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

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Abstract

China's state owned enterprises (SOEs) became profitable following the enactment of reforms to "grasp the big and let go of the small" in the mid-1990s. However, profitability is not necessarily indicative of restructuring because SOEs may receive preferential treatment from the state including bailouts, access to cheap inputs, and product market protections (Kornai, 1990; and 1992, Part III). Did China's SOEs become profitable because of their connections to the state or because they operated more productively? This paper shows that SOEs became more profitable for two reasons. First, because the elasticity of substitution between capital and labor generally exceeds unity and the SOEs' cost of capital relative to labor fell over time, SOEs earned profits by both drastically cutting labor and replacing labor with capital. Second, SOEs were under less political pressure to hire excess labor. While SOEs became more profitable, their productivity was lower than in private and foreign firms.

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1 Introduction

In 1978 China, under the leadership of Deng Xiaoping, initiated a set of reforms that have gradually moved the Chinese economy to a system that embraces markets. In the 1980s a major component of Chinese gradualism was that managers of State Owned Enterprises (SOEs) had incentives first to fulfill administrative targets and then to make profits. Several influential studies document that during the 1980s the SOEs were productive and profitable (Groves, Hong, McMillan and Naughton, 1994 and 1995; Jefferson, Rawski and Zheng, 1996; Li, 1997). However, it also well documented that by the early 1990s the SOEs had become unprofitable and were draining government budgets (Putterman and Dong, 2000).

Following Deng Xiaoping's celebrated Southern Tour in 1992, reforms designed to boost SOEs' profitability and overall performance were accelerated. In particular, following the announcement of the slogan "grasp the big and let go of the small" in the Fifth Plenary Sessions of Fourteenth Central Committee of the Communist Party in 1995, many large and medium sized SOEs were corporatized; and, many small SOEs owned by local governments were privatized.[1]

The Chinese Annual Surveys of Industrial Production (ASIP) provide a rich description of SOEs as well as private, foreign and collective firms in the manufacturing sector during the reform period of 1998-2007. Evidence from ASIP suggests that SOE performance dramatically improved during 1998-2007. Figure 1 illustrates that the share of unprofitable SOEs declined from 44 percent in 1998 to 22 percent in 2007; and, while the share of unprofitable SOEs in 1998 was much higher than the shares of unprofitable foreign and private firms, by 2007 the shares of unprofitable SOEs and foreign firms were roughly the same, and the differences between the shares of unprofitable SOEs and private firms had become much smaller. Figure 2 illustrates that SOEs' profit shares of value added sharply increased from 2.7 percent in 1998 to 22.2 percent in 2007. While SOEs had much lower profit shares than private and foreign firms in 1998, by 2007 the profitability of SOEs was comparable to the outcomes of private and foreign firms.

How did the Chinese SOEs become more profitable? It is well documented that in socialist and developing economies SOEs receive preferential treatment from the state including bailouts in periods of financial stress, access to cheap inputs and protections against competitors in product and

[1] These policies were discussed as early as 1993 and some of them were contained in the "Company Law" published in the 1994. For an overview of these reforms, see Hsieh and Song (2013).

input markets (see Kornai 1990; and 1992, Part III). Thus, an SOE might be profitable because it receives preferential treatment from the state and not because it operates productively. In order to determine how China's SOEs became profitable, we draw on recent applied theoretical work (Azmat, Manning and Van Reenen, 2012; and Karabarbounis and Neiman, 2014) and recent developments in micro-econometrics (De Loecker and Warzynski, 2012) and develop a comprehensive method for evaluating the performance of SOEs that focuses on firm-level payments to labor as a share of value added.

Firm-level value added includes payments to labor, profits, depreciation and tax payments to the government net of subsidies (net taxes). Thus, one minus labor's share in an SOE is a good proxy for the government's share because it includes payments to the state (profits and depreciation) as well as net taxes.[2,3] Moreover, labor's share is a more stable measure than profit's share, which can be negative, for example, when a firm is paying large up-front investment costs. Thus, understanding the evolution of labor's share for SOEs is useful for understanding SOEs' underlying production technology and profitability.

Figure 3 illustrates that labor's share of value added in SOEs fell from 30.9 percent in 1998 to 16.3 percent in 2007. In order to understand this sharp decline, it is noteworthy that SOEs around the world often receive product market protections from the state such as entry restrictions for potential competitors. SOEs may also be under political pressure from the state to hire excess labor. In this vein, Azmat et al (2012) build a model in which firms can enjoy some market power in product markets: moreover, while private firms maximize profits, SOEs have an objective function including profits and the political benefits of excess employment. The Azmat et al model predicts that an SOE pays a lower share to labor and earns more profits when the state gives it more product market protections and when the state puts it under less pressure to hire excess labor.

Another factor that is relevant to the decline in labor's share is that China's SOEs often receive preferential treatment from the state in input markets and this enables them to obtain capital goods

[2]SOEs include pure SOEs, joint operating SOEs, solely state-owned limited liability companies and all other shareholding companies in which the state has a controlling share of which there are two types: (1) absolute state controlled companies in which the state holds for more than 50% of total capital and (2) relative state controlled companies in which the state holds less than 50% of total capital, but effectively holds the control rights because its share is relatively large compared to the shares of other ownership categories. Thus, the government's capital share depends on the state share and also on the financial sources of capital.

[3]Profit shares, PS_{it}, are strongly dynamically associated with one minus labor's share, $(1 - LS_{it})$. Thus, if we regress $PS_{it} - PS_{i,t-1}$ on $(1 - LS_{it}) - (1 - LS_{i,t-1})$, we find that the coefficient is 0.486 for SOEs, 0.172 for private firms and 0.331 for foreign firms. These coefficients are all statistically significant at the 5 percent level.

more cheaply than private firms (see Tsai, 2002; Firth, Lin, Liu and Wong, 2009). It is well known that there is a strong link at the firm level between the cost of capital, the elasticity of substitution between capital and labor and labor's share (see, for example, Karabarbounis and Neiman, 2014). When the cost of capital is falling and the elasticity of substitution exceeds unity, firms make more profits by increasing the capital-labor ratio, in percentage terms, by more than the absolute value of the percentage decrease in the cost of capital. Thus, in this case, as the cost of capital falls, labor's share falls. When the cost of capital is falling and the elasticity of substitution is less than unity, firms can boost their profits by increasing the capital-labor ratio, in percentage terms, by less than the absolute value of the percentage decrease in the cost of capital. Thus, in this case, as the cost of capital falls, labor's share increases. In either case, an SOE can make more profits simply because the state provides capital goods more cheaply over time.

We find that SOEs become profitable (and thus decreased labor's share) for two reasons. First, SOEs increased their profits by radically laying off labor and by drastically increasing capital-labor ratios because their cost of capital fell and the elasticity of substitution in Chinese manufacturing sectors was greater than one. Figure 4 uses our measure of the cost of capital relative to labor,[4] and shows that SOEs could obtain capital more cheaply than private firms. Moreover, the cost of capital for SOEs fell by roughly 35 percent during 1998-2007. The second reason why SOEs gained profits and cut labor's share is that the political pressure for them to hire excess labor became less intense. Figure 5 illustrates that political weight of hiring excess labor relative to profits declined from 27.2 percent in 1999 to 13.2 percent in 2007 and that there were only small variations in this transition across regions.[5]

We also find that SOEs enjoyed substantial product market protections and had higher markups than private firms. However, because SOE markups do not exhibit much variation during 1998-2007 they do not explain the gains in SOE gains in profits. Moreover, SOE productivity was unimpressive and lower than in foreign and private firms.

Thus, at the same time that the SOEs were facing less political pressure to serve as "iron

[4] In Figure 4, the relative cost of capital is measured as $\left(\frac{1}{\sigma_s}\right)\ln\left(\frac{N_{it}}{K_{it}}\right) - \ln\left(\frac{a_s}{1-a_s}\right)$, where $\left(\frac{1}{\sigma_s}\right)$ is the reciprocal of elasticity of substitution between capital and labor in sector s, $\left(\frac{N_{it}}{K_{it}}\right)$ is the firm-level labor-capital ratio and $\left(\frac{a_s}{1-a_s}\right)$ picks up the relative importance of capital versus labor in the sectoral production function. See section 3 for a derivation.

[5] This political weight is described in section 3 and estimated in section 5.

rice bowls,"[6] SOEs were benefiting from their connections to the state and obtaining increasingly cheap capital. Our assessment of SOEs complements Young's (2003) finding that mobilizing labor, rather than productivity gains, drove the growth in China's non-agricultural state sector during 1978-1998. Our study shows that removing labor and replacing it with cheap capital, rather than productivity gains, enabled SOEs to become more profitable during 1998-2007. 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. Finally, consistent with the argument in Brandt, Van Biesebroeck and Zhang (2012) that exiting (as well as entry) promoted productivity,[7] we also find that productivity growth within SOEs mildly caught up to levels in private and foreign firms because many unproductive SOEs exited.

Our paper contributes to the debate about the possibility of restructuring SOEs without privatizing them. Shleifer and Vishny (1994) warn that this "corporatization" 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 were not productive is consistent with Shleifer and Vishnys' prediction that corporatization may not promote efficiency. Qian (1996) warns that the corporatization policy in China 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 and provides an overview of labor share trends. Section 3 uses a model to derive predictions about how political pressure to hire excess labor, product market competition, the elasticity of substitution between

[6] The iron rice bowl is a Chinese idiom referring to the system of guaranteed lifetime employment in state enterprises. Job security and level of wages were not related to job performance - but adherence to party doctrine played a very important role (BBC News).

[7] Brandt et al (2012) make this argument using a total factor productivity measure that nets out the contribution of capital and labor to value-added growth. This study uses a broader productivity measure that nets out the contribution of capital, labor and materials to output (revenue) growth.

capital and labor and user cost of capital determine an SOE's payments to labor as share of value added. Section 4 provides on overview of how the model is estimated, section 5 reports the results and section 6 concludes.

2 Labor's Share

2.1 Data Overview

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.[8] The analysis is limited to manufacturing firms.[9] Table 1 reports summary statistics from the ASIP aggregated by ownership. We follow Brandt et al (2012) and use a firm's registration type to determine its ownership which can include: state owned enterprises (SOEs), collective and hybrid enterprises (collectives), private foreign firms (foreign firms), and domestically owned firms (private 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 been through mergers and consolidations: and, as of 2014 there were 113 central SOEs.[10] Central SOEs are all big conglomerates and each owns many second-tier and third-tier SOEs.[11] They also have subsidiaries listed in the Shanghai Stock Exchange or Shenzhen Exchange, or even listed in Hong Kong. Within these central SOEs there are 53 SOEs located at even a higher political position that

[8] 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.

[9] We follow Brandt et al (2012) to use firm ID, name, industry, address and other information to track firms over time. One sixth of all firms that are observed for more than one year experience a change in their official ID over the sample period, probably due to restructuring, so it is important to track firms over time.

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

[11] 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.

are denoted "top central SOEs."[12] Their 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.[13] 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 on the local economies.[14]

Table 1 reports several key production and income variables aggregated by ownership groups. In this table and in several subsequent tables and figures, for ease of exposition, we exclude collectives because they constitute a small share of value added, employment, materials and capital.[15] Table 1.1 shows that the overall number of firms expands from 124,215 in 1998 to 277,744 in 2007. This expansion was largely driven by an almost ten-fold increase in the number of private firms, and offset by a roughly two-thirds decline in the number of SOEs. Another indication of the growing importance of private firms versus SOEs is the share of value added from private firms increased from 9 percent in 1998 to 45 percent in 2007, while the SOEs' share of value added was initially 42 percent and fell to 18 percent.

SOEs in China have traditionally been an important source of jobs. It is thus striking that overall employment in SOEs during 1998-2007 fell by 63 percent, while employment within private and foreign firms grew by 639 percent and by almost 200 percent, respectively. During 1998-2007, the capital-labor ratio in manufacturing grew by 58 percent; however, the growth within SOEs of 173 percent is much more rapid than the rates of 90 percent and 14 percent within private and foreign firms. Table 1.1 also shows that the overall real wage in manufacturing grew by 163 percentage. These gains are the sharpest within SOEs (229 percent), then within private firms (135 percent) and, lastly, within foreign firms (118 percent). SOE workers in 1998 were paid much less

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

[13] While they have this polititcal rank, they are not working as vice ministers.

[14] See Appendix 5 for summary statistics for the top central SOEs and the other SOEs.

[15] The category for collectives is included in the estimation results in Tables 1, 4, 5, 7.1 and 7.2. However, to save space, we do not report results for collectives in these tables.

than workers in foreign firms and marginally more than workers in private firms; by 2007 workers in SOEs had the second highest real wages.

Table 1.2 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 added increased overall by 12 percentage points; and, this gain is most pronounced in SOEs (a 19.5 percentage point increase) and then foreign firms (a 10 percentage point increase) and negligible within private firms (a 2 percentage point increase). Table 1.2 also shows that labor's share of value added fell by 8.6 percentage points: and, again, this change is most pronounced within SOEs (-14.6 percentage points) and then private firms (-6.9 percentage points) and is negligible within foreign firms (-1.1 percentage points). Clearly, government capital's share in SOEs increased and SOEs became more profitable during 1998-2007.

The data in Table 1 provides some hints as to just how these SOEs became profitable. While private and foreign firms hired more labor and gradually increased capital-labor ratios, SOEs hired less labor and more drastically increased capital-labor ratios. By 2007 SOEs were paying the highest real wages. However, during 1998-2007 SOEs labor shares fell sharply because contraction of employment was stronger than the growth in real wages.

