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Online Appendix to "Grasp the Large, Let Go of the Small: The Transformation of the State Sector in China"

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A.1 **Equilibrium Allocation** Dene

$$\begin{aligned} \omega_i &\equiv \left(\frac{r}{MRPK_i}\right)^{\alpha}\left(\frac{\overline{MRPL}}{MRPL_i}\right)^{1-\alpha} \\ &= \frac{\left(\sum_i \left(1+\tau_i^L\right) L_i\right)^{1-\alpha}}{\left(1+\tau_i^K\right)^{\alpha}\left(1+\tau_i^L\right)^{1-\alpha}}, \end{aligned} \tag{19}$$

where we use the facts that $(1-\alpha)(1-\eta) Y = \sum_i \left(1+\tau_i^L\right) wL_i$ and $MRPK_i = \left(1+\tau_i^K\right)(r+\delta)$ from (3) and (4). Differentiating ω_j with respect to A_i yields

$$\frac{\partial \omega_j}{\partial A_i} = (1-\alpha)\frac{\sum_{j'}\left(1+\tau_{j'}^L\right)\frac{\partial L_{j'}}{\partial A_i}}{\sum_i \left(1+\tau_i^L\right) L_i}\omega_j.$$

Substituting it back into (13) gives

$$\frac{\partial Y}{\partial A_i} = \frac{1}{1-\alpha}\frac{Y}{\Omega}\left(\underbrace{\frac{Y_i}{Y}\frac{\Omega}{A_i}}_{\text{the direct effect}} + \underbrace{(1-\alpha)\,\Omega\frac{\sum_{j'}\left(1+\tau_{j'}^L\right)\frac{\partial L_{j'}}{\partial A_i}}{\sum_i\left(1+\tau_i^L\right)L_i}}_{\text{the reallocation effect}}\right) \tag{20}$$

The equilibrium labor allocation implies

$$\frac{\partial L_i}{\partial A_i} = \frac{1-\eta}{\eta}\frac{L_i}{A_i}\left(1-L_i\right),$$

and

$$\frac{\partial L_j}{\partial A_i} = -\frac{1-\eta}{\eta}\frac{L_i}{A_i}L_j.$$

Substituting the above two equations back into the reallocation effect in (20) yields (13).

Differentiating ω_j with respect to τ_i^L and following a similar procedure, we establish (15).

8.2 Closed Economy

The analysis in Section 2 assumes that the supply of capital is perfectly elastic. This implies that if some firms have preferential access to capital, this has no effect on the cost of capital faced by firms that do not have preferential access. We now consider the effect of adopting the other polar assumption that the aggregate supply of capital is fixed. With this assumption, (11) is now given by

$$Y = N^{\frac{\eta}{1-\eta}} A^* \left(\sum \omega_i^{\frac{1-\eta}{\eta}} Y_i^*\right)^{\frac{\eta}{1-\eta}} K^{\alpha},$$

where A^* and Y_i^* are the same as those defined in the text, but

$$\begin{aligned}\omega_i &\equiv \left(\frac{\overline{MPRK}}{MRPK_i}\right)^\alpha \left(\frac{\overline{MRPL}}{MRPL_i}\right)^{1-\alpha} \\ &= \frac{\left(\sum_i \left(1+\tau_i^K\right) \frac{K_i}{K}\right)^\alpha \left(\sum_i \left(1+\tau_i^L\right) L_i\right)^{(1-\alpha)}}{\left(1+\tau_i^K\right)^\alpha \left(1+\tau_i^L\right)^{1-\alpha}}.\end{aligned}$$

