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Daniel Berkowitz | Hong Ma | Shuichiro Nishioka

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John A. and Cynthia Fry Gunn Building | 366 Galvez Street, Stanford, CA 94305-6015

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

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Abstract

There is evidence that labor's share of income has been declining in many countries since the 1980s. While theoretical explanations for declining labor shares use models with representative firms, this paper proposes a model in which firms can be heterogeneous in terms of capital-intensity, market power, ownership, and productivity. Using theoretical insights from Azmat, Manning and Van Reenen (2012), Blanchard and Giavazzi (2003) and Karabarbounis and Neiman (2014) and econometric methods from De Loecker and Warzynski (2012), we find that the rightward shift in the distribution of market power for private firms, the rightward shift in the distribution of capital intensity for all firms, and the declining political pressure on state owned firms to protect jobs have all contributed to the decline in labor shares in China's manufacturing sector.

Keywords: Labor's Share, State-Owned Enterprise, Political Pressure, Cost of Capital, Elasticity of Substitution, Markups

JEL Classification: E25, O19, O52.

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

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

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

1 Introduction

Several studies document that labor's share of national income has been declining in many countries since the 1980s.¹ Blanchard and Giavazzi (2003) argue that weakening employment protection policies have contributed to the decline in labor shares in OECD member countries; Azmat, Manning and Van Reenen (2012) show that softening product market competition and also declining employment protection policies have depressed labor shares in European network industries; and, Karabarbounis and Neiman (2014) show how the decreasing price of investment goods in combination with strong substitutability between capital and labor has contributed to declining labor shares in many countries. These explanations for declining labor shares use models with representative firms.

This paper builds on these models and shows how distributions in firm-level characteristics can drive firm-level differences in labor shares and, in turn, influence aggregate labor shares. A model is developed in which firms can differ by the capital intensity of their production processes, their market power, ownership, and productivity. The model predicts that a capital-intensive firm will pay low labor shares when capital and labor can be easily substituted in its production function; and, a firm that has market power will pay low labor shares. Moreover, a state owned firm (versus a similar private firm) will pay high labor shares because it is under political pressure to employ workers.

This paper documents that capital intensities, market power and ownership can explain labor share variations across firms.² And, consequently, the shifts in the distributions of capital intensities and market power, and a weakening of labor market protections imposed on state owned firms can explain the declining trend in the aggregate labor shares.

The model in this paper derives a substitution channel through which an increase in a firm's capital intensity can influence the firm's payments to labor as a share of value added. When the elasticity of substitution between capital and labor in a firm's production function exceeds (is less than) unity, a firm that becomes more capital-intensive will have a lower (higher) value of labor's share. And, when the elasticity of substitution between capital and labor is unity (the Cobb-

¹See Rodriguez and Jayadev (2010) Karabarbounis and Neiman (2014) and Azmat, Manning and Van Reenen (2012). Earlier studies include Blanchard (1997), Blanchard and Giavazzi (2003), Jones (2003) and Bentolila and Saint-Paul (2003).

²Productivity does not matter for labor's share because both the wage bill and value added are homogenous of degree one in productivity. Thus, labor's share is homogeneous of degree zero in productivity.

Douglas case), a firm's labor share is independent of its capital-labor ratio. This implies that a rightward shift in the distribution of capital intensities will depress labor shares in that sector when the elasticity of substitution between capital and labor exceeds unity. And, if most sectors have an elasticity of substitution that exceeds unity, a rightward shift in the capital intensity of all firms depresses the overall aggregate labor share.

The model also shows that a firm will reduce its labor shares when it gains market power. Thus, a rightward shift in the firm-level distribution of market power will always depress labor's share. Finally, policies that ease the pressure on state owned firms to create jobs will also lower labor's share. The model also shows that weaker employment protection policies effectively lowers the cost of capital relative to labor. Thus, weaker employment protections cause labor shares to decline through a substitution channel when the elasticity of substitution between capital and labor exceeds unity.

The structural parameters of this model are estimated using a rich data set of manufacturing firms in China during 1998-2007.³ The case of China is important since it is well documented that aggregate labor shares in China have been falling since the mid to late 1990s (Bai and Qian, 2010; Qian and Zhu, 2012). And, as will be subsequently documented, during 1998-2007 there was substantial capital deepening in most manufacturing firms and increasing markups within private firms: moreover, there was less political pressure placed on state owned enterprises (SOEs) to hire excess labor (Berkowitz, Ma and Nishioka, 2015, and Hsieh and Song, 2015).

While the papers on labor shares that are cited above examine the transition of country-level or sectoral-level labor shares over time, this paper focuses on how labor shares systematically differ across firms at a point in time and how this distribution evolves and shapes the evolution of aggregate labor shares. Figures 1-4 use data from the Chinese Annual Surveys of Industrial Production (ASIP) and provide an overview of results. Figure 1 shows that between 1998 and 2007 the share of firms paying relatively lower labor shares increases. Figure 2 compares the cross-firm mean of labor shares with aggregate labor shares in manufacturing during 1998-2007 and, as will be argued, is useful for understanding the characteristics of firms that pay low and high labor shares. Mean labor shares are the sum of firm-level labor shares divided by the total number of firms; and, aggregate labor shares equal the sum of wage bill divided by the sum of value added.

³Scholars have used this data has in almost all fields of economics. For example, prominent macroeconomics and productivity papers include Hsieh and Klenow (2009), Song, Storesletten and Zilibotti (2011) and Brandt et al (2012).

Both measures fell during 1998-2007: mean labor shares fell from 53.3% to 35.8% and aggregate labor shares fell from 26.4% to 18.4%. Simple algebra implies that mean labor shares are higher than aggregate labor shares because firms that have higher value added have lower labor shares throughout the period.

This paper documents that the elasticity of substitution between capital and labor exceeds unity in 128 out of 136 3-digit manufacturing sectors. While most studies find that the capital-labor elasticity of substitution is less than one (see León-Ledesma et al, 2010 and Chirinko et al, 2011; and, see Acemoglu, 2003, p.3 and Footnote 3 for a broad survey), this paper studies China during a period of exceptionally rapid structural change and a period when many manufacturing firms massively imported new machines. These estimates are made using recent econometric methods developed in De Loecker and Warzynski (2012); however, as shown in the Appendix 3, the similar results are obtained using alternative econometric methods.⁴

This finding that the capital-labor substitution elasticity generally exceed unity implies that in any year more capital intensive firms pay lower labor shares. Moreover, if a firm's capital stock grows more quickly than its employment of labor, the model predicts that a firm produces more value added.⁵ Therefore, the fact that aggregate labor shares are always lower than mean labor shares in Figure 2 is consistent with the observation that more capital intensive firms are also larger (as measured by value added) and pay lower labor shares.

Figure 3 compares the cumulative distribution of capital intensities in 1998 and 2007 for SOEs and private firms. For expositional ease, the range of capital intensities runs from 0 to 0.3.⁶ This range picks up most of the private sector and misses the long tail in the state sector in 2007: it covers 99% of SOEs in 1998 and 89% in 2007; and, it covers 97% of private firms in 1998 and 95% in 2007. Figure 3 shows that between 1998 and 2007 the distribution of firm-level capital intensities shifted to the right, and this shift was sharper for SOEs. Thus, firms became more capital intensive and larger and paid lower labor shares. This trend was most pronounced in the state sector.

The model also predicts that firms having more market power produce higher value added but

⁴We concentrate on traditional approaches for estimating sector-level production functions and recovering elasticities of substitution between labor and capital. See Raval and Oberheim (2014) for a method that uses firm-level capital-labor substitution elasticities and other structural parameters to obtain the substitution elasticity in an aggregate production function.

⁵In section 3, equation (13) shows that for any firm value added is increasing in output. Moreover, by inspection of equation (2) firm output is increasing in its capital stock. Thus, output increases when capital increases and labor is fixed. It is straightforward then to show that output is increasing when capital grows more rapidly than labor.

⁶This is real capital (in millions of RMB) per employee.

are not necessarily more or less capital intensive. This is because a firm that gains market power increases its markup and will enjoy higher value added. However, this increase in markups has no impact on the firm’s cost of capital relative to labor, and, therefore, does not influence its mix of capital and labor (capital intensity). Figure 4 compares the cumulative distribution of markups for SOEs and for private firms in 1998 and 2007. By inspection, the firm-level distribution of markups does not change for SOEs while it shifts to the right for private firms.⁷ Thus, private firms gained market power and became larger and paid lower labor shares. And, the distribution of markups in SOEs remained stable over time.

This paper will show that the significant firm-level heterogeneity in capital intensity and product market competition are systematically related to firm-level variations in labor shares. Then, it is documented how the shifts in the firm-level distributions of capital intensity and market power drive down the distribution of labor shares. The paper will also show how declining employment protections also drives aggregate labor shares. The next two section describe the data and the model. Section 4 provides a brief overview of the paper’s estimation strategy and results and section 5 concludes.

