Online Appendix for
"Exports and Credit Constraints under Incomplete Information: Theory and Evidence from China"

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Appendix

A.1 The Loan Schedules

The bank's profit maximization problem is to choose $M_d(x), M_e^d(x), M_e^e(x), I_d(x)$ and $I_e(x)$ to maximize its profit:

$$\max_{M,I}\int_{\underline{x}_d}^{\underline{x}_e}(I_d(x)-i\tau_d M_d(x))f(x)\,dx+\int_{\underline{x}_e}^{\infty}\left(I_e(x)-i\tau_d M_e^d(x)-i\tau_e M_e^e(x)\right)f(x)\,dx \tag{1}$$

$$\begin{aligned}
&s.t.\ \left[\Phi_d\left(x,M_d(x)\right)-1\right]\frac{M_d'(x)}{\delta}=I_d'(x)\ \text{ if } x\in[\underline{x}_d,\underline{x}_e),\\
&\left[\Phi_e^d\left(x,M_e^d(x)\right)-1\right]\frac{M_e^{d\prime}(x)}{\delta}+\left[\Phi_e^e\left(x,M_e^e(x)\right)-1\right]\frac{M_e^{e\prime}(x)}{\delta}=I_e'(x)\ \text{and}\\
&\Phi_e^d\left(x,M_e^d(x)\right)=\Phi_e^e\left(x,M_e^e(x)\right),\ \text{ if } x\in[\underline{x}_e,\infty),
\end{aligned}$$

where $f(x)$ is the probability density function of firms' productivity distribution.

The constraints to the bank's problem involve these control variables as well as their derivatives, $M_e^{d\prime}(x)$ and $M_d'(x)$. Incorporating constraints in the control variables and their derivatives is relatively straightforward using the Euler-Lagrange equation of the calculus of variations (Chiang, 2000, p. 137). We simplify the notation by denoting $\Phi_d\left(x,M_d(x)\right)$ as Φ_d, $\Phi_e^d\left(x,M_e^d(x)\right)$ as Φ_e^d and $\Phi_e^e\left(x,M_e^e(x)\right)$ as Φ_e^e. We define the Lagrangian function using the integrand of the bank's objective and the incentive-compatibility constraint, for $x\in[\underline{x}_d,\underline{x}_e]$ as:

$$\pounds=\left(I_d(x)-i\tau_d M_d(x)\right)f(x)+\lambda(x)\left(\left(\Phi_d-1\right)M_d'(x)/\delta-I_d'(x)\right). \tag{2}$$

Likewise, the Lagrangian function is defined for exporting firms, $x\in[\underline{x}_e,\infty)$, as,

$$\begin{aligned}
\pounds&=\left(I_e(x)-i\tau_d M_e^d(x)-i\tau_e M_e^e(x)\right)f(x)+\lambda(x)\left(\left(\Phi_e^d-1\right)M_e'(x)/\delta-I_e'(x)\right), \qquad (3)\\
&=\left(I_e(x)-i\tau_d M_e^d(x)-i\tau_e\left(\frac{\eta_e}{\eta_d}\left(M_e^d(x)-C_d\delta\right)+C_e\delta\right)\right)f(x)\\
&+\lambda(x)\left(\left(\Phi_e^d-1\right)\frac{M_e^{d\prime}(x)}{\delta\eta_d}-I_e'(x)\right),
\end{aligned}$$

where the second equality is obtained by substituting in $\frac{M_e^e(x)/\delta-C_e}{M_e^d(x)/\delta-C_d}=\frac{\eta_e}{\eta_d}$.

According to the Euler-Lagrange equation, the solution to the bank's profit maximization problem must satisfy the conditions $\frac{\partial \pounds}{\partial I} - \frac{d}{dx}\frac{\partial \pounds}{\partial I'} = 0$ and $\frac{\partial \pounds}{\partial M} - \frac{d}{dx}\frac{\partial \pounds}{\partial M'} = 0$. For x$\in [\underline{x}_d, \underline{x}_e]$ these conditions are:

$$\begin{aligned} f\left(x\right) + \lambda'\left(x\right) &= 0, \qquad (4) \\ i\tau_d f\left(x\right) - \lambda\left(x\right)\frac{\partial \Phi_d}{\partial M_d}\frac{M_d'(x)}{\delta} + \left(\Phi_d - 1\right)\frac{\lambda'\left(x\right)}{\delta} + \frac{\lambda\left(x\right)}{\delta}\frac{d\Phi_d}{dx} &= 0. \end{aligned}$$

Since $\Phi_d = \Phi_d\left(x, M_d(x)\right)$ then $\frac{d\Phi_d}{dx} = \frac{\partial \Phi_d}{\partial x} + \frac{\partial \Phi_d}{\partial M_d}M_d'(x)$, and it follows that the second equation is simplified as,

$$i\tau_d f\left(x\right) + \left(\Phi_d - 1\right)\frac{\lambda'\left(x\right)}{\delta} + \frac{\lambda\left(x\right)}{\delta}\frac{\partial \Phi_d}{\partial x} = 0. \qquad (5)$$