(20) should be rewritten as

$$\frac{\partial Y}{\partial A_i} = \frac{Y}{\Omega}\left(\underbrace{\frac{Y_i}{Y}\frac{\Omega}{A_i}}_{\text{the technological effect}} \underbrace{+\alpha\Omega\frac{\sum_{j'}\left(1+\tau_{j'}^K\right)\frac{1}{K}\frac{\partial K_{j'}}{\partial A_i}}{\sum_i\left(1+\tau_i^K\right)\frac{K_i}{K}} + (1-\alpha)\,\Omega\frac{\sum_{j'}\left(1+\tau_{j'}^L\right)\frac{\partial L_{j'}}{\partial A_i}}{\sum_i\left(1+\tau_i^L\right)L_i}}_{\text{the reallocation effect}}\right)$$

The equilibrium capital allocation implies that

$$\frac{\partial K_i}{\partial A_i} = \frac{1-\eta}{\eta}\frac{K_i}{A_i}\left(1-\frac{K_i}{K}\right),$$

and

$$\frac{\partial K_j}{\partial A_i} = -\frac{1-\eta}{\eta}\frac{K_i}{A_i}\frac{K_j}{K}.$$

Substituting back into $\frac{\partial Y}{\partial A_i}$ leads to

$$\frac{\partial Y}{\partial A_i} = \frac{1}{\eta\left(1-\eta\right)}\frac{1}{A_i}\left(K_i\left(MPRK_i-(1-\eta)\,\overline{MRPK}\right)+L_i\left(MRPL_i-(1-\eta)\,\overline{MRPL}\right)\right).$$

The reallocation effect is now determined by both labor and capital misallocation. Here, if TFP grows in firms that also have preferential access to capital, then this increases the cost of capital facing firms that do not have preferential access. And if the gap in the marginal product of capital is large enough, the effect of worse capital allocation potentially outweighs the effect of higher TFP on aggregate output.

8.3 State-Owned Firms Registered as Private Firms

Table A.1 reports the distribution by registration status of the firms that we identify as state-owned firms but that are not registered as state-owned. Most of these firms are registered as limited-liability corporations, sharing-holding corporations, or foreign firms. In 2007, for example, the three groups accounted for 94 percent of the state-owned firms registered as private firms.

Table A.1: The Registration Status Distribution of the State-Owned Firms Registered as Private Firms (%)

	limited-liability corporations	share-holding corporations limited	foreign-invested enterprises	others
1998	21.5	18.6	35.4	24.5
2007	60.4	15.9	17.7	6.0

Note: "Others" include collectively-owned enterprises, cooperative enterprises, joint ownership enterprises (excluding firms with state ownership) and domestic private enterprises.

8.4 Exit Rates

We first estimate the annual exit rates using firm numbers from 1991 through 1995. According to the China Statistical Yearbook 1996, there were 104.7 and 118.0 thousand industrial state-owned firms (by registration status) in 1991 and 1995, respectively. The same source reports 7.97 and 7.22 million private industrial firms in 1991 and 1995, respectively.[32] We assume no state ownership transformation before 1995. Therefore, all firms that were state (private) in 1991 and survived through 1995 remained to be state (private) in 1995. To back out the exit rates from firm number, we need to know the number of entries from 1992 through 1995. Our 1995 NBS data suggest that 4.7, 5.3, 4.2 and 3.2 thousand state-owned firms (again, by registration status) were established in 1992, 1993, 1994 and 1995, respectively, and survived in 1995. The number for private firms is 644.3, 865.2, 681,1 and 625.9 thousand, respectively.[33] Finally, assuming that firms are subject to the ownership-specific exit rate, denoted by $x(J)$, we can back out $x(J)$ by the following equation:

$$n_{1995}(J) = n_{1991}(J) \cdot (1 - x(J))^4 + e_{1992}(J) \cdot (1 - x(J))^3 + \cdots + e_{1995}(J),$$

where $n_t(J)$ and $e_t(J)$ stand for the number of firms and entries of ownership type J at period t, respectively.

The exit rates for the 1998-2007 period are obtained using the firm data. Specifically, we first compute the survival rate as the ratio of state (private) firms surviving from 1998 to 2007 as percentage of the total number of state (private) firms in 1998. Here, state-owned firms and private firms are classified by their 1998 ownership. We then back out $x(J)$ by

$$x(J) = 1 - s(J)^{\frac{1}{9}},$$

where $s(J)$ denotes the survival rate of ownership type J.

