Recasting the Iron Rice Bowl: The Reform of China's State Owned Enterprises

Daniel Berkowitz*, Hong Ma†, and Shuichiro Nishioka‡

March 31, 2015

Abstract

The profitability of China's state owned enterprises (SOEs) sharply increased following the enactment of reforms in the mid-1990s. Rapid growth in profitability could indicate that SOEs restructured; however, it might also indicate that the state used its standard tools including product market protections, input subsidies and financial bailouts for its SOEs that in fact enable SOEs to avoid restructuring (Kornai, 1990; and 1992, Part III). This paper shows that SOE profitability grew for two reasons. First, the elasticity of substitution between capital and labor in 136 3-digit Chinese manufacturing sectors is generally estimated at above unity: thus, as the cost of capital for SOEs fell, the capital-intensity and profitability of SOEs dramatically increased. Second, our estimates show that over time SOEs were under less political pressure to hire excess labor. While the productivity of SOEs improved due to the policy of "grasping" the big ones and "letting go" of the small ones, it still lagged foreign and private firms. Overall, our results indicate that SOE restructuring was limited.

Word count: 9607 words. We have benefitted from discussions with Swati Dhingra, Rob Elliott, James Kung, Miguel León-Ledesma, Chen Lin, Yi Lu, Yue Ma, John Morrow, Veronica Rappoport, Tom Rawski, Zheng Michael Song, Kellee Tsai, Dennis Yang, Xiaodong Zhu and participants at seminars at the University of Hong Kong, Hong Kong University of Science and Technology, London School of Economics, University of Birmingham, University of Pittsburgh, the 2nd InsTED (Institutions, Trade and Economic Development) Workshop, the 5th annual conference on the Chinese Economy at Tsinghua University and the joint AEA/ACES panel at the Boston ASSA meetings. Berkowitz also thanks the School of Economics and Management at Tsinghua University for providing an ideal research environment.

*Department of Economics, University of Pittsburgh, 4711 WW Posvar Hall Pittsburgh PA 15216, Tel: +1(412) 648-7072, Email: dmberk@pitt.edu (corresponding author)

†Department of Economics, Tsinghua University, Beijing, China, 100084, Tel: +86(010) 6279-4388, Email: mahong@sem.tsinghua.edu.cn

‡Department of Economics, West Virginia University, 1601 University Avenue Morgantown WV 26506-0625, Tel: +1(304) 293-7875, Email: shuichiro.nishioka@mail.wvu.edu

1 Introduction

When China had a planned economy, state owned enterprises (SOEs) were pervasive and provided job security and stable wages and were popularly known as the "iron rice bowl." Naughton (1995, p.44) notes that most workers in SOEs "not only stayed in a single enterprise for life: they could often pass their jobs on to their children when they retired." It was legally and practically impossible for SOEs "to fire workers, and quits were almost unknown." SOE managers were expected to produce outputs in order to fulfill planned targets; and, they were also under pressure to sustain the iron rice bowl.

Following the enactment of market reforms in 1978, SOE managers were allowed to sell outputs at market prices and keep a share of the profits once they had fulfilled targets negotiated with their superiors in the bureaucracy.[1] SOE managers were also give some more power to hire and fire workers. Nevertheless, by 1989 labor turnover in SOEs remained very low and only 0.5% of state workers were either fired, quit or were on contacts that were not renewed (Naughton, 1995, p.212).

Several influential studies document that the SOEs were productive and profitable during the 1980s (Groves et al, 1995; Jefferson et al, 1996; Li, 1997). However, by the early 1990s SOEs had become unprofitable and were draining local government budgets. Thus, in 1992 the "iron rice bowl" was criticized in the official press and there were massive layoffs of SOE workers starting in the mid-1990s. The Company Law of July 1994 was designed to improve SOE performance and contained a set of reforms for "corporatizing" SOEs. Following the Fourteenth Party Congress in 1995, large and medium sized SOEs were corporatized, and small SOEs were privatized or shutdown, and this basic strategy of "grasping the big" SOEs and "letting go of the small" ones has subsequently remained in force.[2]

The Chinese Annual Surveys of Industrial Production (ASIP) provides a rich description of SOEs as well as private, foreign and hybrid firms (for herein, denoted hybrids) in the manufacturing sector during 1998-2007. Evidence from the ASIP indicates that there was a massive shakeout where roughly two-thirds of the operating manufacturing SOEs in 1998 were either privatized or shut down as of 2007 and employment in SOEs fell by 62.5% between 1998 and 2007. Using the

[1] This overview of reforms draws on Gordon and Li (1991), Groves et al (1994, 1995), Jefferson et al (1996), Li (1997), Liu and Zhao (2011) and Putterman and Dong (2000).

[2] For an oveview of these reforms, see Chen et al (2006), Deng et al (2011), Fan et al (2011), Hsieh and Song (2015), Kato and Long (2002), Liao et al (2013) and Sun and Tong (2003).

ASIP data, Figure 1 illustrates that SOE profitability[3] rapidly grew from 2.8% to 21.6% during 1998-2007. While aggregate profitability in SOEs lagged all other firms by roughly 13% in 1998, SOE profitability was marginally higher than in all other firms as of 2007.

Figure 1 is also useful for comparing the profitability of SOEs with the subset of SOEs that were in operation throughout 1998-2007 and operated as SOEs for at least one year during 1998-2007. We denote this subset of SOEs the "SOEs-balanced sample." In any year the SOEs-balanced sample excludes SOEs that subsequently exited before 2007, and excludes SOEs that entered after 1998. Thus, reformers might select the SOEs-balanced sample for treatment because on average they were subject to a higher dosage of reform than entire sample of SOEs. Figure 1 illustrates that while the SOEs-balanced sample exhibit higher profitability than the entire sample of SOEs, both SOE groups exhibit a qualitatively similar growth in profitability throughout 1998-2007.

Does the rapid growth in SOE profitability indicate that SOEs restructured? While profitability growth can indicate that SOEs restructured, it could also indicate that the state used its standard tools including product market protections, input subsidies and financial bailouts for SOEs that enables SOEs to avoid restructuring (Kornai, 1990; and 1992, Part III).

In order to evaluate the performance of China's SOEs, this paper develops a theory of SOE profitability and also measures SOE productivity. Regarding profitability, it is often the case that the state in China (and around the world) puts political pressure on its SOEs to pursue non-economic objectives such as hiring excess labor. In this vein, Azmat, Manning, and Van Reenen (2012) build a model in which SOEs have an objective function including profits and the political benefits of excess employment. The Azmat et al model makes predictions about the impact of product market competition and political pressure on SOEs to hire excess labor. We extend this model and find that an SOE's profitability increases when it has more product market power and when it is under less political pressure to hire excess labor.

Another issue related to SOE profitability is that the Chinese state can enable its SOEs to obtain capital goods more easily and cheaply than private firms (see Tsai, 2002; Firth, Lin, Liu and Wong, 2009). There is a well known theoretical link between the cost of capital relative to labor, the elasticity of substitution between capital and labor, and labor's share (see, for example, Karabarbounis and Neiman, 2014). We explore the theoretical link between cost of capital, the

[3] Profitability is profits as a share of value added. Throughout this paper profitability and profit shares are synonymous.

elasticity of substitution and profitability for SOEs that are under political pressure to hire excess labor. When the cost of capital relative to labor is falling, then an SOE will increase the capital intensity of its production processes. We show that this increase in capital intensity causes an SOE's profitability to increase (decrease) when the elasticity of substitution between capital and labor exceeds (is less than) unity, and has no impact when the elasticity of substitution is unity.

Using this theoretical framework to guide our empirical work, we find that the profitability of SOEs rapidly grew for two reasons. First, we estimate the elasticity of substitution between capital and labor in 136 3-digit manufacturing sectors and find that in general it is greater than unity: thus, as cost of capital for SOEs fell, SOEs dramatically increased their capital-intensity. Second, we estimate the political pressures for SOEs to hire excess labor and find that it fell from 54.8% of a unit of profits in 1998 to 26.9% in 2007. These results indicate that SOEs' access to increasingly cheap capital inputs and the declining political pressure on SOEs to hire excess labor drove the rapid growth in SOE profitability.

In order to directly measure whether SOEs restructured, we measure firm-level productivity using a standard method.[4] Syverson (2011, p.327) argues that productivity is a critical indicator of a firm's long term prospects in a market economy simply because "higher productivity producers are more likely to survive than their less efficient industry competitors." (p.327) We find the productivity of most SOEs was lower than the productivity of firms in the private and foreign sectors. An exception to this finding is SOEs that have strong connections to the federal government were as productive as foreign and private firms. However, these centrally connected SOEs accounted for only 19% of output 1998 and 26% of output as of 2007. Thus, our results indicate that SOE restructuring overall was limited.

Our finding that SOEs were profitable because they had access to cheap capital and not because they were productive is related to the findings in Song, Storesletten and Zilibotti (2011) that China's SOEs are relatively unproductive but survive because they have preferential access to cheap loans from state banks for financing investment. Our finding that political pressure on SOEs to hire excess labor fell during 1998-2007 is related to the finding in Hsieh and Song (2015) that labor distortions between private firms and corporatized firms had largely disappeared by 2007. Moreover, similar to

[4] In our theory, profitability is not a function of productivity because profits (the numerator of profitability) and value added (the denominator of profitability) are both homogenous of degreee one in productivity. Thus, we must consider productively separately from profitability.

Hsieh and Song (2015), we find the policy of "grasping the big" SOEs while "letting go of the small" SOEs boosted the productivity of SOEs. However, in contrast to Hsieh and Song (2015) we find that in general the productivity of SOEs that operated throughout 1998-2007 lagged productivity levels in private and foreign firms.

Our paper contributes to the debate about the effectiveness of corporatizing SOEs without privatizing them. Shleifer and Vishny (1994) warn that this policy is problematic for two reasons: first, politicians, who have political objectives that differ from economic efficiency, control the SOEs and, secondly, insiders can use the SOEs for their own personal gain. Our finding that SOEs did not exhibit robust productivity gains is consistent with the Shleifer and Vishny prediction that corporatization without privatization can generate inefficiencies. Qian (1996) warns that the corporatization without privatization might encourage SOE insiders to preserve their rents by choosing diffuse outside investors and weak corporate boards. In fact there is evidence that this is the case. Fan, Morck and Yeung's (2011, p.4-8) survey documents how the Chinese Communist Party has used organizational and financial schemes to keep control over the corporate boards in SOEs. Deng, Morck, Yu and Yeung (2011) argue that Communist Party secretaries can ignore or overrule boards and CEOs. An additional discussion of corporate governance within SOEs is contained in the conclusion.

The rest of this paper is organized as follows. The next section describes the data; section 3 builds a model that make predictions about how political pressure to hire excess labor, product market competition, the elasticity of substitution between capital and labor and capital-intensity determine an SOE's profitability; section 4 discusses how the CES production function used in the profitability model is estimated; section 5 provides an overview of how the profitability model is estimated and assesses its goodness of fit; section 6 reports the productivity growth of SOEs relative to private and foreign firms and section 7 concludes.

2 Overview of Data

We use the data from the Chinese Annual Surveys of Industrial Production (ASIP), which covers all SOEs and all non-state enterprises with total sales exceeding 5 million RMB in the industrial sector (including manufacturing, mining and utilities) during 1998-2007.[5] The analysis is limited to manufacturing firms.[6] We follow Brandt, Van Biesebroeck and Zhang (2012) and use a firm's registration type to determine its ownership which can include: state owned enterprises (SOEs), domestically owned firms (private firms), private foreign firms (foreign firms), and hybrid firms. When the ownership structure is unavailable, we use a firm's major contributor to paid-in capital to determine its ownership type.

In subsequent analysis we also account for SOEs that have exceptionally strong political connections with the central government and may thus behave differently. In 2003, there were 196 SOEs directly supervised by the State-owned Assets Supervision and Administration Commission of the State Council (SASAC) that are denoted "central SOEs." Over time, central SOEs have also gone through mergers and consolidations: and, as of 2014 there were 113 central SOEs.[7] Central SOEs are all big conglomerates and each owns many second-tier and third-tier SOEs.[8] They also have subsidiaries listed in the Shanghai Stock Exchange or in the Shenzhen Stock Exchange, or even listed in the Hong Kong Stock Exchange. Within these central SOEs there are 53 SOEs located at even a higher political position that are denoted "top central SOEs."[9] The chief executives of top central SOEs are often directly appointed by the Central Organization Department of the Chinese Communist Party, and these SOE leaders have the political rank of vice minister.

It is not possible to directly identify top central SOEs in the data set: this is because the ASIP records firms according to legal entity and a top central SOE may own many such legal entities around the country and each of them will have an independent firm code. Thus, we identify a top central SOE as a firm in any year that employs more than 10,000 workers and has gross output volume exceeding one billion RMB, and is registered as an SOE. This is a conservative measure since many third-tier and even second-tier SOEs that are in this group may be excluded. However, this measure is consistent with the fact that top central SOEs are large and have a major impact

[5] As noted by Cai and Liu (2009), this dataset should be reliable because it is designed for computing Chinese GDP. The National Bureau of Statistics of China (NBS) oversees this data and has implemented standard data monitoring procedures and has strict double checking procedures for firms above the 5 million RMB reporting threshold. Moreover, firms do not have clear incentives to misreport their information because such information cannot be used against them by other government agencies such as the tax authorities.

[6] We follow Brandt et al (2012) and use each firm's ID, name, industry, address and other information to track it over time. We do this becuase one sixth of all firms that are observed for more than one year have change their official ID over the sample period.

[7] Those names of these central SOEs can be found on the website: http://www.sasac.gov.cn/

[8] A second-tier SOE is a subsidiary of the subidiary to the parent company. A third-tier SOE is a subsidary of the second-tier SOE.

[9] See U.S. Chamber of Commerce (2012), p.60, footnote 192.

on the local economies.