Using a similar simplification, for $x \in [\underline{x}_e, \infty)$ we obtain the conditions:

$$f\left(x\right) + \lambda'\left(x\right) = 0, \qquad (6)$$

$$\left(i\tau_d + i\tau_e\frac{\eta_e}{\eta_d}\right) f\left(x\right) + \left(\Phi_e^d - 1\right)\frac{\lambda'\left(x\right)}{\delta\eta_d} + \frac{\lambda\left(x\right)}{\delta\eta_d}\frac{\partial \Phi_e^d}{\partial x} = 0. \qquad (7)$$

We impose a transversality condition on the bank's problem such that $\lambda\left(\infty\right) = 0$. Then the optimal condition for exporting firms (6) indicates that $\lambda\left(x\right) = \lambda\left(\underline{x}_e\right) - \int_{\underline{x}_e}^{x} f\left(x\right)dx = \lambda\left(\underline{x}_e\right) - \left(F\left(x\right) - F\left(\underline{x}_e\right)\right)$, where $F\left(x\right)$ is the cumulative density function of $f(x)$. Combined with the transversality condition, it readily follows that $\lambda\left(\underline{x}_e\right) = 1 - F\left(\underline{x}_e\right)$ and consequently $\lambda\left(x\right) = 1 - F\left(x\right)$ for $x \in [\underline{x}_e, \infty)$. Using $\lambda\left(\underline{x}_e\right) = 1 - F\left(\underline{x}_e\right)$ and the optimality condition for domestic firms (4), we also obtain $\lambda\left(x\right) = 1 - F\left(x\right)$ for $x \in [\underline{x}_d, \underline{x}_e]$.

Given Pareto distribution of productivity, substituting this solution for $\lambda\left(x\right)$ into (5) and (7), and noticing that $\partial\Phi_d/\partial x = \left(\frac{\sigma-1}{\sigma}\right)\Phi_d/x$ and $\partial\Phi_e^d/\partial x = \left(\frac{\sigma-1}{\sigma}\right)\Phi_e^d/x$, it follows that the solution for the credit constraints is

$$\begin{aligned} \Phi_d\left(x, M_d(x)\right) = \overline{\Phi}_d &\equiv \left(1 + i\delta\tau_d\right)\left(1 - \frac{\sigma - 1}{\sigma\theta}\right)^{-1}, \qquad (8) \\ \Phi_e^d\left(x, M_e^d(x)\right) = \Phi_e^e\left(x, M_e^e(x)\right) = \overline{\Phi}_e &\equiv \left[1 + i\delta\left(\tau_d\eta_d + \tau_e\eta_e\right)\right]\left(1 - \frac{\sigma - 1}{\sigma\theta}\right)^{-1}. \end{aligned}$$

Substituting the full expressions for $\Phi_d\left(x, M_d(x)\right)$ or $\Phi_e^d\left(x, M_e^d(x)\right)$ and $\Phi_e^e\left(x, M_e^e(x)\right)$ into the above conditions, we obtain the loan schedules for domestic firms and exporters as:

$$
\begin{aligned}
\frac{M_d(x)}{\delta} &= \left(\frac{\sigma-1}{\sigma}\left(\frac{x}{w}P\right)^{\frac{\sigma-1}{\sigma}} Y^{\frac{1}{\sigma}}\right)^{\sigma} \overline{\Phi}_d^{-\sigma} + C_d, \\
\frac{M_e^d(x)}{\delta} &= \left(\frac{\sigma-1}{\sigma}\left(\frac{x}{w}P\right)^{\frac{\sigma-1}{\sigma}} Y^{\frac{1}{\sigma}}\right)^{\sigma} \overline{\Phi}_e^{-\sigma} + C_d, \\
\frac{M_e^e(x)}{\delta} &= \left(\frac{\sigma-1}{\sigma}\left(\frac{x}{w}P^*\right)^{\frac{\sigma-1}{\sigma}} Y^{*\frac{1}{\sigma}}\right)^{\sigma} \overline{\Phi}_e^{-\sigma} + C_e.
\end{aligned} \tag{9}
$$

A.2 The Cutoff Productivity Levels and the Interest Payment Schedules

Using the solutions for the domestic credit constraints $\overline{\Phi}_d$ together with the incentive-compatibility condition

$$
\left[\Phi_d\left(x, M_d(x)\right) - 1\right] \frac{M_d'(x)}{\delta} = I_d'\left(x\right), \tag{10}
$$

we can re-write the interest payments as:

$$
I_d(x) = I_d(\underline{x}_d) + \left(\overline{\Phi}_d - 1\right)\left(M_d(x) - M_d(\underline{x}_d)\right)/\delta. \tag{11}
$$

A similar expression can be obtained for $I_e(x)$. Substituting these into the bank's profit maximization problem, it becomes,

$$
\begin{aligned}
&\max_{\underline{x}_d, \underline{x}_e} \int_{\underline{x}_d}^{\underline{x}_e} \left[I_d(\underline{x}_d) + [\overline{\Phi}_d - 1]\left(M_d(x) - M_d(\underline{x}_d)\right)/\delta - i\tau_d M_d\left(x\right)\right] f\left(x\right) dx \\
&+ \int_{\underline{x}_e}^{\infty} \left[I_e(\underline{x}_e) + [\overline{\Phi}_e - 1]\left(M_e(x) - M_e(\underline{x}_e)\right)/\delta - i\tau_d M_e^d\left(x\right) - i\tau_e M_e^e\left(x\right)\right] f\left(x\right) dx.
\end{aligned} \tag{12}
$$