[32] These numbers are based on the annual surveys conducted by NBS before 1998, which are not comparable to the surveys after 1998 due to very different sampling schemes.

[33] Notice that our 1995 NBS sample has substantially fewer firms than implied by the China Statistical Yearbook 1996. Specifically, our 1995 NBS data cover 87.9 thousand state-owned firms and 422.4 thousand private firms. The number of entries reported in the text is adjusted by the sample sizes of state and private firms, to make them consistent with firm numbers in the China Statistical Yearbook.

8.5 Labor Share

We first calculate the labor share for private firms in each two-digit industry in the 1998-2007 balanced panel. We exclude state-owned firms, as their labor shares might be contaminated by labor distortions (see Section 4). Labor compensation includes (i) wage and benefits that are available from 1998 through 2007; and (ii) pension, health insurance, public housing funds and unemployment insurance, introduced after 2004. Then, we calculate the labor share averaged across industries, using industry total value added as the weight. It is well known that labor share is unusually low in the NBS sample: The average labor share is merely 26.2 percent in the period 2004-2007. An important reason is the discrepancy between the reported value added and the reported income (Qian and Zhu, 2012). We will not take a stand on whether value added is overreported or income is underreported. Instead, following Qian and Zhu (2012), we use the following formula to calculate labor share:

$$\text{labor share} = \frac{\text{labor income}}{\text{labor income} + \text{total profit} + \text{depreciation} + \text{value added tax}}.$$

The denominator on the right-hand side is the reported income, which should be identical to the reported value added in theory. Here, the assumption is that the ratio of the reported labor income to the actual labor income is identical to the ratio between the reported value added and income. The adjusted average labor share increases to 30.0 percent. However, this is still below the level implied by the national income data. So, we blow up the adjusted labor share in each industry proportionally, so that the average labor share equals 50 percent. Finally, α is set to match the adjusted industry labor share:

$$\alpha = 1 - \frac{\text{labor share in industry } s}{1 - \eta}.$$

8.6 Strategic and Pillar Industries

The "strategic" industries are defense, electric power and grid, petroleum and petrochemical, telecommunication, coal, civil aviation and shipping. The "pillar" industries are equipment manufacturing, auto, information technology, construction, iron and steel, non-ferrous metals, chemicals, and surveying and design. There are a total of nine two-digit "strategic" or "pillar" industries in the industrial sector: Mining and Washing of Coal (code 06, Coal henceforth), Extraction of Petroleum and Natural Gas (code 07, Petroleum Extraction henceforth), Processing of Petroleum, Coking, Processing of Nuclear Fuel (code 25, Petroleum Processing henceforth) and Production and Supply of Electric Power and Heat Power (code 44, Power henceforth) are categorized into strategic industries. Pillar industries include Manufacture of Raw Chemical

Materials and Chemical Products (code 26, Chemicals henceforth), Smelting and Pressing of Ferrous Metals (code 32, Ferrous Metals henceforth), Smelting and Pressing of Non-Ferrous Metals (code 33, Non-Ferrous Metals henceforth), Manufacture of Transport Equipment (code 37, Auto henceforth), and Manufacture of Communication Equipment, Computers and Other Electronic Equipment (code 40, Information Technology henceforth).

8.7 Efficiency Units of Labor

The 2004 economic census reports the number of a firm's employees in five education categories: (i) postgraduate; (ii) university; (iii) two- or three-year college; (iv) high school; and (v) middle school and below. To construct efficiency units of labor, we assign the years of schooling of 19, 16, 14, 12 and six to the five categories, respectively, and assume a rate of return to schooling of ten percent (see, e.g., Zhang et al., 2005). Since the educational composition is available only for 2004, we have to make two more assumptions. First, the firms that are in the 2004 sample have constant educational composition over time. Second, for the firms that are not in the 2004 sample, their efficiency units of labor as a ratio of their employment follow the 2004 industry-ownership average.