2.2 Trends in Labor's Share

As we have already argued in the introduction, one minus a firm's labor share is a good proxy for government's share and is a useful measure of a firm's profitability. Thus, understanding just why SOEs' labor shares changed so dramatically can help us understand how SOEs became profitable.[16]

There are two standard approaches to computing firm-level value added: the production approach, which obtains value added from total sales minus operating costs; and, the income approach, which adds up capital depreciation, wage compensation, production taxes net of subsidies and operating profits to obtain value added. For technical reasons we use the production approach.[17] Our

[16] The stability of labor's share of value added or national income has been one of the stylized facts of growth (e.g., Gollin, 2002).

[17] If a firm incurs a large enough loss, labor compensation could be larger than value added and labor's share is negative. In our data, we employ the production approach because it creates less negative values for labor's share. In theory, value added from the income approach should be equal to that from the production approach. In practice, however, these two approaches often differ becuase of misreporting and because they use different systems for recording financial and production variables.

baseline measure of the labor's share is

$$LS_{it} = \frac{w_{it}N_{it}}{VA_{it}} \tag{1}$$

where $w_{it}N_{it}$ is labor compensation of firm i in year t, which is the product of the average wage rate (w_{it}) and the number of employees (N_{it}). Labor compensation includes several additional benefits beyond standard wages including unemployment insurance. Value added from the production approach is VA_{it}.

Figure 6 plots annual labor shares in the manufacturing sector; this figure also plots labor shares from China's corporate sector that uses the flow of funds method as computed by Karabarbounis and Neiman (2014). By our measure, labor shares declined by 8.6 percentage points (from 26 percent in 1998 to 17.4 percent in 2007); the Karabarbounis and Neiman (2014) measure shows a decline of 6.3 percentage points (from 54.5 percent in 1998 to 48.2 percent in 2007). The two measures tend to co-move. The Karabarbounis-Neiman measure includes the service sector, while our measure excludes this sector. Thus, the Karabarbounis-Neiman measure of labor's share is higher than our measure, in part, because the service sector tends to have higher labor shares than manufacturing sectors.[18] For the rest of the paper, however, we use our data from manufacturing sector because it enables us to look at detailed firm-level data.

Another concern with our approach is that labor's share is much lower than the figures from the national accounts. However, the results in this section and for the rest of the paper are robust when we follow the approach in Hsieh and Klenow (2009) and Brandt et al (2012) and inflate wage payments so that our aggregated firm-level labor share values are consistent with the national-level figures.[19]

In order to get some understanding for the link between the decline in labor shares and ownership, the change in labor shares is decomposed into its between and within effects according to a firm's ownership classification. To do this, we use the general decomposition method from Karabarbounis and Neiman (2014) who examine labor share changes across industries and within each industry. For our purposes, we examine the change in the labor shares arising from the com-

[18] The production approach that we use tends to understate labor shares because the compensation items (profits, wages, tax payments, etc.) sum up to 80% of the estimated value added. This is another reason our labor share is different from the Karabarbounis and Neiman (2014) measure.

[19] See Qian and Zhu (2013) for a detailed discussion of the different measures of labor shares in China. See Appendix 6 for the detailed methodologies and the adjustments.

position of ownership types versus the change in the labor shares within each ownership type. The equation used for this decomposition exercise is

$$\triangle LS = \sum \triangle S^o ALS^o + \sum \triangle LS^o AS^o. \tag{2}$$

In equation (2), the change in labor shares during 1998 to 2007 (i.e., -8.6 percentage points) is $\triangle LS = LS_{2007} - LS_{1998}$ where LS_{2007} and LS_{1998} are the labor shares in manufacturing in 2007 and 1998. We also define the following four variables: (1) the change in labor share of ownership type o is $\triangle LS^o = LS^o_{2007} - LS^o_{1998}$ where LS^o_{2007} and LS^o_{1998} are the labor shares aggregated across all firms of ownership type o in 1998 and 2007, (2) the change in the share in value added for ownership type o is $\triangle S^o = S^o_{2007} - S^o_{1998}$ where S^o_{2007} and S^o_{1998} are overall shares of the type o firms in value added in 1997 and 2008, (3) the average labor share for the ownership type o at 1998 and 2007 is $ALS^o = 0.5(LS^o_{2007} + LS^o_{1998})$, and (4) firm type o's average share in value added is $AS^o = 0.5(S^o_{2007} + S^o_{1998})$. In equation (2), the first term in the right-hand side is the between effect, which captures the change associated with the share of each ownership in value added. The second term is the within effect because it measures the change in the labor shares within each ownership type o.

Table 2 reports the results of this decomposition exercise: it lists between effects, within effects and total changes in labor's share for SOEs, private firms, foreign firms and collectives. The last row sums across ownership types and contains overall between effects, within effects and total changes. It is notable that almost 90 percent of the 8.6 percentage point decline in labor's share stems from within effects (-7.6 percentage points). Moreover, about three fifths of the within effect comes from within SOEs effects (-4.5 percentage points), followed by one fourth from the within effect of private firms (-1.9 percentage points).

A simple inspection of the breakdown of between effects by ownership categories provides some insight into why overall between effects are negligible. The large and negative between SOE effect (-5.3 percentage points) was driven largely by the privatization of SOEs. However, the privatization of SOEs led to an expansion in the number of private firms that was associated with a positive private between effect (6.7 percentage points) that more than offset the negative SOE between effect.[20]

[20] In the 1998-2002 there were 45,586 SOEs. As of 2003-2007 only 13,586 of these firms remained as SOEs; and, 229 became private foreign firms, 4,374 became private domestic firms and 229 became hybrids (collectives). The remaining 26,978 SOEs from 1998-2002 exited druing 2003-2007.

Thus, changes within SOEs, and not the privatization of SOEs, appear to have driven the declining labor shares during 1998-2007. Additional support for this assertion can be found in Appendix 2, where we decompose the total change in labor shares into the between and within effects for industrial sectors, provinces and exporter status. The results indicate that the composition changes of value added across industries, provinces and exporters do not explain a significant share of the decline in labor's share.

3 Labor's Share: Theoretical Considerations

In order to understand why labor's share fell in particular within SOEs during 1998-2007, in this section we build a simple model of Chinese SOEs and non-SOEs. We consider an economy inhabited by firms that are differentiated by sectors, denoted s, and ownership, denoted o and that operate in various time periods, denoted t. A firm i in period t uses labor (N_{it}), capital (K_{it}) and materials (M_{it}), and a sector-specific technology to produce a good. The technology for converting these inputs into outputs is the same in each sector and does not change over time. 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:

$$Q_{it} = \omega_{it} \left[a_s (N_{it})^{\frac{\sigma_s - 1}{\sigma_s}} + (1 - a_s)(K_{it})^{\frac{\sigma_s - 1}{\sigma_s}} \right]^{\frac{\alpha_s \sigma_s}{\sigma_s - 1}} (M_{it})^{1-\alpha_s} \tag{3}$$

In this specification, Q_{it} is real output for a firm i at time t; ω_{it} is firm-specific productivity[21]; a_s is the sector-specific weight on labor versus capital in factor inputs ($0 < a_s < 1$); 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.[22]

A firm operates in competitive input markets and can hire all of the labor, capital and materials it wants at input prices that are denoted w_{it}, r_{it}, and $\tilde{p}_{it}$, respectively. However, product markets

[21] Our productivity measure captures the overall efficiency of firms beyond their usage of labor, capital and materials. Thus, it is broader than total factor productivity (TFP) which measures the efficiency of producing value added with their usage of labor and capital. In Appendix 4, p.32, we also allow the productivity term to be labor-augmenting.

[22] The assumption of constant returns to scale is validated empirically in Appendix 4.

are imperfectly competitive and each firm faces an inverse demand function:

$$p_{it} = B_{it}(Q_{it})^{-\frac{1}{\eta_{it}}} \tag{4}$$

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

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

Because production functions exhibit constant return to scale, in what follows and without loss of generality, we simplify the analysis and set the wage for each firm equal to one.

SOEs that are de facto controlled and owned by the federal, provincial or local governments are also expected 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 $(1-1/\phi_{ot})N_{it}$ where $\phi_{ot} \geq 1$ for SOEs and $\phi_{ot} = 1$ for private, collective and foreign firms. Thus, the degree to which the state pressures SOEs to hire excess labor is increasing in ϕ_{ot}.

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

$$U_{it} = \Pi_{it} + \left(1 - \frac{1}{\phi_{ot}}\right) N_{it} \ \text{ s.t. } VA_{it} \geq 0 \tag{5}$$

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.[23] This setup is similar to Azmat et al (2012). One conceptual difference is that we use an output production function, while Azmat et al (2012) employ a value-added production function.[24] A second difference is a firm's production function in Azmat et al implies that the elasticity of substitution between capital and labor is unity, while our model allows this structural parameter to vary between zero and infinity.

We solve for the case in which the financial value added is non-binding and subsequently discuss

[23] A zero profits constraint is too strong since there are firms that in each period lose money. A non-negative value added constraint ensures that firms that operate in any period at a minimum do not destroy value.

[24] As suggested by Basu and Fernald (1995; 1997), the value-added production function could be misspecified if the firms face imperfectly competitive markets and the return to scale differs from one. We will show that most of Chinese manufacturing firms have positive markups, which indicates that the assumption of perfect competition is not appropriate. This is why we use the revenue-base production function versus the value-added production function.

the case in which the value added constraint is binding. The first order condition for maximizing equation (5) with respect to labor is

$$\phi_{ot}\left(1-\frac{1}{\eta_{it}}\right)\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}}=\frac{N_{it}}{p_{it}Q_{it}}. \tag{6}$$

The first order condition with respect to capital is:

$$\left(1-\frac{1}{\eta_{it}}\right)\frac{\partial Q_{it}/Q_{it}}{\partial K_{it}/K_{it}}=\frac{r_{it}K_{it}}{p_{it}Q_{it}}. \tag{7}$$

Then, from equations (3), (6) and (7), a simple expression for the firm-level labor-capital ratio as a function of sectoral production function parameters, firm-level costs and the political weight on labor is derived:

$$\frac{N_{it}}{K_{it}}=\left(r_{it}\phi_{ot}\frac{a_s}{1-a_s}\right)^{\sigma_s} \tag{8}$$

where the cost of capital (relative to labor) is $r_{it}\phi_{ot}$ and the nominal cost of capital (which does not account for the political weight on labor) is r_{it}. Thus, when $0<\sigma_s$ the labor-capital ratio is increasing in nominal price of capital (r_{it}), the political weight on labor (ϕ_{ot}), the cost of capital ($r_{it}\phi_{ot}$) and the weight on labor versus capital in factor inputs (a_s).

We lack the data necessary to compute the nominal and real costs of capital.[25] However, if we knew the sectoral production function parameters and if we could observe a firm's labor-capital ratio, then the cost of capital for each firm could be computed by inverting equation (8): $r_{it}\phi_{ot}=\left(\frac{1}{\sigma_s}\right)\ln\left(\frac{N_{it}}{K_{it}}\right)-\ln\left(\frac{a_s}{1-a_s}\right)$. This calculation of the cost of capital during 1998-2007 for private and foreign firms and SOEs has already been illustrated in Figure 4.

Finally, the first order condition for materials is:

$$\left(1-\frac{1}{\eta_{it}}\right)\frac{\partial Q_{it}/Q_{it}}{\partial M_{it}/M_{it}}=\frac{\tilde{p}_{it}M_{it}}{p_{it}Q_{it}}. \tag{9}$$

Using the first order condition for materials in equation (9) and $(\partial Q_{it}/Q_{it})/(\partial M_{it}/M_{it})=1-\alpha_s$,

[25] See Chirinko et al (2011) and their appendix for a discussion of the highly detailed data necessary for making this calculation.

it is straightforward to compute a firm's markup, μ_{it}:[26]

$$\mu_{it} = \frac{1}{1-\frac{1}{\eta_{it}}} = \frac{p_{it}Q(1-\alpha_s)}{\tilde{p}_{it}M_{it}}. \tag{10}$$

Using the markup equation (10) and the definition of value added, value added can be expressed as:

$$VA_{it} = p_{it}Q_{it} - \tilde{p}_{it}M_{it} = p_{it}Q_{it}\left(1 - \frac{1-\alpha_s}{\mu_{it}}\right) \tag{11}$$

Since $0 < 1 - (1-\alpha_s)/\mu_{it} < 1$, a firm always generates positive value added when $Q_{it} > 0$ and the value added constraint in equation (5) is non-binding.

Differentiating the production function equation (3) with respect to N_{it} and multiplying by N_{it}/Q_{it}, the expression for the output elasticity of labor is

$$\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} = \frac{\alpha_s a_s (N_{it})^{\frac{\sigma_s-1}{\sigma_s}}}{a_s(N_{it})^{\frac{\sigma_s-1}{\sigma_s}} + (1-a_s)(K_{it})^{\frac{\sigma_s-1}{\sigma_s}}}. \tag{12}$$

Note that if the production function is Cobb-Douglas ($\sigma_s = 1$), then $\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} = a_s\alpha_s$.