Solving this maximization problem requires taking first order derivative respect to $\underline{x}_d$ and $\underline{x}_e$. In order to do this, we shall first show some properties of the interest payments for marginal firms, $I_d(\underline{x}_d)$ and $I_e(\underline{x}_e)$. The domestic firm's profit is,

$$
\pi_d(x, x) = \frac{\sigma}{\sigma-1}\left(M_d(x)/\delta - C_d\right)\overline{\Phi}_d - \left(M_d(x) + I_d(x)\right) - (1-\delta)\frac{M_d(x)}{\delta}. \tag{13}
$$

The first term, the revenue, is given by the product of total variable cost, $\left(M_d(x)/\delta - C_d\right)$ and the ratio of marginal revenue to marginal cost, $\frac{\sigma}{\sigma-1}\overline{\Phi}_d$. Since $\pi_d(x, x)$ is an increasing function in x, it follows that the zero-cutoff-profit condition for the domestic producer is:

$$I_d(\underline{x}_d) = \frac{\overline{\Phi}_d \sigma}{\sigma - 1}\left(M_d(\underline{x}_d)/\delta - C_d\right) - M_d(\underline{x}_d) - (1-\delta)\,\frac{M_d(\underline{x}_d)}{\delta}. \tag{14}$$

For the exporter, a similar argument shows that profits are:

$$\pi_e(x,x) = \frac{\overline{\Phi}_e \sigma}{\sigma - 1}\left(M_e(x)/\delta - C_d - C_e\right) - \left(M_e(x) + I_e(x)\right) - (1-\delta)\,\frac{M_e(x)}{\delta}. \tag{15}$$

The zero-cutoff-profit condition for the exporter is $\pi_e(\underline{x}_e,\underline{x}_e) = \pi_d(\underline{x}_e,\underline{x}_e)$. By using (13) and (15) evaluated at $x = \underline{x}_e$, we obtain,

$$\begin{aligned} I_e(\underline{x}_e) = {} & \frac{\sigma\overline{\Phi}_e}{\sigma-1}\left(M_e(\underline{x}_e)/\delta - C_d - C_e\right) - M_e(\underline{x}_e) \\ & - \frac{\sigma\overline{\Phi}_d}{\sigma-1}\left(M_d(\underline{x}_e)/\delta - C_d\right) + I_d(\underline{x}_d) + \left(\overline{\Phi}_d - 1 + \delta\right)\frac{M_d(\underline{x}_e)}{\delta} \\ & - \left(\overline{\Phi}_d - 1\right)\frac{M_d(\underline{x}_d)}{\delta} - \frac{(1-\delta)}{\delta}\left(M_e(\underline{x}_e) - M_d(\underline{x}_e)\right) \end{aligned} \tag{16}$$

The two equations (14) and (16) imply that the bank can freely choose the cutoff productivity, $\underline{x}_d$ and $\underline{x}_e$, independently. Once the bank selects the the cutoff productivities, it can then set the associated interest payments for the cutoff firms according to (14) and (16). But from the latter equation, the interest payments $I_e(\underline{x}_e)$ will depend on the value of $\underline{x}_d$, which appears on the right.

The first-order condition of (12) with respect to $\underline{x}_d$ is, taking into account that (16) includes terms related to $\underline{x}_d$, is

$$\int\limits_{\underline{x}_d}^{\infty}\left(\frac{dI_d(\underline{x}_d)}{d\underline{x}_d} - \left(\overline{\Phi}_d - 1\right)\frac{dM_d(\underline{x}_d)}{d\underline{x}_d}\frac{1}{\delta}\right) f(x)\,dx = \left[I_d(\underline{x}_d) - i\tau_d M_d(\underline{x}_d)\right] f(\underline{x}_d). \tag{17}$$

Notice that:

$$\int\limits_{\underline{x}_d}^{\infty}\left(\frac{dI_d(\underline{x}_d)}{d\underline{x}_d} - \left[\overline{\Phi}_d - 1\right]\frac{dM_d(\underline{x}_d)}{d\underline{x}_d}\frac{1}{\delta}\right) f(x)\,dx = \overline{\Phi}_d\left(M_d(\underline{x}_d)/\delta - C_d\right)\frac{f(\underline{x}_d)}{\theta},$$

where the equality holds since $\frac{dI_d(\underline{x}_d)}{d\underline{x}_d} = \left(\frac{\sigma}{\sigma-1}\overline{\Phi}_d - 1\right)\frac{1}{\delta}\frac{dM_d(\underline{x}_d)}{d\underline{x}_d}$ from (14), $\frac{1-F(\underline{x}_d)}{\underline{x}_d f(\underline{x}_d)} = \frac{1}{\theta}$ under Pareto distribution and $\frac{dM_d(\underline{x}_d)}{d\underline{x}_d} = \frac{\sigma-1}{\underline{x}_d}\left(M_d(\underline{x}_d)/\delta - C_d\right)\delta$ from the loan schedule solution (9). Also notice from (14) that:

$$\begin{aligned}&\left[I_d(\underline{x}_d) - i\tau_d M_d\left(\underline{x}_d\right)\right] f\left(\underline{x}_d\right)\\ &= \left[\frac{\sigma\overline{\Phi}_d}{\sigma-1}\left(M_d(\underline{x}_d)/\delta - C_d\right) - \left(1+i\tau_d\right) M_d(\underline{x}_d) - (1-\delta)\,\frac{M_d(\underline{x}_d)}{\delta}\right] f\left(\underline{x}_d\right).\end{aligned}$$