8.8 Heterogeneous Markups

We assume a two-level CES aggregate of Q_i,

$$Q = \left(\sum_{i}^{N(P)} Q_i^{1-\eta} + Q\left(S\right)^{1-\eta} \right)^{\frac{1}{1-\eta}}, \tag{21}$$

where

$$Q\left(S\right) = \left(\sum_{i}^{N(S)} Q_i^{(1-\theta)(1-\eta)} \right)^{\frac{1}{(1-\theta)(1-\eta)}}, \quad \theta \in [0, 1) .$$

Here, $Q\left(S\right)$ is a CES aggregate of goods produced by state-owned firms; $N\left(S\right)$ and $N\left(P\right)$ denote the set of state-owned and private firms, respectively. When $\theta = 0$, (21) will collapse to (1).

The value added for the goods produced by private firms remains the same as before. Y-L and Y-K ratios are also identical to those in (3) and (4).

The new CES aggregate changes the demand curve for the goods produced by state-owned firms:

$$Q_i = \frac{Y\left(S\right)}{P\left(S\right)} \left(\frac{P_i}{P\left(S\right)} \right)^{-\frac{1}{1-(1-\theta)(1-\eta)}}. \tag{22}$$

Here, $Y(S) \equiv \sum_i^{N(S)} Y_i$ denotes the total value added of state-owned firms, and $P(S) \equiv \left(\sum_i^{N(S)} P_i^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}}\right)^{\frac{1-(1-\theta)(1-\eta)}{(1-\theta)(1-\eta)}}$ represents a price index of the goods of state-owned firms. (22) shows that $\theta > 0$ reduces the price elasticity. The corresponding markups are $1/\left((1-\theta)(1-\eta)\right)$, higher than $1/(1-\eta)$ when $\theta = 0$. The value added of state-owned firms should be rewritten as

$$Y_i = \left(\frac{Y(S)}{Y}\right)^{\theta} Y^{1-(1-\theta)(1-\eta)} \left(A_i K_i^{\alpha} L_i^{1-\alpha}\right)^{(1-\theta)(1-\eta)}, \tag{23}$$

where $i \in N(S)$.[34] Profit maximization leads to

$$(1-\alpha)(1-\theta)(1-\eta)\frac{Y_i}{L_i} = \left(1+\tau_i^L\right) w, \tag{24}$$

$$\alpha(1-\theta)(1-\eta)\frac{Y_i}{K_i} = \left(1+\tau_i^K\right)(r+\delta), \tag{25}$$

for $i \in N(S)$. (24) and (25), together with (3) and (4), imply that state-owned firms would have higher labor and capital productivity than private firms if there were no distortions. Intuitively, higher markups reduce the production scale and increase the average revenue products.

TFP of private firms still follows the standard formula:

$$A_i = \left(\frac{Y_i}{Y}\right)^{\frac{\eta}{1-\eta}} \left(\frac{Y_i}{K_i}\right)^{\alpha} \left(\frac{Y_i}{L_i}\right)^{1-\alpha}, \tag{26}$$

while the formula needs to be revised for state-owned firms:

$$A_i = \left(\frac{Y_i}{Y(S)}\right)^{\frac{\theta}{(1-\theta)(1-\eta)}} \left(\frac{Y_i}{Y}\right)^{\frac{\eta}{1-\eta}} \left(\frac{Y_i}{K_i}\right)^{\alpha} \left(\frac{Y_i}{L_i}\right)^{1-\alpha}, \tag{27}$$

where $Y(S)$ is the total value added of state-owned firms in industry s. The first term on the right-hand side, $(Y_i/Y(S))^{\frac{\theta}{(1-\theta)(1-\eta)}}$, is the new element. Since $Y_i \leq Y(S)$, using (26) would bias the TFP upwards for state-owned firms. The bias becomes more severe for smaller firms. The reason is as follows. When $\theta = 0$, (26) isolates TFP from revenues. When $\theta > 0$, (26) is misspecified and unable to perfectly separate price and quantity. Moreover, thanks to the sleeper demand curve faced by state-owned firms, the firms with lower output would raise their prices more than they would in the setting with $\theta = 0$. The bias goes up accordingly.