Finally, using equations (6), (8), (10), (11) and (12), a simple expression for labor share's of value added can be derived:

$$\begin{aligned} LS_{it} &= \frac{\phi_{ot}\alpha_s}{\mu_{it}-1+\alpha_s}\left[1+\left(\frac{1-a_s}{a_s}\right)\left(\frac{N_{it}}{K_{it}}\right)^{\frac{1-\sigma_s}{\sigma_s}}\right]^{-1} && (13)\\ &= \phi_{ot}\alpha_s\left[1+\left(\frac{1-a_s}{a_s}\right)^{\sigma_s}(r_{it}\phi_{ot})^{1-\sigma_s}\right]^{-1}[\mu_{it}-1+\alpha_s]^{-1}. && (14)\end{aligned}$$

Equation (14) can be rewritten to

$$LS_{it} = \phi_{ot}\alpha_s[F(\sigma_s, r_{it}\phi_{ot}, a_s)]^{-1}[G(\mu_{it}, \alpha_s)]^{-1} \tag{15}$$

where $F(\sigma_s, r_{it}\phi_{ot}, a_s) = 1+\left(\frac{1-a_s}{a_s}\right)^{\sigma_s}(r_{it}\phi_{ot})^{1-\sigma_s}$ is denoted the substitution effect and $G(\mu_{it}, \alpha_s) = \mu_{it} - 1 + \alpha_s$ is denoted the markup effect, and labor's share is decreasing in both terms.

In this setup, we obtain two results from Azmat et al (2012). First, higher markups μ_{it},

[26] 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.

strengthens $G(\mu_{it}, \alpha_s)$, which, in turn, lowers labor's share. Thus, a firm that gains market power will cut labor's share. Second, more political pressure, ϕ_{ot}, makes hiring labor more desirable for SOEs (where SOE's objective includes political benefits of excess employment). Thus, an increase in ϕ_{ot} causes an SOE to increase labor's share. This is the direct effect of ϕ_{ot} in equation (15).

Our innovation is to consider how changes in the cost of capital, $r_{it}\phi_{ot}$, can influence labor's share through the substitution effect, $F(\sigma_s, r_{it}\phi_{ot}, a_s)$. Our model draws on the well known result from micro-economic theory that impact of the cost of capital on labor's share depends on the elasticity of substitution between capital and labor. When labor and capital are substitutes ($\sigma_s > 1$), $F(\sigma_s, r_{it}\phi_{ot}, a_s)$ is decreasing in the cost of capital. In the Cobb-Douglas case where $\sigma_s = 1$, $F(\sigma_s, r_{it}, \phi_{ot}, a_s)$ does not change. And, when labor and capital are complements: $\sigma_s < 1$, $F(\sigma_s, r_{it}\phi_{ot}, a_s)$ is increasing in the cost of capital.

In equation (15) an increase in the nominal cost of capital, r_{it}, influences labor's share exclusively through the substitution term. Specifically, an increase in r_{it} increases the cost of capital, which causes labor's share to increase (decrease) when $\sigma_s > 1$ ($\sigma_s < 1$) and has no effect when $\sigma_s = 1$. However, an increase in the political weight, ϕ_{ot}, influences labor's share through its direct effect and by increasing the cost of capital in the substitution term for an SOE. Thus, when labor and capital are not complements, i.e. $\sigma_s \geq 1$, the model predicts that labor's share is increasing in ϕ_{ot}. In principle if the absolute impact of an increase in the political weight, ϕ_{ot}, is sufficiently strong through $F(\sigma_s, r_{it}\phi_{ot}, a_s)$ when $\sigma_s < 1$, then it is possible that labor share's can be decreasing in ϕ_{ot} . However, in Appendix 3 we show that for our functional form, the direct effect dominates the substitution effect and labor's share is always increasing in ϕ_{ot}.

By inspection of equations (14) and (15) labor's share is highly non-linear in the political weight on labor (ϕ_{ot}), which is one of our major parameters of interest. Thus, in our subsequent estimates of ϕ_{ot}, we redefine the substitution effect, $F(\sigma_s, r_{it}\phi_{ot}, a_s)$, so that the cost of capital ($r_{it}\phi_{ot}$) is replaced by the labor-capital ratio derived by a simple inversion of (8): $\tilde{F}(\sigma_s, N_{it}/K_{it}, a_s) = 1 + \left(\frac{1-a_s}{a_s}\right)\left(\frac{N_{it}}{K_{it}}\right)^{(1-\sigma_s)/\sigma_s}$:

$$LS_{it} = \phi_{ot}\alpha_s[\tilde{F}(\sigma_s, N_{it}/K_{it}, a_s)]^{-1}[G(\mu_{it}, \alpha_s)]^{-1} \tag{16}$$

This simplification creates some estimation issues that we will discuss in section 5.1.

4 Estimating the Sectoral Production Function

Our objective is to estimate equation (14). However, as previously noted, we do not have the necessary firm-level measures for the cost of capital. Thus, we estimate equation (16) which represents that relative cost of capital as a function of the firm-level labor-capital ratio and parameters of the sectoral production function. The empirical strategy has two stages. First, equation (3) is estimated using the general method of moments (GMM) procedure from De Loecker and Warzynski (2012). This first stage fully identifies structural variables fro each sectoral production functions, $\hat{\sigma}_s$, $\hat{\alpha}_s$, $\hat{a}_s$ and $\hat{\mu}_{it}$. Once we have obtained the estimates of these structural parameters, we proceed to use the sectoral parameters from the first stage and estimate political pressure on SOEs to excess labor in equation (16).

4.1 Estimation Strategy

The 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. And, the method of Chirinko et al (2011) requires a long and stable (stationary) time series for the production data and the real user cost of capital that we do not have.

In this paper, we follow a recent approach proposed by De Loecker and Warzynski (2012)[27] and obtain all the parameters (i.e., $\hat{\sigma}_s$, $\hat{\alpha}_s$, $\hat{a}_s$ and $\hat{\mu}_{it}$) using a GMM estimation procedure. 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.

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

Equation (3) is estimated in two stages. In the first stage estimating equation, the second-order polynomial function of the three inputs is included and, following standard practice, an exporter dummy variable (E_{it}) is included and interacted with the three inputs. Because SOEs might have special access in materials markets, an SOE dummy variable (D_{it}^{SOE}) is also included and interacted with the three inputs.[28] In this setup, materials are assumed to be the flexible input. The following first stage equation is estimated:

$$\ln(Q_{it}) = \Phi_t \left[\ln(N_{it}), \ln(K_{it}), \ln(M_{it}), E_{it}, D_{it}^{SOE}\right] + \epsilon_{it} \tag{17}$$

where the variables Q_{it} and M_{it} are deflated with industry-level output and input deflators from Brandt et al (2012).[29]

After the first stage equation is estimated, we obtain the fitted value of equation (17), $\hat{\Phi}_t$, 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

$$\ln(\bar{\omega}_{it}(\Omega)) = \hat{\Phi}_t - \frac{\bar{\alpha}_s \bar{\sigma}_s}{\bar{\sigma}_s - 1} \ln\left[\bar{a}_s (N_{it})^{\frac{\bar{\sigma}_s - 1}{\bar{\sigma}_s}} + (1 - \bar{a}_s)(K_{it})^{\frac{\bar{\sigma}_s - 1}{\bar{\sigma}_s}}\right] - (1 - \bar{\alpha}_s) \ln(M_{it}). \tag{18}$$

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 $\ln(K_{it})$, $\ln(N_{i,t-1})$,

[28] The interaction between the SOE dummy and the three inputs should capture potential distortions created by SOEs having special access to material inputs and enables us to accurately estimate the production function parameters.

[29] 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):[30]

$$E\left[\zeta_{it}(\Omega)\begin{pmatrix}\ln(K_{it})\\ \ln(N_{i,t-1})\\ \ln(K_{it})\ln(N_{i,t-1})\\ [\ln(K_{it})]^2\\ [\ln(N_{i,t-1})]^2\\ \ln(M_{i,t-1})\end{pmatrix}\right]=0 \tag{19}$$

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.[31]

Once we have these optimal parameters for each industry, we can obtain the value of the markup by using equation (10):

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

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.[32] This denominator would be biased if SOEs had preferential access to materials inputs: this would lead SOEs to over-use materials compared to private firms that lack this preferential access. 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 is 2.5 percentage points lower than in private firms, and 2.9 percentage points lower than foreign firms. While these

[30] 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.

[31] In the baseline case, we use $\Omega=(\bar{\alpha}_s,\,\bar{\sigma}_s,\,\bar{a}_s)$ where $0.05\leqq\bar{\alpha}_s\leqq 0.05+40\kappa$; $-0.3\leqq(\bar{\sigma}_s-1)/\bar{\sigma}_s\leqq-0.3+20\tilde{\kappa}$; $0.65\leqq\bar{a}_s\leqq 0.75+30\hat{\kappa}$ with the grid of $\kappa=0.005$, $\tilde{\kappa}=0.04$, and $\hat{\kappa}=0.01$.Note that we search over the comprehensive range of the elasticity of substitution: from 0.67 to 2.00. In Apppendix 4 we report various robustness checks.

[32] 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 there are many negative value added outcomes. Firm-level revenue is measured with much less noise than value added.

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.[33]

Table 3 reports three parameters of equation (3) for each of 28 2-digit CIC industries[34] estimated from the moment condition in equation (19). On average the weight on factor inputs ($\hat{\alpha}_s$) is 0.11 and the weight on labor relative to capital ($\hat{a}_s$) is 0.83. A surprising finding is that the elasticity of substitution between labor and capital ($\hat{\sigma}_s$) on average is 1.40: the lowest value of this structural parameter is 0.77 and the maximum value is 1.85. Moreover, the elasticity of substitution is less than unity only for five sectors.[35] These findings are somewhat surprising because they differ significantly from studies of the United States where, using different estimation methods, where it that the elasticity of substitution was found to less than one (see León-Ledesma, McAdam and Willman, 2010; Chirinko et al, 2011).

4.2 Substitution Effects

These results indicate that there is a high degree of the substitutability between labor and capital in the Chinese manufacturing sector. In this situation, our theory predicts that if the cost of capital declines over time, then SOEs can make profits by increasing capital-labor ratios and reducing labor's share.

Figure 4 illustrates the evolution of the log relative cost of capital for SOEs, private and foreign firms that we obtain by inverting equation (8). As already noted, the relative cost of capital was lower in SOEs than in private firms, indicating that SOEs had preferential access to capital. While the cost of capital was relatively stable for foreign firms, it fell gradually for SOEs and private firms.

[33] These results are available upon request.

[34] The 28 manufacturing sectors (CIC 2-digit code numbers are in the parenthesis) are Food Processing (13), Food Production (14), Beverages (15), Tobacco (16), Textile (17), Garments (18), Leather and Fur (19), Timber (20), Furniture (21), Papermaking (22), Printing (23), Cultural, Educational and Sports products (24), Petroleum Processing (25), Raw Chemical (26), Medical Products (27), Chemical Fibers (28), Rubber (29), Plastics (30), Non-metallic Mineral Products (31), Pressing of Ferrous Metals (32), Pressing of Nonferrous Metals (33), Metal Products (34), General Machinery (35), Special Equipment (36), Transport Equipment (37), Electrical Machinery and Equipment (39), Electronic and Telecom Equipment (40) and Instruments (41).

[35] 0.98 for "timber" (20), 0.85 for "furniture" (21), 0.77 for "cultural, educational and sports products" (24), 0.98 for "non-metallic mineral products" (31) and 0.77 for "pressing of nonferrous" (33).

In order to determine if the pattern illustrated in Figure 4 is robust after controlling for time-, province- and sector-fixed effects, the following equation is estimated:

$$\ln(X_{it}) = \theta^o D_{it}^o + \theta^p D_{it}^p + \theta^s D_{it}^s + \theta^t D_{it}^t + e_{it}. \tag{20}$$

In equation (20) the dependent variable $\ln(X_{it})$ is the log of the relative cost of capital 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 illustrated in Figure 4, their cost of capital was stable. Thus, equation (20) 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.

The results are reported in Table 4. There are 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 panel 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 from the entire sample shows that the relative cost of capital for SOEs fell by roughly 20 percent (from 0.256 log points in 1998-2002 to 0.035 log points in 2003-2007). The results indicate that although SOEs faced higher costs of capital in 1998-2002 relative to foreign firms, their cost of capital had declined to the level of foreign firms by 2003-2007. It is also striking that while the relative cost of capital fell by roughly the same amount within SOEs and private firms, SOEs maintained their privileged access to capital relative to private firms throughout 1998-2007.

The second set of estimates shows that the top central SOEs had preferential access to capital market compared to the other SOEs. For example, while the relative cost of capital for the top central SOEs was 66 percent cheaper than for the foreign firms in the entire period, for the other SOEs it was 16 percent more expensive. By comparing the second and third panels of the table, we can examine the impact of exit and entry for the differences in relative cost of capital. Because the findings for the balanced panel are somewhat similar to those in the entire sample, exit and entry do not appear to matter.

4.3 Markups

Our theory predicts that an increase in markups causes labor's share to fall. Figure 7 illustrates that SOEs markups exhibit very little time series variation, implying that markups cannot explain falling labor shares within SOEs. Figure 7 also indicates that SOEs have a higher weighted average of markups than private and foreign firms. This pattern, however, does not hold when we estimate equation (20) using the log of markups as the explanatory variable. Across all the estimation results regardless of the time periods, the log of markups for SOEs do not differ statistically from foreign firms (Table 5); however SOE markups are higher than foreign firms if we do not control for the differences in provinces, industries and years (Figure 7).

Our results from Figure 7 and Table 5 jointly indicate that SOEs were in the high markup industries and this is consistent with the findings in Li, Liu and Wang (2012). Table 5 also confirms that there were no significant changes in markups in the 1998-2002 and 2003-2007 periods. Finally, as in the second and third panels, markups for the top central SOEs and all other SOEs do not change over time. Thus, there was no apparent change in product market protections granted to SOEs and product market competition cannot explain declining labor share within SOEs.