The first-order condition with respect to $\underline{x}_d$ is then solved as,

$$M_d(\underline{x}_d)/\delta - C_d = (\sigma-1)\,C_d. \tag{18}$$

We then have the loan for the cutoff producer as,

$$M_d(\underline{x}_d)/\delta = \sigma C_d, \tag{19}$$

The amount σC_d appearing in (19) is identical to the total costs of the credit-unconstrained production for the cutoff producer in Melitz (2003). Despite this, the cutoff productivity $\underline{x}_d$ differs from that in Melitz (2003), because the domestic firm faces a credit constraint and therefore produces *less* than otherwise. It follows that σC_d finances the costs of a firm with productivity *above* the cutoff productivity in Melitz (2003).[1] Substituting this loan for the cutoff producer into (14), we can obtain the interest payment for the cutoff producer and the interest payment schedule for firms with x$\in[\underline{x}_d, \underline{x}_e]$ as

$$I_d(x) = \left(\overline{\Phi}_d - 1\right)\frac{M_d(x)}{\delta}. \tag{20}$$

The first-order condition with respect to $\underline{x}_e$ is slightly more complicated:

$$\begin{aligned}&\int_{\underline{x}_e}^{\infty}\left(\frac{dI_e(\underline{x}_e)}{d\underline{x}_e} - [\overline{\Phi}_e - 1]\frac{1}{\delta}\frac{dM_e(\underline{x}_e)}{d\underline{x}_e}\right) f\left(x\right) dx\\ &= \left(\left(I_e(\underline{x}_e) - i\tau_d M_e^d\left(\underline{x}_e\right) - i\tau_e M_e^e\left(\underline{x}_e\right)\right) - \left(I_d(\underline{x}_e) - i\tau_d M_d\left(\underline{x}_e\right)\right)\right) f\left(\underline{x}_e\right).\end{aligned} \tag{21}$$

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[1] That productivity is obtained by combining (19) with the loan schedules in (9) as: $\underline{x}_d = w\left(\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{(\sigma-1)C_d}{YP^{\sigma-1}}\right)^{\frac{1}{\sigma}}\overline{\Phi}_d\right)^{\frac{\sigma}{\sigma-1}}$. Our finding that $\overline{\Phi}_d > 1$ means that this cutoff productivity exceeds that in Melitz (2003), which is obtained when $\overline{\Phi}_d = 1$.

Similar to the solution for $\underline{x}_d$, we notice that,

$$\begin{aligned}
&\int_{\underline{x}_e}^{\infty} \left(\frac{dI_e(\underline{x}_e)}{d\underline{x}_e} - [\overline{\Phi}_e - 1] \frac{dM_e(\underline{x}_e)}{d\underline{x}_e} \frac{1}{\delta} \right) f(x)\, dx \\
&= \left(\frac{\overline{\Phi}_e}{\theta} \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right) - \frac{\overline{\Phi}_d}{\theta} \left(M_d(\underline{x}_e)/\delta - C_d \right) \right) f(\underline{x}_e) \\
&= \left(\frac{\overline{\Phi}_e}{\theta} - \frac{\overline{\Phi}_d}{\theta} \left(\frac{\overline{\Phi}_d}{\overline{\Phi}_e} \right)^{-\sigma} \eta_d \right) \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right) f(\underline{x}_e)
\end{aligned}$$

where the first equality holds since,

$$\frac{dI_e(\underline{x}_e)}{d\underline{x}_e} = \left(\frac{\sigma \overline{\Phi}_e}{\sigma - 1} - 1 \right) \frac{1}{\delta} \frac{dM_e(\underline{x}_e)}{d\underline{x}_e} - \frac{\overline{\Phi}_d}{(\sigma - 1)\,\delta} \frac{dM_d(\underline{x}_e)}{d\underline{x}_e},$$

and $\frac{dM_e(\underline{x}_e)}{d\underline{x}_e} = \frac{(\sigma-1)}{\underline{x}_e} \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right) \delta$. The second equality holds since

$$\frac{M_d(\underline{x}_e)/\delta - C_d}{M_e^d(\underline{x}_e)/\delta - C_d} = \left(\frac{\overline{\Phi}_d}{\overline{\Phi}_e^d} \right)^{-\sigma},$$

due to (9), and $\left(M_e^d(\underline{x}_e)/\delta - C_d \right) = \eta_d \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right)$ due to

$$\frac{M_e^e(x)/\delta - C_e}{M_e^d(x)/\delta - C_d} = \frac{\eta_e}{\eta_d}. \tag{22}$$

