***	-0.409***	-0.419***	-0.404***	-0.407***	-0.384***
	(-108.062)	(-61.134)	(-29.461)	(-45.731)	(-72.065)	(-86.623)	(-40.443)	(-48.092)	(-93.012)	(-126.327)
Constant	2.035***	1.452***	2.373***	2.121***	1.988***	2.079***	2.318***	2.406***	1.999***	1.648***
	(64.395)	(31.722)	(18.265)	(28.202)	(39.549)	(51.109)	(24.406)	(29.627)	(54.316)	(66.753)
R Square	0.6625	0.6609	0.6936	0.6731	0.687	0.6767	0.678	0.6609	0.6893	0.7032
N	8203	3222	532	1567	3333	4675	1014	1563	5559	9343

	FEx36P	FEx37P	FEx39P	FEx40P	FEx41P	FEx42P	FEx43P	FEx44P	FEx45P	FEx46P
$\ln X$	-0.414***	-0.361***	-0.383***	-0.369***	-0.372***	-0.452***	-0.439***	-0.385***	-0.348***	-0.362***
	(-107.385)	(-96.415)	(-83.681)	(-100.591)	(-74.634)	(-69.442)	(-47.467)	(-13.432)	(-5.312)	(-7.692)
Constant	1.740***	1.510***	1.936***	1.667***	1.801***	2.239***	2.452***	1.935***	1.844**	2.331***
	(57.212)	(46.727)	(23.639)	(50.850)	(41.035)	(40.376)	(31.692)	(6.909)	(3.120)	(6.490)
R Square	0.7329	0.7232	0.6929	0.702	0.7191	0.7211	0.6562	0.4542	0.7505	0.4549
N	5564	5051	4210	6101	3385	2754	1838	250	35	68

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t statistics in parentheses

Table 14 Estimation results of Pareto distributions of non-exporters' domestic sales and exporters' foreign sales based on productivity estimated using FE

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ζ_l	0.497	0.408	0.346	0.123	0.137	0.128	0.110	0.213	0.146	0.138	0.128	0.180	0.185	0.179	0.177	0.176	0.174	0.173	0.180	0.176
	(0.013)	(0.012)	(0.015)	(0.005)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
χ_l	2.398	1.793	1.369	0.254	0.011	0.051	0.187	0.716	0.337	0.276	0.200	0.513	0.644	0.623	0.603	0.594	0.578	0.574	0.628	0.596
	(0.090)	(0.090)	(0.112)	(0.051)	(0.047)	(0.043)	(0.042)	(0.021)	(0.020)	(0.019)	(0.019)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012	) (0.012	) (0.012)	(0.011)
ψ_l	3.666	2.912	2.326	0.278	0.006	0.123	0.024	0.964	0.064	0.056	0.003	0.563	0.537	0.493	0.475	0.467	0.449	0.445	0.500	0.470
	(0.121)	(0.120)	(0.134)	(0.074)	(0.074)	(0.067)	(0.066)	(0.022)	(0.027)	(0.027)	(0.026)	(0.014)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
R^2	0.775	0.704	0.496	0.371	0.326	0.331	0.307	0.506	0.380	0.368	0.346	0.357	0.397	0.400	0.394	0.393	0.388	0.387	0.401	0.394
	26	27	28	29	30	31	32	33	34	35	36	37	39	40	41	42	43	44	45	46
ζ_l	0.160	0.160	0.161	0.162	0.166	0.151	0.140	0.146	0.166	0.158	0.150	0.144	0.143	0.147	0.149	0.149	0.148	0.147	0.146	0.147
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
χ_l	0.396	0.430	0.433	0.444	0.453	0.303	0.211	0.257	0.435	0.509	0.481	0.441	0.429	0.473	0.488	0.485	0.483	0.470	0.465	0.471
	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
ψ_l	0.594	0.602	0.610	0.620	0.652	0.543	0.457	0.504	0.577	0.455	0.355	0.308	0.298	0.330	0.352	0.352	0.348	0.339	0.337	0.342
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	0.012)	(0.012)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013	) (0.013)	(0.013)	(0.013)	(0.013)
R^2	0.372	0.390	0.397	0.399	0.408	0.358	(0.330	0.345	0.397	0.392	0.385	0.381	0.390	0.391	0.404	0.403	0.399	0.396	0.394	0.396

Note: All the estimated parameters are significant at 1 percent, and the time fixed effects are ignored.