5 Estimating Labor Shares

5.1 Pooled and Dynamic Estimations

Using our estimates for the production parameters ($\hat{\sigma}_s$, $\hat{\alpha}_s$, $\hat{a}_s$, and $\hat{\mu}_{it}$), we log equation (16) and estimate the log of firm-level labor shares as a function of the substitution effect (i.e., $\tilde{F}(\cdot) = \tilde{F}(\hat{\sigma}_s, N_{it}/K_{it}, \hat{a}_s)$), the markup effect (i.e., $G(\cdot) = G(\hat{\mu}_{it}, \hat{\alpha}_s)$), and time-invariant political weight on excess employment (i.e., $\phi_{ot} = \phi_o$):

$$\begin{aligned} \ln(LS_{it}) \quad = \quad & \delta \ln(LS_{i,t-1}) + \delta^{\sigma} \ln\left[\tilde{F}(\cdot)\right] + \delta^{\mu} \ln\left[G(\cdot)\right] + \delta^{\phi} D_{it}^{SOE} \\ & + \delta^{p} D_{it}^{p} + \delta^{s} D_{it}^{s} + \delta^{t} D_{it}^{t} + e_{it}. \end{aligned} \tag{21}$$

This estimating equation enables us to recover the implied sectoral political pressure to hire excess labor, ϕ_o. To do this, we use D_{it}^{SOE}, which is a dummy variable that equals one for an SOE and is zero otherwise. Our benchmark estimating equation includes province-, sector- and year-specific fixed effects.[36] The sector-fixed effects are important for two reasons. First, sector-specific fixed effects capture α_s (the output elasticity of materials) in equation (16). Second, they capture measurement errors associated with the parameters ($\hat{\sigma}_s$, $\hat{\alpha}_s$ and $\hat{a}_s$) estimated from equation (19). We also include the one-year lagged value of log labor share to capture the dynamic character of our analysis.

Equation (21) is estimated using ordinary least squares (OLS). For each explanatory variable, we report the estimated parameters and their standard errors (clustered at the 2-digit CIC level) in parentheses. Models 1 through 8 are variants of equation (21). Model 5 contains all of the variables in equation (21) and is the baseline. Models 1 through 4 drop selected variables from the baseline. Because there are macro-level discrepancies in labor shares between the ASIP and NBS data in model 6 we follow the approach in Klenow and Hsieh (2009) and adjust the ASIP data so that it matches the NBS data (see Appendix 6 for a detailed explanation). Because there is a potential concern that top central SOEs are run very differently than the other SOEs, in model 7 the top central SOEs are dropped from the sample. In order to check if these results are robust when the effects of entry and exit are ignored, in model 8 the sample is a balanced panel.[37]

Consistent with the predictions of our theory, the results in Table 6.1 indicate that labor's share is positively associated with the political weight on excess employment and negatively associated with the markup and labor-capital substitution terms. These associations are precisely estimated and statistically significant at the 5 percent confidence level. However, while our theory says that the expected coefficients for the markup and labor-capital substitution terms are both negative one and our estimates for these regressors are negative but lower in absolute magnitude than negative one. (In the next section we show how the political weight on excess employment can be derived when the markup and substitution terms are set to negative one). It is straightforward to convert the estimated SOE regressor, $\hat{\delta}^{\phi}$,to quantify the political pressure to hire excess labor.

[36] The province-fixed effects would capture the other potential factors that determine labor share. For example, the accumulation of human capital would be province- or region-specific factor (e.g., Cheng, Morrow and Tacharoen, 2013).

[37] When we estimate models 1 through 8, we eliminate the observations for each year if the firms are included in the top and bottom 0.5% values for each of labor's share (LS_{it}), markup ($\hat{\mu}_{it}$) and productivity ($\hat{\omega}_{it}$). Our data contain 1,767,214 observations from 472,402 firms and 10 years. We drop 46,261 observations as the outliers and have 1,720,953 for estimating models 1 and 2. The inclusion of the lagged labor share further reduces the observations to 1,207,486. Even if we drop these outlier values, we have 59,680 observations of labor share, which are greater than one. To account for these observations, we use the Tobit estimation method with the right-censored value greater than zero for log labor's share and confirm the robustness of the results.

For example, consider the benchmark equation (Model 5) in which $\hat{\delta}^{\phi} = \ln(\hat{\phi}_o)$ is estimated to be 0.273. As specified in equation (5), this coefficient implies that SOEs place a 23.9 percent weight $(1 - 1/\hat{\phi}_o = 1 - 1/\left[\exp(0.273)\right] = 0.239)$ on employment relative to profits.

Table 6.2 focuses on the dynamic character of labor's share. Estimating the objective parameters consistently requires that we deal with several standard econometric issues. The first issue is serial correlation. As has already been shown (see Table 6.1), the log labor share for firm i at year t (i.e., $\ln(LS_{it})$) correlates with its lagged value (i.e., $\ln(LS_{i,t-1})$), which could cause dynamic panel bias (Nickell, 1981). The second issue is simultaneity and endogeneity. In particular, the labor-capital ratio in the substitution effect term is a function of the cost of capital (i.e., the political weight on excess employment (ϕ_o) times the nominal cost of capital (r_{it})) as in equation (14). As previously explained, because we do not have reliable administrative data necessary for calculating the direct (and exogenous) real user cost of capital, we compute the real cost of capital using the labor-capital ratio and inverting equation (8). Another issue is that the markup can be endogenous when it is computed as the marginal product of labor divided by the labor share of revenue if labor is a flexible input (i.e., De Loecker and Warzynski, 2012). In order to overcome this endogeneity issue, the markup is computed by dividing the marginal product of intermediate inputs with the revenue share of intermediate inputs as in equation (10).

Model 1 in Table 6.2 handles serial correlation: this could be an issue since the panel data set used spans ten continuous years. We use the traditional robustness test and check the time differenced series of our variables. Since the time-differences eliminate any constant terms, we are forced to drop the political weight on employment. Nevertheless, we obtain the expected signs for both the markup and substitution effect terms. Moreover, the magnitudes for both terms are even stronger (i.e., the labor-capital substitution effect is -0.651 and the markup effect is -0.554) than the previous results that did not use time-differencing (i.e., models 3 through 8 in Table 6.1). Results are robust when the AR(1) adjustment in Baltagi and Wu (1999) with the firm-level fixed effects is used.

Finally, to deal with endogeneity and serial correlation simultaneously, the baseline equation is estimated using Arellano and Bond's (1991) differenced GMM procedure and Blundell and Bond's (1998) system GMM procedure. We report various specifications, depending on whether both the substitution and markup effect terms are treated as endogenous variables in addition to the lagged log labor share. Again, because of the inclusion of time-differencing or firm-fixed effects, the political weight on employment is dropped. Nevertheless, results are similar to those reported in Table 6.1. Overall, the results in Table 6.1 and 6.2 support our theoretical predictions of just how markups, political pressure to hire excess labor and labor-capital substitution influence labor's share.

5.2 The Evolution of Political Pressure to Hire Excess Labor

In order to examine how political pressure to hire excess employees has evolved during 1999-2007, equation (21) is modified and $\delta^{\phi} D_{it}^{SOE}$ is replaced with the time-varying term with $\delta_t^{\phi} D_{it}^{SOE}$:

$$\begin{aligned} \ln(LS_{it}) &= \delta \ln(LS_{i,t-1}) + \delta^{\sigma} \ln\left[\tilde{F}(\cdot)\right] + \delta^{\mu} \ln\left[G(\cdot)\right] + \delta_t^{\phi} D_{it}^{SOE} \\ &\quad + \delta^{p} D_{it}^{p} + \delta^{s} D_{it}^{s} + \delta^{t} D_{it}^{t} + e_{it}. \end{aligned} \tag{22}$$

If the reforms announced in 1995 in the Fourteenth Party Congress were de facto enacted, then it should be observed that SOEs were under less political pressure over time to hire excess workers. If this was the case, then this would provide another explanation (along with substitution effects) for the decline in labor's share of value added in SOEs as shown in Figure 3.

Table 6.3 reports the results for the panel from all observations (All) as well as four regions (North, East, South and West) of China.[38] The first column reports the results from all observations. Although coefficients related to political pressure are estimated for each year, in order to see in the simplest fashion just how political pressure to hire excess labor has changed over the entire period, we only report the coefficients for the years 1999 and 2007. The coefficient for political pressure is 0.317 in year 1999, and by 2007 it has fallen to 0.141. This means that the political weight $(1 - 1/\hat{\phi}_{ot})$ went from 27.2 percent in 1999 to 13.2 percent in 2007 relative to profits. These estimates are statistically significant at the 5 percent confidence level in both years and indicate that over time SOEs could pay more attention to making profits. The declines in political pressure to hire excess labor are slightly different across the regions and are more pronounced in reformist

[38] Each region includes the following provinces or province-equivalent municipal cities. North: Beijing, Tianjin, Hebei, Shanxi, Neimenggu, Liaoning, Jilin and Heilongjiang, East: Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi and Shandong, South: Henan, Hubei, Hunan, Guangdong, Guangxi and Hainan, and West: Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shan'xi, Gansu, Qinghai, Ningxia and Xinjiang.

regions such as the East and South, and less pronounced for the North and West regions (Table 6.3 and Figure 5).

As already discussed in the previous section, while the estimated substitution and markup effects in (16) that we use to compute political pressure are negative and qualitatively consistent with our theory, these estimated effects are smaller in absolute magnitude than the values of negative one from our theory. Thus, as robustness check we take our model seriously and recover the political weights on excess employments from equation (16) when the coefficients on the substitution and markup effects are both set to negative one. To do this, first the theoretical residual in labor share for each firm in each year are calculated:

$$\ln(LR_{it}) \equiv \ln(LS_{it}) + \ln\left[\tilde{F}(\cdot)\right] + \ln\left[G(\cdot)\right] - \ln(\alpha_s).$$

Then, an equation similar to equation (22) to recover the political weights is estimated:

$$\ln(LR_{it}) = \delta \ln(LR_{i,t-1}) + \delta_t^{\phi} D_{it}^{SOE} + \delta^p D_{it}^p + \delta^s D_{it}^s + \delta^t D_{it}^t + e_{it}. \quad (23)$$

Table 6.3 also reports the results for equation (23). Although the political weights are slightly weaker, they exhibit a very similar declining trend during 1999-2007.

5.3 Productivity

If SOEs had successfully restructured during 1998-2007, then they would have had exhibited a high level of productivity. Figure 8 illustrates that this is not the case. Throughout 1998-2007, productivity within SOEs was lower than within private and foreign firms. Moreover, Figure 8 suggests that average productivity within SOEs[39] did not make progress in catching up with private and foreign firms.

The general pattern in Figure 8 is only partially robust when we account for fixed effects and estimate equation (20) using the log productivity as the explanatory variable. The results of this estimation are reported in Table 7.1. The first set of estimates from the entire sample shows that, consistent with Figure 8, private and foreign firms have comparable productivity performance, and the productivity of SOEs is 5.5 percent lower than that of foreign firms during 1998-2007.

[39] Average is weighted by output (revenue).

However, in contrast to Figure 8, the productivity gap between SOEs and foreign firms shrinks by 3.6 percentage points (from -0.072 log points in 1998-2003 to -0.036 log points in 2003-2007).

The second set of estimates from the entire sample shows that the other SOEs (i.e., not top central SOEs) are the laggards in terms of productivity. The productivity of top central SOEs is similar to the levels in foreign and private firms. However, we cannot draw sensible inferences about the top central SOEs because they have high standard errors. In this second set of estimates, the productivity gap between other SOEs and foreign firms shrunk by 3.6 percentage points.

These results are qualitatively robust when we limit the sample to a balanced panel. However, this shrinkage of this productivity gap between other SOEs and foreign firms in the balanced panel was only 1.8 percentage points (from -0.059 log points in 1998-2003 to -0.041 log points in 2003-2007), which is less profound than the 3.6 percent decline in the entire sample. These results imply that the exits of unproductive SOEs were responsible for the productivity catch-up of SOEs; this is consistent with the general argument in Brandt et al (2012) that entry and exit promoted productivity.

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. Table 7.2 reports the evolution of productivity for the 45,586 firms that were SOEs in 1998-2002. Within this group, 13,586 were continuing SOEs, 538 became collectives, 229 were privatized as foreign firms and 4,374 were privatized as domestic firms. We use firms that were SOEs in 1998-2002 and who were private (domestic) firms as of 2003-2007 as the reference group and estimate an specification similar to equation (20). However, we use the sample from 45,586 SOEs, change the ownership dummy variable to the ownership *change* dummy variable and use the log of productivity as the dependent variable.

In Table 7.2 the first set of estimates from the entire sample shows the productivity of SOEs that had become private firms was similar to the productivity of SOEs that had become foreign firms. And, in the first set of estimates the continuing SOEs were less productive than SOEs that had privatized as of 2003-2007, and it is striking that the SOEs that had exited prior to 2003-2007 were almost 4.6 percent less productive than the SOEs that had been privatized. This indicates that continuing SOEs depressed productivity, while the exiters promoted productivity. Finally, while the other SOEs continuers had lower productivity than SOEs that became private in the entire sample, there was no significant difference between these two groups in the balanced panel. This is additional evidence indicating SOE exiters enhanced productivity.

6 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 SOE performance that considers a host of indicators besides profits including product market competition, political pressures to hire excess labor, the cost of capital and productivity. We find that SOEs benefited from their connections with the state primarily for two reasons: the state gave the SOEs preferential access to capital, and the state also lowered over time the pressure on SOEs to hire excess labor. Because Chinese manufacturing have an elasticity of substitution between capital and labor that exceeds unity, then SOEs could be profitable by simply cutting labor and rapidly accumulating capital. We also find that most SOEs earned profits without being productive.