Table 1 describes ownership transitions of SOEs between the period 1998-2002 and 2003-2007. The top row highlights the importance of net exits during 1998-2002 for the evolution of SOEs between these two periods. Of the 41,778 SOEs in operation in 1998-2002, more than half (24,417) were net exiters. Of the 17,361 SOEs remaining in operation after 1998-2002, one-fifth (3,572) were privatized and 6% (1,033) became either foreign or hybrid firms. Thus, out of the 41,778 SOEs in operation in 1998-2002, about 31% (12,756) were "SOE-continuers." The first column in Table 1 underscores the primary importance of the "SOE-continuers" and the secondary relevance of net entry during 2003-2007 for the evolution of SOEs. Out of the 20,008 SOEs in operation in 2003-2007, 64% (12,756) were "SOE-continuers" and 32.5% (6,483) were net entrants, and only 2.5% were private, foreign and hybrid firms during 1998-2002.

Table 2 contains summary statistics for our sample of firms aggregated by ownership.[10] In this table and in several subsequent tables and figures, for ease of exposition, the hybrid firm category is excluded because they constitute a small share of output, value added and employment. The top panel (Table 2.1) describes the entire data set and shows the overall number of firms expands from 119,190 in 1998 to 270,351 in 2007.[11] Underlying this expansion was an almost eleven-fold increase in the number of private firms and a roughly two-and-a-half fold increase in foreign firms that was offset by a roughly two-thirds decline in the number of SOEs. During this period SOEs became relatively less important than private and foreign firms: the output share of SOEs fell from 37.5% to 16%, while the overall output share of private and foreign firms increased from 36.5% to 79%.

As previously argued, China's SOEs traditionally have been an important source of jobs. It is thus striking that overall employment in SOEs during 1998-2007 fell by 62.5%, while employment within private and foreign firms grew by 635% and almost 200%, respectively. It is also striking that SOEs increased the capital intensity of their production processes more aggressively than private and foreign firms. During 1998-2007, the aggregate capital-labor ratio grew by 48%; however, the 151% growth within SOEs was much more rapid than the 86% growth within private firms and the negligible (3%) growth within foreign firms. While the capital-labor ratio for SOEs in 1998 was

[10] We keep a firm-year observations if all the data for gross output, intermediate inputs, real capital, employees, and labor shares (wage divided by value added) are available. To eliminate outliers, we drop the firms in the bottom and the top 0.25% of the distribution of values for labor shares and capital-labor ratios and in the bottom and the top 0.1% of the distribution of values for intermediate input spending divided by gross output. As a result, we have 1,704,355 observations, which is an unbalanced panel of 457,591 firms over ten years (1998 to 2007).

[11] See Appendix Table A.1 for summary statistics for the top central SOEs and the other SOEs.

0.089 and comparable to the foreign firms (0.099) and higher than private firms (0.048), by 2007 the SOEs' aggregate capital-labor ratio of 0.224 was roughly 2.5 times and 2.2 times higher than in the private and foreign sectors.

There are two other noteworthy patterns for labor and wages. First, the overall real wage in manufacturing grew by 162%, and these gains were most pronounced within SOEs (224.5%), then within private firms (140%) and, lastly, within foreign firms (116%). State-sector real wages in 1998 were close to private-sector real wages and roughly one-third lower than foreign-sector wages. By 2007, state-sector wages were roughly equivalent to foreign-sector wages and almost 50% higher than private-sector wages. Second, labor's share of value added fell by 8 percentage points, and, this change was most pronounced for SOEs (a 14 percentage point decline), and then private firms (a 6.7 percentage point drop) and negligible within the foreign sector. Thus, labor's share within SOEs fell because the declining rate of employment exceeded the increasing rate of wage growth. A potential reason for this sharp decline of employment is that SOEs drastically released labor and replaced it with capital.

Table 2.1 also reports aggregate profits/value added (profitability) and the share of profitable firms by ownership category. During 1998-2007, profitability increased by 11.4 percentage points; and, this gain was most pronounced for SOEs (an 18.9 percentage point increase) and then foreign firms (an 8.7 percentage point increase) and negligible within private firms (a 2.3 percentage point increase). In order to deal with potential selection bias, the bottom panel (Table 2.2) reports the same descriptive statistics for the balanced sample of firms. According to Table 2.2, aggregate profitability in the balanced panel increased by 9.3 percentage points: and, again, this increase was most pronounced within SOEs (14.9 percentage points).

In the next section we develop a theoretical model for understanding whether the observed increase in SOE profit shares is indicative of restructuring. In order to check if the SOEs have restructured, in a subsequent section we derive and analyze the productivity of SOEs.

3 Profitability: Theoretical Considerations

We consider an economy inhabited by firms that are differentiated by sectors, denoted s, and that operate in various time periods, denoted t. A firm i in period t has a sector-specific time-invariant production function that converts augmented labor (N_{it}),[12] capital (K_{it}) and materials (M_{it}) into output (Q_{it}). Firms within a sector are differentiated in each period by its firm-specific productivity. We use a flexible production function that allows for a constant elasticity of substitution between labor and capital and a unitary (Cobb-Douglas) elasticity of substitution between materials and factor inputs:

$$Q_{it} = \omega_{it} \left[a_s (N_{it})^{\frac{\sigma_s - 1}{\sigma_s}} + (1 - a_s) (K_{it})^{\frac{\sigma_s - 1}{\sigma_s}} \right]^{\frac{\alpha_s \sigma_s}{\sigma_s - 1}} (M_{it})^{1-\alpha_s} \tag{1}$$

In this specification, Q_{it} is real output for a firm i at time t[13]; ω_{it} is firm-specific productivity; a_s is the sector-specific weight on labor versus capital in factor inputs ($0 < a_s < 1$)[14]; σ_s is the sector-specific elasticity of substitution between capital and labor ($0 \leq \sigma_s < +\infty$); α_s is the Cobb-Douglas weight between the factor inputs (i.e., labor and capital) and intermediate inputs ($0 < \alpha_s < 1$). The production function exhibits constant returns to scale.[15]

Input markets are competitive and a firm can hire its labor, capital and materials at input prices that are denoted w_{it}, r_{it}, and $\tilde{p}_{it}$, respectively. Product markets are imperfectly competitive and each firm faces an inverse demand function:

$$p_{it} = B_{it}(Q_{it})^{-\frac{1}{\eta_{it}}} \tag{2}$$

where η_{it} denotes the price elasticity of demand: $\eta_{it} \geq 1$. In each period, private firms choose inputs in order to maximize profits, which are denoted Π_{it}:

$$\Pi_{it} = p_{it} Q_{it} - w_{it} N_{it} - r_{it} K_{it} - \tilde{p}_{it} M_{it}.$$

[12] Augmented labor is the product of the head count of employees multiplied by the differences in human capital across China's four regions (the North, South, East and West as described in footnote 25). See Cheng, Morrow, and Tacharoen (2013) for the regional differences in factor markets within China. Human capital is computed each year as the average aggregate wage rate in each region divided by the national aggregate wage. Our empirical findings are similar if we do not make this adjustment.

[13] Basu and Fernald (1995 and 1997) show that the structural parameters estimated from a value-added production function could be biased if firms operate in imperfectly competitive product markets and there are non-constant returns to scale. This paper will document that most Chinese manufacturing firms earn positive profits, which indicates that they operate in imperfectly competitive product markets. This is one of the reasons why we prefer to use an output-based production function.

[14] A value of a_s close to 1 does not indicate that a firm in sector s always has a low capital-labor ratio. For example, equation (7) in this section will show that a firm can be capital-intensive even if a_s is close to one as long as the cost of capital relative to labor is low and the elasticity of substitution between capital and labor greater than unity.

[15] See Appendix 3 for the empirical validation of the constant returns to scale assumption.

SOEs are also under political pressure to hire excess labor even if this entails foregoing profits. To capture this regulatory environment, SOEs have a political benefit for hiring an additional employee equal to $(1 - 1/\phi_t)w_{it}$ where $\phi_t \geq 1$ for SOEs and $\phi_t = 1$ for private, hybrid and foreign firms. Thus, the degree to which the state pressures SOEs to hire excess labor is increasing in ϕ_t. This setup is similar to Azmat et al (2012).[16]

Firms are assumed to choose labor, capital and materials in order to maximize the objective function

$$U_{it} = \Pi_{it} + \left(1 - \frac{1}{\phi_t}\right) w_{it} N_{it} \text{ s.t. } VA_{it} \geq 0 \tag{3}$$

where $VA_{it} \geq 0$ is a financial constraint, i.e., in any period a firm operates when it can generate at least positive value added. We first solve for the case in which the financial constraint is non-binding and subsequently show that it is always non-binding.

The first order conditions for maximizing the objective function in equation (3) with respect to labor is:

$$\phi_t \left(1 - \frac{1}{\eta_{it}}\right) \frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} = \frac{w_{it} N_{it}}{p_{it} Q_{it}}. \tag{4}$$

The first order condition with respect to capital is:

$$\left(1 - \frac{1}{\eta_{it}}\right) \frac{\partial Q_{it}/Q_{it}}{\partial K_{it}/K_{it}} = \frac{r_{it} K_{it}}{p_{it} Q_{it}}. \tag{5}$$

Because there are constant returns to scale in production and α_s is the Cobb-Douglas weight for factor inputs, then $\frac{\partial Q_{it}/Q_{it}}{\partial K_{it}/K_{it}} = \alpha_s - \frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}}$ and it is useful to simplify equation (5) to

$$\left(1 - \frac{1}{\eta_{it}}\right) \left[\alpha_s - \frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}}\right] = \frac{r_{it} K_{it}}{p_{it} Q_{it}}. \tag{6}$$

Combining equations (4) and (5), the firm-level labor-capital ratio can be expressed as a function of the sectoral production function parameters, firm-level costs and the political weight on labor:

[16] There are several conceptual differences between our model and the Azmat et al (2012) model. First, we use an output production function, while Azmat et al (2012) employ a value-added production function. Second, implicit in the production function that Azmat et al (2012) use is the assumption of an elasticity of substitution between capital and labor equal to unity, while our model allows this structural parameter to vary between zero and infinity.

$$\frac{K_{it}}{N_{it}} = \left(\phi_t \frac{r_{it}}{w_{it}} \frac{a_s}{1-a_s}\right)^{-\sigma_s}. \tag{7}$$

Thus, when $0 < \sigma_s$, the capital-labor ratio is decreasing in the political weight on labor (ϕ_t), decreasing in nominal cost of capital (r_{it}), increasing in wage rate (w_{it}), and decreasing in the weight on labor versus capital in factor inputs (a_s).

Many models assume that in well-functioning economies firms face uniform input prices because there is some underlying law of one price.[17] However, this would imply that there is no firm-level variation in capital intensity within a sector. Thus, to be consistent with the observed firm-level heterogeneity in capital intensity, our model allows factor prices to be non-uniform.

Finally, the first order condition for materials is:

$$\left(1 - \frac{1}{\eta_{it}}\right) \frac{\partial Q_{it}/Q_{it}}{\partial M_{it}/M_{it}} = \frac{\tilde{p}_{it} M_{it}}{p_{it} Q_{it}}. \tag{8}$$

Using the first order condition for materials in equation (8) and $(\partial Q_{it}/Q_{it})/(\partial M_{it}/M_{it}) = 1-\alpha_s$, it is straightforward to compute a firm's markup, μ_{it}:[18]

$$\mu_{it} = \frac{1}{1 - \frac{1}{\eta_{it}}} = \frac{p_{it} Q(1-\alpha_s)}{\tilde{p}_{it} M_{it}}. \tag{9}$$

Value added for a firm is its revenues minus materials costs. Thus, using the markup equation (9), value added can be expressed as:

$$VA_{it} = p_{it} Q_{it} - \tilde{p}_{it} M_{it} = p_{it} Q_{it} \left(1 - \frac{1-\alpha_s}{\mu_{it}}\right). \tag{10}$$

Since $1 > 1 - \frac{1-\alpha_s}{\mu_{it}} > 0,$ a firm always generates positive value added when $Q_{it} > 0$. Therefore, the value added constraint in equation (3) is non-binding.

[17] For example, the influential model in Hsieh and Klenow (2009) assumes that capital is allocated efficiently when all firms face uniform factor prices. However, when firms within business groups or SOEs have access to cheaper credits, this creates a distortion and a loss of efficiency for the economy.

[18] De Loecker and Warzynski (2012) obtain the markup by assuming that firms employ labor flexibly. Thus, they use the output elasticity with respect to labor and labor's share to calculate markups. In our model, SOEs are under political pressure to hire labor and this limits their flexibility in labor markets. Thus, we follow the approach in Lu, Tao and Yu (2012) and use intermediate inputs as the flexible production input. However, as we describe in our next section, we can use the control function approach to allow for some distortions in the SOE's input market.

Our goal is to derive an expression for profitability (profit shares of value added). Since $\Pi_{it} = p_{it}Q_{it} - w_{it}N_{it} - r_{it}K_{it} - \tilde{p}_{it}M_{it} = VA_{it} - w_{it}N_{it} - r_{it}K_{it}$, a firm's profit share is

$$\frac{\Pi_{it}}{VA_{it}} = 1 - \left(\frac{w_{it}N_{it}}{VA_{it}} + \frac{r_{it}K_{it}}{VA_{it}} \right). \tag{11}$$

A simple interpretation of equation (11) is that profitability equals one minus the total factor share. Using the first order conditions in equations (4) and (6), the relationship between revenue and value added in equation (10), a firm's labor share is:

$$\frac{w_{it}N_{it}}{VA_{it}} = \frac{\phi_t}{\mu_{it} - 1 + \alpha_s} \left[\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} \right] \tag{12}$$

and a firm's capital share is:

$$\frac{r_{it}K_{it}}{VA_{it}} = \frac{1}{\mu_{it} - 1 + \alpha_s} \left[\alpha_s - \frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} \right]. \tag{13}$$

Combining equations (11), (12) and (13), profitability is

$$\frac{\Pi_{it}}{VA_{it}} = \frac{\mu_{it} - 1}{\mu_{it} - 1 + \alpha_s} - \frac{\phi_t - 1}{\mu_{it} - 1 + \alpha_s} \left[\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} \right] \tag{14}$$

where the output elasticity of labor is

$$\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} = \alpha_s \left[1 + \left(\frac{1 - a_s}{a_s} \right) \left(\frac{K_{it}}{N_{it}} \right)^{\frac{\sigma_s - 1}{\sigma_s}} \right]^{-1}. \tag{15}$$

We use the system of equations (14) and (15) for making predictions about the impact of μ_{it} (markups), ϕ_t (political weight on excess employment) and K_{it}/N_{it} (capital intensity) on profitability. In the Cobb-Douglas case ($\sigma_s = 1$), the output elasticity of labor is constant and capital intensity has no effect on profitability. Thus, in general we study situations where $\sigma_s \neq 1$ and capital intensity (K_{it}/N_{it}) impacts firm-level profitability exclusively through the firm's output elasticity of labor.