2 Data and Patterns

We use the data from the Chinese Annual Surveys of Industrial Production (ASIP), which covers all manufacturing firms with total annual sales exceeding roughly 500,000 RMB per year or roughly 612,000 US dollars.⁸ Our major firm-level outcome variable is payment to labor as a share of value-added or labor’s share:

$$LS_{it} = \frac{w_{it}N_{it}}{VA_{it}} \quad (1)$$

where $w_{it}N_{it}$ is labor compensation of firm i in year t , which is the product of the firm-level average wage rate (w_{it}) and the number of employees (N_{it}),⁹ and VA_{it} is a measure of value added using

⁷The Kolmogorov-Smirnov test formally tests the null hypothesis that the cumulative distribution of markups in 1998 and in 2007 are the same. This test fails to reject the null for SOEs (p-value is 0.328) and rejects the null for private firms (p-value = 0.000).

⁸We use an average exchange rate of 8.17 per dollar during 1998-2007. Following Brandt et al (2012) we track firms over time by using each firm’s ID, name, industry, address and other information. One sixth of all firms that are observed for more than one year have change their official ID over the sample period.

⁹Labor is the product of the head count of employees multiplied by the differences in human capital across China’s four regions (see Berkowitz et al (2015) for detail). The results do not change even if we use the unadjusted values

the production approach.¹⁰ Our baseline measure of aggregate labor shares can be thought of as a lower bound for the manufacturing sector because it is much lower than the comparable figures from the national accounts which include broad benefits paid to labor, while the only benefit to labor in our labor compensation measure is unemployment insurance. 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, Van Biesebroeck and Zhang (2012) and inflate wage payments so that the aggregated firm-level labor share values are consistent with the national-level figures.

Our labor shares measure excludes private manufacturing firms with sales less than 500,000 RMB per year and, as previously argued, we would expect their labor shares would be relatively high. Gollin (2002) notes in the system of national accounts the income of small firms in which the proprietors are self-employed is generally treated as capital income. Gollin then finds that labor shares become more stable once the income of self-employed proprietors is treated as wage income. In China the income of self-employed proprietors is classified as labor income during 1997-2003 and then as capital income since 2004. While this change could partly explain the drop in aggregate labor shares in manufacturing between 2003 and 2004, it does not explain the decline during 1998-2003 and during 2004-2007. Moreover, our study is concerned with changes in aggregate labor shares and data from the National Bureau of Statistics shows that aggregate labor shares did decline in industry throughout 1998-2007 and, even after 2004 when the accounting standards had changed and categorized the income of self-employed proprietors as labor income. Finally, the contribution of below scale firms to labor share dynamics is small because the data from the 2004 Chinese industrial census show that below-scale firms account for 28.8% of the industrial workforce and 9.9% of output.

Table 1 contains summary statistics. In order to capture firm-level differences in ownership, we report data for state owned enterprises (SOEs) and private firms, and total figures. Private firms include domestically owned private firms, foreign owned private firms and hybrid forms of ownership such as collectives. Table 1 Panel 1 reports aggregate data for the entire sample and shows that the total number of firms, real value added, employment and the value of real capital grew by 127%, 400%, 39% and 105% during 1998-2007, respectively. Simple inspection shows that private firms led this rapid growth and the share of SOEs in Chinese economy declined, suggesting

of the number of employees.

¹⁰This approach computes value added from gross output minus operating costs.

a massive structural change during 1998-2007.¹¹

During 1998-2007 aggregate labor shares declined by 7.9% points. This decline may, however, reflect a selection bias where firms with relatively high labor shares exit and firms with relatively low shares enter. However, aggregate labor shares fell by roughly the same amount in the entire sample (-7.9% points) and balanced sample (-8.2% points - see Table 1 Panel 2), indicating that selection is not a problem.

Another concern is that equity pay schemes became more important in SOEs that were either privatized or corporatized. Thus, some of the manager income reported as labor income in pre-corporatization SOEs or pre-privatization SOEs became capital income after these SOEs were corporatized or privatized and this change in income accounting could be the major reason why labor shares fell. If this was an issue, we would observe that aggregate labor shares are much more stable in the balanced sample that excludes the corporatized SOEs and the privatized SOEs than in the balanced sample. However, aggregate labor shares decline substantially by 8.2% points in the balanced sample and 6.6% points in the balanced sample excluding the corporatized and privatized SOEs.¹² While income accounting changes could be part of the reason for the 1.6% point sharper drop in the balanced panel, the theoretical analysis in the next section also predicts that corporatized SOEs and privatized SOEs would cut labor shares more steeply than SOEs that were neither corporatized nor privatized because they were under less pressure to hire excess labor.

In 1998 aggregate labor shares were much higher in SOEs than in private firms (31.5% for SOEs versus 22.8% for private firms); however, aggregate labor shares fell much more sharply in SOEs (-14.1 % points for SOEs versus -4.1 % points for private firms during 1998-2007), and by 2007 labor shares were slightly lower for SOEs (17.4%) versus private firms (18.7%).¹³ We have already

¹¹Many SOEs were privatized or exited; and, there was substantial turnover and net entry in the private sector. Thus, there might be some selection bias. In Appendix 1, we show that although on average the firms that exited had higher labor shares, the weighted average of these firms did not differ from the new entrants and incumbent firms. Therefore, the results indicate that the exited firms were relatively small. Moreover, the entire sample does not suffer too much from selection bias because it has patterns that are similar to a balanced sample that drops entrants and exiters (see Table 1 Panel 2).

¹²A corporatized SOE is an SOE in 1998 and a shareholding company for which the state holds the major share as of 2007. There are 290 of these corporatized SOEs in the balanced sample. A privatized SOE is an SOE in 1998 and a private firm in 2007. There are 2,650 privatized SOEs in the balanced sample.

¹³Karabarounis and Neiman (2014) use the flow of funds method and obtain labor shares for China's corporate sector. By our measure, labor shares declined by 7.9 percentage points for the full sample; the Karabarounis 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 Karabarounis-Neiman measure includes the service sector, while our measure excludes this sector. Thus, the Karabarounis-Neiman measure of labor's share is higher than our measure, in part, because service sectors tend to have higher labor shares than manufacturing sectors.

argued that throughout 1998-2007 aggregate labor shares were always lower than mean labor shares because the larger firms paid the lower shares. Table 1 summarizes this pattern for the start and end of the time series: mean labor shares exceeded aggregates by 26.9% points in 1998 and 17.4% points in 2007. This pattern also holds within our ownership classifications: means labor shares exceeded aggregates by 50.2% points in 1998 and 28.4% points in 2007 for SOEs and by 18.4% points in 1998 and 16.6% points in 2007 for private firms.

Figures 5-8 illustrate patterns mentioned in the introduction using the textile sector in 2007 as an example. As has been already argued, if firms operate with the CES production functions that have an elasticity of substitution between labor and capital exceeding unity, then we would expect that larger firms are more capital intensive and also have higher markups. Figure 5 is consistent with this expectation: when the log of value added is regressed on the log of capital intensity, the slope of the fitted line is 0.155, and this association is statistically significant at the 1% level. This positive slope for textiles is representative: out of 136 3-digit sectors during 1998-2007, we find that these fitted slopes are statistically significant (5% level) in all sectors and the average value of the slope is 0.336.

Figure 6 illustrates a positive association between value added and markups and is also consistent with our theoretical prediction that larger firms have more market power. The slope of the fitted line is 2.987, and this association is statistically significant at the 1% level. Again, textiles are a representative example of Chinese manufacturing: the fitted slopes are positive and statistically significant in all sectors and the average value of the fitted slope is 3.022.

By comparing aggregate and mean labor shares, we have already documented that larger firms pay lower labor shares. This finding is consistent with the data if capital intensive firms are not only large in value added but also pay lower labor shares. Using, once again, textiles in 2007, Figure 7 shows that capital intensive firms tend to have lower labor shares. The fitted value of the slope of the regression of the log labor share on the log of capital intensity is -0.199, which is statistically significant at the 1% level. Moreover, during 1998-2007 the average value of the fitted slope across all industries is -0.204 and it is statistically significant in 133 of the 136 sectors. As we will be clarified in the next theoretical section, this negative association between firm-level labor shares and capital-intensities is consistent with a model where firms have CES production functions with an elasticity of substitution between capital and labor exceeding unity.

Similarly, if firms have product market power, we would also expect that they pay low labor shares. Figure 8 confirms this expectation for textiles in 2007: here the fitted value of the slope of log of labor share regressed on log of markup is -2.463. Moreover, when we consider all sectors during 1998-2007, the slope is negative and statistically significant in 135 out of the 136 sectors and it has an average value of -2.562. As will be shown in the next section, this negative association between labor shares and product market power is consistent with a model which firms face less than perfectly elastic demand.