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. Our results are an update to Young's (2003) findings that the Chinese non-agricultural sector during 1978-1998 grew to a large extent by mobilizing labor and without much productivity gain. During Young's period of study, SOEs accounted for a large share of the non-agricultural sector. Our period of analysis post-dates Young's and is also a time when there is much more private activity. We find that while SOEs were profitable, they were less productive than foreign and private firms.

Finally, the results of our 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 (2013) 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.

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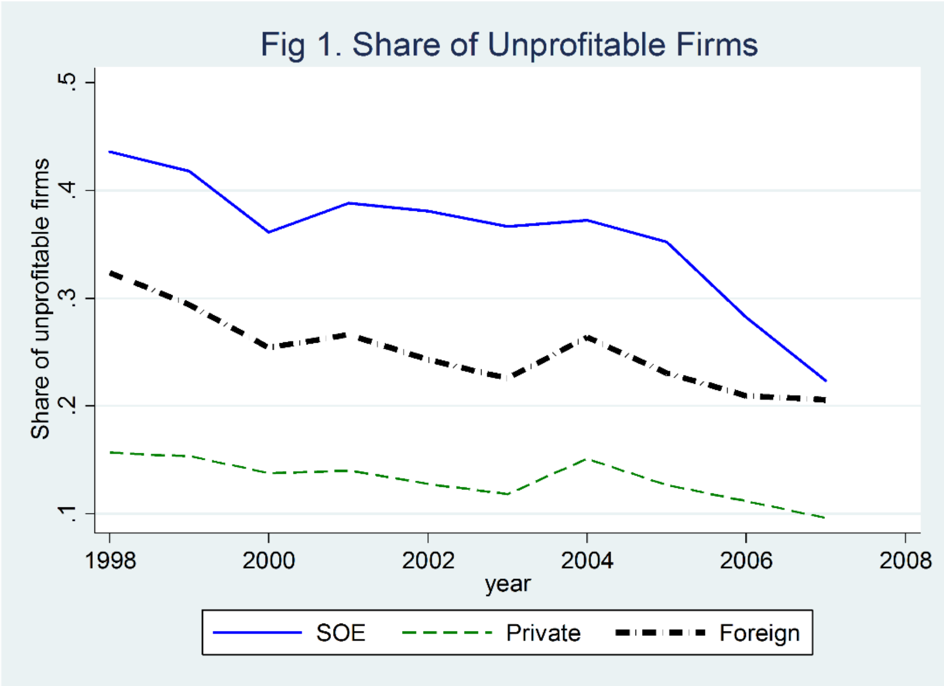
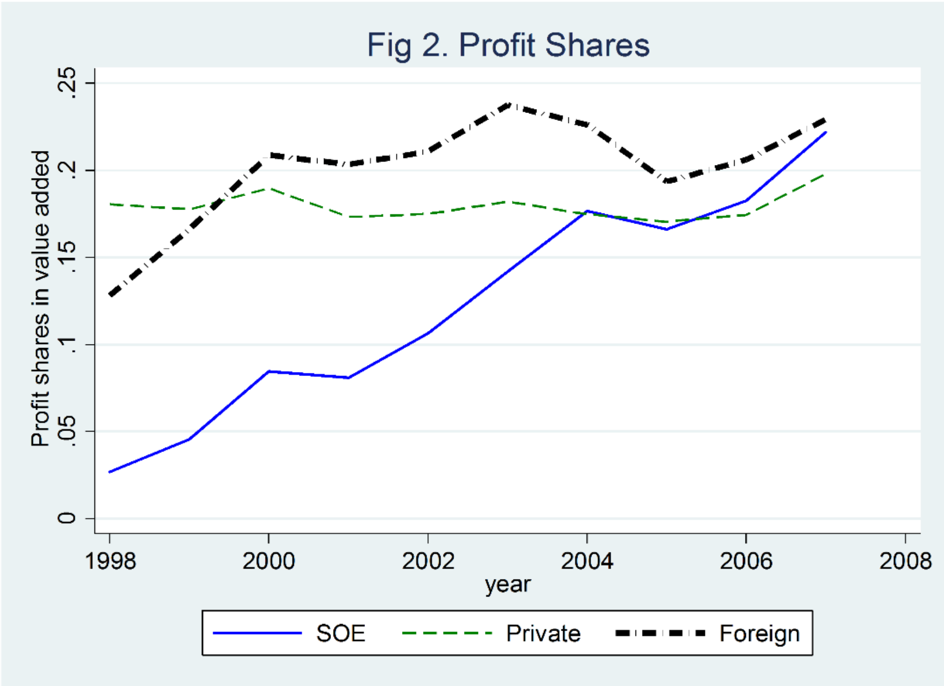
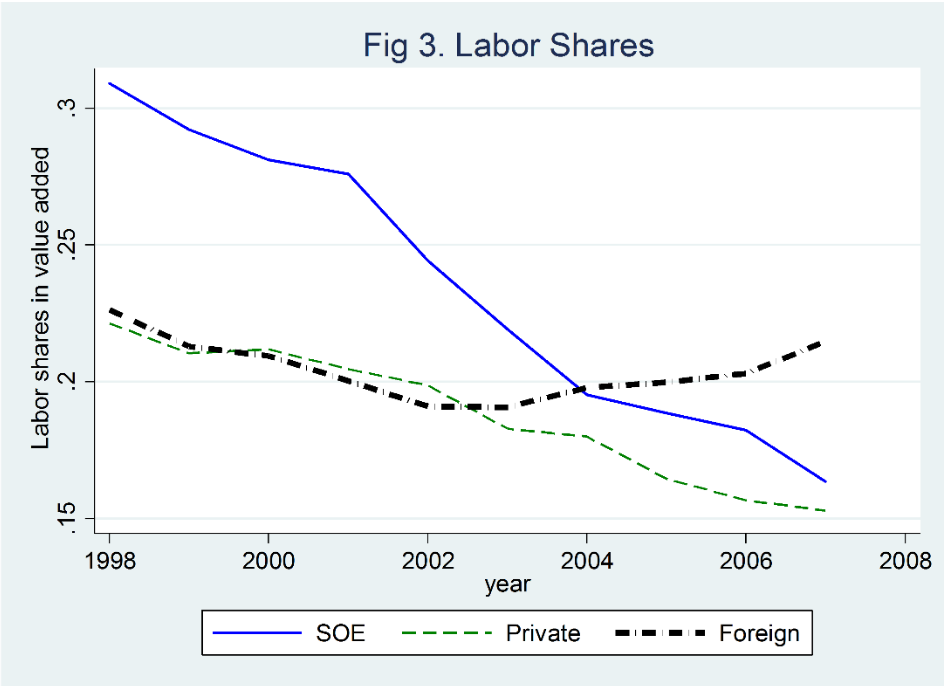
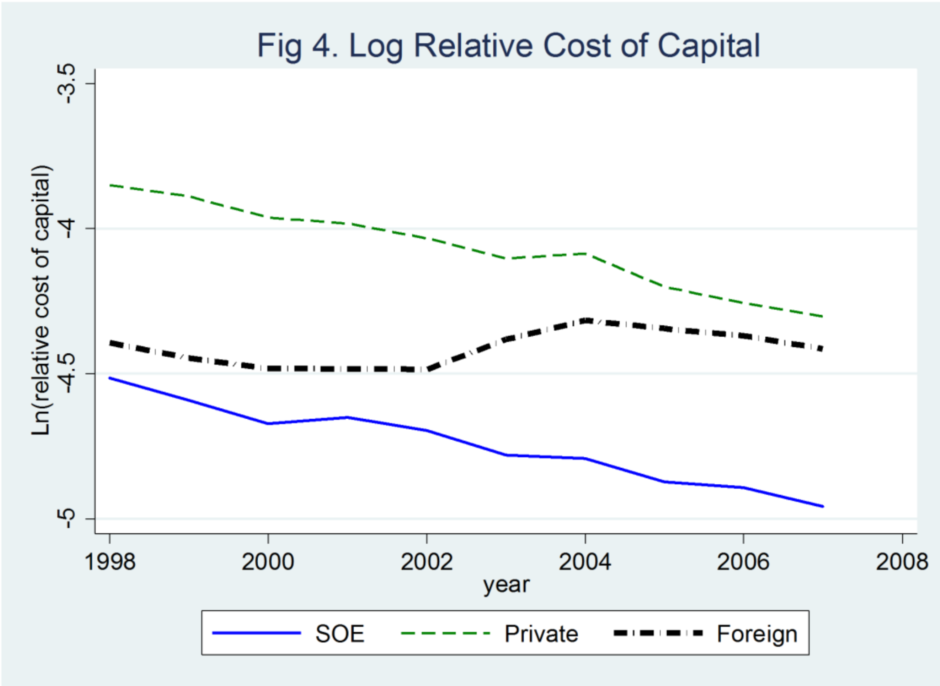
Tables and Figures









Note: Top and bottom 0.5% of outlier values are dropped. Weighted by output (revenue).

Table 1. Summary Statistics Aggregated by Ownership

1. Production Variables

	SOE			Private			Foreign			Total		
	1998	2007	change	1998	2007	change	1998	2007	change	1998	2007	change
The number of firms	38,208	12,501	-67.3%	18,353	194,614	960.4%	21,830	56,636	159.4%	124,215	277,744	123.6%
Value added (billion RMB)	620	1,313	111.8%	138	3,351	2321.0%	372	2,477	565.5%	1,476	7,505	408.6%
Employee (1,000)	23,274	8,511	-63.4%	4,030	29,790	639.1%	6,560	19,521	197.6%	44,911	60,889	35.6%
Real capital (billion RMB)	2,200	2,195	-0.2%	200	2,808	1302.0%	746	2,520	237.9%	3,647	7,811	114.2%
Real wage rate (RMB)	8,232	27,086	229.0%	7,602	17,875	135.1%	12,831	27,913	117.5%	8,558	22,489	162.8%
Real capital/employee	0.095	0.258	172.9%	0.050	0.094	89.7%	0.114	0.129	13.5%	0.081	0.128	58.0%

Notes: (1) The column of "change" reports a percentage change from 1998 to 2007. (2) We do not report collectives/hybrid firms due to the space constraint. (3) The industry-level output deflator (1998 prices) is used to deflate value added and wage.

2. Income Variables

	SOE			Private			Foreign			Total		
	1998	2007	change	1998	2007	change	1998	2007	change	1998	2007	change
Profit/value added (%)	2.7%	22.2%	19.5%	18.0%	19.8%	1.7%	12.8%	22.9%	10.1%	9.1%	21.2%	12.1%
Wage bill/value added (%)	30.9%	16.3%	-14.6%	22.1%	15.3%	-6.9%	22.6%	21.5%	-1.1%	26.0%	17.4%	-8.6%
Share of unprofitable firms (%)	43.6%	22.3%	-21.2%	15.6%	9.6%	-6.0%	32.4%	20.6%	-11.8%	27.9%	12.6%	-15.3%

Notes: (1) The column of "change" reports a percentage-point change from 1998 to 2007. (2) 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.