When $\phi_t = 1$ and SOE is under no pressure to hire excess labor, the second term on the right hand side of equation (14) vanishes: $\frac{\Pi_{it}}{VA_{it}} = \frac{\mu_{it}-1}{\mu_{it}-1+\alpha_s}$. In this case profitability is increasing in

μ_{it} and is unaffected by K_{it}/N_{it}.

Next, consider the situation where an SOE is under political pressure to hire excess labor: $\phi_t > 1$. By inspection of the second term on the right hand side of equation (14), profitability increases as ϕ_t decreases. The impact of K_{it}/N_{it} on profitability, however, depends on σ_s (the elasticity of substitution between labor and capital). Profitability is increasing in K_{it}/N_{it} when $\sigma_s > 1$ and decreasing in K_{it}/N_{it} when $\sigma_s < 1$. As already noted, when $\sigma_s = 1$, the output elasticity of labor is constant. In the next section we will show that $\sigma_s > 1$ is the empirically relevant case.

Equation (7) indicates that an increase in w_{it} or a decrease in r_{it}, or a decrease in ϕ_t lowers capital intensity (K_{it}/N_{it}) which, in turn, can influence profitability, as described above. Thus, a decrease in the political pressure to hire excess labor (ϕ_t) has a direct positive effect on profitability and also an indirect positive effect through output elasticity of labor on profitability when $\sigma_s > 1$.

Finally, firm-level productivity (ω_{it}) does not enter into our system of equations (14) and (15). This is because profits (the numerator of profitability) and value added (the denominator of profitability) are both homogenous of degree one in productivity. Because productivity is a direct measure of restructuring, we measure and analyze it later in this paper.

4 Estimating Production Functions

Understanding estimating the system of equations (14) and (15) enables us to understand the role that markups, capital intensity and political pressure to hire excess labor play in shaping the profitability of SOEs. If we can derive estimates for the structural parameters in each of 136 3-digit sectoral production functions and use observed firm-level capital-labor ratios, we can estimate the output elasticity of labor for each firm in equation (15). We can then use this estimated output elasticity of labor along with estimates for markups, the political weight on hiring excess labor and parameters from the sectoral production functions to estimate a predicted measure of time-varying firm-level profitability using equation (14).

We do this in two stages. First, in this section the sectoral production function equation (1) is estimated using the general method of moments (GMM) procedure similar to De Loecker and Warzynski (2012). This first stage fully identifies the structural variables for each sectoral production function ($\hat{\sigma}_s$, $\hat{\alpha}_s$, $\hat{a}_s$) and it also enables us to estimate firm-level markups ($\hat{\mu}_{it}$). Once we have obtained the estimates of these structural parameters, in a subsequent section we proceed to estimate the political pressure on SOEs to hire excess labor using a simple expression for labor's share of value added.

Traditional methods of estimating a constant elasticity of substitution (CES) production function include Kmenta (1967) and Chirinko, Fazzari and Meyer (2011). While the approach of Kmenta (1967) uses the polynomial approximation of Taylor's theorem, Chirinko et al (2011) use the first order condition of the CES production function and estimate the long-run elasticity of substitution between labor and capital. However, these influential and traditional methods are not suitable for our purposes. For example, the Kmenta (1967) approach is to approximate the elasticity of substitution around unity; however, this approach becomes increasingly inaccurate as the actual elasticity of substitution between capital and labor diverges from one. The method of Chirinko et al (2011) requires a long and stable (stationary) time series; however, 1998-2007 in China is relatively short period that, as we have documented, has had major structural changes. Moreover, their method is unable to identify all the production parameters that we need to estimate our system of equations (14) and (15).

In this paper, we follow a recent approach proposed by De Loecker and Warzynski (2012)[19] and obtain the production function parameters ($\hat{\sigma}_s$, $\hat{\alpha}_s$, $\hat{a}_s$) for the 136 3-digit sectors and the time-varying firm-level markups ($\hat{\mu}_{it}$) using a GMM estimation procedure.[20] De Loecker and Warzynski (2012) follow the tradition of estimating firm level production functions (i.e., Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg, Caves and Frazer, 2006). These papers concentrate on overcoming the simultaneity bias that can occur when the firm observes productivity shocks (ω_{it}) but the econometrician does not. These productivity shocks are thus problematic because they can shape how a firm optimally chooses its flexible inputs.

The production function in equation (1) is estimated in two stages. In the first stage, the second-order polynomial function of the three inputs is included. Because SOEs might have special access in materials markets, an SOE dummy variable (D_{it}^{SOE}) is included and interacted with the the polynomial function. In this setup, materials are assumed to be the flexible input. The following

[19] See their online appendix for the application of their method to a CES production function.

[20] Similar estimates of the production function parameters and markups are obtained when we use two other procedures: 1) the Translog production function and the Kmenta (1967) approximation with firm-fixed effects, and 2) simple non-linear least squares (NLS) with firm-fixed effects. These estimates are reported in Appendix sections 3.1 and 3.2.

first stage equation is estimated:

$$\ln(Q_{it}) = \Phi_t \left[\ln(N_{it}), \ln(K_{it}), \ln(M_{it}), D_{it}^{SOE}\right] + \epsilon_{it} \tag{16}$$

where the variables Q_{it} and M_{it} are deflated with industry-level output and input deflators from Brandt et al (2012).[21]

After the first stage equation is estimated, we obtain the fitted value of equation (16), $\hat{\Phi}_t$, and compute the corresponding value of productivity for any combination of parameters $\Omega = (\bar{\alpha}_s, \bar{\sigma}_s, \bar{a}_s)$. This enables us to express the log of productivity $\ln(\bar{\omega}_{it}(\Omega))$ as

$$\ln(\bar{\omega}_{it}(\Omega)) = \hat{\Phi}_t - \frac{\bar{\alpha}_s \bar{\sigma}_s}{\bar{\sigma}_s - 1} \ln\left[\bar{a}_s (N_{it})^{\frac{\bar{\sigma}_s - 1}{\bar{\sigma}_s}} + (1 - \bar{a}_s)(K_{it})^{\frac{\bar{\sigma}_s - 1}{\bar{\sigma}_s}}\right] - (1 - \bar{\alpha}_s)\ln(M_{it}). \tag{17}$$

By assuming a non-parametric first order Markov process, we can approximate the productivity process with the third order polynomial:

$$\ln(\bar{\omega}_{it}(\Omega)) = \gamma_0 + \gamma_1 \ln(\bar{\omega}_{i,t-1}(\Omega)) + \gamma_2 \left[\ln(\bar{\omega}_{i,t-1}(\Omega))\right]^2 + \gamma_3 \left[\ln(\bar{\omega}_{i,t-1}(\Omega))\right]^3 + \zeta_{it}(\Omega).$$

From this third order polynomial, we can recover the innovation to productivity, $\zeta_{it}(\Omega)$, for a given set of the parameters. Since the productivity term, $\ln(\bar{\omega}_{it}(\Omega))$, can be correlated with the current choices of flexible inputs, $\ln(N_{it})$ and $\ln(M_{it})$, but it is not correlated with the predetermined variable, $\ln(K_{it})$, the innovation to productivity, $\zeta_{it}(\Omega)$, will not be correlated with $\ln(K_{it})$, $\ln(N_{i,t-1})$,

[21] See Appendix 1 for the development of consistent real capital stock data.

and $\ln(M_{i,t-1})$. Thus, we use the moment condition similar to De Loecker and Warzynski (2012):[22]

$$E\left[\zeta_{it}(\Omega)\begin{pmatrix}\ln(K_{it})\\ \ln(N_{i,t-1})\\ \ln(K_{it})\ln(N_{i,t-1})\\ [\ln(K_{it})]^2\\ [\ln(N_{i,t-1})]^2\\ \ln(M_{i,t-1})\end{pmatrix}\right]=0 \tag{18}$$

and search for the optimal combination of $\hat{\alpha}_s$, $\hat{\sigma}_s$, and $\hat{a}_s$ by minimizing the sum of the moments using the the weighting procedure proposed by Hansen (1982) for the plausible values of Ω.[23]

Table 3 reports three parameters of equation (1) for each of 136 3-digit CIC industries estimated from the moment condition in equation (18). On average the weight on factor inputs ($\hat{\alpha}_s$) is 0.185 and the weight on labor relative to capital ($\hat{a}_s$) is 0.812. A surprising finding is that the elasticity of substitution between labor and capital ($\hat{\sigma}_s$) on average is 1.467: the lowest value of this structural parameter is 0.715 and the maximum value is 2.328. Moreover, the elasticity of substitution exceeds unity for 94.1% of the sectors (128 out of 136 sectors). These findings are somewhat surprising because in studies of the United Stated that use different estimation methods, the elasticity of substitution was found to less than one (see León-Ledesma, McAdam and Willman, 2010; Chirinko et al, 2011).

[22] The choice of the instrumental variables in the current moment condition is based on the discussion in De Loecker and Warzynski (2012). Since our CES term can be approximated by the interaction terms and non-linear terms of log labor and log capital (Kmenta, 1967), we use the six instrumental variables in order to identify the three parameters. The moment condition is thus over-identified. As a robustness check, we also use just four instrumental variables, i.e., log of lagged labor, log of capital, the interaction of log of lagged labor and log of capital, and log of lagged material input. We find that our results are robust.

[23] We use the non-linear least square with firm-fixed effects procedure (NLS) to obtain the initial values of $\tilde{\Omega} = (\tilde{\alpha}_s, \tilde{\sigma}_s, \tilde{a}_s)$. In the cases where NLS does not converge to the reasonable range of parameters for a 3-digit sector, we then use the corresponding NLS results for the 2-digit sectors. Once we obtain these starting values, we search over $\Omega = (\bar{\alpha}_s, \bar{\sigma}_s, \bar{a}_s)$ where $\bar{\alpha}_s = \{\tilde{\alpha}_s - 10\kappa_1, \tilde{\alpha}_s - 9\kappa_1, ..., \tilde{\alpha}_s + 10\kappa_1\}$, $(\bar{\sigma}_s - 1)/\bar{\sigma}_s = \{(\tilde{\sigma}_s - 1)/\tilde{\sigma}_s - 10\kappa_2, (\tilde{\sigma}_s - 1)/\tilde{\sigma}_s - 9\kappa_2, ..., (\tilde{\sigma}_s - 1)/\tilde{\sigma}_s + 10\kappa_2\}$, and $\bar{a}_s = \{\tilde{a}_s - 10\kappa_1, \tilde{a}_s - 9\kappa_1, ..., \tilde{a}_s + 10\kappa_1\}$ with the grids of $\kappa_1 = 0.005$ and $\kappa_2 = 0.02$.

5 Profit Shares

5.1 Capital Intensity

The results in the previous section indicate that there is a high degree of the substitutability between labor and capital in the Chinese manufacturing sector. In this situation, as previously noted, our theory predicts that an increase in capital intensity in SOEs will cause the profitability of SOEs to increase.

Using Table 2 we have already shown that between 1998 and 2007 the 151% growth in capital intensity for SOEs was much more rapid than the 86% growth rate in the private sector and the negligible (3%) growth rate in the foreign sector. Figure 2 illustrates the pronounced rightward shift in the distribution of capital intensities for SOEs in 1998 versus 2007. It is striking that the right tail of the distribution is much higher and much fatter in 2007.

In order to check whether the rapid growth of capital intensity for SOEs compared to private and foreign firms is robust after controlling for ownership-, time-, province- and sector-fixed effects, the following equation is estimated:

$$\ln(X_{it}) = \sum_o \theta^o D_{it}^o + \sum_p \theta^p D_{it}^p + \sum_s \theta^s D_{it}^s + \sum_t \theta^t D_{it}^t + \varepsilon_{it} \tag{19}$$

where ε_{it} is an independent and identically distributed random variable.

In equation (19), the dependent variable $\ln(X_{it})$ is the log of capital intensity of firm i in year t and D_{it}^o, D_{it}^p, D_{it}^s and D_{it}^t are ownership-, province-, sector-, and year-dummy variables, respectively. Foreign firms are the reference group because, as previously described, their capital intensity was stable during 1998-2007. Thus, equation (19) estimates how SOEs and private firms differ from foreign firms after controlling for province-, sectoral- and year-fixed effects. Since the outcomes are reported in logs, these differences are in percentage terms.

Table 4 contains results for three cases: 1) the entire sample, 2) the entire sample accounting for differences within SOEs (top central and all other SOEs), and 3) the balanced sample accounting for differences within SOEs. In each case, the model is estimated for the entire period 1998-2007, for 1998-2002 and then for 2003-2007. The first set of estimates for the entire sample shows that the relative capital intensity of SOEs increased by almost 29% (from -0.403 log points in 1998-2002 to -0.116 log points in 2003-2007). The results indicate that throughout 1998-2007 SOEs on average were less capital intensive than foreign firms and more capital intensive than private firms.