Table 15 Cutoffs of domestic sales of non-exporters and foreign sales of exporters

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
$\underline{D}_l$	98.84	132.79	12.40	103.20	7.12	8.47	12.19	97.87	97.92	98.77	10.34	97.06	100.62	104.16	98.26	99.44	97.70	98.11	105.22	99.33
$\underline{X}_l$	0.95	1109.50	1.00	7.71	0.73	489.53	36.12	0.02	1.42	0.11	2.04	0.06	0.39	1.10	0.86	2.15	0.54	0.54	0.64	3.10

	26	27	28	29	30	31	32	33	34	35	36	37	39	40	41	42	43	44	45	46
$\underline{D}_l$	102.64	98.52	12.82	107.62	100.43	6.61	105.62	108.63	97.70	97.51	104.21	100.19	109.58	5.63	98.35	107.36	5.74	97.21	108.01	6.55
$\underline{X}_l$	0.02	0.21	3.09	0.06	0.06	0.09	6.48	0.26	0.02	0.02	0.02	0.02	0.07	0.21	0.02	0.99	1.99	13.90	109.52	1.26

Table 16 Parameters of the Melitz-Pareto Model

	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ρ_l	0.70	0.68	0.75	0.88	0.77	0.86	0.78	0.86	0.87	0.82	0.86	0.85	0.85	0.85	0.86	0.86	0.84	0.86	0.85
σ_l	3.38	3.08	4.02	8.43	4.31	7.40	4.65	7.12	7.91	5.71	7.01	6.54	6.68	6.85	6.93	7.07	6.43	6.98	6.48
b_l	0.46	2.86	0.18	0.15	0.00	2.80	0.35	0.49	0.20	16.00	0.18	0.83	0.93	0.43	0.30	0.29	0.60	0.57	0.24
k_l	1.18	0.85	1.05	0.91	0.42	0.70	0.78	0.89	0.95	0.60	1.08	1.02	1.02	1.04	1.04	1.06	0.94	1.08	0.96
ζ_l	0.50	0.41	0.35	0.12	0.13	0.11	0.21	0.15	0.14	0.13	0.18	0.19	0.18	0.18	0.18	0.17	0.17	0.18	0.18
χ_l	2.40	1.79	1.37	0.25	0.05	0.19	0.72	0.34	0.28	0.20	0.51	0.64	0.62	0.60	0.59	0.58	0.57	0.63	0.60
ψ_l	3.67	2.91	2.33	0.28	0.12	0.02	0.96	0.06	0.06	0.00	0.56	0.54	0.49	0.48	0.47	0.45	0.45	0.50	0.47
$\underline{D}_l$	98.84	132.79	12.40	103.20	8.47	12.19	97.87	97.92	98.77	10.34	97.06	100.62	104.16	98.26	99.44	97.70	98.11	105.22	99.33
$\underline{X}_l$	0.95	1109.50	1.00	7.71	489.53	36.12	0.02	1.42	0.11	2.04	0.06	0.39	1.10	0.86	2.15	0.54	0.54	0.64	3.10
C_l	11.00	6.01	3.93	1.29	1.05	1.21	2.05	1.40	1.32	1.22	1.67	1.90	1.86	1.83	1.81	1.78	1.78	1.87	1.81
C_l^*	39.10	18.39	10.24	1.32	1.13	1.02	2.62	1.07	1.06	1.00	1.76	1.71	1.64	1.61	1.60	1.57	1.56	1.65	1.60
f_l	29.24	43.07	3.08	12.24	1.96	1.65	21.06	13.76	12.48	1.81	13.84	15.40	15.60	14.34	14.36	13.82	15.26	15.08	15.34
κ_l	0.28	359.84	0.25	0.91	113.51	4.88	0.00	0.20	0.01	0.36	0.01	0.06	0.16	0.13	0.31	0.08	0.08	0.09	0.48
M_l	780.52	9.06	9834.40	11526538.17	194206429523.96	0.01	1310.81	816.87	530279.46	0.00	472912.98	90.26	48.28	4067.30	38877.92	55563.81	432.41	970.47	82304.56
M_l^*	10009.28	140.62	156300.79	14010036.91	340842898547.67	0.00	4199.51	125.92	107684.02	0.00	624336.30	50.62	23.36	1973.51	18893.83	26473.73	205.14	476.59	40226.16
$\underline{\theta}_l$	0.42	3.63	0.11	0.21	0.00	3.17	0.49	0.71	0.29	18.86	0.24	1.02	1.15	0.53	0.37	0.35	0.76	0.69	0.29
$\underline{\theta}_{Xl}$	0.02	2.70	0.02	0.14	0.00	4.73	0.04	0.48	0.14	18.52	0.07	0.41	0.58	0.27	0.22	0.17	0.33	0.33	0.18
ς_l	35.66	1.29	6.22	1.41	0.64	0.75	7.71	1.41	2.06	1.01	3.92	2.51	1.98	2.04	1.73	2.17	2.16	2.20	1.62
F_l	-87.68	-699.26	-11.64	-11.24	-68.43	-5.48	-20.66	-11.79	-10.15	-2.26	-12.41	-15.48	-15.75	-14.39	-14.57	-13.60	-15.00	-15.11	-15.80