3 Heterogeneous Firms and Labor Shares

We consider an economy inhabited by firms that vary according to their capital intensities, market power, ownership and productivity. In this economy there is a firm i in sector s in period t that uses a sector-specific constant returns to scale production function that converts labor (N_{it}), capital (K_{it}) and materials (M_{it}) into an output (Q_{it}):

$$Q_{it} = \omega_{it} \left[a_s (N_{it})^{\frac{\sigma_s - 1}{\sigma_s}} + (1 - a_s) (K_{it})^{\frac{\sigma_s - 1}{\sigma_s}} \right]^{\frac{\alpha_s \sigma_s}{\sigma_s - 1}} (M_{it})^{1 - \alpha_s} \quad (2)$$

Each firm is differentiated by its productivity, ω_{it} . The parameters of the sectoral production function include the weight on labor versus capital in factor inputs, a_s , where $0 < a_s < 1$; the sector-specific elasticity of substitution between capital and labor, σ_s , where $0 \leq \sigma_s < +\infty$; and relative weight between the factor inputs (i.e., labor and capital) and intermediate inputs, α_s , where $0 < \alpha_s < 1$.

Each firm faces a perfectly elastic supply of labor, capital and materials at input prices w_{it} , r_{it} , and \tilde{p}_{it} , respectively. And, each firm faces a downward sloping demand curve for its product:

$$p_{it} = B_{it} (Q_{it})^{-\frac{1}{\eta_{it}}} \quad (3)$$

where η_{it} denotes the price elasticity of demand: $\eta_{it} \geq 1$. Here, firms are heterogeneous in their markups, μ_{it} (market power) and these markups can be time-varying:

$$\mu_{it} = \frac{1}{1 - \frac{1}{\eta_{it}}}. \quad (4)$$

Firms are also heterogeneous according to ownership and can be private firms or state owned enterprises (SOEs). As argued in Shleifer and Vishny (1994), SOEs are under political pressure to preserve jobs while private firms are not. In order to capture this difference, let ϕ_t denote political pressure on SOEs in period t and $(1 - 1/\phi_t)$ is the political benefit of hiring an additional worker:

$$\phi_t = 1 \text{ for private firms, } \phi_t \geq 1 \text{ for SOEs.} \quad (5)$$

A firm i in sector s in period t chooses inputs (N_{it} , K_{it} , and M_{it}) in order to maximize a payoff, U_{it} , that includes profits and the political benefits of providing paid employment:

$$U_{it} = \Pi_{it} + \left(1 - \frac{1}{\phi_t}\right) w_{it} N_{it} \quad (6)$$

where

$$\Pi_{it} = p_{it} Q_{it} - w_{it} N_{it} - r_{it} K_{it} - \tilde{p}_{it} M_{it}. \quad (7)$$

The first order conditions for the objective function in equation (6) with respect to labor and capital are:

$$\frac{\phi_t}{\mu_{it}} \frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} = \frac{w_{it} N_{it}}{p_{it} Q_{it}} \quad (8)$$

and

$$\frac{1}{\mu_{it}} \frac{\partial Q_{it}/Q_{it}}{\partial K_{it}/K_{it}} = \frac{r_{it} K_{it}}{p_{it} Q_{it}}. \quad (9)$$

Combining equations (8) and (9), we can derive an expression for firm-level capital intensity as a function of the sectoral production function parameters and the firm-level costs of capital relative to labor:

$$\frac{K_{it}}{N_{it}} = \left(\phi_{ot} \frac{r_{it}}{w_{it}} \frac{a_s}{1 - a_s} \right)^{-\sigma_s} \quad (10)$$

Finally, the first order condition for materials is

$$\frac{1}{\mu_{it}} \frac{\partial Q_{it}/Q_{it}}{\partial M_{it}/M_{it}} = \frac{\tilde{p}_{it} M_{it}}{p_{it} Q_{it}}. \quad (11)$$

Since $\frac{\partial Q_{it}/Q_{it}}{\partial M_{it}/M_{it}} = 1 - \alpha_s$, equation (11) can be simplified and converted into an expression for markups:

$$\mu_{it} = (1 - \alpha_s) \frac{p_{it} Q_{it}}{\tilde{p}_{it} M_{it}}. \quad (12)$$

Using these results, we next derive an expression for a firm's labor shares as a function of the fundamental sources of firm heterogeneity: capital intensity (K_{it}/N_{it}), product market power (μ_{it}), ownership structure (ϕ_t) and productivity (ω_{it}). The denominator of labor's share is value added, which is revenues minus materials (operating costs). Using this definition and manipulating the first order condition for materials (12), value added is:

$$VA_{it} = p_{it} Q_{it} - \tilde{p}_{it} M_{it} = p_{it} Q_{it} \left(1 - \frac{1 - \alpha_s}{\mu_{it}} \right) \quad (13)$$

Using the first order conditions for labor, capital and materials and the relationship between revenue and value added in equation (13), a firm's labor share is

$$\frac{w_{it} N_{it}}{VA_{it}} = \frac{\phi_t}{\mu_{it} - 1 + \alpha_s} \left[\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}} \right] \quad (14)$$

where

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

The system of equations (14), (15) and (10) show how firm-level heterogeneity in exogenous variables, r_{it}/w_{it} (factor price ratio), μ_{it} (markups) and ϕ_t (state ownership), determine firm-level labor shares within each sector. Moreover, since we do not observe the firm-level user costs of capital (r_{it}), we use the system of two equations (14) and (15) in which the capital-intensity (K_{it}/N_{it}) plays

a critical role in the analysis.¹⁴

In this setup, capital intensity in equation (15) shapes labor shares in equation (14) exclusively through its impact on $\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}}$ (the output elasticity of labor). In the Cobb-Douglas case ($\sigma_s = 1$), capital intensity has no impact on $\frac{\partial Q_{it}/Q_{it}}{\partial N_{it}/N_{it}}$, and thus, no impact on labor shares. When $\sigma_s > 1$, an increase in capital intensity lowers the output elasticity of labor which, in turn, depresses labor's share. And, when $\sigma_s < 1$, an increase in capital intensity increases labor's share. Thus, everything else equal, more capital intensive firms have lower labor shares when $\sigma_s > 1$ and higher labor shares when $\sigma_s < 1$; and, capital intensity is unrelated to labor shares when $\sigma_s = 1$.

In this setup, equation (14) obtains the result in Azmat et al (2012) where higher markups (μ_{it}) for a firm lowers its labor shares. Moreover, less political pressure on an SOE to protect jobs (ϕ_t) directly lower its labor shares. However, equation (10) indicates that a decrease in ϕ_t increases capital intensity (K_{it}/N_{it}) which, in turn, can influence labor's share through the output elasticity of labor. Thus, when $\sigma_s > 1$, a decline in ϕ_t lowers labor's share through a direct channel and also indirectly through its impact of capital intensity on the output elasticity of labor. As we will show in the estimation sections, in general $\sigma_s > 1$ in China's manufacturing sectors. Thus, everything else equal we would expect that when SOEs are under less pressure to hire excess workers, labor shares will be lower.

Finally, firm-level productivity (ω_{it}) does not enter into the system of equations (14) and (15). Thus, for the rest of the paper we focus on how the evolutions of firm-level distributions in capital intensity, market power and ownership shape firm-level labor shares.

4 Empirical Strategy

The empirical strategy has two stages. First, the production function equation (2) is estimated using the generalized method of moments (GMM) procedure from De Loecker and Warzynski (2012). This first stage fully identifies the structural variables from each sectoral production function ($\hat{\sigma}_s$, $\hat{\alpha}_s$ and \hat{a}_s) and uses these estimated structural parameters to then estimate firm-level markups ($\hat{\mu}_{it}$). In Appendix 3, we describe this procedure and also show that similar results for the capital-labor substitution elasticity are obtained using the estimation procedure developed by Kmenta (1967) and also using non-linear least squares. In a second stage, which is described later in this section,

¹⁴Tests of the the general validity of this system can be found in Appendix 4.

the political pressure parameter ($\tilde{\phi}_t$) is estimated.

Table 2 summarizes the estimated structural parameters for the production function in equation (2) for each of the 136 3-digit sectors. The estimated weights on factor inputs ($\hat{\alpha}_s$) and labor relative to capital (\hat{a}_s) are on average 0.185 and 0.812. A result that will be critical for our interpretation of how firm-level heterogeneity by capital intensity shapes labor shares is the elasticity of substitution between labor and capital ($\hat{\sigma}_s$) exceeds unity for 128 out of 136 sectors. Moreover, the cross-section average, minimum value and maximum value for the capital-labor elasticity of substitution are 1.467, 0.715 and 2.328, respectively.