The second set of estimates shows that capital intensity grew in top central SOEs by 19.5% (0.828 log points in 1998-2002 and 1.023 log points in 2003-2007) and in the other SOEs by 27.9% (-0.407 log points in 1998-2002 and -0.128 log points in 2003-2007). These estimates also show that throughout 1998-2007 the top central SOEs were much capital intensive than foreign firms, which were more capital intensive than the other SOEs; and, the private sector firms were the least capital intensive.

Comparing the second and third set of estimates (the entire and balanced samples accounting for differences within SOEs) enables us to check for the impact of exit and entry on the capital intensity of SOEs. Qualitatively, the results in the balanced panel and full sample are similar. However, the capital intensity of the top central SOEs is smaller in the balanced sample, while the capital intensity of the other SOEs is larger in the balanced sample. Between 1998 and 2007 the number of top-central SOEs increased by 92.5% (120 firms in 1998 and 231 firms in 2007) while the number of other SOEs decreased by -67.6% (35,671 firms in 1997 and 11,552 firms in 2007; see Appendix Table A.1). Top central SOEs are much larger and more capital intensive. Thus, consistent with the narrative in Hsieh and Song (2015), these differences between the entire and balanced samples indicate that in the case of the top central SOEs there was a net entry and nationalization of relatively large firms, and in the case of the other SOEs there was a net exit and privatization of relatively small SOEs.

5.2 Markups

Using the production function parameters that we have estimated for each of the 136 3-digit sectors, we can compute the value of the markup using equation (9):

$$\hat{\mu}_{it} = \frac{(1 - \hat{\alpha}_s)}{\tilde{p}_{it} M_{it} / p_{it} Q_{it}}$$

where we use the actual values of nominal gross output ($p_{it}Q_{it}$) and intermediate input spending ($\tilde{p}_{it}M_{it}$) to compute expenditures on materials as a share of total revenue ($\tilde{p}_{it}M_{it}/p_{it}Q_{it}$) in the denominator of the markup equation.[24]

[24] De Loecker and Warzynski (2012) use an adjusted (fitted) value for their nominal output measure (see their equation (16)) in order to eliminate the noise term from their real output (value added) measure. This adjustment is important for the use of value added which is highly vulnerable to measurement error. For example, in our data

The denominator in equation (9) would be biased if SOEs had preferential access to materials inputs that private and firms do not have. To determine if this is a problem, we check if there are differences between SOEs and private firms, and SOEs and foreign firms in terms of material expenditures as a share of revenues in the fifth, tenth, fiftieth (median), ninetieth and ninety-fifth percentiles of their distributions. In each case we fail to reject the null that these differences are statistically significant. On average, materials expenditures as a share of revenues in SOEs are 2.5 percentage points lower than in private firms, and 2.9 percentage points lower than foreign firms. While these differences are statistically significant, they are both less than 1/10th of sample standard deviation and thus quantitatively small. Moreover, if SOEs over-used materials because of their preferential access to materials, we would expect that on average their spending on materials as a share of revenues would be higher than in the private and foreign firms. Thus, these patterns give us some assurance that the above markup equation is reasonably accurate.

Our theory predicts that an increase in markups causes profitability to increase. Figure 3 shows, however, that the distribution of log markup for SOEs is stable in 1998 and 2007 and thus suggests that markups cannot explain the increasing profitability of SOEs. Moreover, the markup varies significantly across firms, and not all the firms have theoretically consistent markup values greater values than one (or log(markups) greater than or equal to zero). This impression that markups do not explain the growth in SOE profitability is confirmed when we estimate equation (19) using the log of markups as the explanatory variable. Results of this estimation are reported in Table 5. In the all three sets of estimates, there is no statistical difference between SOEs and foreign firms throughout 1998-2007. In the entire sample, SOEs have higher markups than foreign firms in 1998-2002, and this difference vanishes in 2003-2007. Accounting for differences within SOEs, there is no difference between top central SOEs and foreign firms. However, the other SOEs have a higher markup than foreign firms in 1998-2002 that disappears in 2003-2007. In the balanced sample estimates that account for differences in SOEs, there is no statistical difference between foreign firms and top central SOEs and also between foreign firms and other SOEs during both 1998-2002 and 2003-2007. This difference between the entire sample and balanced sample indicates that within the group of other SOEs, the SOEs that exited and were privatized had relatively high markups.

there are many negative value added outcomes. However, we use firm-level revenue which is measured with much less noise than value added.

5.3 Political Pressure to Hire Excess Labor

Using our estimates for the sectoral production parameters ($\hat{\sigma}_s$, $\hat{\alpha}_s$, $\hat{a}_s$) and for the time-varying firm-level markups, $\hat{\mu}_{it}$, we can use our theoretical model to estimate an SOE's political benefit of hiring excess labor, $1 - 1/\phi_t$. Because ϕ_t is log-linearly associated with labor's share while it is not log-linearly associated with profit's share, our strategy is to develop an equation for labor's share from which we can estimate $\ln(\phi_t)$ and then calculate $1 - 1/\phi_t$. Combining the labor share equation (12) with the output elasticity of labor equation (15), then we have

$$\ln(\hat{\phi}_t) = \ln\left(\frac{w_{it}N_{it}}{VA_{it}}\right) + \ln\left(\hat{\mu}_{it} - 1 + \hat{\alpha}_s\right) - \ln\left(\hat{\alpha}_s\right) + \ln\left[1 + \left(\frac{1-\hat{a}_s}{\hat{a}_s}\right)\left(\frac{K_{it}}{N_{it}}\right)^{\frac{\hat{\sigma}_s - 1}{\hat{\sigma}_s}}\right] \tag{20}$$

where labor's share ($w_{it}N_{it}/VA_{it}$) and capital intensity (K_{it}/N_{it}) are observed and reasonably well measured, and the remaining sectoral production parameters have already been estimated.

Because equation (20) contains measurement errors, we use the following equation to obtain our estimates for political weight:

$$\ln(\hat{\phi}_t) = \sum_t \pi_t D_{it}^{SOE} D_{it}^t + e_{it} \tag{21}$$

where the error term consists of year-, province-, and sector-specific components: $e_{it} = \sum_t \theta^t D_{it}^t + \sum_p \theta^p D_{it}^p + \sum_s \theta^s D_{it}^s + \varepsilon_{it}$ and ε_{it} is a random variable that is independently and identically distributed.

Our estimate of political weight for excess employment is $\tilde{\phi}_t = \exp(\tilde{\pi}_t)$. If the reforms first announced in 1995 in the Fourteenth Party Congress were de facto enacted, then it should be observed that the political benefit for SOEs of hiring excess labor, $1 - 1/\tilde{\phi}_t$, fell over time. If this pattern emerges, then this would provide another explanation (along with capital intensity effects) for the rapid increase in profitability of SOEs.

Table 6 Panel 1 reports the SOEs' estimated political benefits of hiring excess labor from the entire sample. The subsequent columns (North, East, South and West) contain the results for China's four regions.[25] Although the coefficients are estimated for each year, for ease of exposition,

[25] Each region includes the following provinces or province-equivalent municipal cities: the North includes Beijing, Tianjin, Hebei, Shanxi, Neimenggu, Liaoning, Jilin and Heilongjiang; the East includes Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi and Shandong; the South includes Henan, Hubei, Hunan, Guangdong, Guangxi and

we only report the results for the years 1998 and 2007. The estimated coefficient $\tilde{\pi}_t$ associated with political pressure in equation (21) is 0.794 in year 1998, and 0.313 in 2007. This means that the estimated benefit to an SOE of hiring excess labor, $(1 - 1/\tilde{\phi}_t) = (1 - 1/(\exp(\tilde{\pi}_t))$, fell from 54.8% in 1998 of profits to 26.9% of profits in 2007. These estimates are statistically significant at the 1 percent confidence level in both years and indicate that over time SOEs could pay more attention to making profits. The declines in an SOEs political benefits of hiring excess are slightly different across the regions and are more pronounced in reformist regions such as the East and South, and less pronounced for the North and West regions (Table 6).

Table 6 Panel 2 and Figure 4 highlight the importance of entry and exit. We report estimates of the SOEs' benefit of hiring excess labor using only the balanced panel. Moreover, we only choose the firms that operated without the ownership changes over the entire period. As shown for the full sample in the first panel, the SOEs' political benefit of hiring excess labor falls. However, in contrast to full sample, reform is not more pronounced in the East and South, suggesting that it is the dynamics of entry and exit that are critical to the more pronounced fall in political pressure in the East and South regions.

5.4 Predictions for Profit Shares

As shown in the previous sections, the capital deepening and the declining pressure to employ excess labor are two fundamental reasons why profitability of SOEs increased over the period. Figure 5 illustrates the goodness of fit of our profitability theory. In order to obtain the predicted aggregate SOE profit shares of value added, we insert the estimated production parameters, the average value of the markup, and the estimated political pressure variable (the column "All" in Table 6 Panel 2) and the observed capital-labor ratio into equations (14) and (15). The dashed line in Figure 5 illustrates the aggregate predicted profit shares for SOEs for each year during 1998-2007, which is close to the aggregate observed profitability.

Using the same predicted profit shares, Figure 6 plots the capital intensity and profitability schedules for SOEs in 1998 and 2007. In this figure the capital intensity in each year exhibits enormous heterogeneity and spans roughly eight log points (a ratio of $3,000 \doteqdot \exp(0)/\exp(-8)$). As predicted by our theory for the case in which the elasticity of substitution between capital and

Hainan; and, the West includes Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shan'xi, Gansu, Qinghai, Ningxia and Xinjiang.

labor exceeds unity, the capital intensity-profitability schedules for SOEs are upward sloping in both years. Figure 6 also illustrates that between 1998 and 2007 the capital intensity-profitability schedule shifts upward. Thus, for any level of capital intensity, predicted profitability for an SOE was higher in 2007 than in 1998. For example, consider the predicted value for 1998 when SOEs faced significant pressure to hire excess employment. In this year, SOEs with log capital-labor ratios roughly less than -4 on average were predicted to have negative profits. However, by 2007, all SOEs, including the relatively small ones with log capital-labor ratios less than -4, were predicted to have positive profits.

Fixing capital-intensity, our theory predicts that higher markups and/or declining political pressure to hire excess labor would cause this upward shift. However, since SOE markups were relatively stable during 1998-2007, we conclude that declining political pressure on SOEs to hire excess labor drove the upward shift in the capital intensity-profitability schedule. Moreover, the rightward shift of the distribution of the log capital-labor ratio for SOEs and the fattening up the upper tail of this distribution between 1998 and 2007 (see Figure 2) also drove the increase in aggregate SOE profitability.

6 Productivity

If SOEs had successfully restructured during 1998-2007, then their productivity should have been similar to levels in private and foreign firms. Figure 7 illustrates this is not the case. SOE productivity lagged the foreign and private sectors in 1998. While SOE productivity grew during 1998-2007, it failed to catch up to the private and foreign firms as of 2007.

Estimation results using the log of productivity as an explanatory variable in equation (19) are reported in Table 7.1. Log productivity for SOEs and private firms is relative to productivity in foreign firms, where foreign sector productivity is growing (see Figure 7). The first set of estimates from the entire sample shows that, consistent with Figure 7, private and foreign firms have comparable productivity levels, and the productivity of SOEs is 13.4% lower than foreign firms during 1998-2007. While the productivity gap between SOEs and foreign firms shrinks by 5.4% (from -0.153 log points in 1998-2003 to -0.99 log points in 2003-2007), the SOEs still fail to catch up as 2003-2007.

The second set of estimates from the entire sample shows that the other SOEs are laggards in terms of productivity, and the top central SOEs have productivity levels that are similar to foreign and private firms throughout 1998-2007. Thus, the finding in Hsieh and Song (2015) that China's SOEs had an impressive productivity performance applies to the top central large SOEs.[26] However, it is important to note that the top central SOEs account for roughly 26% of SOE output and 18% of SOE employment in 2007 even after the "grasp the big and let go of the small" policy. Thus, in general SOE productivity growth was not impressive, indicating that SOE restructuring, especially in the case of other SOEs, was limited. These results are similar and somewhat stronger for the balanced sample in Table 7.1. Figure 8 illustrates that in the balanced sample the productivity of SOEs failed to catch up to the private and foreign sectors.

If SOEs had restructured during 1998-2007, then we would observe that the performance of continuing SOEs during 2003-2007 would be no worse than SOEs that had become private during 2003-2007. We use firms that operated as SOEs in 1998-2002 and then became private firms as of 2003-2007 as the reference group and estimate an specification similar to equation (19) using the log of productivity as the dependent variable. We report the results in Table 7.2. The first column indicates that in 1998-2002 the SOE-continuers were 4.8% less productive than the SOEs that were privatized in 2003-2007. Moreover, the SOEs that subsequently exited were the least productive SOEs (by 10.9%) in 1998-2002. Thus, there may have been some selection on SOE privatization, liquidation and corporatization by productivity. However, comparing columns 1 and 2, it is clear that the productivity advantage of SOEs that were privatized in 2003-2007 over the SOE-continuers grew from 4.8% in 1998-2002 to 6.4% in 2003-2007 and the productivity gap between SOE-continuers and SOEs that were privatized grew.

The second set of columns in Table 7.2, where we account for differences within SOEs (top central and all other SOEs), shows that this basic pattern is robust. However, in this case it is the other SOEs that continue to operate as SOEs that are 4.9% less productive than the SOEs that were privatized in 2003-2007 and 6.6% less productive in 2003-2007. The top central SOEs-continuers are marginally more productive than the SOEs that privatize as of 2003-2007 although the large standard errors do not enable us to reject the null hypothesis that there is no difference between SOE-continuers and the SOEs that were privatized.