The right hand side of (21) can be rewritten as, ignoring $f(\underline{x}_e)$,

$$\begin{aligned}
&\left(I_e(\underline{x}_e) - i\tau_d M_e^d(\underline{x}_e) - i\tau_e M_e^e(\underline{x}_e) \right) - \left(I_d(\underline{x}_e) - i\tau_d M_d(\underline{x}_e) \right) \\
&= \frac{\sigma \overline{\Phi}_e}{\sigma - 1} \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right) - (1 + i\tau_d) M_e^d(\underline{x}_e) - (1 + i\tau_e) M_e^e(\underline{x}_e) \\
&- \frac{\sigma \overline{\Phi}_d}{\sigma - 1} \left(M_d(\underline{x}_e)/\delta - C_d \right) + (1 + i\tau_d) M_d(\underline{x}_e) - \frac{(1-\delta)}{\delta} \left(M_e(\underline{x}_e) - M_d(\underline{x}_e) \right) \\
&= \left(\frac{\sigma \overline{\Phi}_e}{\sigma - 1} - 1 - i\delta(\tau_d \eta_d + \tau_e \eta_e) \right) \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right) - (1 + i\delta\tau_e) C_e \\
&- \left(\frac{\sigma \overline{\Phi}_d}{\sigma - 1} - 1 - i\delta\tau_d \right) \left(\frac{\overline{\Phi}_d}{\overline{\Phi}_e} \right)^{-\sigma} \eta_d \left(M_e(\underline{x}_e)/\delta - C_d - C_e \right).
\end{aligned}$$

Putting these together, we can solve out the loans for the cutoff exporter as, using the same trick as in (18),

$$M_e(\underline{x}_e)/\delta = \left(\Delta\, (\sigma - 1) + 1 \right) C_e + C_d, \tag{23}$$

where Δ is defined as:

$$\Delta \equiv \left(\frac{1+i\delta\tau_e}{1+i\delta(\tau_d\eta_d+\tau_e\eta)}\right)\left(1-\left(\frac{1+i\delta(\tau_d\eta_d+\tau_e\eta_e)}{1+i\delta\tau_d}\right)^{\sigma-1}\eta_d\right)^{-1}.$$

To interpret this parameters, consider the case where $i=0$. Then we see that $\Delta = 1/\eta_e$, or the inverse of the relative size of the export market. It can be confirmed that the amount $M_e^e(\underline{x}_e)/\delta$ given by (23) is then precisely equal to the export costs of production for the cutoff exporter in the Melitz (2003) model. But for the same reason as above, the cutoff productivity is higher in our setting since firms are credit constrained.[2] Substituting the solution of the loan for the cutoff exporter into (16), and with rather extensive simplification, we can solve for the interest payment for the cutoff exporter as

$$I_e(\underline{x}_e) = \left(\overline{\Phi}_e - 1\right)\frac{M_e(\underline{x}_e)}{\delta} + i\Theta. \tag{24}$$

The second term $i\Theta$ is derived by

$$\begin{aligned}
i\Theta &= I_e(\underline{x}_e) - [\overline{\Phi}_e - 1]M_e(\underline{x}_e)/\delta,\\
&= \overline{\Phi}_e C_e\left(\left(1-\left(\frac{\overline{\Phi}_e}{\overline{\Phi}_d}\right)^{\sigma-1}\eta_d\right)\Delta - 1\right) - \left(\overline{\Phi}_e - \overline{\Phi}_d\right)C_d,\\
&= \frac{i\delta\left(\tau_e-\tau_d\right)}{\left(1-\frac{\sigma-1}{\sigma\theta}\right)}\left(\eta_d C_e - \eta_e C_d\right),
\end{aligned}$$

where the first equality follows by substituting in the interest payment by the cutoff exporter (16), the interest payment by domestic firms (20) and the loan for the cutoff exporter, and the second equality holds by substituting in Δ.

A.3 The Augmented Olley-Pakes (1996) TFP Estimates

By assuming that the expectation of future productivity shocks x_{jt+1}, x_{jt+2}, ... relies on its contemporaneous value, the firm j's investment $\tilde{I}_{jt}$ (not to be confused with interest payments) is

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[2] Explicitly the cutoff exporter productivity is solved as, $\underline{x}_e = w\left(\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{\Delta(\sigma-1)C_e}{YP^{\sigma-1}+Y^*P^{*\sigma-1}}\right)^{\frac{1}{\sigma}}\overline{\Phi}_e\right)^{\frac{\sigma}{\sigma-1}}$. Since $\overline{\Phi}_e > 1$ and that Δ is increasing in i under our maintained assumption that $\tau_e > \tau_d$, this cutoff productivity exceeds that in Melitz (2003), which is obtained when $\Delta = 1/\eta_e$ and $\overline{\Phi}_e = 1$.