Fig. 5. Political Weight by Region

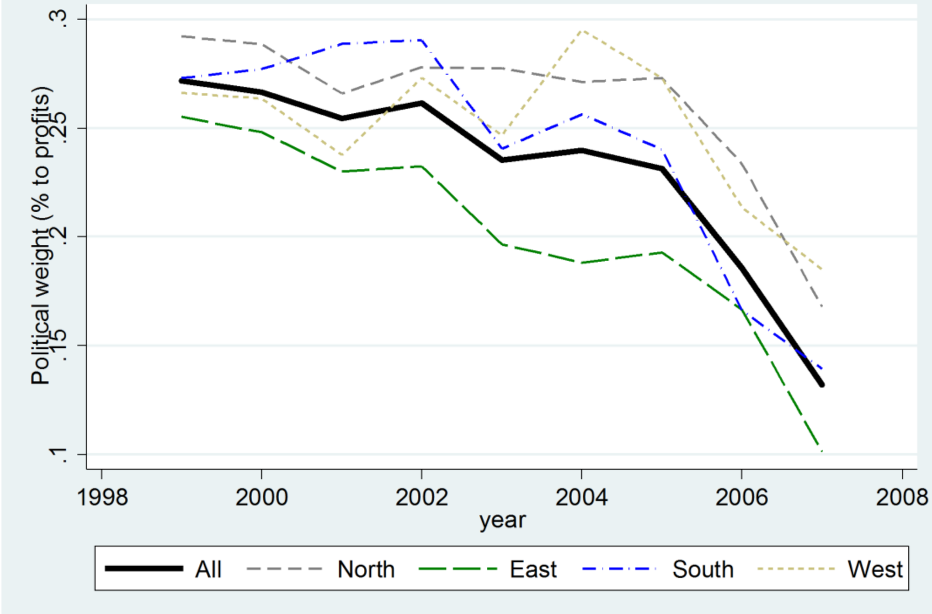


Fig 6. Trends in Labor Shares

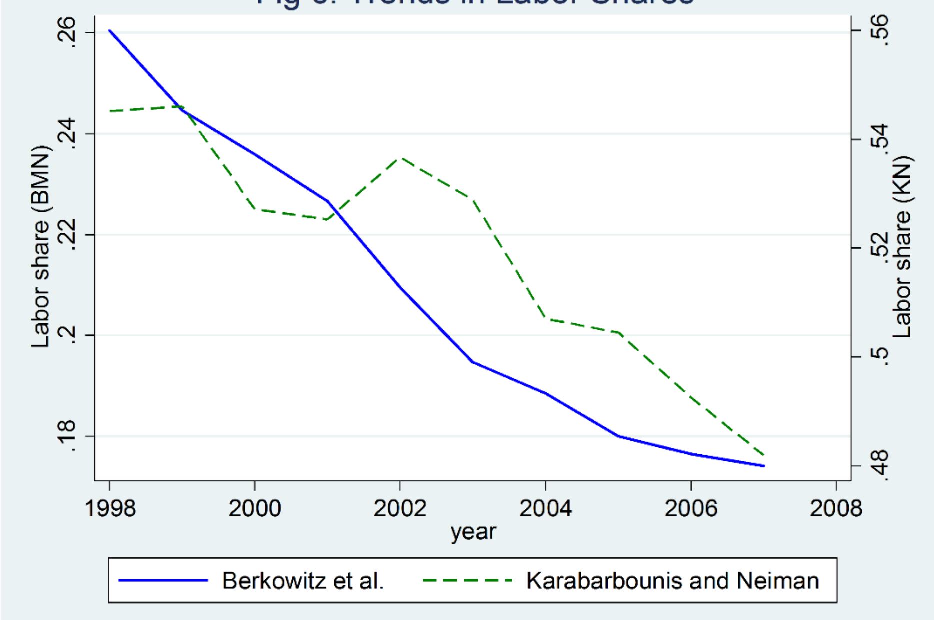
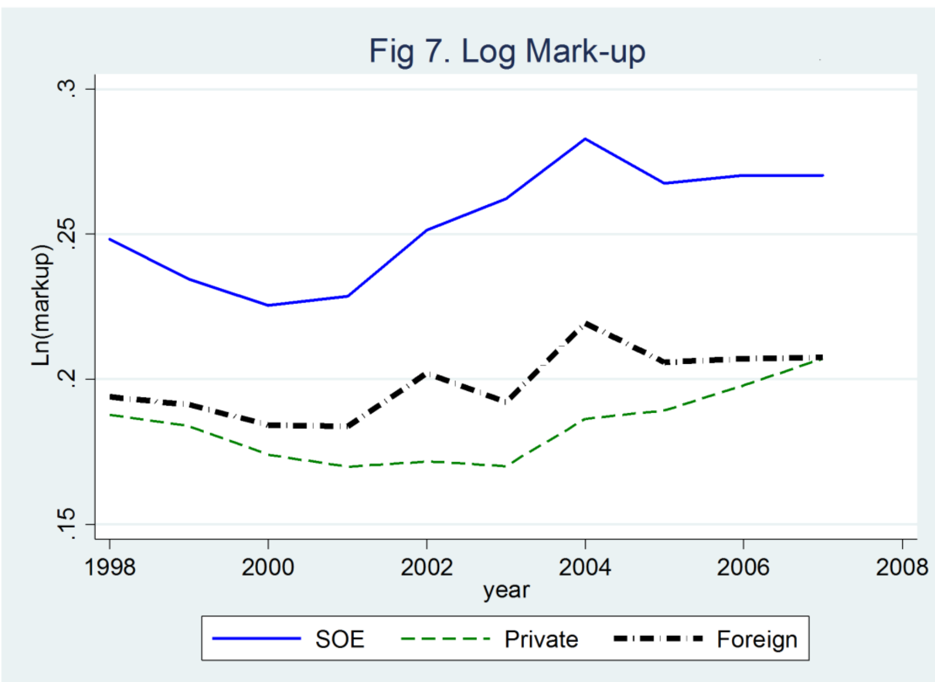


Table 2. Between and Within Effects by Ownership

	Between effect	Within effect	Total change
SOE	-5.3%	-4.5%	-9.8%
Private	6.7%	-1.9%	4.8%
Foreign	-3.6%	-0.9%	-4.5%
Collective	1.2%	-0.3%	0.9%
Total effect	-1.0%	-7.6%	-8.6%

Table 3. The Overall Estimates for the 28 Manufacturing Sectors

	Parameters			
	Mean	St.dev	Min	Max
α_s (weight on factor inputs)	0.11	0.08	0.05	0.25
σ_s (elasticity of substitution)	1.40	0.37	0.77	1.85
a_s (weight on labor)	0.83	0.11	0.65	0.94



Note: Top and bottom 0.5% of outlier values are dropped. Weighted by output (revenue).

Table 4. Differences in Log Relative Cost of Capital

	Entire sample			Entire sample			Balanced panel		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs	0.155**	0.256**	0.035						
	(0.038)	(0.039)	(0.043)						
Top central SOEs				-0.660**	-0.590**	-0.702**	-0.467**	-0.423**	-0.525**
				(0.155)	(0.165)	(0.150)	(0.141)	(0.169)	(0.124)
Other SOEs				0.161**	0.259**	0.044	0.146**	0.213**	0.0745**
				(0.038)	(0.039)	(0.043)	(0.034)	(0.034)	(0.037)
Private firms	0.364**	0.503**	0.308**	0.363**	0.503**	0.308**	0.340**	0.476**	0.240**
	(0.035)	(0.042)	(0.035)	(0.035)	(0.042)	(0.035)	(0.036)	(0.039)	(0.036)
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	1,749,548	642,374	1,107,174	1,749,548	642,374	1,107,174	401,216	199,453	201,763
R-squared	0.632	0.642	0.632	0.633	0.642	0.632	0.707	0.705	0.711

Notes: (1) Clustered standard errors (2-digit CIC) are in the parentheses. (2) ** (*) indicates significant at the 5% (10%) confidence level.

Table 5. Differences in Log Markup

	Entire sample			Entire sample			Balanced panel		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs	-0.001	0.009*	-0.007						
	(0.005)	(0.005)	(0.006)						
Top central SOEs				-0.008	0.018	-0.029	0.009	0.021	0.001
				(0.084)	(0.093)	(0.072)	(0.088)	(0.092)	(0.083)
Other SOEs				-0.001	0.009*	-0.007	-0.006	-0.004	-0.007
				(0.005)	(0.005)	(0.006)	(0.007)	(0.007)	(0.007)
Private firms	-0.022**	-0.015**	-0.025**	-0.022**	-0.015**	-0.025**	-0.023**	-0.024**	-0.022**
	(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	1,748,725	641,724	1,107,001	1,748,725	641,724	1,107,001	291,011	145,588	145,423
R-squared	0.224	0.206	0.241	0.224	0.206	0.241	0.258	0.262	0.260

Notes: See Table 4.

Table 6.1. Log Labor Shares for Pooled Estimations

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Adjust labor shares	No	No	No	No	No	Yes	No	No
Exclude top central SOEs	No	No	No	No	No	No	Yes	No
Balanced panel	No	No	No	No	No	No	No	Yes
Substitution effect (δ^{σ})	-0.798	-0.768	-0.409		-0.430	-0.427	-0.428	-0.399
	(0.074)	(0.075)	(0.044)		(0.046)	(0.046)	(0.046)	(0.039)
Markup effect (δ^{μ})	-0.448	-0.425	-0.364	-0.368	-0.367	-0.367	-0.368	-0.342
	(0.020)	(0.018)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)
Political weight on excess				0.264	0.273	0.335	0.275	0.177
employment (δ^{φ})				(0.016)	(0.017)	(0.017)	(0.017)	(0.014)
Lagged log labor share			0.598	0.592	0.581	0.581	0.580	0.630
			(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)
Year dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector (2-digit CIC) dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,720,953	1,720,953	1,207,486	1,207,486	1,207,486	1,207,486	1,205,804	257,055
R-squared	0.207	0.256	0.560	0.561	0.566	0.573	0.566	0.618

Notes: (1) Clustered standard errors (2-digit CIC) are in the parentheses. (2) Model 5 is the baseline as described in equation (21). (3) All coefficients are statistically significant at the 5% confidence level.

Table 6.2. Log Labor Shares for Dynamic Panel Estimations

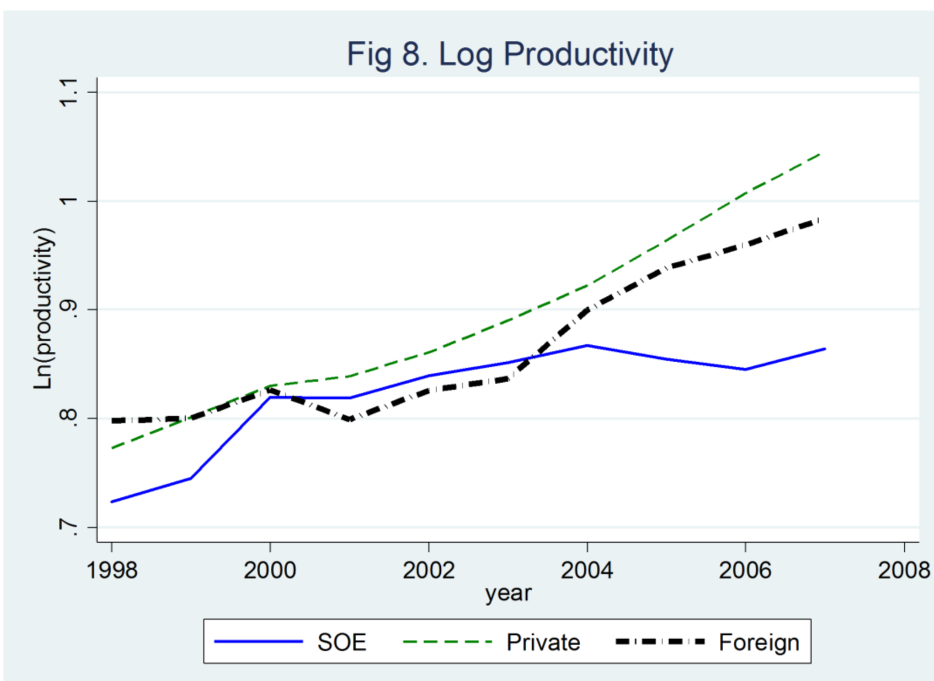
	Difference	AR(1)	Difference GMM		System GMM			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Adjust labor shares	No	No	No	No	No	No	Yes	No
Exclude top central SOEs	No	No	No	No	No	No	No	Yes
Endogenize markup and substitution effects	-	-	No	Yes	No	Yes	Yes	Yes
Substitution effect (δ^{σ})	-0.651	-0.821	-0.639	-0.620	-0.686	-0.419	-0.426	-0.421
	(0.086)	(0.008)	(0.015)	(0.014)	(0.015)	(0.010)	(0.010)	(0.010)
Markup effect (δ^{μ})	-0.554	-0.543	-0.595	-0.564	-0.634	-0.529	-0.528	-0.528
	(0.015)	(0.001)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
Lagged log labor share			0.145	0.069	0.280	0.192	0.202	0.192
			(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	1,204,935	1,253,704	843,340	843,340	1,207,486	1,207,486	1,207,486	1,205,804
Number of firm fixed effects		351,801	260,099	260,099	346,434	346,434	346,434	346,239
# of instrumental variables			38	110	47	135	135	135

Notes: (1) AR(1) is Baltagi and Wu (1999), difference GMM is Arellano and Bond (1991), and system GMM is Blundell and Bond (1998). (2) Various standard errors are in the parentheses. (3) All coefficients are statistically significant at the 5% confidence level. (4) In models 3 and 5, lagged log labor share is treated as endogenous variable. In models 4, 6, 7 and 8, lagged log labor share, the mark-up term, and the substitution term are all treated as endogenous variables.

Table 6.3. Time-specific Political Weights for Four Regions

	Equation (22)					Equation (23)				
	All	4 Regions				All	4 Regions			
		North	East	South	West		North	East	South	West
Substitution effect (δ^{σ})	-0.428	-0.435	-0.416	-0.430	-0.407					
	(0.046)	(0.052)	(0.043)	(0.058)	(0.049)					
Markup effect (δ^{μ})	-0.368	-0.370	-0.356	-0.378	-0.411					
	(0.012)	(0.015)	(0.011)	(0.013)	(0.019)					
Political weight (δ^{φ}_{1999})	0.317	0.345	0.295	0.319	0.309	0.232	0.278	0.214	0.240	0.255
	(0.021)	(0.027)	(0.023)	(0.026)	(0.034)	(0.015)	(0.019)	(0.014)	(0.023)	(0.032)
Political weight (δ^{φ}_{2007})	0.141	0.184	0.107	0.150	0.204	0.106	0.129	0.077	0.129	0.136
	(0.014)	(0.019)	(0.015)	(0.024)	(0.022)	(0.011)	(0.017)	(0.009)	(0.02)	(0.023)
Lagged dependent variable	0.580	0.545	0.603	0.570	0.532	0.686	0.661	0.714	0.661	0.637
	(0.009)	(0.013)	(0.008)	(0.009)	(0.015)	(0.007)	(0.009)	(0.006)	(0.008)	(0.013)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector (2-digit CIC) dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,207,486	186,055	631,319	290,634	99,473	1,204,935	185,455	630,207	290,038	99,230
R-squared	0.567	0.568	0.562	0.570	0.591	0.758	0.726	0.787	0.727	0.730

Notes: (1) All coefficients are significant at the 5% level. (2) Political weights on excess employment from 2000 to 2006 are available upon request.



Note: Top and bottom 0.5% of outlier values are dropped. Weighted by output (revenue).