The third set of columns reports estimates for the balanced sample. The qualitative pattern

[26] Hsieh and Song (2015) use a total factor productivity measure for capital and labor, while we use a brooader productivity measure that includes materials.

from the second set of columns is robust. However, the difference between the productivity of the other SOEs that continue versus those that were privatized in 2003-2007 is attenuated (the continuers are now 2.4% less productive in 1998-2002 and 4.1% less productive in 2003-2007). This again indicates that the net exit of SOEs promoted productivity growth.

7 Conclusions

If we were simply to examine profitability, it appears that SOEs in China successfully restructured during 1998-2007. In this paper we have developed a comprehensive method for evaluating the drivers of SOE profitability including product market competition, political pressures to hire excess labor, and the ability to substitute labor for capital. We also document the evolution of SOE productivity in a setup that allows for flexible substitution between capital and labor and markups in product markets. We find that SOEs profitability increased primarily for two reasons: because the elasticity of substitution between capital and labor exceeds unity and SOEs had preferential access to capital, SOEs could become profitable by radically increasing their capital intensity. Second, the state put its SOEs under less political pressure to hire excess labor. We also find that, with the exception of top central SOEs, in general SOEs became profitable without having impressive productivity gains.

Our findings provide an important counter-example to the Chong, Guillen and López-de-Silanes (2011) study of privatization of SOEs around the world. Using privatization prices, Chong et al argue that releasing excess labor in SOEs that are privatizing is more important for restructuring than labor retrenchment policies. However, in the case of China, we document that while SOEs massively released labor, the large group of other SOEs did not restructure. This suggests that simply firing labor without weakening political connections between SOEs and the state is problematic.

The results in this study are consistent with other studies that highlight the problems with state interference in firms and the benefits of weakening state influence. Chen, Firth, Gao and Rui (2006) document that Chinese firms that have more outsiders on their boards are less likely to engage in fraud. And, the studies of Fan, Morck and Yeung (2011) and Deng, Morck, Yu and Yeung (2011) document that outside board members are often ignored in corporatized SOEs. In well functioning corporations, there should be more turnover of CEOs when firms are performing poorly, and less turnover when they are performing well. However, Kato and Long (2002) document that this expected inverse relationship between firm performance and CEO turnover is weak in SOEs during 1998-2002, and significant and stronger in private owned firms. As part of the reform, medium and large-sized Chinese SOEs sold stock to some private investors while the state typically retained the block of controlling shares. Sun and Tong (2003) show that returns on sales and earning actually decrease after this partial privatization (or corporatization) of SOEs during 1994-1998; while SOE leverage increased. Moreover, this split share structure led to a whole series of well-known rent-seeking activities among the large shareholders who held the non-traded blocs such as guaranteed loans to the large shareholders and other related party transactions. However, in 2005 with the split share reform private agents could start to buy up the large blocs on non-tradable shares that had been controlled by the state. Liao, Liu and Wang (2012) argue that the SOEs who effectively dismantled this split share structure weakened the power of the state to influence their activities. This reform was effectively a privatization and led to gains in output, profits and employment levels of SOEs who implemented them.

Author Affiliations

Department of Economics, University of Pittsburgh; Department of Economics, Tsinghua University; and, Department of Economics, West Virginia University.

Appendix

Appendix 1: Real Capital Stock

A real capital stock series is constructed using the perpetual inventory method as described in Brandt et al (2012). We have the book value of firms' fixed capital stock at the original purchase prices. Since these book values are the sum of nominal values for different years, they cannot be used directly. Thus, we construct a real capital stock series using the following formula:

$$K_{it} = (1-\delta)\, K_{i,t-1} + (BK_{it} - BK_{i,t-1})/P_t, \tag{22}$$

where BK_{it} is the book value of the capital stock for firm i in year t; and P_t is the investment deflator as constructed by Brandt and Rawski (2008). To construct the real capital stock series, we then need to know the initial nominal value of the capital stock, which is projected as

$$BK_{i,t_0} = BK_{i,t_1} / (1 + g_{ps})^{t_1 - t_0},$$

where BK_{i,t_1} is the book value of capital stock when firm i first appears in the data set in year t_1,and, g_{ps} is the average growth rate of capital, calculated using province-sector level capital growth rate between the earliest available survey (1995) and the first year that the firm enters the data.[27] For firms founded later than 1998, the initial book value of capital stock is taken directly from the data set.

Using information on the age of firm i, we could get the projected book value of the capital stock in the beginning year t_0 (BK_{i,t_0}), which can be thought of as the initial nominal value of capital. So the real capital stock is $K_{i,t_0} = BK_{i,t_0}/P_{t_0}$. We could also compute the real capital stock in each year, assuming the annual depreciation rate as 0.09, using the perpetual inventory method as in equation (22).[28] Our estimated real capital is highly correlated with the original value of nominal capital as well as the net value of nominal capital.

Appendix 2: Summary Statistics within SOEs

Table A.1 reports several key production and income variables aggregated by two types of SOEs: top central SOEs and all other SOEs. Table A.1 shows that the overall number of SOEs declines from 35,791 in 1998 to 11,783 in 2007. This decline is driven by all other SOEs because there is an increase in the number of top central SOEs.. Employment in top central and other SOEs fell by 18.7% and 66.5%, respectively. During 1998-2007, the growth rate of the capital-labor ratio for other SOEs is much more rapid than the rate within top central SOEs although there was a persistent difference in their capital-intensities even in 2007 (i.e., 0.33 capital-labor for top central SOEs versus 0.20 for other SOEs). Table A.1 also reports the distribution of profit and wage shares of value added and the share of profitable firms. During 1998-2007, the share of profits in value

[27] To be more concrete, we use 1995 industrial census and calculate the province-sector level growth rate for the book value of capital. Note that Brandt et al (2012) use the province-sector level aggregate capital stock growth, which ignores entry and exit. We instead use the province-sector level average capital stock growth.

[28] We also try an alternative depreciation rate of 0.05 and find that our results are qualitatively similar.

added increased by 15.7% for top central SOEs and 19.8% for other SOEs. These results are robust when we use the balanced sample.

Appendix 3: The Elasticity of Substitution and Returns to Scale

This section of the appendix contains several robustness checks for our production function in equation (1). Subsections 3.1 and 3.2 check whether our finding that the elasticity of substitution between capital and labor generally exceeds unity is robust when two alternative estimation procedures are employed: non-linear least squares estimation with firm-fixed effects (NLS), and estimation using a Translog production function under the Kmenta (1967) constraints. Subsection 3.3 checks if our finding that the elasticity of substitution between capital and labor exceeds unity is robust when we allow for labor-augmenting productivity. The production function in equation (1) is assumed to exhibit constant returns to scale. Subsection 3.3 estimates a version of the CES production function that does not enforce constant returns to scale. Our finding that the elasticity of substitution exceeds unity is robust. Moreover, we find that the assumption of constant returns to scale is highly realistic. Throughout this section our findings generated with a GMM procedure as reported in Table 3 are referred to as the baseline findings.

3.1: Non-Linear Least Squares with Firm-Fixed Effects (NLS)

By assuming a fixed productivity level for each firm, we can estimate equation (1) using non-linear least squares (NLS) with firm-fixed effects. Ackerberg et al (2006) stress that estimation with the NLS procedure has an endogeneity issue that creates a systematic bias. Still, because NLS is a standard procedure we use it as a robustness check and estimate the following:

$$
\begin{aligned}
d\left[\ln(Q_{it})\right] \quad = \quad & \frac{\alpha_s\sigma_s}{\sigma_s-1}\ln\left[a_s(N_{it})^{\frac{\sigma_s-1}{\sigma_s}}+(1-a_s)\left(K_{it}\right)^{\frac{\sigma_s-1}{\sigma_s}}\right] \\
& -\frac{\alpha_s\sigma_s}{\sigma_s-1}\ln\left[a_s(\bar{N}_{it})^{\frac{\sigma_s-1}{\sigma_s}}+(1-a_s)\left(\bar{K}_{it}\right)^{\frac{\sigma_s-1}{\sigma_s}}\right]+(1-\alpha_s)d\left[\ln(M_{it})\right]+\varepsilon_{it}.
\end{aligned}
\tag{23}
$$

where $d(x_{it}) = x_{it} - (1/T_i)\sum_t x_{it}$, $\bar{x}_{it} = (1/T_i)\sum_t x_{it}$, and T_i is the number of observations available for firm i.

Table A.2 reports the three structural parameters for the production function in equation (1) for each of the 28 2-digit CIC industries in Panel 1.1 and each of the 136 3-digit CIC industries in Panel 1.2. Since the NLS method sometimes has difficulty converging to what we have argued is the reasonable parameter space, we do not report the results for one industry in the 2-digit setting and 15 industries for the 3-digit setting. Our general finding that the elasticity of substitution between capital and labor exceeds unity (see Table 3) is robust. However, the elasticity of substitution tends to be higher than the baseline GMM findings in Table 3. However, 94.1% of the sectors have an elasticity of substitution exceeding unity which is what is observed in the baseline.

3.2: Translog with Kmenta (1967) Restrictions

In this subsection we estimate the elasticity of substitution using the Kmenta (1967) method which approximates a Translog production function around a Cobb-Douglas production function. Because the elasticity of substitution equals unity in Cobb-Douglas production function, we expect this procedure will bias the estimated elasticity of substitution towards unity. Moreover, we expect this bias to become more severe as the absolute difference between the actual elasticity of substitution and unity increases. In our estimation, we enforce the constant returns to scale assumption and Kmenta's restrictions for the CES production function and obtain the following equation:

$$\begin{aligned} \ln(Q_{it}) &= \ln(\omega_{it}) + \beta_s^n \ln(N_{it}) + \beta_s^k \ln(K_{it}) - 0.5\beta_s^{kn}(\ln(N_{it}))^2 - 0.5\beta_s^{kn}(\ln(K_{it}))^2 \\ &\quad + \beta_s^{kn}(\ln(K_{it})\ln(N_{it})) + (1 - \beta_s^n - \beta_s^k)\ln(M_{it}). \end{aligned} \tag{24}$$

Here, we can obtain the implied elasticity of substitution between labor and capital from

$$\sigma_s = \left[1 + \beta_s^{kn}(\beta_s^n + \beta_s^k)/(\beta_s^n \beta_s^k)\right]^{-1}.$$

The simplest way to estimate equation (24) is to assume that there are no systematic productivity innovations ($\ln \omega_{it} = \ln \omega_i$) and then estimate the Translog production function with firm-fixed effects:

$$d\left[\ln(Q_{it})\right] = \beta_s^n d\left[\ln(N_{it})\right] + \beta_s^k d\left[\ln(K_{it})\right] - 0.5\beta_s^{kn} d\left[\ln(N_{it})^2\right] - 0.5\beta_s^{kn} d\left[\ln(K_{it})^2\right] + \beta_s^{kn} d\left[\ln(N_{it})\ln(K_{it})\right] + (1-\beta_s^n-\beta_s^k) d\left[\ln(M_{it})\right] + \varepsilon_{it} \tag{25}$$

The second set of panels in Table A.2 reports the three parameters of equation in sectoral production function (25). Consistent with our expectations that estimated elasticity of substitution will be biased towards unity, the average estimates for the elasticity of substitution (i.e., 1.252 for the mean value of 28 2-digit industries and 1.282 for the mean value of 136 3-digit industries) are smaller than the baseline GMM estimates in Table 3. However, we still find that 94.1% of the sectors have an elasticity of substitution between capital and labor that is greater than unity which is what we also observe in the baseline.

3.3: Human Capital Adjustments and the CRS Assumption

Throughout the paper, we adjust the number of employees in a firm using regional differences in the average wage. Cheng et al (2013) argue that because human capital levels are significantly different across regions in China, it is important to adjust for these differences when estimating the sectoral production functions. The first panel in Table A.3 summarizes results when we make no adjustments for differences in human capital in the 3-digit industries. Here we simply use the head count of employees as a measure of N_{it}. On average the weight on factor inputs ($\hat{\alpha}_s$) is 0.183 and the weight on labor relative to capital ($\hat{a}_s$) is 0.810 which is very close to the baseline results ($\hat{\alpha}_s$ = 0.183, and $\hat{a}_s$ = .812). The elasticity of substitution between labor and capital ($\hat{\sigma}_s$) on average is 1.462, which is almost identical to the baseline GMM results ($\hat{\sigma}_s$= 1.467) . Here the elasticity of substitution exceeds unity in 94.1% of the sectors which is the same as the baseline.

In the second panel in Table A.3 we measure labor accounting for firm-level differences in human capital. This alternative measure is the total firm-level wage payment ($w_{it}N_{it}$) divided by province-level average wage for each year (w_t^p):

$$\tilde{N}_{it} = \frac{w_{it}N_{it}}{w_t^p}. \tag{26}$$

Assuming that an individual's wage is positively associated with her/his labor productivity, this alternative measure should reflect the composition of skills within each firm. The estimation results are similar to our baseline results. On average the elasticity of substitution is slightly lower (1.396 versus 1.467), the weight on factor inputs is lower (0.148 versus 0.183), and the weight on labor relative to capital is higher (0.829 versus 0.812). These differences in structural parameters are small and do not change the paper's general conclusions. Moreover, 94.1% of the sectors have an elasticity of substitution exceeding unity which is same as the baseline.

As discussed above, the assumption of constant returns to scale is a critical for estimation since, along with the use of a revenue (gross output) production, it ensures that our estimates are unbiased in an economy with imperfectly competitive product markets (see Basu and Fernald 1995 and 1997). In the third panel in Table A.3, we relax the assumption of constant returns to scale by using an independent weight on intermediate inputs ($\bar{\alpha}_s^*$ where $\bar{\alpha}_s + \bar{\alpha}_s^*$ may not sum to unity). In this setup, we must now search over the vector of four parameters $\breve{\Omega} = (\bar{\alpha}_s, \, \bar{\sigma}_s, \, \bar{a}_s, \bar{\alpha}_s^*)$. To implement this procedure, we search locally around the estimated values of the parameters from the NLS estimates. As in Table A.3, the results do not differ from the baseline specification and the returns to scale are close to unity for the most of the industries. Moreover, 93.3% of the sectors have an elasticity of substitution exceeding unity which is comparable to the baseline (94.1%).