The structural parameters estimated from the sectoral production functions and firm-level markups are used in a second stage to estimate the political pressure on SOEs to hire excess labor. Combining the labor share in equation (14) with the output elasticity of labor in equation (15), the model implies that the log political pressure parameter in year t ¹⁵ is:

$$\ln(\hat{\phi}_t) = \ln\left(\frac{w_{it}N_{it}}{VA_{it}}\right) + \ln(\hat{\mu}_{it} - 1 + \hat{\alpha}_s) - \ln(\hat{\alpha}_s) + \ln\left[1 + \left(\frac{1 - \hat{a}_s}{\hat{a}_s}\right) \left(\frac{K_{it}}{N_{it}}\right)^{\frac{\hat{\sigma}_s - 1}{\hat{\sigma}_s}}\right] \quad (16)$$

where labor's share ($w_{it}N_{it}/VA_{it}$) and capital intensity (K_{it}/N_{it}) are observed from the data.

Because the above equation (16) contains measurement errors and, as is, can vary across firms, the following equation is used to estimate a uniform annual political pressure parameter that is purged of measurement error:

$$\ln(\hat{\phi}_t) = \sum_t \pi_t D_{it}^{SOE} D_{it}^t + e_{it} \quad (17)$$

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

Table 3 reports the estimated coefficient, $\hat{\pi}_t$ where $\exp(\hat{\pi}_t) \equiv \tilde{\phi}_t$, in equation (17) and the implied political benefit of hiring excess employment, $(1 - 1/\tilde{\phi}_t)$, for the entire sample and the balanced sample with continuers.¹⁶ Because the political pressure parameter is an annual average

¹⁵It is simple to adjust this equation so that the political pressure parameter varies at a regional or sectoral level in any year.

¹⁶The balanced sample with continuers only includes firms that operated throughout the period of 1998-2007 and never changed their ownership classification.

difference between all SOEs and all private firms, we would expect that it would be different in the entire sample and the balanced sample with continuers. Compared to the entire sample, the balanced sample with continuers excludes firms that changed the ownerships and entered after 1998 and also excludes firms that exited before 2007. In Appendix 1, we show that firms exiting before 2007 (exiters) were predominately small SOEs that had higher mean labor shares than SOE incumbents and private firms; and firms entering after 1998 (entrants) were predominately large SOEs that also had higher labor shares than incumbent SOEs and private firms. The exit of small SOEs was stronger at the start of the sample period, while the entry of large SOEs became more important toward the end of the sample period. Thus, we would expect that political pressure parameter would be higher in the entire sample at the beginning of the sample period, and higher in the balanced sample with continuers at the end of the period.

Consistent with our expectations, in 1998 the estimated political benefit of hiring excess labor was 54.7% of SOE profits in the full sample and 49.4% in the balanced sample with continuers; and in 2007 the estimated political benefit was lower in the full sample (26.8% of SOE profits) than in the balanced sample with continuers (31.8%). All of these estimated political pressure variables are statistically significant at the 1% confidence level in all years.

More importantly, Figure 9 illustrates that the political pressure on SOEs to protect jobs is declining on an annual basis in both the entire sample and the balanced sample with continuers. Thus, consistent with our theory, this decline in political pressure to protect employment drives down labor shares in SOEs through a direct channel which in turn lowers aggregate labor shares. Moreover, this decline in political pressure drives down the cost of capital inputs relative to labor for SOEs: and, since the elasticity of substitution between capital and labor generally exceeds unity, the decline in political pressure pushes down SOE labor shares and aggregate labor shares through a substitution channel.

4.1 Capital Intensity and Markups

Recalling Figure 3, the cumulative distribution of the capital-labor ratio shifted to the right during 1998-2007; and, this shift was more profound for SOEs. Because the elasticity of substitution is generally greater than unity, our theory predicts that the rightward shift in the firm-level capital-intensity distributions is a force underlying the decline in aggregate labor shares.

In an effort to check whether the rapid growth of capital intensity is robust after controlling for province-, sector-, and ownership-fixed effects, the following equation is estimated:

$$\ln(X_{it}) = c + \sum_t \theta^t D_{it}^t + \sum_p \theta^p D_{it}^p + \sum_s \theta^s D_{it}^s + \sum_o \theta^o D_{it}^o + \varepsilon_{it} \quad (18)$$

where D_{it}^t , D_{it}^p , D_{it}^s and D_{it}^o are year-, province-, sector-, and ownership-dummy variables; and ε_{it} is an independent and identically distributed random variable. In equation (18) the constant term c is capital intensity for the baseline, which is a private textile firm in the Jiangsu province in 1998. Thus, $t \neq 1998$, $p \neq \text{Jiangsu}$, $s \neq \text{textiles}$ and $o \neq \text{private firm}$.

In equation (18), the dependent variable, $\ln(X_{it})$, is the log of capital intensity of firm i in year t . We are interested in the cross-firm average log of capital intensity for each year, conditional on differences in provinces, sectors, and ownership. Table 4 Panel 1 reports the conditional change in the average log of capital intensity from 1998 to 2007 (θ^{2007} in equation (18)) for the entire sample and the balanced sample.

In the entire sample, capital intensity grew by almost 42%, and the 64.3% growth rate for SOEs was much more rapid than the 38.4% growth rate for private firms. In the balanced sample, the growth of capital intensity is 23.1% points lower in the balanced sample for SOEs and 5.8% points higher for private firms. There are several explanations for the striking difference in the growth rates of capital intensity for SOEs in the entire and balanced samples. First, the exit of small labor-intensive SOEs raised the initial capital intensity of SOEs in the balanced sample. Second, even though there was some net entry of large SOEs, this occurred towards the end of the sample period, and the net exit of SOEs early on in the sample period was more powerful than net exit of SOEs towards the end of the period. In sum, the sharp rightward shift in the unconditional distributions of capital intensities that has been documented is robust to a set of fixed effects and holds in the entire and balanced samples.

As shown in Figure 4, during 1998-2007 the cumulative distribution for SOE markups was stable and for private firm markups shifted out rightward. In this case, our theory predicts that changes in the distribution of private markups can also explain the decline in aggregate labor shares. In order to check for whether the growth of markups in the private sector is robust to fixed effects and corrections for measurement error, we estimate equation (18) and use the log of markups as

the dependent variable $\ln(X_{it})$. In order to calculate markups, the estimated production function parameters for each of the 136 3-digit sectors are inserted into equation (12).

The results are contained in Table 4 Panel 2. The conditional changes in markups from 1998 to 2007 were 2.5% in the entire sample and 2.0% in the balanced sample, and these conditional changes are statistically significant at the 1% level. Moreover, the growth of conditional means for SOEs in the entire and balanced samples were 0.0% and 1.1%, where the latter term is not statistically significant at the 5% level. Thus, the general argument that there was rightward shift in private markups between 1998 and 2007 is robust after allowing for province, sectoral and ownership fixed effects.

4.2 Heterogeneity in Labor Shares

This section uses graphical analysis for selected sectors in 2007 to provide some intuition for how firm-level heterogeneity shapes the decline in aggregate labor shares during 1998-2007. In order to pin down the contribution of changes in firm-level heterogeneity to changes in the distribution of labor shares a counter-factual analysis is conducted in the next subsection. A more detailed analysis of the role that entry and exit and ownership and globalization play in depressing labor's share is contained in the Appendix (Parts 1 and 2).

Figure 10 plots predicted labor shares as a function of firm-level capital intensities for three sectors in 2007. These sectors are chosen to capture the breadth of sectoral capital-labor substitution elasticities: paper products are close to the 10th percentile ($\hat{\sigma}_{paper} = 1.06$), beverages are the closest to the median ($\hat{\sigma}_{beverages} = 1.47$), and shipbuilding is roughly the 90th percentile ($\hat{\sigma}_{ship} = 1.99$). Predicted labor shares are calculated using the estimated production function parameters for each sector, the mean value of markups for private firms in each sector and firm-level capital-labor ratios in 2007. For expositional purposes, the right hand side tail is truncated at 0.3, and this covers 96%, 82% and 93% of the paper, beverage and shipbuilding firms, respectively. Consistent with our theory, in each sector labor shares are decreasing in capital intensity.¹⁷ And, as argued by Solow (1957, p.629) we would also expect that aggregate labor shares decline as capital-labor ratios increase because most of the elasticities are distributed to the right of unity. Moreover, the slopes

¹⁷By inspection of Figure 10, labor shares are all convex in capital intensity. By simple manipulation of equations (14), and (10), it is straightforward to establish convexity when the elasticity of substitution between capital and labor exceeds unity.

in Figure 10 are steeper for sectors with a higher value of the elasticity of substitution: paper firms have an elasticity of substitution that only slightly exceeds unity, and its slope, while negative, is close to zero (Cobb-Douglas): shipbuilding firms have the highest elasticity of substitution and the steepest negative slope. These findings are consistent with the argument in Solow (1957, p.620), that the elasticity of substitution has been substantially different than unity for capital deepening to have a significant impact on labor shares.