Although higher markups bias the TFP level of state-owned firms upwards, the effect on their TFP growth turns out to be ambiguous. (27) shows that (26) would be unbiased if Y_i and $Y(S)$ grew in proportion. Otherwise, TFP growth of state-owned firms would be biased upwards (downwards) if its output grew faster (slower) than the total output of the state sector.

[34] We use the fact that $P_s(S) = (Y_s/Y_s(S))^{\frac{\eta}{1-\eta}}$.

By contrast, (26) unambiguously biases the TFP growth of privatized state-owned firms downwards because of the markups change by privatization. For privatized state-owned firms, we should back out their TFP before and after privatization by (27) and (26), respectively. Using (26) throughout would bias the initial TFP of privatized state-owned firms upwards and underestimate their TFP growth.

The markups change due to privatization provides a way of calibrating θ. Applying the method developed by De Loecker and Warzynski (2012) to the same NBS dataset, Du et al. (2013) find that markups fall by 1.5 percent after privatization. This would imply that $\theta = 0.015$. To consider a more dramatic markups difference in the robustness check, we set $\theta = 0.029$ to increase state-owned firms' markups by three percent, doubling the estimates in Du et al. (2013). This implies markups of 1.2 for state-owned firms.

As expected, taking into account higher markups lowers the calibrated value of TFP. The average is 0.32 for the initial relative TFP of surviving state-owned firms backed out by (27), a quarter less than the average of 0.43 for that backed out by the original formula (26). As explained above, the difference comes from $(Y_i/Y(S))^{\frac{\theta}{(1-\theta)(1-\eta)}}$ in (27).[35] We find a similar magnitude of adjustment for the relative TFP of surviving state-owned firms in 2007 and that of surviving privatized state-owned firms in 1998.

The difference becomes less distinguishable when it comes to the relative TFP growth of surviving state-owned firms. In fact, (27) slightly increases the average relative TFP growth of the state-owned firms from an annualized rate of 3.0 to 3.4 percent.[36] Yet, adjusting markups has a large effect on the TFP growth of the privatized state-owned firms. The average relative TFP growth increases from 3.5 to 6.9 percent.

MRPK and MRPL are given by

$$1 + \tau_i^K \propto \Theta_i \frac{Y_i}{K_i}, \quad 1 + \tau_i^L \propto \Theta_i \frac{Y_i}{L_i}, \tag{28}$$

where $\Theta_i = 1$ for private firms and for privatized state-owned firms after privatization, and $\Theta_i = 1-\theta$ for state-owned firms and for privatized state-owned firms before privatization. When $\theta > 0$, the original formula would underestimate the capital and labor distortions for state-owned firms. The reason is straightforward: Higher markups increase the average revenue products of state-owned firms. The magnitude of the bias on the distortions seems quantitatively small.

[35] Quantitatively, the average of the median $Y_i/Y(S)$ in each industry is 0.39 percent in 1998, translating into $(Y_i/Y(S))^{\frac{\theta}{(1-\theta)(1-\eta)}}$ of 0.82.

[36] (27) finds lower relative TFP growth for firms with larger initial size, for the reasons discussed above. The difference is quantitatively small, though. For instance, (27) reduces the relative TFP growth of the corporatized SOEs in the top percentile from an annualized rate of 11.4 to 10.7 percent.

The adjustment term in (28), Θ_i, is much closer to one than that in (27). Consequently, the calibrated distortions remain essentially unchanged.