References

[1] D. Ackerberg, K. Caves, and G. Frazer, "Structural Identification of Production Functions." mimeo, UCLA, 2006.

[2] G. Azmat, A. Manning, and J. Van Reenen, "Privatization and the Decline of Labour' Share: International Evidence from Network Industries." *Economica*, 79, 470-492, 2012.

[3] S. Basu and J.G. Fernald, "Are Apparent Productive Spillovers a Figment of Specification Error?" *Journal of Monetary Economics*, 36, 165-188, 1995.

[4] S. Basu and J.G. Fernald, "Returns to Scale in U.S. Production: Estimates and Implications." *Journal of Political Economy*, 105, 249-283, 1997.

[5] L. Brandt, J. Van Biesebroeck, and Y. Zhang, "Creative Accounting or Creative Destruction? Firm-Level Productivity Growth in Chinese Manufacturing." *Journal of Development Economics*, 97, 339-351, 2012.

[6] H. Cai and Q. Liu, "Competition and Corporate Tax Avoidance: Evidence from Chinese Industrial Firms." *Economic Journal*, 119, 1-32, 2009.

[7] G. Chen, M. Firth, D.N. Gao and O.M. Rui, "Ownership Structure, Corporate Governance, and Fraud: Evidence from China." *Journal of Corporate Finance,* 12, 424-448, 2006.

[8] W. Cheng, J. Morrow, and K. Tacharoen, "Productivity As If Space Mattered: An Application to Factor Markets Across China." mimeo, LSE, 2013.

[9] R.S. Chirinko, S.M. Fazzari, and A.P. Meyer, "A New Approach to Estimating Production Function Parameters: The Elusive Capital-Labor Substitution Elasticity." *Journal of Business and Economics Statistics*, 29(4), 587-594, 2011.

[10] A. Chong, J. Guillen, and F. López-de-Silanes, "Privatization and Labor Policies," *Journal of Public Economics,* 95 (9-10), 1119-1130, 2011.

[11] J. De Loecker and F. Warzynski, "Markups and Firm-Level Export Status." *American Economic Review*, 102(6), 2437-2471, 2012.

[12] Y. Deng, R. Morck, J. Yu and B. Yeung, "Monetary and Fiscal Stimuli, Ownership Structure, and China's Housing Market." NBER Working Paper No. 16871, National Bureau of Economic Research, 2011.

[13] J. Fan, R. Morck and B. Yeung, "Capitalizing China." NBER Working Paper No. 17687, National Bureau of Economic Research, 2011.

[14] M. Firth, C. Lin, P. Liu, and S.M.L. Wong, "Inside the Black Box: Bank Credit Allocation in China's Private Sector." *Journal of Banking and Finance*, 33, 1144-1155. 2009.

[15] R. Gordon and W. Li, "Chinese Enterprise Behavior Under Reform." *American Economic Review Papers and Proceedings,* 82, 202-206, 1991.

[16] T. Groves, Y. Hong, J. McMillan and B. Naughton, "Autonomy and Incentives in Chinese State Enterprises." *Quarterly Journal of Economics*, 109(1), 183-209, 1994.

[17] T. Groves, Y. Hong, J. McMillan and B. Naughton, "China's Evolving Managerial Labor Market." *Journal of Political Economy*, 103, 873-892, 1995.

[18] L.P. Hansen, "Large Sample Properties of Generalized Method of Moments Estimators." *Econometrica*, 50, 1029-1054, 1982.

[19] C-T Hsieh and P.J. Klenow, "Misallocation and Manufacturing TFP in China and India." *Quarterly Journal of Economics*, 124(4), 1403-1448, 2009.

[20] C-T Hsieh and Z. Song, "Grasp the Large, Let Go of the Small: The Transformation of the State Sector in China." In Press, *Brookings Papers on Economic Activity*, 2015.

[21] G.H. Jefferson, T.G. Rawski. and Y. Zheng, "China's Industrial Productivity: Trends, Measurement Issues and Recent Developments." *Journal of Comparative Economics*, 23(2), 146-180, 1996.

[22] T. Kato and C. Long, "CEO Turnover, Firm Performance, and Enterprise Reform in China: Evidence from Micro Data." *Journal of Comparative Economics*, 34, 796-817, 2006.

[23] L. Karabarbounis and B. Neiman, "The Global Decline of the Labor Share." *Quarterly Journal of Economics*, 129(1), 206-223, 2014.

[24] J. Kmenta, "On Estimation of the CES Production Function." *International Economic Review*, 8(2), 180–189, 1967.

[25] J. Kornai, The Road to a Free Economy. Shifting from a Socialist System: The Example of Hungary, W.W. Norton, New York, 1990.

[26] J. Kornai, The Socialist System: Princeton University Press, Princeton, New Jersey, 1992.

[27] M.A. León-Ledesma, P. McAdam, and A. Willman, "Identifying the Elasticity of Substitution with Biased Technical Change." *American Economic Review*, 100(4), 1330–1357, 2010.

[28] J.A. Levinsohn and A. Petrin, "Estimating Production Functions Using Inputs to Control for Unobservables." *Review of Economic Studies*, 70(2): 317–40, 2003.

[29] W. Li, "The Impact of Economic Reform on the Performance of Chinese State Owned Enterprises, 1980-1989." *Journal of Political Economy*, 105(5), 1080-1106, 1997.

[30] X. Li, X Liu and Y. Wang, "A Model of China's State Capitalism." mimeo, the Hong Kong University of Science and Technology, October 2012.

[31] L. Liao, B. Liu, and H., Wang, "China's Secondary Privatization: Perspectives from the Split-Share Structure Reform" *Journal of Financial Economics,* Forthcoming.

[32] H. Liu and Z. Zhao, "Parental Job Less and Children's Health." IZA DP No. 5846, July 2011.

[33] Y. Lu, Z, Tao and L. Yu, "Agglomeration and Markups." mimeo, National University of Singapore and University of Hong Kong, 2012.

[34] B. Naughton, Growing Out of the Plan: Melbourne, Australia: Cambridge University Press, 1995.

[35] S.G. Olley and A. Pakes. "The Dynamics of Productivity in the Telecommunications Equipment Industry." *Econometrica*, 64 (6), 1263-97, 1996.

[36] L. Putterman and X. Dong, "China's State-Owned Enterprises: Their Role, Job Creation, and Efficiency in Long-Term Perspective." Modern China, 26(4), 403-447, 2000.

[37] Y. Qian, "Enterprise Reform in China: Agency Problems and Political Control." *Economics of Transition,* 4(2), 427-447, 1996.

[38] A. Shleifer and R.W. Vishny, "Politicians and Firms." *Quarterly Journal of Economics*, 109, 995-1025, 1994.

[39] C. Syverson, "What Determines Productivity?" *Journal of Economic Literature,* 49:2, 326-365, 2011.

[40] Z. Song, K. Storesletten and F. Zilibotti, "Growing Like China." *American Economic Review*, 101(1), 196-233, 2011.

[41] Q. Sun and W.H.S. Tong, "China Share Issue Privatization: The Extent of Its Success." *Journal of Financial Economics,* 70, 183-222, 2003.

[42] K.S. Tsai, Back-Alley Banking: Private Entrepreneurs in China, Ithaca, New York: Cornell University Press, 2002.

[43] U.S. Chamber of Commerce, China's Approval Process for Inbound Foreign Investment. U.S. Chamber of Commerce, Washington D.C., 2012.

Tables and Figures

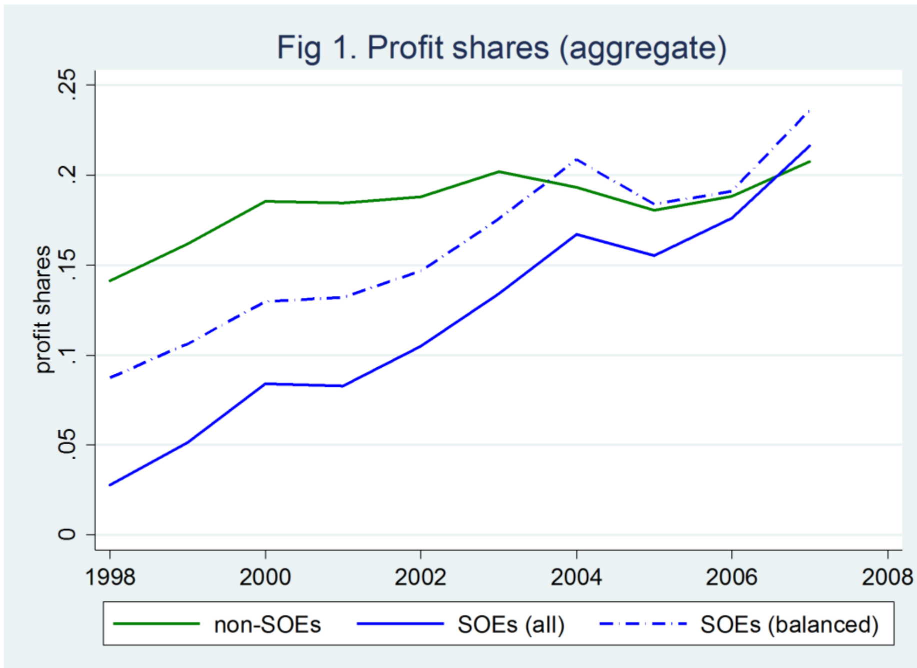


Table 1: Changes in ownership during 1998-2002 and 2003-2007

	Ownerships in 03-07				net exit	Total
	SOE	private	foreign	hybrid	during 98-02	(98-02)
Ownerships in 98-02						
SOE	12756	3572	291	742	24417	41778
private	301	45643	1543	1997	19780	69264
foreign	81	628	26922	218	11662	39511
hybrid	387	13161	1167	20877	34633	70225
net entry during 03-07	6483	172961	43168	14201		236813
Total (03-07)	20008	235965	73091	38035	90492	457591

Notes: We use the majority rule to determine the ownership classification in each period. For example, consider a SOE firm that operated for all ten years and was privatized in 2001. In this case, since the firm was owned by the state for 3 years (1998-2000) and then privately for 2 years (2001-2002) for the first period of 1998-2002, the firm is categorized as a SOE in 1998-2002 and private in 2003-2007. For 5% (7%) of the observations during the 2003-2007 (1998-2002), the number of years in which the two ownership classifications are the same or when there are three ownership types in each period. In these cases, we allocate the ownership classification according to the following priority order (hybrid, foreign, private, and then SOEs) so that we can have the most conservative measure for SOEs.

Table 2: Summary statistics aggregated by ownership

1. Entire sample

	SOE			private			foreign			total		
	1998	2007	change	1998	2007	change	1998	2007	change	1998	2007	change
The number of firms	35,791	11,783	-67.1%	17,862	190,576	966.9%	20,939	54,507	160.3%	119,190	270,351	126.8%
Real output (billion RMB)	1,908	4,012	110.3%	506	11,384	2149.3%	1,353	8,546	531.7%	5,091	25,147	393.9%
Employee (1,000)	21,289	7,973	-62.5%	3,933	28,891	634.5%	6,351	18,971	198.7%	42,343	58,760	38.8%
Real capital (billion RMB)	1,901	1,785	-6.1%	190	2,592	1263.5%	628	1,924	206.4%	3,197	6,566	105.3%
Profits/value added (%)	2.8%	21.6%	18.9%	17.4%	19.6%	2.3%	13.8%	22.5%	8.7%	9.5%	20.9%	11.4%
Wage bill/value added (%)	31.5%	17.4%	-14.1%	22.6%	15.9%	-6.7%	23.3%	23.5%	0.2%	26.4%	18.4%	-7.9%
Intermediate inputs/revenue (%)	75.5%	75.5%	0.0%	77.4%	75.3%	-2.1%	77.8%	77.1%	-0.7%	76.9%	75.9%	-1.0%
Share of unprofitable firms (%)	42.7%	21.7%	-20.9%	15.5%	9.5%	-6.0%	31.8%	20.3%	-11.5%	27.3%	12.4%	-14.8%
Real wage rate (RMB)	8,232	26,717	224.5%	7,519	18,020	139.7%	12,461	26,965	116.4%	8,467	22,202	162.2%
Real capital/employee	0.089	0.224	150.7%	0.048	0.090	85.6%	0.099	0.101	2.6%	0.076	0.112	48.0%

2. Balanced sample

	SOE			private			foreign			total		
	1998	2007	change	1998	2007	change	1998	2007	change	1998	2007	change
The number of firms	5,990	3,539	-40.9%	5,682	14,388	153.2%	6,914	7,296	5.5%	28,363	28,363	0.0%
Real output (billion RMB)	827	2,163	161.5%	212	2,651	1149.9%	636	2,239	251.8%	2,101	7,635	263.4%
Employee (1,000)	8,167	4,226	-48.3%	1,521	5,734	277.0%	2,792	4,497	61.1%	15,691	15,620	-0.5%
Real capital (billion RMB)	840	944	12.4%	76	642	749.7%	306	518	69.0%	1,376	2,237	62.6%
Profits/value added (%)	8.7%	23.6%	14.9%	19.0%	21.9%	2.9%	18.1%	23.9%	5.9%	13.7%	23.0%	9.3%
Wage bill/value added (%)	31.0%	17.6%	-13.4%	21.5%	15.2%	-6.3%	22.9%	22.8%	-0.1%	26.3%	18.1%	-8.2%
Intermediate inputs/revenue (%)	74.5%	74.2%	-0.3%	77.6%	76.5%	-1.1%	77.4%	76.3%	-1.1%	76.4%	75.7%	-0.6%
Share of unprofitable firms (%)	26.3%	22.0%	-4.2%	11.1%	12.0%	0.8%	26.8%	19.2%	-7.6%	19.3%	15.6%	-3.7%
Real wage rate (RMB)	9,612	28,636	197.9%	7,746	19,351	149.8%	13,522	30,274	123.9%	9,721	25,412	161.4%
Real capital/employee	0.103	0.223	117.2%	0.050	0.112	125.4%	0.110	0.115	4.9%	0.088	0.143	63.3%

Notes: (1) The ratios are calculated from the aggregates by ownership. For example, profits/value added for SOE in 1998 is profits from all SOEs divided by value added from all SOEs. (2) The industry-level output deflator (1998 prices) is used to deflate gross output and wage rate. (3) The column denoted "change" reports a percentage-point change from 1998 to 2007 for the variables with (%). The same column reports a percentage change from 1998 to 2007 for the other variables. (4) We do not report hybrid firms due to space constraints.