Figure 11 compares predicted labor shares for private firms and SOEs in 2007. Textile firms in 2007 are again used as the example as their elasticity of substitution is close to the cross-sectoral average ($\hat{\sigma}_{textiles} = 1.374 < \hat{\sigma}_{average} = 1.467$). Predicted labor shares for private firms are calculated following the procedure previously outlined. To calculate predicted labor shares for SOEs, political weights on excess employment must also be included; and we use the results from the balanced sample with continuers (see Table 3) since they deal with selection issues. Consistent with our theory, SOEs pay higher labor shares at any level of capital intensity and the impact of ownership at any level of firm-level capital intensity is highly potent. For example, SOEs' labor shares are 26.1, 24.9 and 23.6 percentage points higher in the 25th percentile, median and 75th percentile of capital intensity than private firms' labor shares.¹⁸ While we have shown that ownership differences are powerful in the textile sector, this pattern is representative because the estimated political weight is uniform across sectors.

Next, we examine how firm heterogeneity in markups causes the cross-firm difference in labor share. Figure 12 depicts predicted labor shares as a function of markups in 2007 for private firms in textile sector with low and high values of capital intensities. High capital-intensity private firms are in the 75th percentile (0.083), and this is more than five times higher than low capital-intensity firms in 25th percentile (0.018). Because the elasticity of substitution between capital and labor exceeds unity in textiles, our theory predicts that labor shares are lower in the high capital intensity firms. While the results in Figure 12 are consistent with this prediction, it is important to notice how a difference in markups causes a significant difference in labor shares across firms. In the textile sector, the 25th, 50th and 75th percentile estimated values of markups are 0.985, 1.05 and 1.13, respectively. Moving the 25th to 75th percentile value of markups, labor's share declines significantly from 0.867 (0.785) to 0.469 (0.425) with the 25th (75th) percentile value of

¹⁸We use the single percentile value of capital intensity in the sector. The 25th percentile, the median, and 75th percentile values of capital intensity are 0.018, 0.040, and 0.084, respectively.

capital intensity, which are much greater impacts comparing to the corresponding percentile changes of capital intensities.

4.3 Predicted Labor Shares Shifts: 1998-2002 to 2003-2007

Figure 13 illustrates our counter-factual analysis. In order to isolate the separate contribution of changes in the distribution of capital intensities, markups and political pressure to protect jobs, we proceed in four steps. First, we plot the baseline (1998-2002) predicted cumulative distribution of labor shares using the 1998-2002 mean values of firm-level capital-labor ratios, firm-level markups and the political weights.¹⁹ In order to avoid selection problems, we use the balanced sample for the capital-labor ratios and markups, and the balanced sample with continuers for political pressure. The predicted baseline cumulative distribution is denoted Model 1. Second, we replace the baseline average capital-intensity ratios with the 2003-2007 average ratios. This predicted cumulative distribution is denoted Model 2, and the difference between Model 2 and Model 1 is the simulated impact of capital intensity changes. Third, we replace the baseline markups in Model 2 with 2003-2007 markups. This predicted cumulative distribution is denoted Model 3, and the difference between Model 3 and Model 2 is the simulated impact of markup changes. Finally, we replace the baseline political pressure in Model 3 with political pressure in 2003-2007. This is the cumulative distribution for 2003-2007 and it is denoted Model 4; and, the difference between Model 4 and Model 3 is the simulated impact of changes in political pressure.

Table 5 contains summary statistics for the predicted labor shares in 1998-2002 (Model 1) and 2003-2007 (Model 4). In order to evaluate goodness of fit of our model, "predicted" labor shares are compared with "actual" and "adjusted" labor shares, where the latter refers to adjustments made by Hsieh and Klenow (2009) and Brandt et al (2012) so that the aggregate firm-level labor shares reasonably match the national figures.²⁰ Table 5 shows that in each period, the actual labor shares for the mean, the 25th, 50th and 75th percentiles are always higher than the actual labor shares and lower than the adjusted labor shares. In 1998-2002, actual, predicted and adjusted labor share distributions are similar in terms of skewness and kurtosis; however, in 2003-2007 the actual and adjusted labor share distributions have much fatter tails and are more skewed to the right than the

¹⁹Since firm-level markups are widely distributed over time for some firms, we use the average value of markups in the first half (1998-2002) and that of the second half (2003-2007).

²⁰This adjustment procedure is discussed on p.5 of this paper.

predicted distribution. These findings indicate that while our model fits the data reasonably well, the predictive value of the model is not good for the upper tail in 2003-2007.

Between the two periods (1998-2002 and 2003-2007), the distribution of firm-level capital ratios shifted to the rights, the firm-level distribution of markups in the private sector shifted to the right, and political pressures on SOEs were relaxed. Moreover, the capital-labor substitution elasticity through 1998-2007 was generally greater than unity. Thus, consistent with our theory, in Figure 13 the predicted distribution of labor shares shifts to the left when the 1998-2002 values of capital-labor ratios, markups and political pressure are replaced, one by one, with the 2003-2007 values.

Table 6 reports the summary statistics of the predicted distributions of labor shares for Models 1 through 4. The declines in labor shares from Model 1 to Model 4 become more profound at the upper end of the distribution and are -4.2% points (26.6% - 30.8%), -5.1% points (40.8% - 45.9%) and -9.3% points (60.4% - 69.7%) at the 25th, 50th and 75th percentiles, respectively. It is also striking that declining political pressure plays a more important role at higher levels of the distribution: the change in predicted labor share at the 25th percentile value is -1.0% points change (from 27.7% for Model 3 to 26.6% for Model 4), whereas the corresponding change at the 75th percentile value is -5.3% points change (from 65.7% for Model 3 to 60.4% for Model 4). An explanation for these findings is that SOEs in the 1998-2002 period generally had the highest labor shares, and it was the SOEs that were directly influenced by the declining political pressure to hire labor during 1998-2007.

Moreover, at the 25th percentile point, the largest change is created from the markup (-1.8% points change from 29.5% for Model 2 to 27.7% for Model 3), followed by capital intensities (-1.4% points change from 30.8% for Model 1 to 29.5% for Model 2) and the political weight (-1.0% points change). At the 75th percentile point, as previously noted, changes in political pressure make the largest contribution to declining labor shares (-5.3% points change), and this is followed by markups (-2.7% points change from 68.4% for Model 2 to 65.7% for Model 3) and capital intensity (-1.3% points change from 69.7% for Model 1 to 68.4% for Model 2). Overall, increasing market power for private firms, capital deepening for both private and state firms, and declining political pressure on SOEs were all important contributors, and the relative contribution varies along the labor shares distribution.²¹

²¹By simple inspection of Table 6, markup gains appear to be the biggest contributor to declining labor shares. For example, at the mean level, markups changes account for 6.3% points of the predicted 11.7% point decline in labor's

Conclusions

The declining labor shares in countries around the world observed since the 1980s is of concern because it is associated with growing income and wealth inequality. In an influential study, Piketty (2014) documents that declining labor shares and growing income and wealth inequality are inherent features of market economies. A critical component of Piketty's argument is the elasticity of substitution between capital and labor in an aggregate country-level production function exceeds unity (see also Acemoglu and Robinson, 2014; Rowthorn, 2014). This basic assumption is controversial because, as we have noted already, influential empirical studies document that this structural parameter is generally less than unity.

Using detailed firm-level data for China and an estimation method of De Loecker and Warzynski (2012), we have documented that the elasticity of substitution between capital and labor generally exceeds unity during 1998-2007. This is a surprising finding and could reflect massive imports of new machinery and massive structural change. However, we also show weakening product market competition and weakening job protections have also played similarly important role in driving down labor's share. Finally, the relative impact of capital-deepening, product market competition and job protections vary in importance along the distribution of labor shares.

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share. However, in Appendix 4 and Appendix Table 2 we show the actual impact of markup changes is somewhat less profound than predicted by our theory (moreover, our theory accurately predicts the impact of capital-intensity changes and political pressures change). Thus, overall, markups, capital intensities and political pressure all play an important role.

Appendix

Appendix 1: Exit and Entry

In the next two subsections we argue that entry and exit of firms have only a negligible influence on the decline in aggregate labor shares. This implies that sample selection is not problematic and we can understand the drivers of labor share declines using the balanced sample. We then document that changes in labor shares within SOEs is one of the key drivers in the decline of labor shares while globalization, particularly international trade, appears to have no direct impact.

Traditionally, SOEs in China have been the dominant force in the manufacturing sector. It is thus striking that the overall number of SOEs during 1998-2007 declined by 67%, while the number of private firms increased by 210%. Moreover, during 1998-2007 the mean value of labor's share across Chinese manufacturing firms declined from 53.3% in 1998 to 35.8% in 2007 (Table 1). These patterns suggest that the exit and entry of firms played an important role in the declining trend in labor's share.