modeled as an increasing function of both current productivity x_{jt} and log capital, $\ln K_{jt}$. Following previous work such as Amiti and Konings (2007) and Keller and Yeaple (2009), the Olley–Pakes approach is extended by adding the firm's export decision and a WTO indicator as two extra arguments of the investment function $\tilde{I}_{jt} = h_1(x_{jt}, \ln K_{jt}, X_{jt}, WTO_t)$ where X_{jt} is the export indicator to measure whether firm j exports in year t, and WTO_t is an indicator that equals one if the WTO agreement has occurred after 2001 and zero before that. Therefore, inverting the investment function with respect to its first argument we obtain:[3]

$$TFP2_{jt} \equiv x_{jt} = h_1^{-1}(\tilde{I}_{jt}, \ln K_{jt}, X_{jt}, WTO_t). \tag{25}$$

Given the production function

$$\ln Y_{jt} = \gamma_k \ln K_{jt} + \gamma_l \ln L_{jt} + x_{jt} + \varepsilon_{jt}, \tag{26}$$

and defining the function $h_2(\cdot)$ as $\gamma_k \ln K_{jt} + h_1^{-1}(\tilde{I}_{jt}, \ln K_{jt}, X_{jt}, WTO_t)$, the estimation of the labor coefficient γ_l is obtained as:

$$\ln Y_{jt} = \gamma_l \ln L_{jt} + h_2(\tilde{I}_{jt}, \ln K_{jt}, X_{jt}, WTO_t) + \varepsilon_{jt}. \tag{27}$$

The second step is to obtain an unbiased estimated coefficient of γ_k. Olley-Pakes use the following specification:

$$\ln Y_{jt} - \hat{\gamma}_l \ln L_{jt} = \gamma_k \ln K_{jt} + E(x_{jt}|x_{jt-1}, pr_{j,t}) + [x_{jt} - E(x_{jt}|x_{jt-1}, pr_{j,t})] + \varepsilon_{jt}, \tag{28}$$

where the estimated value of the labor coefficient is used on the left. The expectation of productivity appearing in (28) is modeled as a polynomial function of lagged productivity, which can be obtained as $(h_{2j,t-1} - \gamma_k \ln K_{j,t-1})$, and also the predicted probability of the firm's survival into the year t, $pr_{j,t}$, based on year $t-1$ information. The predicted probability is obtained from Probit estimation.[4]

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[3] Olley and Pakes (1996) show that the investment demand function is monotonically increasing in the productivity shock x_{jt}, by making some mild assumptions about the firm's production technology.

[4] Note that here the non-linear least squares approach is adopted to estimate (28) since it requires the estimated coefficients of the log-capital in the first and second term to be identical (Pavcnik, 2002).

The term $[x_{jt} - E(x_{jt}|x_{jt-1}, pr_{j,t})]$ is the productivity shock for surviving firms, but does not affect the investment or exit choice so it is treated as an error.

We estimate TFP1, shown by (26) in the main text, and TFP2, shown by 25), using our dataset of Chinese firms. Given that the measure of TFP requires real terms of firm's inputs (labor and capital) and output, we adopt different price deflators for inputs and outputs. Data on input deflators and output deflators are directly from Brandt, Van Biesebroeck and Zhang (2012) in which the output deflators are constructed using "reference price" information from *China's Statistical Yearbooks* whereas input deflators are constructed based on output deflators and China's national input-output table (2002).[5] In addition, it is essential to construct the real investment variable when using the Olley-Pakes (1996) approach. As usual, we adopt the perpetual inventory method to investigate the law of motion for real capital and real investment. Rather than assigning an arbitrary number for the depreciation ratio, we use the exact firm's real depreciation provided by the Chinese firm-level data set.[6]

Since different sectors use different technology in production, we estimate the input elasticities γ_l and γ_k by industry (Pavcnik, 2002). Columns (1)-(2) of Table A1 reports the estimated elasticity coefficient of labor and capital for the thirty China's manufacturing sectors coded from 13 to 42, according to China's adjusted industrial classifications (GB/T4754), which were adopted in 2002.[7] The sum of the estimated elasticities for labor and capital is close to constant returns-to-scales for most of the sectors.[8] We report the sectoral average of TFP1 and TFP2 in columns (3) and (4), and the variance of TFP1 and TFP2 across firms within an industry in columns (5) and (6),

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[5] Such data can be accessed via http://www.econ.kuleuven.be/public/N07057/CHINA/appendix/.

[6] Admittedly, using accounting measure of depreciation may cause some errors if China has special depreciation allowance for particular sectors or classes of firms. However, this is not prevalent in China given that common accounting rules for depreciation by manufacturing firms were adopted in 1993. Nevertheless, by experimenting with different depreciation rates (4%, 5%, or 10%), we find no significant differences for our TFP measures.

[7] Firm data before 2002 were clustered into industrial data by adopting the old industrial classification. We concord such data so that they are consistent with data after 2002.

[8] Note that the tobacco industry instead exhibits increasing return-to-scale.

respectively.

Using 2-digit sector definitions shown in Table A1, in Figure A1 we graph firm's revenue against their interest payments, averaged over time and firms within each 2-digit sector.