Table 3: CES production function estimates for the 136 3-digit sectors

	Parameters			
	Mean	St.dev	Min	Max
σ_s (elasticity of substitution)	1.467	0.314	0.715	2.328
α_s (weight on factor inputs)	0.185	0.059	0.048	0.329
a_s (weight on labor)	0.812	0.132	0.100	0.989

Fig 2. Histogram of log capital-labor ratio (SOE)

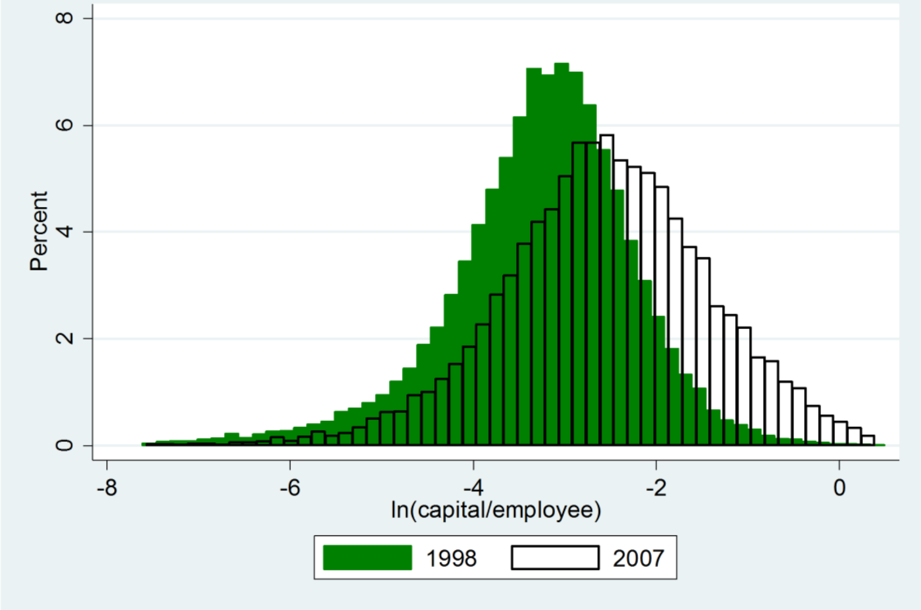
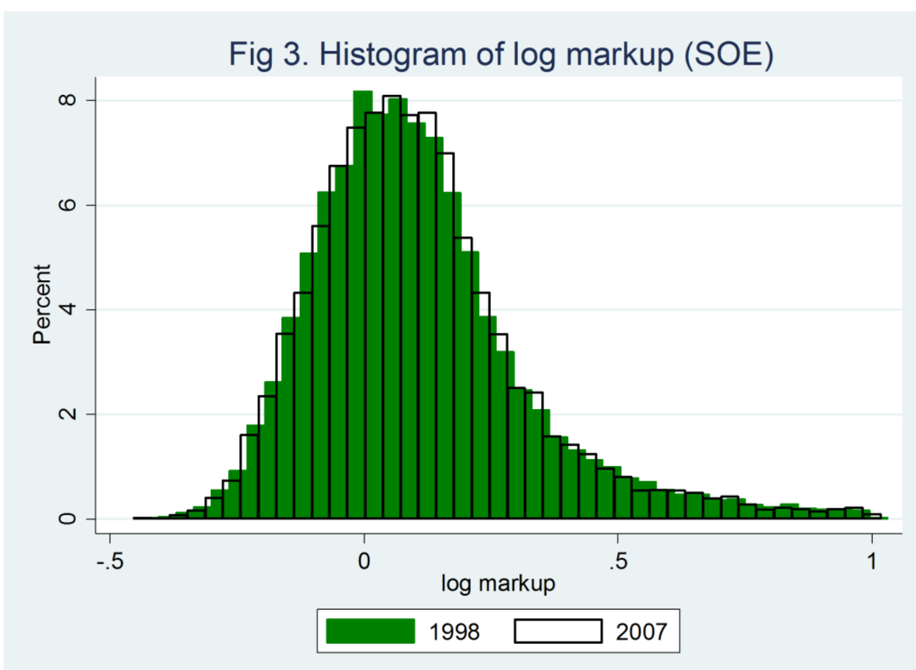


Table 4: Differences in the log capital-labor ratio

	Entire sample			Entire sample			Balanced sample		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs	-0.275***	-0.403***	-0.116**						
	(0.046)	(0.050)	(0.051)						
Top central SOEs				0.943***	0.828***	1.023***	0.679***	0.509***	0.836***
				(0.124)	(0.162)	(0.103)	(0.098)	(0.126)	(0.087)
Other SOEs				-0.283***	-0.407***	-0.128**	-0.196***	-0.297***	-0.086*
				(0.046)	(0.050)	(0.050)	(0.045)	(0.048)	(0.045)
Private firms	-0.523***	-0.700***	-0.451***	-0.523***	-0.699***	-0.451***	-0.483***	-0.669***	-0.340***
	(0.041)	(0.045)	(0.041)	(0.041)	(0.045)	(0.041)	(0.043)	(0.047)	(0.040)
Foreign firms	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,704,355	621,209	1,083,146	1,704,355	621,209	1,083,146	283,630	141,815	141,815
R-squared	0.169	0.174	0.180	0.170	0.175	0.180	0.253	0.268	0.235

Notes: (1) Clustered standard errors (3-digit CIC) are in the parentheses. (2) *** (**) indicates significance at the 1% (5%) confidence level.



Note: We limit the range of the log markup from -0.5 to 1.

Table 5: Differences in the log markup

	Entire sample			Entire sample			Balanced sample		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs	0.007	0.018***	-0.004						
	(0.004)	(0.004)	(0.005)						
Top central SOEs				-0.023	0.014	-0.051	-0.006	0.006	-0.012
				(0.086)	(0.096)	(0.074)	(0.087)	(0.093)	(0.081)
Other SOEs				0.007	0.018***	-0.003	-0.006	-0.006	-0.007
				(0.004)	(0.004)	(0.005)	(0.007)	(0.007)	(0.007)
Private firms	-0.022***	-0.015***	-0.026***	-0.022***	-0.015***	-0.026***	-0.023***	-0.026***	-0.021***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Foreign firms	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,704,355	621,209	1,083,146	1,704,355	621,209	1,083,146	283,630	141,815	141,815
R-squared	0.094	0.087	0.105	0.094	0.087	0.105	0.114	0.112	0.124

Notes: See Table 4.

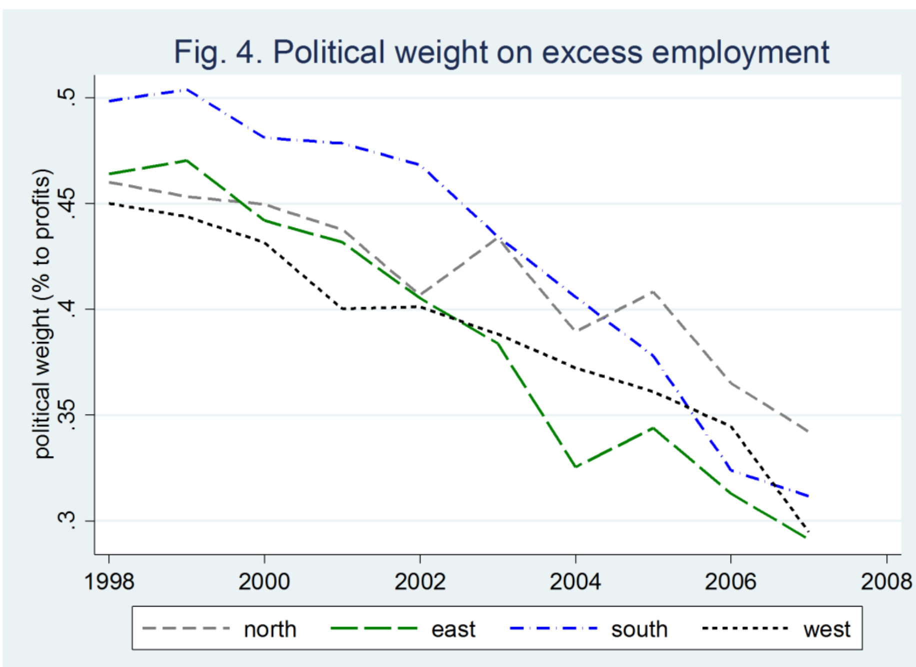


Table 6: Estimates for the SOEs' political benefit of excess employment

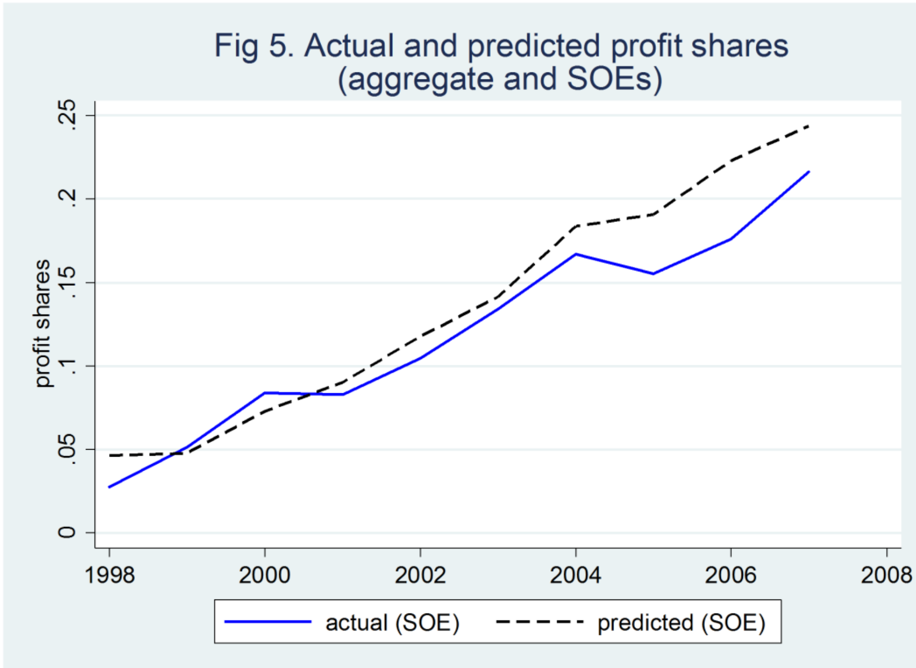
1. Entire sample

	All	North	East	South	West
Implied political weight in 1998 ($1\text{-}1/\phi_{1998}$)	0.548	0.560	0.537	0.523	0.516
Estimated coefficient on $D^{SOE}D^{1998}$ in equation (21)	0.794***	0.820***	0.769***	0.741***	0.725***
(standard errors)	(0.033)	(0.036)	(0.032)	(0.037)	(0.055)
Implied political weight in 2007 ($1\text{-}1/\phi_{2007}$)	0.269	0.308	0.239	0.247	0.313
Estimated coefficient on $D^{SOE}D^{2007}$ in equation (21)	0.313***	0.368***	0.273***	0.284***	0.375***
(standard errors)	(0.028)	(0.031)	(0.030)	(0.036)	(0.036)
Observations	1,673,443	264,705	870,524	400,938	137,276
R-squared	0.273	0.274	0.276	0.260	0.336

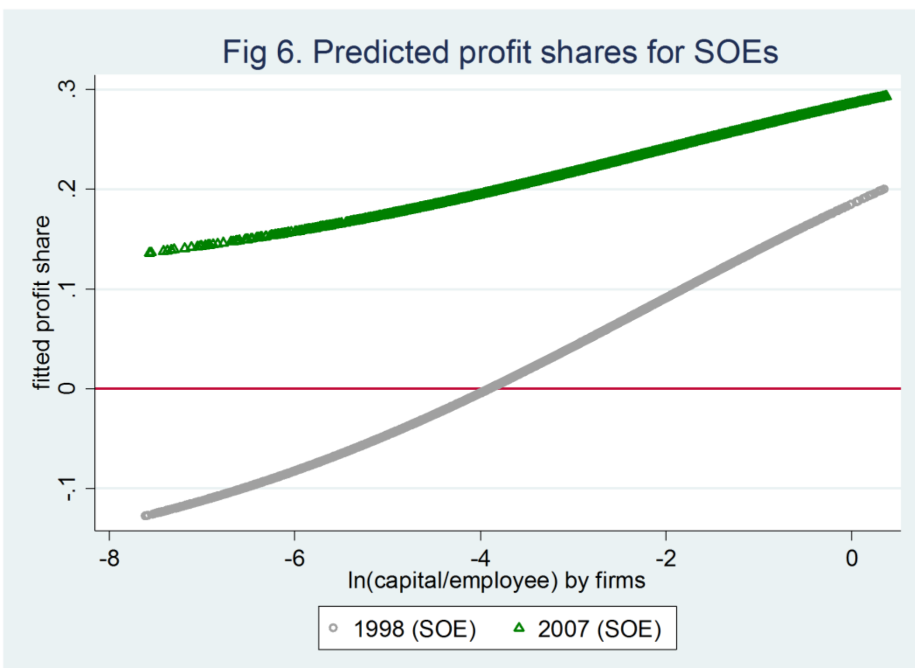
2. Balanced sample (continuers w/o ownership changes)

	All	North	East	South	West
Implied political weight in 1998 ($1\text{-}1/\phi_{1998}$)	0.485	0.460	0.464	0.498	0.450
Estimated coefficient on $D^{SOE}D^{1998}$ in equation (21)	0.664***	0.616***	0.624***	0.690***	0.598***
(standard errors)	(0.046)	(0.055)	(0.057)	(0.059)	(0.077)
Implied political weight in 2007 ($1\text{-}1/\phi_{2007}$)	0.311	0.342	0.291	0.311	0.295
Estimated coefficient on $D^{SOE}D^{2007}$ in equation (21)	0.373***	0.419***	0.344***	0.373***	0.349***
(standard errors)	(0.044)	(0.057)	(0.059)	(0.051)	(0.060)
Observations	162,544	22,967	87,541	37,864	14,172
R-squared	0.317	0.337	0.318	0.315	0.391

Notes: (1) Clustered standard errors (3-digit sectors) are in the parentheses. (2) All coefficients are statistically significant at the 1% confidence level. (3) All specifications include sector-, province-, and year-fixed effects. (4) We exclude the firms that are in the top and bottom 0.25% of the distribution of values for labor's share, markups, and the output elasticity of labor.