However, Figures A.1 and A.2 indicate that impact of entry and exit on aggregate labor shares is quite similar to the impact of incumbent firms. Figures A.1 and A.2 illustrate the (unweighted) mean and aggregate value of the labor shares for incumbent firms, exiters, and entrants in any year t , where incumbents operate in years $t - 1$ and t , exiters operate in year $t - 1$ but not in year t , and entrants do not operate in year $t - 1$ but operate in year t . We find that while the exiters had higher values of labor's share on average, these three groups had the similar aggregate trends in labor's share. Because the bulk of the firms that exited were labor intensive and had low markups, they were small and their value added shares had a negligible impact on aggregate labor shares.

Appendix 2: Between and Within Effects

In order to get some understanding of the links between the decline in labor shares and various types of firms, the change in labor shares is decomposed into its between and within effects. 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. We first examine the change in the labor shares arising from the composition of ownership types versus the change in

the labor shares within each ownership type and use the following decomposition:

$$\Delta LS = \sum \Delta S^o ALS^o + \sum \Delta LS^o AS^o. \quad (19)$$

In equation (19) $\Delta LS = LS_{2007} - LS_{1998}$ denotes the change in aggregate labor shares (-7.94% points), and LS_{2007} and LS_{1998} are the labor shares in manufacturing in 2007 and 1998 (18.4% in 2007 and 26.4% in 1998). The other variables in equation (19) account for differences in ownership (o = private and state). These four variables are (1) the change in aggregate labor share of ownership type o is $\Delta LS^o = LS_{2007}^o - LS_{1998}^o$ where LS_{2007}^o and LS_{1998}^o 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 $\Delta S^o = S_{2007}^o - S_{1998}^o$ where S_{2007}^o and S_{1998}^o 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 $ALS^o = 0.5(LS_{2007}^o + LS_{1998}^o)$, and (4) firm type o 's average share in value added is $AS^o = 0.5(S_{2007}^o + S_{1998}^o)$. In equation (19), 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 .

The first row in the first panel in Table A.1 reports the results of this decomposition according to aggregate values by ownership (private, state, foreign, and hybrid): it lists between effects, within effects and total changes in labor's share. It is notable that nearly 90% of the 7.94 percentage point decline in labor's share stems from within effects (-6.88 percentage points). The second panel of Table A.1. reports the same decomposition for the balanced panel and confirms that within effects explain most of the aggregate labor share decline.

In order to get a better understanding of the importance of within effects for labor share declines, we allow the superscript o in equation (19) to represent some other categories. The second row in Table A.1 Panel 1 reports the between and within effects for the status of exporters versus non-exporters. As predicted in the standard firm-heterogeneity model of trade by Melitz (2003), exporters are expected to be more productive and/or they should 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 global markets is critical for explaining the decline in labor

shares. However, the data suggests that there is no clear evidence that the increasing share of exporters has an impact on declining labor share. Specifically, the between effect explains only 0.17 percentage point of total 7.94% point decline in aggregate labor shares. Finally, the dominant role of within effects is consistent even we examine the between effects across 3-digit sectors, provinces, and individual firms.²² Our results suggest that the composition changes of value added across ownerships, exporters, industries, provinces and firms do not explain the significant part of the labor share decline in China. These conclusions are sustained if we use the balanced sample.

Appendix 3: Estimation of the Capital-Labor Elasticity of Substitution

The traditional micro-econometric methods for estimating the capital-labor elasticity of substitution production include Kmenta (1967), non-linear least squares (e.g., Henningsen and Henningsen, 2012) 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 a CES (constant elasticity of substitution) production function in order to estimate the long-run capital-labor elasticity of substitution. The Chirinko et al method is not suitable for the case of Chinese manufacturing during 1998-2007: this is a period of rapid structural change and the Chirinko et al method requires a stable (stationary) time series of firm-level production variables. Moreover, the Chirinko et al method requires rich firm-level data on the cost of capital that we do not have.

Before we introduce the method from De Loecker and Warzynski (2012), in what follows we discuss two traditional micro-econometric approaches for estimating the elasticity of substitution between labor and capital.

Kmenta’s Approach

Kmenta (1967) uses the polynomial approximation of Taylor’s theorem around the Cobb-Douglas production function ($\sigma_s = 1$):

²²For this decomposition analysis for the entire sample of firms, it is important to note how we handle exit and entry. We follow Grilliches and Regev (1995) and develop a hypothetical firm as an aggregate of all exiters in 1998 and that of all entrants in 2007.

$$\begin{aligned}
q_{it} &= \ln(\omega_{it}) + \beta_s^n n_{it} + \beta_s^k k_{it} + \beta_s^{kn} (n_{it})^2 + \beta_s^{kn} (k_{it})^2 \\
&\quad - 2\beta_s^{kn} (n_{it}k_{it}) + (1 - \beta_s^n - \beta_s^k)m_{it}.
\end{aligned} \tag{20}$$

where lower-case letters denote logged values: $q_{it} = \ln(Q_{it})$, $n_{it} = \ln(N_{it})$, $k_{it} = \ln(K_{it})$, and $m_{it} = \ln(M_{it})$.

Here, we can obtain the capital-labor elasticity of substitution from

$$\sigma_s = \left[1 + \beta_s^{kn} (\beta_s^n + \beta_s^k) / (\beta_s^n \beta_s^k) \right]^{-1}. \tag{21}$$

A standard method for estimating equation (20) is to assume there is no systematic productivity innovation: ($\ln(\omega_{it}) = \ln(\omega_i)$), and estimate it with firm-fixed effects using the within-firm transformation:

$$\begin{aligned}
d(q_{it}) &= \beta_s^n d(n_{it}) + \beta_s^k d(k_{it}) + \beta_s^{kn} d(n_{it})^2 + \beta_s^{kn} d(k_{it})^2 \\
&\quad - 2\beta_s^{kn} d(n_{it}k_{it}) + (1 - \beta_s^n - \beta_s^k)d(m_{it}) + \sum_t \theta^t D_{it}^t + \varepsilon_{it}
\end{aligned} \tag{22}$$

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

Olley and Pakes (1996) and Akerberg et al (2006) criticize the within-transformation models, and that is why we use the De Loecker and Warzynski (2012) approach in the main body of our paper. Regarding the estimation of the capital-labor elasticity of substitution, Thursby and Lowell (1978) also show that the Kmenta (1967) approach becomes increasingly inaccurate as the absolute value of the actual elasticity of substitution minus one gets larger. Nevertheless, as a robustness check the first and second panels in Table A3 summarize the estimated parameters for the production function in equation (22) for each of 28 2-digit and 136 3-digit sectors. The capital-labor elasticity of substitution obtained from equation (21) exceeds unity for 92.9% of 2-digit sectors and 82.7% of 3-digit sectors.

Non-Linear Least Squares

The parameters of equation (2) could be estimated by non-linear least squares. However, a challenging issue with this method is to achieve convergence (Henningsen and Henningsen, 2012). Thus, it is important to obtain good initial parameter values and to impose reasonable constraints on parameters so that the CES production function is as close to long-linear as possible. Regarding initial parameter values, we use the estimated parameter values from equation (22). Regarding the constraints on parameters in the production function specification, we make the most of enforcing the unit elasticity of substitution between the factor inputs and intermediate inputs and the constant returns to scale in production. By assuming $\ln(\omega_{it}) = \ln(\omega_i)$, we can also estimate equation (2) using non-linear least squares with the within-firm transformation:

$$\begin{aligned}
 d(q_{it}) &= \frac{\alpha_s \sigma_s}{\sigma_s - 1} \ln \left(a_s (N_{it})^{\frac{\sigma_s - 1}{\sigma_s}} + (1 - a_s) (K_{it})^{\frac{\sigma_s - 1}{\sigma_s}} \right) \\
 &\quad - \frac{\alpha_s \sigma_s}{\sigma_s - 1} \ln \left(a_s (\tilde{N}_{it})^{\frac{\sigma_s - 1}{\sigma_s}} + (1 - a_s) (\tilde{K}_{it})^{\frac{\sigma_s - 1}{\sigma_s}} \right) \\
 &\quad + (1 - \alpha_s) d(m_{it}) + \sum_t \theta^t D_{it}^t + \varepsilon_{it}
 \end{aligned} \tag{23}$$

where $\tilde{X}_i = (1/T_i) \sum_t X_{it}$.

The third and fourth panels in Table A3 report the estimated parameters in equation (23) for each of 27 2-digit and 121 3-digit sectors.²³ The elasticity of substitution between labor and capital (σ_s) exceeds unity for 96.3% of 2-digit sectors and 95.0% of 3-digit sectors, indicating that labor and capital are strong substitutes in Chinese manufacturing during 1998-2007.