Table 7.1. Differences in Log Productivity

	Entire sample			Entire sample			Balanced panel		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs	-0.055**	-0.072**	-0.036**						
	(0.017)	(0.019)	(0.013)						
Top central SOEs				0.028	0.018	0.022	-0.027	-0.012	-0.028
				(0.049)	(0.057)	(0.049)	(0.052)	(0.07)	(0.041)
Other SOEs				-0.056**	-0.072**	-0.036**	-0.051**	-0.059**	-0.041**
				(0.018)	(0.019)	(0.013)	(0.014)	(0.014)	(0.012)
Private firms	-0.011**	-0.012**	-0.012**	-0.011**	-0.012**	-0.012**	-0.029**	-0.033**	-0.026**
	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
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	1,748,725	641,724	1,107,001	1,748,725	641,724	1,107,001	291,170	145,786	145,384
R-squared	0.718	0.649	0.768	0.718	0.649	0.768	0.731	0.729	0.757

Notes: See Table 4.

Table 7.2. Differences in Log Productivity for SOEs (1998-2002)

	Entire sample			Entire sample			Balanced panel		
	98-07	98-02	03-07	98-07	98-02	03-07	98-07	98-02	03-07
SOEs (98-07)	-0.016**	-0.017**	-0.020**						
	(0.007)	(0.006)	(0.008)						
Top central SOEs (98-07)				0.029	0.059	0.019	0.009	0.035	0.000
				(0.049)	(0.066)	(0.051)	(0.044)	(0.058)	(0.038)
Other SOEs (98-07)				-0.017**	-0.018**	-0.021**	-0.002	0.000	-0.004
				(0.007)	(0.006)	(0.008)	(0.005)	(0.005)	(0.007)
SOEs (98-02) to Foreign (03-07)	0.015	0.018	0.015	0.015	0.018	0.015	0.025**	0.016	0.034**
	(0.012)	(0.018)	(0.012)	(0.012)	(0.018)	(0.012)	(0.013)	(0.015)	(0.013)
Exiters		-0.046**			-0.046**				
		(0.012)			(0.012)				
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	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 (2-digit CIC) dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128,096	128,350	56,890	128,096	128,350	56,890	43,506	21,793	21,713
R-squared	0.508	0.38	0.569	0.508	0.38	0.569	0.61	0.574	0.657

Notes: (1) Clustered standard errors (2-digit CIC) are in the parentheses. (2) ** (*) indicates significant at the 5% (10%) confidence level. (3) There were 45,586 SOEs in 1998-2002. In 2003-2007, 13,586 firms remained as SOEs, 538 firms were transformed their ownerships to hybrid firms. 229 firms were privatized to foreign firms and 4,374 firms were privatized to domestic private firms. The remaining 26,978 firms disappeared from the sample (exiters). Among 45,586 SOEs in the 1998-2002 period, 241 SOEs were centrally controlled. Similarly, among 13,467 SOEs in 2003-2007, 281 SOEs were centrally controlled.

Online Appendix

Appendix 1: Real Capital Stock

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

$$K_{it} = (1-\delta)\,K_{i,t-1} + (BK_{it} - BK_{i,t-1})/P_t \tag{24}$$

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

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

BK_{i,t_1} is the book value of capital stock when firm i first appears in the data set in year t_1; 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.[40] 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 (24).[41] Our estimated real capital is highly correlated with the original value of nominal capital as well as the net value of nominal capital.

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

[41] We also try alternative depreciation rate at 0.05, the results are qualitatively similar.

Appendix 2: The Between and Within Effects

We decomposed the national-level decline in labor's share into the between and within effects by ownership types of firms. In the literature of the industry-level analyses, however, labor share should differ across industries since the underlying production technologies are industry-specific. For example, the apparel production process requires more labor than capital, suggesting that labor shares are higher in labor-intensive industries. In Chinese data, labor-intensive industries include garments (18), leather and fur (19) and textile (17), whereas capital-intensive industries include petroleum processing (25) and metal products (35). Somewhat surprisingly, several food industries such as food processing (13) and beverages (15) are capital-intensive in China.

The superscript o in equation (2) represents ownership categories. We also allow the superscript o in equation (2) to represent other categories in order to better understand the importance of the within effect for labor share declines. In Table A.2, we report the between and within effects. First, we divide the firms into exporters versus non-exporters (e.g., Bernard and Jensen, 1997 and 1999). As in the standard firm-heterogeneity model of trade by Melitz (2003), exporters would be more productive, or they would have higher markups in the product markets (De Loecker and Warzynski, 2012). In this case, it is plausible that the rapid pace of China's integration into a global market would be critical to explain the decline in labor share in China. However, the data suggests that there is no significant change between the exporter and non-exporter statuses. Specifically, the between effect explains only 0.2 percentage point of total decline (a 8.6 percentage point decline) in labor share. This tendency is consistent even we examine the between effects across regions, provinces, and sectors (2-digit CIC industries). Our results suggest that the composition changes of value added across exporters, industries and provinces do not explain the significant part of the labor share decline in China.

Appendix 3: The Overall Impact of the Political Weight on Labor's Share

It is possible that labor's share can be decreasing in the political weight when the elasticity of substitution is less than one. However, differentiating equation (14). with respect to ϕ_{ot}, it is straightforward to show:

$$\frac{\partial LS_{it}}{\partial \phi_{ot}} = LS_{it}\left[\left(\frac{1}{\phi_{ot}}\right) - \left(\frac{\partial F/\partial \phi_{ot}}{F}\right)\right] > 0 \;\; \forall\, \sigma_s \geq 0 \tag{25}$$

since $\forall\ \sigma_s \geq 0, \forall\ \phi_{ot} \geq 1, \left(\frac{1}{\phi_{ot}}\right) \geq 1$ and $\partial F / \partial \phi_{ot} / F =$

$$\left[(1-\sigma_s)\left(\frac{1-a_s}{a_s}\right)^{\sigma_s}(\phi_{ot})^{-\sigma_s}(r_{it})^{1-\sigma_s}\right]\left[1+\left(\frac{1-a_s}{a_s}\right)^{\sigma_s}(r_{it}\phi_{ot})^{1-\sigma_s}\right]^{-1} < 1.$$

Appendix 4: Production Function

Cobb-Douglas Production Function

As suggested by Basu and Fernald (1995; 1997), the structural parameters estimated from a value-added production function could be biased if firms face imperfectly competitive markets and the returns to scale differ from one. As shown in the section of markups, most of Chinese manufacturing firms have positive markups, which indicates that the assumption of perfect competition is not appropriate for our study. This is one of the reasons why we prefer to use the revenue-base production function. The assumption of constant return to scale in our theoretical function is discussed in this appendix. Overall, we show that the return to scale is close to one for most of the 28 sectors.

Although our main objective is to estimate the CES production function (i.e., equation (3)), it is useful to start with estimating the production function with the Cobb-Douglas form:

$$Q_{it} = \omega_{it}(N_{it})^{\alpha_s^N}(K_{it})^{\alpha_s^K}(M_{it})^{\alpha_s^M}. \tag{26}$$

Equation (26) is similar to the objective function in Ackerberg et al (2006). Firms need more time to optimize the employment of labor and the installment of capital than to purchase intermediate inputs. Given this timing assumption, a firm's demand for intermediate inputs depends on the predetermined amounts of labor and the current stock of capital:

$$\ln(M_{it}) = h_t\left[\ln(\omega_{it}), \ln(N_{it}), \ln(K_{it})\right].$$

Throughout the current paper, we follow Ackerberg et al (2006) and make the most of the timing assumption to invert productivity:

$$\ln(\omega_{it}) = h_t^{-1}\left[\ln(N_{it}), \ln(K_{it}), \ln(M_{it})\right].$$

In the first stage, the second order polynomial function of the three inputs is estimated:

$$\begin{aligned}\ln(Q_{it}) &= \alpha_s^N \ln(N_{it}) + \alpha_s^K \ln(K_{it}) + \alpha_s^M \ln(M_{it}) \\ &\quad + h_t^{-1}\left[\ln(N_{it}), \ln(K_{it}), \ln(M_{it})\right] + \epsilon_{it} \\ &= \Psi_t\left[\ln(N_{it}), \ln(K_{it}), \ln(M_{it})\right] + \epsilon_{it}. \end{aligned} \tag{27}$$

After the first stage equation (27) is estimated, we can obtain $\hat{\Psi}_t$ and compute the corresponding value of productivity for any combination of parameters $\Lambda = (\bar{\alpha}_s^N,\ \bar{\alpha}_s^K, \bar{\alpha}_s^M)$. This enables us to express the log of productivity $\ln(\bar{\omega}_{it}(\Lambda))$ as

$$\ln(\bar{\omega}_{it}(\Lambda)) = \hat{\Psi}_t - \bar{\alpha}_s^N \ln(N_{it}) - \bar{\alpha}_s^K \ln(K_{it}) - \bar{\alpha}_s^M \ln(M_{it}). \tag{28}$$

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

$$\ln(\bar{\omega}_{it}(\Lambda)) = \bar{\gamma}_0 + \bar{\gamma}_1 \ln(\bar{\omega}_{i,t-1}(\Lambda)) + \bar{\gamma}_2 \left[\ln(\bar{\omega}_{i,t-1}(\Lambda))\right]^2 + \bar{\gamma}_3 \left[\ln(\bar{\omega}_{i,t-1}(\Lambda))\right]^3 + \zeta_{it}(\Lambda).$$

From this third order polynomial, we can recover the innovation to productivity, $\zeta_{it}(\Lambda)$, for a given set of the parameters. Since the innovation to productivity, $\zeta_{it}(\Lambda)$, will not be correlated with $\ln(K_{it})$, $\ln(N_{i,t-1})$, and $\ln(M_{i,t-1})$ according to the timing condition, we can use the following moment condition:

$$E\left[\zeta_{it}(\Lambda)\begin{pmatrix}\ln(K_{it}) \\ \ln(N_{i,t-1}) \\ \ln(M_{i,t-1})\end{pmatrix}\right] = 0 \tag{29}$$

and search for the combinations of $\bar{\alpha}_s^N$, $\bar{\alpha}_s^K$ and $\bar{\alpha}_s^M$ where $0.04 \leqq \bar{\alpha}_s^N \leqq 0.04 + 20\kappa$; $0.04 \leqq \bar{\alpha}_s^K \leqq 0.04 + 20\kappa$; $0.66 \leqq \bar{\alpha}_s^M \leqq 0.66 + 30\kappa$ with the grid of $\kappa = 0.01$.

In Table A.4.1, we report the combination of $\bar{\alpha}_s^N$, $\bar{\alpha}_s^K$ and $\bar{\alpha}_s^M$ that minimizes equation (29), which is denoted $\hat{\alpha}_s^N$, $\hat{\alpha}_s^K$ and $\hat{\alpha}_s^M$. On average the weight on log labor is 0.19, that on log capital is 0.07 and that on log intermediate inputs is 0.75. Our results indicate that Chinese manufacturing use intermediate inputs intensively and use more labor than capital as factor inputs. The sum of these three estimated parameters is the return to scale. The average value of the returns to scale across the 28 sectors is 1.01 with a small standard error (0.03). Our results indicate that we cannot reject the assumption of constant return for most of the industries.

Robustness Checks for the Baseline Equation

De Loecker and Warzynski (2012) follow the timing assumption of Ackerberg et al (2006) and extend it to a flexible production function. While De Loecker and Warzynski (2012) focus on the translog production function, we concentrate on equation (3). In this appendix, to reduce the computational burden, we obtain the starting values of the parameters ($\tilde{\alpha}_s$, $\tilde{\sigma}_s$, $\tilde{a}_s$) and search locally for the neighborhood of the starting values. In particular, we estimate the following equation with non-linear least squares (NLS) and obtain $\tilde{\Omega} = (\tilde{\alpha}_s, \tilde{\sigma}_s, \tilde{a}_s)$:

$$\begin{aligned} \hat{\Phi}_t &= \tilde{\gamma}_0 + \frac{\tilde{\alpha}_s \tilde{\sigma}_s}{\tilde{\sigma}_s - 1} \ln \left[\tilde{a}_s (N_{it})^{\frac{\tilde{\sigma}_s - 1}{\tilde{\sigma}_s}} + (1 - \tilde{a}_s) (K_{it})^{\frac{\tilde{\sigma}_s - 1}{\tilde{\sigma}_s}} \right] + (1 - \tilde{\alpha}_s) \ln(M_{it}) \\ &\quad + \tilde{\gamma}_1 \ln(\tilde{\omega}_{i,t-1}(\tilde{\Omega})) + \tilde{\gamma}_2 \left[\ln(\tilde{\omega}_{i,t-1}(\tilde{\Omega})) \right]^2 + \tilde{\gamma}_3 \left[\ln(\tilde{\omega}_{i,t-1}(\tilde{\Omega})) \right]^3 + \zeta_{it}. \end{aligned} \quad (30)$$

In case equation (30) does not converge to realistic values for some sectors, we use the starting values estimated from the entire sample.[42] Once we obtain these starting values, we search over $\Omega = (\bar{\alpha}_s, \bar{\sigma}_s, \bar{a}_s)$ where $\tilde{\alpha}_s - 10\kappa_1 \leqq \bar{\alpha}_s \leqq \tilde{\alpha}_s + 10\kappa_1$; $(\tilde{\sigma}_s - 1)/\tilde{\sigma}_s - 10\kappa_2 \leqq (\bar{\sigma}_s - 1)/\bar{\sigma}_s \leqq (\tilde{\sigma}_s - 1)/\tilde{\sigma}_s + 10\kappa_2$; $\tilde{a}_s - 10\kappa_1 \leqq \bar{a}_s \leqq \tilde{a}_s + 10\kappa_1$ with the grids of $\kappa_1 = 0.005$ and $\kappa_2 = 0.02$.