Note: We obtained the predicted profit shares using the estimated production parameters, the actual capital-labor ratio, and the average markup value (1.11).



Note: We obtained the predicted profit shares using the means of the estimated production parameters, the actual capital-labor ratios, and the average markup value (1.11).

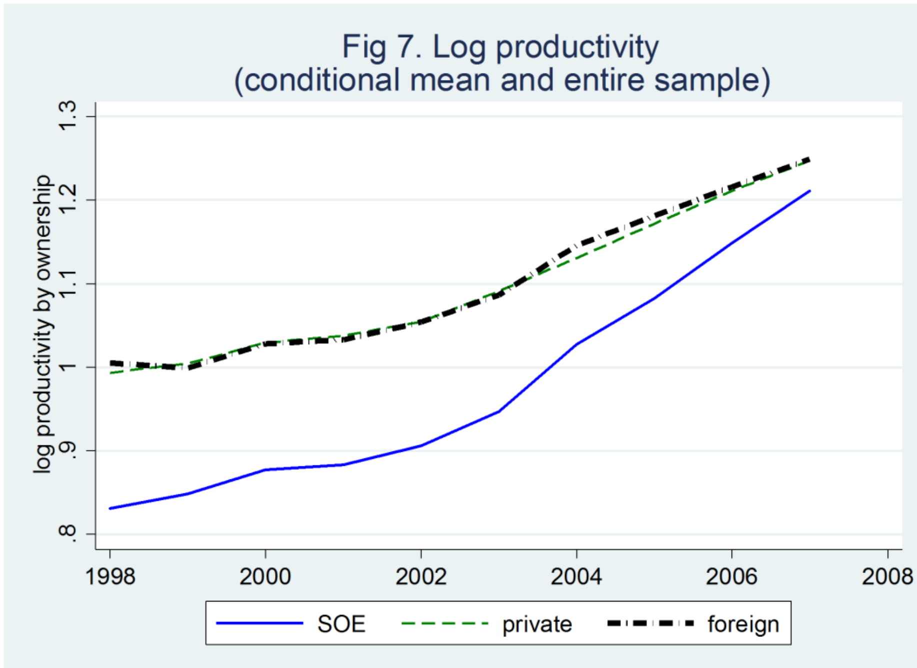


Table 7.1: Differences in log productivity

	Entire sample			Entire sample			Balanced sample		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs	-0.134***	-0.153***	-0.099***						
	(0.008)	(0.008)	(0.007)						
Top central SOEs				-0.003	-0.013	0.002	-0.005	-0.034	0.015
				(0.052)	(0.075)	(0.047)	(0.065)	(0.087)	(0.056)
Other SOEs				-0.135***	-0.154***	-0.100***	-0.114***	-0.128***	-0.097***
				(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)
Private firms	-0.005*	-0.006**	-0.004*	-0.005*	-0.006**	-0.004*	-0.035***	-0.036***	-0.035***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Foreign firms	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,704,355	621,209	1,083,146	1,704,355	621,209	1,083,146	283,630	141,815	141,815
R-squared	0.459	0.360	0.503	0.460	0.361	0.503	0.498	0.466	0.523

Notes: See Table 4.

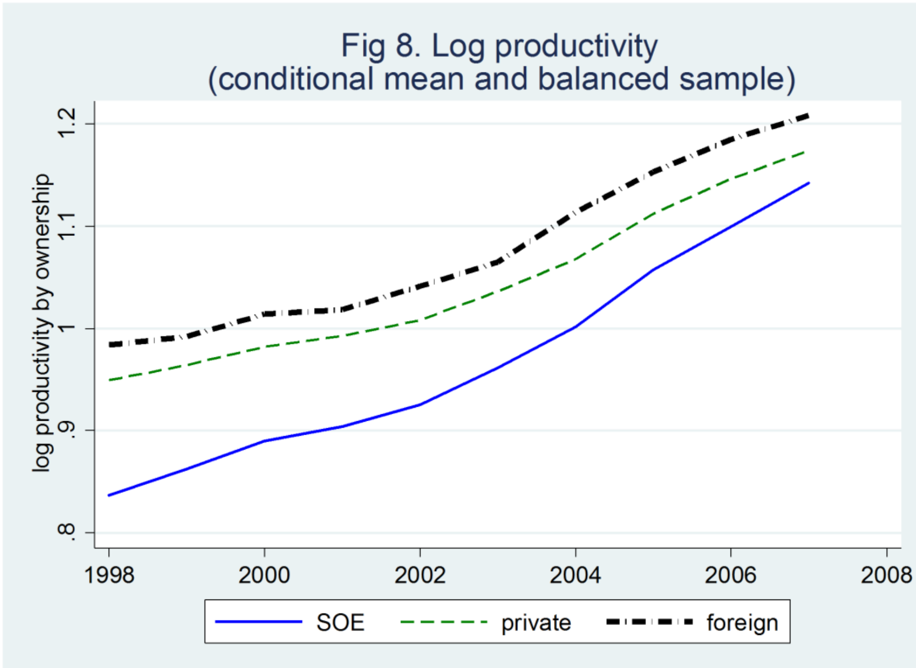


Table 7.2: Differences in log productivity for SOEs

	Entire sample		Entire sample		Balanced sample	
	98-02	03-07	98-02	03-07	98-02	03-07
SOEs (98-07)	-0.048***	-0.064***				
	(0.008)	(0.008)				
Top central SOEs (98-07)			0.076	0.064	0.064	0.072*
			(0.075)	(0.041)	(0.066)	(0.040)
Other SOEs (98-07)			-0.049***	-0.066***	-0.024*	-0.041***
			(0.008)	(0.008)	(0.013)	(0.015)
SOEs (98-02) to Foreign (03-07)	-0.018**	-0.016*	-0.018**	-0.016*	-0.015	-0.020
	(0.009)	(0.009)	(0.009)	(0.009)	(0.014)	(0.015)
Exiters	-0.109***		-0.109***			
	(0.011)		(0.011)			
SOEs (98-02) to Private (03-07)	set to 0	set to 0	set to 0	set to 0	set to 0	set to 0
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sector (2-digit CIC) dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	124,510	55,555	124,510	55,555	21,770	21,770
R-squared	0.200	0.375	0.201	0.376	0.374	0.479

Notes: (1) Clustered standard errors (3-digit CIC) are in the parentheses. (2) *** (**) indicates significance at the 1% (5%) confidence level. (3) See Table 1 for the number of observations for ownership changes for SOEs.

Table A.1: Summary statistics for SOEs

1. Entire sample

	Top central SOEs			Other SOEs			All SOE		
	1998	2007	change	1998	2007	change	1998	2007	change
The number of firms	120	231	92.5%	35,671	11,552	-67.6%	35,791	11,783	-67.1%
Real output (billion RMB)	370	1,054	185.3%	1,538	2,958	92.3%	1,908	4,012	110.3%
Employee (1,000)	1,762	1,433	-18.7%	19,527	6,540	-66.5%	21,289	7,973	-62.5%
Real capital (billion RMB)	387	477	23.3%	1,514	1,308	-13.6%	1,901	1,785	-6.1%
Profits/value added (%)	6.0%	21.7%	15.7%	1.8%	21.6%	19.8%	2.8%	21.6%	18.9%
Wage bill/value added (%)	18.6%	14.4%	-4.2%	35.3%	18.7%	-16.6%	31.5%	17.4%	-14.1%
Intermediate inputs/revenue (%)	71.4%	73.0%	1.6%	76.4%	76.4%	0.0%	75.5%	75.5%	0.0%
Share of unprofitable firms (%)	20.8%	12.1%	-8.7%	42.8%	21.9%	-20.8%	42.7%	21.7%	-20.9%
Real wage rate (RMB)	13,424	37,084	176.3%	7,764	24,445	214.9%	8,232	26,717	224.5%
Real capital/employee	0.220	0.333	51.6%	0.078	0.200	157.9%	0.089	0.224	150.7%

2. Balanced sample

	Top central SOEs			Other SOEs			All SOE		
	1998	2007	change	1998	2007	change	1998	2007	change
The number of firms	66	124	87.9%	5,924	3,415	-42.4%	5,990	3,539	-40.9%
Real output (billion RMB)	184	590	219.9%	643	1,574	144.7%	827	2,163	161.5%
Employee (1,000)	1,098	866	-21.1%	7,069	3,360	-52.5%	8,167	4,226	-48.3%
Real capital (billion RMB)	178	241	35.3%	662	703	6.3%	840	944	12.4%
Profits/value added (%)	11.4%	26.9%	15.5%	7.8%	21.9%	14.1%	8.7%	23.6%	14.9%
Wage bill/value added (%)	19.5%	14.5%	-5.0%	35.2%	19.2%	-16.0%	31.0%	17.6%	-13.4%
Intermediate inputs/revenue (%)	69.2%	67.6%	-1.6%	76.0%	76.6%	0.6%	74.5%	74.2%	-0.3%
Share of unprofitable firms (%)	22.7%	5.6%	-17.1%	26.3%	22.6%	-3.7%	26.3%	22.0%	-4.2%
Real wage rate (RMB)	11,994	39,910	232.7%	9,242	25,731	178.4%	9,612	28,636	197.9%
Real capital/employee	0.162	0.278	71.6%	0.094	0.209	123.5%	0.103	0.223	117.2%

Notes: See Table 2.

Table A.2: Robustness checks for the CES production function estimates

1. NLS with fixed effects

1.1 28 2-digit sectors (no convergence for 1 sector)

	Estimated parameters				% of sectors	
	Mean	St.dev	Min	Max	5% significant	σ_s>1
σ_s (elasticity of substitution)	1.584	0.216	0.949	2.043	100.0%	96.3%
α_s (weight on factor inputs)	0.175	0.032	0.125	0.249	100.0%	-
a_s (weight on labor)	0.829	0.099	0.519	0.959	100.0%	-

1.2 136 3-digit sectors (no convergence for 15 sectors)

	Estimated parameters				% of sectors	
	Mean	St.dev	Min	Max	5% significant	σ_s>1
σ_s (elasticity of substitution)	1.599	0.469	0.014	2.860	94.2%	95.0%
α_s (weight on factor inputs)	0.176	0.042	0.085	0.303	100.0%	-
a_s (weight on labor)	0.812	0.137	0.115	1.000	98.3%	-

2. Translog with Kmenta (1967)

2.1 28 2-digit sectors

	Estimated parameters				% of sectors	
	Mean	St.dev	Min	Max	5% significant	σ_s>1
σ_s (implied elasticity of substitution)	1.252	0.173	0.844	1.809	-	92.9%
ln(labor)	0.100	0.026	0.058	0.167	100.0%	-
ln(capital)	0.082	0.023	0.028	0.125	100.0%	-
ln(labor)ln(capital)	-0.007	0.005	-0.012	0.010	92.9%	-

2.2 136 3-digit sectors (no convergence for 3 sectors)

	Estimated parameters				% of sectors	
	Mean	St.dev	Min	Max	5% significant	σ_s>1
σ_s (implied elasticity of substitution)	1.282	0.356	0.428	2.765	-	82.7%
ln(labor)	0.099	0.037	0.031	0.247	100.0%	-
ln(capital)	0.081	0.028	-0.018	0.158	98.5%	-
ln(labor)ln(capital)	-0.006	0.012	-0.026	0.093	46.6%	-

Table A.3: Robustness checks for human capital and returns to scale

1. Unadjusted employee (σ_s>1 for 94.1% of the 3-digit sectors)

	Estimated parameters			
	Mean	St.dev	Min	Max
σ_s (elasticity of substitution)	1.462	0.310	0.715	2.275
α_s (weight on factor inputs)	0.183	0.059	0.048	0.339
a_s (weight on labor)	0.810	0.131	0.100	0.989

2. Value added/average wage (σ_s>1 for 94.1% of the 3-digit sectors)

	Estimated parameters			
	Mean	St.dev	Min	Max
σ_s (elasticity of substitution)	1.396	0.277	0.690	2.251
α_s (weight on factor inputs)	0.148	0.053	0.059	0.304
a_s (weight on labor)	0.829	0.138	0.095	0.989

3. Without the CRS Restriction (σ_s>1 for 93.3% of the 3-digit sectors)

	Estimated parameters			
	Mean	St.dev	Min	Max
Implied returns to scale	1.001	0.045	0.900	1.080
σ_s (elasticity of substitution)	1.404	0.311	0.637	2.441
α_s (weight on factor inputs)	0.179	0.053	0.058	0.334
α_s* (weight on factor inputs)	0.822	0.054	0.666	0.942
a_s (weight on labor)	0.837	0.134	0.065	0.985