The De Loecker and Warzynski Approach

The method in De Loecker and Warzynski (2012) enables us to fully identify all of the parameters of sectoral CES production functions including the capital-labor elasticity of substitution. This method contains two stages. In the first stage, a second-order polynomial function of the three inputs is included. Because SOEs might have special access in materials markets, a SOE dummy variable (D_{it}^{SOE}) is included and interacted with the the polynomial function. Because capital is determined by past investments and labor markets in China tend to be regulated, materials are

²³The estimations do not converge to the reasonable ranges for one 2-digit sector and 15 3-digit sectors.

assumed to be the flexible input and the following first stage equation is estimated:

$$q_{it} = \Phi_t [n_{it}, k_{it}, m_{it}, D_{it}^{SOE}] + \epsilon_{it}.$$

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

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

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

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

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, n_{it} and m_{it} , but it is not correlated with the predetermined variable, k_{it} , the innovation to productivity, $\zeta_{it}(\Omega)$, will not be correlated with k_{it} , $n_{i,t-1}$, and $m_{i,t-1}$. Thus, we use the moment condition similar to De Loecker and Warzynski (2012) to identify the production function parameters:

$$E \left[\zeta_{it}(\Omega) \begin{pmatrix} k_{it} \\ n_{i,t-1} \\ k_{it} n_{i,t-1} \\ (k_{it})^2 \\ (n_{i,t-1})^2 \\ m_{i,t-1} \end{pmatrix} \right] = 0.$$

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 weighting procedure proposed by Hansen (1982) for the plausible values of Ω .²⁴

²⁴We use equation (23) to obtain the initial values of $\tilde{\Omega} = (\tilde{\alpha}_s, \tilde{\sigma}_s, \tilde{a}_s)$. In the cases where NLS does not converge to the reasonable range of parameters for a 3-digit sector, we then use the corresponding results for the 2-digit sectors.

Appendix 4: Validation of the Theory

A simple expression for labor share's of value added can be derived:

$$LS_{it} = \frac{F(\cdot)}{G(\cdot)} \phi_t. \quad (24)$$

where ϕ_t is the political weight for excess employment, the output elasticity of labor is $F(\cdot) = \hat{\alpha}_s \left[1 + \left(\frac{1 - \hat{a}_s}{\hat{a}_s} \right) \left(\frac{K_{it}}{N_{it}} \right)^{\frac{\hat{\sigma}_s - 1}{\hat{\sigma}_s}} \right]^{-1}$, and the markup effect is $G(\cdot) = \hat{\mu}_{it} - 1 + \hat{\alpha}_s$.

As validation test of our theory of firm-level labor shares, we estimate the variants of the following equation:

$$\ln(LS_{it}) = \delta^\sigma \ln [F(\cdot)] + \delta^\mu \ln [G(\cdot)] + \sum_t \delta_t^\phi D_{it}^{SOE} D_{it}^t + e_{it}. \quad (25)$$

This estimating equation enables us to recover the implied sectoral political pressure to hire excess labor, ϕ_t , similar to our baseline method. As we defined before, D_{it}^{SOE} is a dummy variable that equals one for an SOE and is zero otherwise. The first set of estimating equations include province-, sector- and year-specific fixed effects. The remaining estimating equations include firm-fixed effects. We also include the one-year lagged value of log labor share to capture the dynamic character of our analysis.

In the first set of estimating equation (25), we use ordinary least squares (OLS). For each explanatory variable, we report the estimated parameters and their standard errors (clustered at the 3-digit CIC level) in parentheses for the entire sample and the balanced sample. Models 1 and 2 are variants of equation (25) with sector-, province-, and year-fixed effects. These two models also include the interactions of year-fixed effects and the SOE dummy, which are supposed to capture the year-specific average difference in labor's share after controlling for the output elasticity of labor and the markup term.

Consistent with the predictions of our theory, the results in Table A.2 indicate that labor's share is positively associated with the output elasticity of labor and political weight on excess

Once we obtain these starting values, we search over $\Omega = (\bar{\alpha}_s, \bar{\sigma}_s, \bar{a}_s)$ where $\bar{\alpha}_s = \{\tilde{\alpha}_s - 10\kappa_1, \tilde{\alpha}_s - 9\kappa_1, \dots, \tilde{\alpha}_s + 10\kappa_1\}$, $(\bar{\sigma}_s - 1)/\bar{\sigma}_s = \{(\tilde{\sigma}_s - 1)/\bar{\sigma}_s - 10\kappa_2, (\tilde{\sigma}_s - 1)/\bar{\sigma}_s - 9\kappa_2, \dots, (\tilde{\sigma}_s - 1)/\bar{\sigma}_s + 10\kappa_2\}$, and $\bar{a}_s = \{\tilde{a}_s - 10\kappa_1, \tilde{a}_s - 9\kappa_1, \dots, \tilde{a}_s + 10\kappa_1\}$ with the grids of $\kappa_1 = 0.005$ and $\kappa_2 = 0.02$.

employment, and negatively associated with the markup term. These associations are precisely estimated and statistically significant at the 1% confidence level. However, while our theory says that the expected coefficients for the markup term are negative one, our estimated coefficients are negative but lower in absolute magnitude than one. Models 3 and 4 use firm-fixed effects instead of sector- and province-fixed effects. Since firm-fixed effects can include the contributions for ownership-specific effects such as the political weights, only the output elasticity of substitution and the markup term can be estimated. The empirical results validate our theoretical predictions.

Models 5 through 11 focus 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. The log labor share for firm i at year t (i.e., $\ln(LS_{it})$) correlates with its lagged value (i.e., $\ln(LS_{i,t-1})$). The second issue is simultaneity and endogeneity. In particular, the labor-capital ratio in the output elasticity of labor is a function of the cost of capital relative to labor (i.e., the political weight on excess employment (ϕ_t) times the cost of capital (r_{it}) divided by wage (w_{it})) as in equation (10).

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 (4). First, we report the AR(1) adjustment in Baltagi and Wu (1999) with the firm-level fixed effects as Models 5 and 6. To deal with endogeneity and serial correlation simultaneously, we use Arellano and Bond’s (1991) differenced GMM procedure and Blundell and Bond’s (1998) system GMM procedure as well. We report the results of the various specifications for the entire sample, 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 with the estimated coefficients on the markup term closer to the theoretical prediction. Overall, the results in Table A.2 support our theoretical predictions of just how markups, political pressure to hire excess labor and labor-capital substitution influence labor’s share.