A.4 Solving for the Second Moment of the Export Share

In the Heckman procedure, we let X_{jt} denote a 0-1 variable whose value depends on the latent variable V_{jt},

$$X_{jt} = \begin{cases} 1 \text{ if } V_{jt} = \alpha' Z_{jt} + \mu_{jt} > 0 \\ 0 \text{ if } V_{jt} = \alpha' Z_{jt} + \mu_{jt} \leq 0 \end{cases} \tag{29}$$

where μ_{jt} is normally distributed and Z_{jt} denotes a vector of variables, including: a constant, the firm's anticipated productivity x_{jt}, and all other exogenous variables. We hence perform the Probit model as our first-step Heckman equation:

$$\Pr(X_{jt} = 1 \,|Z_{jt}) = \Pr(V_{jt} > 0) = \Phi[\alpha' Z_{jt}].$$

In the second-step Heckman equation, the export share is modeled as:

$$\eta_{jt} = X_{jt} \cdot y_{jt}, \quad \text{with } y_{jt} = \beta' Z_{jt} + u_{jt}, \tag{30}$$

where we have chosen $\beta_i = 0$ for the coefficient corresponding to anticipated productivity x_{jt}. We assume that u_{jt} is normally distributed.

Letting $\hat{\eta}_{it}$ denote the predicted export share obtained from the Tobit estimates, then that fitted value is used to estimate:

$$\hat{\eta}_{it} \simeq E(\eta_{jt}|Z_{jt}) = \Pr(X_{jt} = 0 \,|Z_{jt}) \cdot 0 + \Pr(X_{jt} = 1 \,|Z_{jt}) \cdot E(y_{jt}|Z_{jt}, X_{jt} = 1). \tag{31}$$

If we square the estimated share, we obtain:

$$\hat{\eta}_{it}^2 \simeq [E(\eta_{jt}|Z_{jt})]^2 = [\Pr(X_{jt} = 1 \,|Z_{jt})]^2 \cdot [E(y_{jt}|Z_{jt}, X_{jt} = 1)]^2. \tag{32}$$

Notice that squaring the fitted share introduces the square of the probability, $[\Pr(X_{jt} = 1\,|Z_{jt}\,)]^2$, into the above formula.

In contrast, we would like to obtain the fitted value $\widehat{\eta^2_{it}}$ which is an estimate of:

$$\widehat{\eta^2_{it}} \simeq E(\eta^2_{jt}|Z_{jt}) = \Pr(X_{jt} = 0\,|Z_{jt}\,)\cdot 0 + \Pr(X_{jt} = 1\,|Z_{jt}\,)\cdot E(y^2_{jt}|Z_{jt}, X_{jt} = 1). \tag{33}$$

In order to move from (32) to (33), we proceed as follows:

$$\begin{aligned}\widehat{\eta^2_{it}} &\simeq E(\eta^2_{jt}|Z_{jt}) = \Pr(X_{jt} = 1\,|Z_{jt}\,)\cdot E(y^2_{jt}|Z_{jt}, X_{jt} = 1)\\ &= \frac{[\Pr(X_{jt} = 1\,|Z_{jt}\,)]^2[E(y_{jt}|Z_{jt}, X_{jt} = 1)]^2}{[\Pr(X_{jt} = 1\,|Z_{jt}\,)]}\cdot\frac{E(y^2_{jt}|Z_{jt}, X_{jt} = 1)}{[E(y_{jt}|Z_{jt}, X_{jt} = 1)]^2}\\ &\simeq \frac{\hat{\eta}^2_{it}}{[\Pr(X_{jt} = 1\,|Z_{jt}\,)]}\cdot\left[1 + \frac{Var(y_{jt}|Z_{jt}, X_{jt} = 1)}{[E(y_{jt}|Z_{jt}, X_{jt} = 1)]^2}\right],\end{aligned} \tag{34}$$

where we use the fact that $Var(y_{jt}|Z_{jt}, X_{jt} = 1) = E(y^2_{jt}|Z_{jt}, X_{jt} = 1) - [E(y_{jt}|Z_{jt}, X_{jt} = 1)]^2$. We see that starting with the square of the fitted value, $\hat{\eta}^2_{it}$, there are two steps to get to the fitted value of the squared export share: (i) we first need to divide by the Probit probability $[\Pr(X_{jt} = 1\,|Z_{jt}\,)] < 1$, and (ii) then multiply by the last term in brackets in (34). The Probit probability is readily obtained from the first step of the estimation. To estimate the term in brackets, we repace the expectations conditional on Z_{jt} and $X_{jt} = 1$ with the expectations conditional on only exporting, $X_{jt} = 1$. That is, we estimate the ratio appearing within the brackets by $Var(y_{jt}|X_{jt} = 1)/[E(y_{jt}|X_{jt} = 1)]^2$, which is simply the variance of the export share divided by its mean squared, where both are computed conditional on exporting.