In Table A.4.2, we report the results from the entire sample. On average the weight on factor inputs ($\hat{\alpha}_s$) is 0.15 and the weight on labor relative to capital ($\hat{a}_s$) is 0.83. The elasticity of substitution between labor and capital ($\hat{\sigma}_s$) on average is 1.37, which is similar to the results in Table 3. Next, we report the results for a more balanced panel that includes firms that have data on gross output, intermediate inputs and capital and employee records available for at least five years in Table A.4.3. On average the elasticity of substitution between labor and capital is 1.52, the weight on factor inputs is 0.18, and the weight on labor relative to capital is 0.82. These estimates are similar to our baseline estimates. We also report the results for a measure of labor that account for human capital differences in Table A.4.4. Instead of using the reported number of employee,

[42] We replace them with $\tilde{\alpha} = 0.18$, $\tilde{\sigma} = 1.51$ and $\tilde{a} = 0.81$ (these parameters are statistically significant at the 1 percent level) if the elasticity of substitution between labor and capital ($\tilde{\sigma}_s$) is unrealistic. For example, we use the starting values from the entire sample for the 2-digit sector of 16 "tobacco" for the results in Tables A.4.1, A.4.2, and A.4.3.

we develop the alternative measure of the number of employee from the firm-level wage payment ($w_{it}N_{it}$) divided by province-level average wage for each year (w_t^p):

$$\tilde{N}_{it} = \frac{w_{it}N_{it}}{w_t^p}. \tag{31}$$

Assuming that an individual's wage depends on her/his labor productivity, our alternative measure of the number of employee should reflect the composition of skills within each firm. This adjustment is important in estimating the elasticity of substitution since we do not include labor- and capital-augmenting productivity in our production function. Although these factor productivities are crucial to account for international differences in each factor's efficiency, it may not be relevant to our single-country data. Nonetheless, it is important to show the robustness of our results when we use this alternative measure. As in Table A.4.4, the estimation results are similar to our baseline results. On average the elasticity of substitution between labor and capital is 1.22, the weight on factor inputs is 0.14, and the weight on labor relative to capital is 0.85.

As discussed above, the assumption of the constant return to scale is one of the important assumptions for our theory. In Table A.4.5, we report the results when we relax the assumption of the constant return to scale by using the independent weight on intermediate input ($\bar{\alpha}_s^*$ where $\bar{\alpha}_s+\bar{\alpha}_s^*$ may not sum to unity). In this specification, we need to search over the four parameters $\breve{\Omega} = (\bar{\alpha}_s, \bar{\sigma}_s, \bar{a}_s, \bar{\alpha}_s^*)$ where $\hat{\alpha}_s - 5\kappa \leqq \bar{\alpha}_s \leqq \hat{\alpha}_s + 5\kappa$; $(\hat{\sigma}_s - 1)/\hat{\sigma}_s - 5\kappa_3 \leqq (\bar{\sigma}_s - 1)/\bar{\sigma}_s \leqq (\hat{\sigma}_s - 1)/\hat{\sigma}_s + 5\kappa_3$; $\hat{a}_s - 5\kappa \leqq \bar{a}_s \leqq \hat{a}_s + 5\kappa$; $(1-\hat{\alpha}_s) - 5\kappa \leqq \bar{\alpha}_s^* \leqq (1-\hat{\alpha}_s) + 5\kappa$. Note that we search locally around the estimated values of the parameters from Table A.4.2. As in Table A.4.5, the results do not differ from the baseline specification and the returns to scale are close to unity for the most of the industries.

Finally, we relax the assumption of the Hicks-neutral productivity. If the growth of labor-augmenting and that of capital-augmenting productivity differ significantly, our estimates could be biased. To check the robustness, we introduce the labor-augmenting productivity (ω_{it}^L) in the production function:

$$Q_{it} = \left[a_s(\omega_{it}^L N_{it})^{\frac{\sigma_s-1}{\sigma_s}} + (1-a_s)\left(K_{it}\right)^{\frac{\sigma_s-1}{\sigma_s}}\right]^{\frac{\alpha_s\sigma_s}{\sigma_s-1}} M_{it}^{1-\alpha_s}. \tag{32}$$

In the first stage, the following function is estimated. Note that we replace $\ln(N_{it})$ with $\ln(\tilde{N}_{it})$

where $\tilde{N}_{it}$ is from equation (31):

$$\ln(Q_{it}) = \Gamma_t \left[\ln(\tilde{N}_{it}), \ln(K_{it}), \ln(M_{it}), E_{it}, D_{it}^{rt}\right] + \epsilon_{it}. \tag{33}$$

$\tilde{N}_{it}$ in the first stage equation (33) is intended to capture the progress of labor productivity as well as the usage of labor input. After the first stage estimation, we can compute the corresponding value of labor productivity for any combination of parameters $\Omega = (\bar{\alpha}_s, \bar{\sigma}_s, \bar{a}_s)$. This enables us to express the log of labor productivity $\ln(\bar{\omega}_{it}^L(\Omega))$

$$\ln(\bar{\omega}_{it}^L(\Omega)) = \frac{\bar{\sigma}_s}{\bar{\sigma}_s - 1} \left\{ \ln \left[\left(\frac{\exp(\hat{\Gamma}_t)}{(M_{it})^{1-\bar{\alpha}_s}} \right)^{\frac{\bar{\sigma}_s - 1}{\bar{\alpha}_s \bar{\sigma}_s}} - (1 - \bar{a}_s)\,(K_{it})^{\frac{\bar{\sigma}_s - 1}{\bar{\sigma}_s}} \right] - \ln(\bar{a}_s) \right\} - \ln(N_{it})$$

We can approximate the first order Markov process for labor-augmenting productivity with the third order polynomial and can recover the innovation to productivity for a given set of the parameters. We use the same moment condition as the baseline case to find the optimal parameters $\Omega = (\hat{\alpha}_s, \hat{\sigma}_s, \hat{a}_s)$. As in Table A.4.6, the results do not differ from the baseline results.

Appendix 5: Summary Statistics within SOEs

Table A.5 reports several key production and income variables aggregated by two types of SOEs: top central SOEs and all other SOEs. Table A.5.1 shows that the overall number of SOEs declines from 38,208 in 1998 to 12,501 in 2007. This decline was largely driven by all other SOEs. The numbers of employment in top central and other SOEs fell by 25 percent and 67 percent, 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 persistence difference even in 2007 (i.e., 0.44 for top central SOEs and 0.22 for other SOEs). Table A.5.2 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 added increased by 16 percentage points for top central SOEs and 21 percentage points for other SOEs. The decline in labor's share was most pronounced in other SOEs (a 17 percentage point decline).

Appendix 6: Adjustments on Labor Shares

We define that labor's share is labor compensation divided by value added as in equation (1). Our baseline measure of labor compensation includes payable wage and employment benefits. Since labor's share from aggregated manufacturing data is different from the corresponding number from the National Bureau of Statistics of China (NBS) statistical yearbook, we report the results from the following adjustments as model 6 in Table 6.1 and model 7 in Table 6.2. We made two adjustments. One is the adjustment made across all the firms for each year according to the discrepancy between the annual aggregated value of ASIP and that of NBS in industrial sector. The other is the adjustment made across all years for each ownership type according to detailed compensations reported in 2004. In our paper, such adjustments are made only for the purpose of the robustness checks since the number of firms that have the labor shares greater than unity increases significantly with the adjustments particularly for SOEs.

Year-by-year adjustments

The strategy of the adjustments is similar to those in Hsieh and Klenow (2009) and Brandt et al (2012). We first obtain labor's share from the aggregated data of our entire sample for each year from 1998 to 2004. We then obtain the discrepancy between the NBS data on labor share in industrial firms and the labor share calculated using our entire sample. According to the NBS statistics, there is a drastic change in labor's share from 2003 to 2004. The change is mainly due to the revisions in accounting methods since 2004. In particular, the income of self-employed individuals in non-agricultural sector was counted as labor income before 2004, but it has been counted as capital income after 2004. Thus, we made the adjustment on NBS labor's share for year 2004 according to Bai and Qian (2010). Since there are no comparable values for industry sectors from NBS for years 2005 through 2007, we use the national-level labor share minuses 10% for the industrial NBS labor share. The adjustment ratios are available in Table A.6.1.

Compensation adjustments

The second adjustment is the difference in the compensation across the ownership types of the firms. Since it is widely known that SOEs pay more non-wage compensations than the other firms, our data may understate the wage levels of SOEs. In our data from 2004 to 2007, we have information on additional components of non-wage compensations, which include housing subsidy, pension and health care. Then, we can define another measure of wage compensation variable. Using the data from 2004, we adjust the differences in labor compensations by the ownership types according to the ratios in Table A.6.2.

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Tables and Figures (Appendix)

Table A.2. Between and Within Effects

	Between effect	Within effect
Ownership	-1.02%	-7.60%
Export status	-0.19%	-8.43%
Sector (2-digit)	0.34%	-8.97%
Province	-0.36%	-8.27%
Region	-0.08%	-8.54%

Table A.4.1. Cobb-Douglas (Ackerberg et al., 2006)

	Mean	St.dev	Min	Max
α_{sN} (weight on labor)	0.19	0.07	0.05	0.24
α_{sK} (weight on capital)	0.07	0.02	0.05	0.12
α_{sM}(weight on intermediate inputs)	0.75	0.09	0.66	0.94
$\alpha_{sN}+\alpha_{sK}+\alpha_{sM}$ (returns to scale)	1.01	0.03	0.94	1.09

Table A.4.2. The Estimates using Local Search

	Mean	St.dev	Min	Max
α_s (weight on factor inputs)	0.15	0.05	0.06	0.24
σ_s (elasticity of substitution)	1.37	0.32	0.94	2.18
a_s (weight on labor)	0.83	0.06	0.63	0.94

Table A.4.3. The Estimates from the Well-balanced Sample

	Mean	St.dev	Min	Max
α_s (weight on factor inputs)	0.18	0.05	0.06	0.26
σ_s (elasticity of substitution)	1.52	0.41	0.91	2.39
a_s (weight on labor)	0.82	0.06	0.64	0.93

Table A.4.4. The Estimates with Human Capital Adjusted Employee

	Mean	St.dev	Min	Max
α_s (weight on factor inputs)	0.14	0.03	0.06	0.20
σ_s (elasticity of substitution)	1.22	0.16	0.82	1.54
a_s (weight on labor)	0.85	0.11	0.35	0.97

Table A.4.5. The Estimates by Relaxing CRS

	Mean	St.dev	Min	Max
α_s (weight on factor inputs)	0.15	0.07	0.02	0.28
σ_s (elasticity of substitution)	1.22	0.23	0.87	1.69
a_s (weight on labor)	0.85	0.07	0.66	0.95
α_s* (weight on intermediate inputs)	0.86	0.08	0.73	0.98
α_s+α_s* (returns to scale)	1.01	0.02	0.93	1.07

Table A.4.6. The Estimates with Labor-augmenting Productivity

	Mean	St.dev	Min	Max
α_s (weight on factor inputs)	0.16	0.05	0.06	0.25
σ_s (elasticity of substitution)	1.31	0.40	0.82	3.26
a_s (weight on labor)	0.79	0.09	0.43	0.92

Table A.5. Summary Statistics Aggregated by Two Types of SOEs

1. Production Variables

	Top central SOEs			Other SOEs			Total SOEs		
	1998	2007	change	1998	2007	change	1998	2007	change
The number of firms	142	268	88.7%	38,066	12,233	-67.9%	38,208	12,501	-67.3%
Value added (billion RMB)	163	430	164.0%	457	882	93.2%	620	1,313	111.8%
Employee (1,000)	2,114	1,581	-25.2%	21,160	6,931	-67.2%	23,274	8,511	-63.4%
Real capital (billion RMB)	545	695	27.5%	1,655	1,500	-9.3%	2,200	2,195	-0.2%
Real wage rate (RMB)	13,615	38,470	182.6%	7,694	24,490	218.3%	8,232	27,086	229.0%
Real capital/employee	0.258	0.440	70.6%	0.078	0.216	176.8%	0.095	0.258	172.9%

2. Income Variables

	Top central SOEs			Other SOEs			Total SOEs		
	1998	2007	change	1998	2007	change	1998	2007	change
Profit/value added (%)	6.1%	22.5%	16.3%	1.5%	22.0%	20.5%	2.7%	22.2%	19.5%
Wage bill/value added (%)	17.7%	12.8%	-4.8%	35.6%	18.3%	-17.4%	30.9%	16.3%	-14.6%
Share of unprofitable firms (%)	20.4%	12.3%	-8.1%	43.7%	22.6%	-21.1%	43.6%	22.3%	-21.2%

Notes: See Table 1.

Table A.6.1. Labor Share Adjustments across Years

Source	ASIP	NBS			Adjustment
Sector	Industry	All	Industry	All - 0.1	ratio
1998	0.257	0.508	0.393	0.393	1.53
1999	0.245	0.500	0.390	0.390	1.59
2000	0.226	0.487	0.374	0.374	1.65
2001	0.223	0.482	0.373	0.373	1.67
2002	0.215	0.478	0.370	0.370	1.72
2003	0.201	0.462	0.357	0.357	1.78
2004	0.195	0.416	0.305	0.337	1.56
2005	0.182	0.414	N/A	0.314	1.72
2006	0.178	0.406	N/A	0.306	1.72
2007	0.176	0.397	N/A	0.297	1.69

Table A.6.2. Labor Share Adjustments across Ownership Types

	Labor shares (2004)		Adjustment
	Our baseline	Adjusted	ratio
SOE	0.212	0.262	1.24
Private	0.180	0.193	1.07
Foreign (w/o HMT)	0.176	0.198	1.13
HMT	0.234	0.252	1.08
Collective	0.181	0.202	1.11