	26	27	28	29	30	31	32	33	34	35	36	37	39	40	41	42	43	44	45	46
ρ_l	0.85	0.85	0.84	0.87	0.86	0.87	0.86	0.85	0.86	0.87	0.86	0.87	0.88	0.86	0.85	0.85	0.86	0.84	0.83	0.81
σ_l	6.73	6.63	6.43	7.82	7.36	7.87	7.21	6.88	7.05	7.67	7.18	7.56	8.08	7.28	6.63	6.71	7.38	6.42	5.92	5.29
b_l	0.23	0.86	0.30	0.23	0.50	1.08	0.41	0.24	0.57	0.33	0.39	0.65	0.12	0.39	0.86	0.35	2.19	8.41	0.83	31.63
k_l	0.92	0.90	0.87	1.11	1.06	1.04	0.87	0.86	1.00	1.05	0.93	0.94	1.01	0.92	0.84	0.85	0.94	0.80	0.72	0.63
ζ_l	0.16	0.16	0.16	0.16	0.17	0.15	0.14	0.15	0.17	0.16	0.15	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.15	0.15
χ_l	0.40	0.43	0.43	0.44	0.45	0.30	0.21	0.26	0.44	0.51	0.48	0.44	0.43	0.47	0.49	0.49	0.48	0.47	0.47	0.47
ψ_l	0.59	0.60	0.61	0.62	0.65	0.54	0.46	0.50	0.58	0.46	0.36	0.31	0.30	0.33	0.35	0.35	0.35	0.34	0.34	0.34
$\underline{D}_l$	102.64	98.52	12.82	107.62	100.43	6.61	105.62	108.63	97.70	97.51	104.21	100.19	109.58	5.63	98.35	107.36	5.74	97.21	108.01	6.55
$\underline{X}_l$	0.02	0.21	3.09	0.06	0.06	0.09	6.48	0.26	0.02	0.02	0.02	0.02	0.07	0.21	0.02	0.99	1.99	13.90	109.52	1.26
C_l	1.49	1.54	1.54	1.56	1.57	1.35	1.23	1.29	1.54	1.66	1.62	1.55	1.54	1.60	1.63	1.62	1.62	1.60	1.59	1.60
C_l^*	1.81	1.83	1.84	1.86	1.92	1.72	1.58	1.66	1.78	1.58	1.43	1.36	1.35	1.39	1.42	1.42	1.42	1.40	1.40	1.41
f_l	15.25	14.87	1.99	13.76	13.65	0.84	14.66	15.78	13.86	12.71	14.51	13.26	13.57	0.77	14.83	16.00	0.78	15.14	18.25	1.24
κ_l	0.00	0.03	0.48	0.01	0.01	0.01	0.90	0.04	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.15	0.27	2.17	18.51	0.24
M_l	48411.85	35.03	10649.75	341376.33	1259.61	4.38	1112.41	23750.11	418.28	42541.18	8604.15	358.51	52128937.21	9605.28	63.71	10248.63	0.17	0.00	62.19	0.00
M_l^*	166874.95	102.64	31973.76	1011718.06	4177.00	21.46	6447.38	128942.69	983.94	30225.94	3714.50	142.36	20855887.76	3631.06	25.57	4197.66	0.07	0.00	25.88	0.00
$\underline{\theta}_l$	0.34	1.20	0.29	0.31	0.67	1.06	0.68	0.40	0.79	0.40	0.49	0.82	0.16	0.31	1.08	0.45	1.73	10.84	1.12	23.22
$\underline{\theta}_{Xl}$	0.06	0.33	0.18	0.09	0.17	0.45	0.33	0.11	0.17	0.12	0.14	0.26	0.06	0.21	0.28	0.23	1.69	8.93	1.34	19.41
ς_l	4.73	3.17	1.50	3.97	4.13	2.42	1.89	3.09	4.67	3.58	3.15	2.96	2.50	1.40	3.06	1.76	1.02	1.17	0.88	1.12
F_l	-12.87	-13.15	-3.31	-12.02	-12.01	-1.04	-12.23	-12.14	-12.01	-12.19	-13.77	-12.41	-12.44	-1.19	-14.34	-15.46	-1.55	-16.91	-32.47	-2.15

Note: Industry 10 is dropped as it has no exporters for some period, which is inconsistent with the Melitz model. The results are calculated from Table 8, Table 14.