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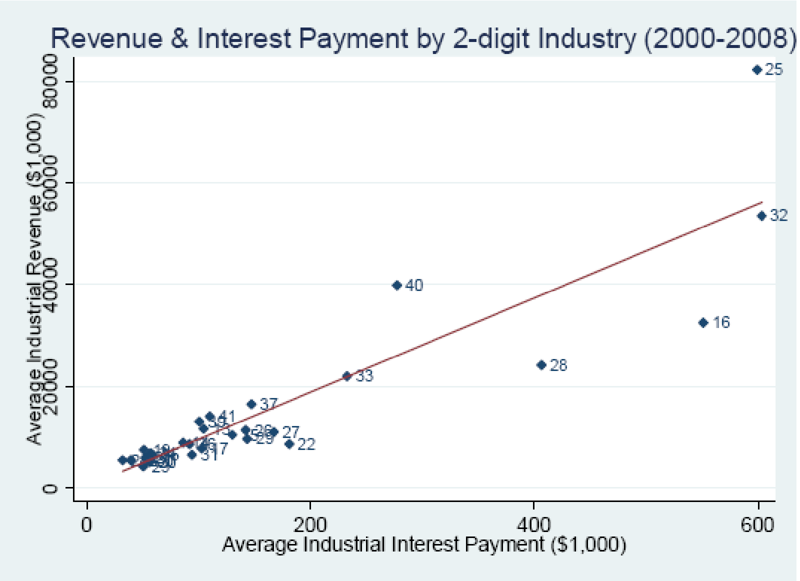
Table A1: Total Factor Productivity of Chinese Plants (2000-2008)

Adjusted Chinese Industrial Classfication (2-digit)	Labor coeff.	Capital coeff.	Mean		Variance	
			TFP1	TFP2	TFP1	TFP2
Processing of Foods (13)	0.438	0.467	3.215	3.370	1.496	1.288
Manufacturing of Foods (14)	0.438	0.388	3.585	3.467	1.308	2.205
Manufacture of Beverages (15)	0.466	0.509	2.460	2.276	1.381	1.639
Manufacture of Tobacco (16)	0.441	0.668	0.645	2.080	1.241	4.768
Manufacture of Textile (17)	0.433	0.290	4.328	4.487	1.084	0.567
Manufacture of Apparel, Footwear & Caps (18)	0.498	0.355	3.408	3.275	1.023	0.379
Manufacture of Leather, Fur, & Feather (19)	0.475	0.421	3.160	3.346	1.191	0.567
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm & Straw Products (20)	0.436	0.546	2.598	2.518	1.323	2.019
Manufacture of Furniture (21)	0.559	0.375	3.147	2.958	1.225	0.773
Manufacture of Paper & Paper Products (22)	0.472	0.359	3.564	3.417	1.167	0.525
Printing, Reproduction of Recording Media (23)	0.417	0.340	3.869	3.615	1.033	0.708
Manufacture of Articles For Culture, Education & Sport Activities (24)	0.493	0.245	4.257	4.366	0.963	0.727
Processing of Petroleum, Coking, &Fuel (25)	0.234	0.568	2.901	3.150	1.593	3.301
Manufacture of Raw Chemical Materials (26)	0.307	0.446	3.823	3.675	1.258	1.019
Manufacture of Medicines (27)	0.414	0.333	4.291	4.556	1.249	0.467
Manufacture of Chemical Fibers (28)	0.383	0.488	2.998	3.563	1.437	1.848
Manufacture of Rubber (29)	0.377	0.368	3.995	3.798	1.106	1.227
Manufacture of Plastics (30)	0.414	0.478	2.993	2.819	1.218	1.445
Manufacture of Non-metallic Mineral goods (31)	0.311	0.468	3.521	3.577	1.260	1.498
Smelting & Pressing of Ferrous Metals (32)	0.452	0.453	3.214	3.371	1.544	1.599
Smelting & Pressing of Non-ferrous Metals (33)	0.367	0.332	4.400	4.834	1.299	0.806
Manufacture of Metal Products (34)	0.413	0.389	3.774	3.865	1.228	0.916
Manufacture of General Purpose Machinery (35)	0.401	0.387	3.849	3.573	1.158	0.860
Manufacture of Special Purpose Machinery (36)	0.402	0.421	3.575	3.462	1.181	1.217
Manufacture of Transport Equipment (37)	0.460	0.447	3.107	3.000	1.237	0.840
Electrical Machinery & Equipment (39)	0.451	0.403	3.723	3.301	1.209	0.671
Computers & Other Electronic Equipment (40)	0.491	0.263	4.526	4.812	1.258	1.110
Manufacture of Measuring Instruments & Machinery for Cultural Activity & Office Work (41)	0.407	0.450	3.451	3.665	1.332	2.061
Manufacture of Artwork (42)	0.462	0.398	3.364	3.793	1.180	1.005

Notes: We do not report standard errors for each coefficient to save space though available upon request. The logarithm of firm productivity for Chinese non-SOEs firms (TFP1 and TFP2) is estimated by industry by the augmented Olley-Pakes approach introduced in the text. Coefficients of labor and capital are calculated at the sectoral average whereas TFP1 and TFP2 is measured at firm-level using firm-level value-added, capital, and labor, respectively. The last four columns report the sectoral mean and variance of log TFP1 and TFP2, respectively.



Notes: The average industrial revenue and interest payment are calculated over years 2000-2008 by 2-digit level Chinese manufacturing sectors. Table 2 provides the detailed description for numbers of each sector.

Figure A1: Chinese Firm's Revenue and Interest Payment by 2-digit Industry