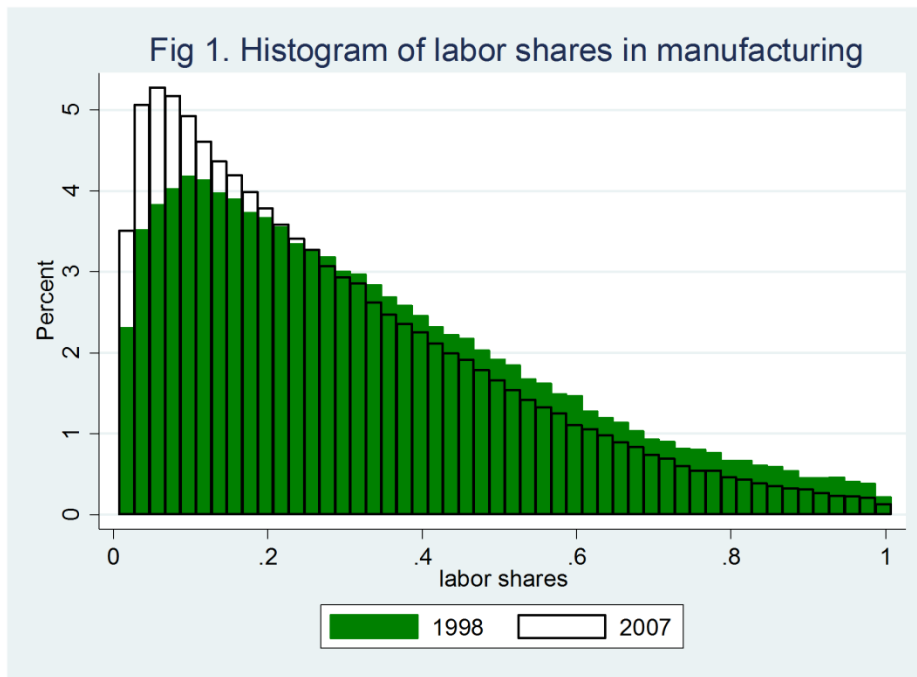
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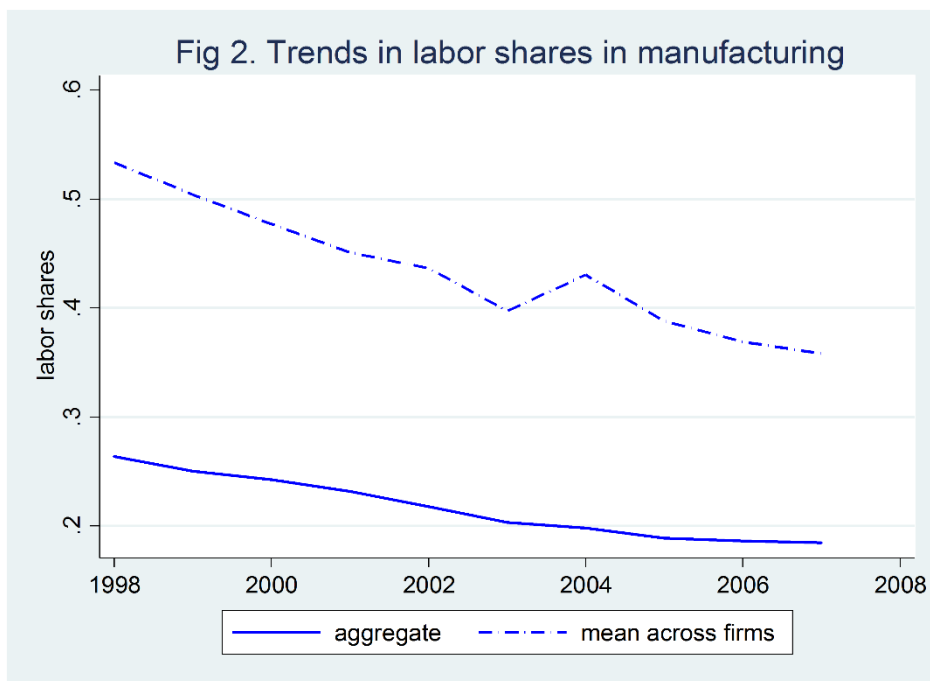
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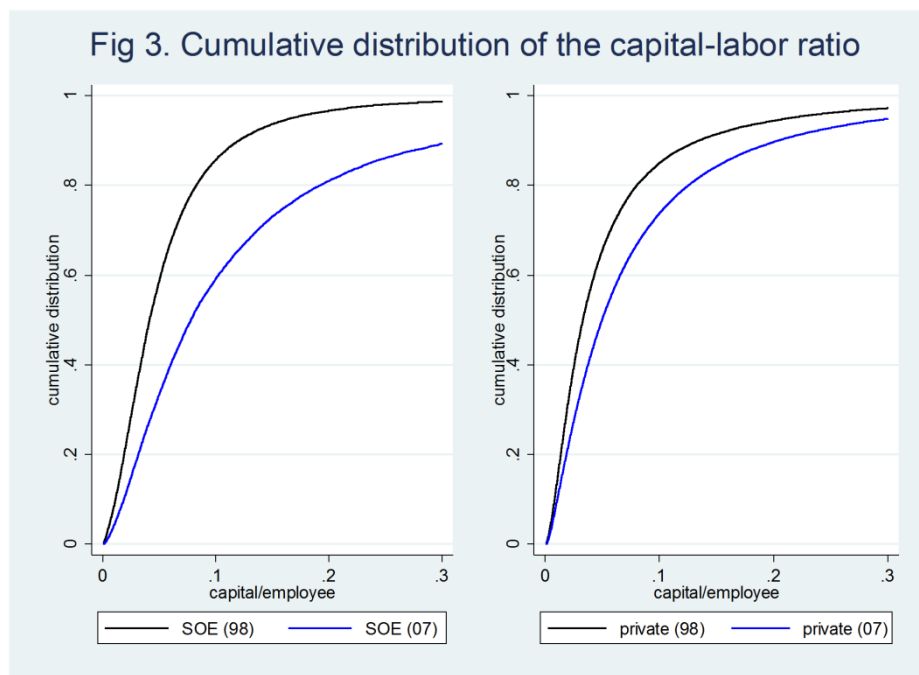
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Figures and Tables

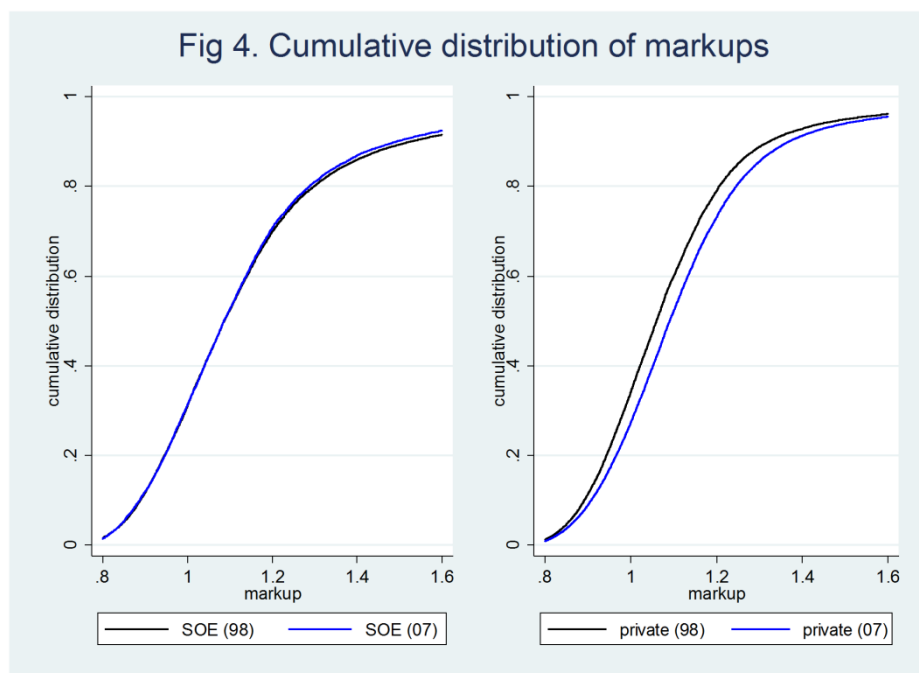


Note: We report the range of labor's shares from 0 to 1, which covers 90% (96%) in 1998 (2007).





Notes: (1) We exclude the firms that are in the top and bottom 0.25% of the distribution of values for labor's share and the capital-labor ratio. (2) We report the range of the capital-labor ratio from 0 to 0.3, which covers 99% (89%) for SOEs and 97 % (95 %) for private firms in 1998 (2007).



Notes: (1) We exclude the firms that are in the top and bottom 0.25% of the distribution of values for labor's share and markup. (2) We report the range of the markup from 0.8 to 1.6, which covers 90% (91%) for SOEs and 95% (95%) for private firms in 1998 (2007).

Table 1: Key variables for the entire and balanced samples

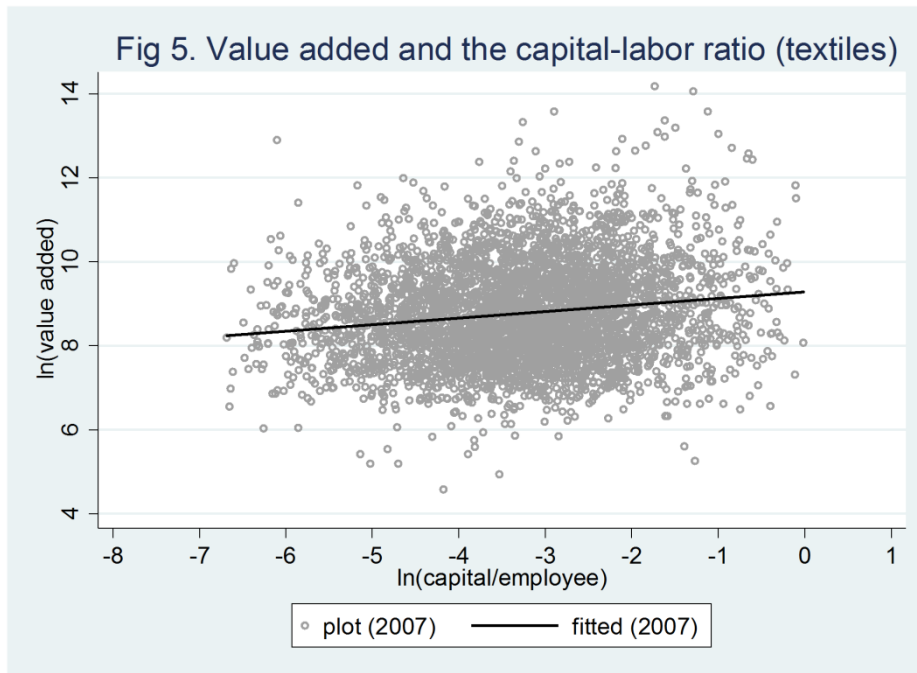
1. Entire sample

	SOE			Private firms			All firms		
	1998	2007	change	1998	2007	change	1998	2007	change
Key variables									
The number of firms	35,791	11,783	-67.1%	83,399	258,568	210.0%	119,190	270,351	126.8%
Total value added (billion RMB)	556	1,145	105.9%	802	5,641	603.1%	1,358	6,787	399.6%
Total employee (1,000)	21,289	7,973	-62.5%	21,054	50,787	141.2%	42,343	58,760	38.8%
Total real capital (billion RMB)	1,901	1,785	-6.1%	1,297	4,781	268.7%	3,197	6,566	105.3%
Real capital/employee	0.089	0.224	150.7%	0.062	0.094	52.8%	0.076	0.112	48.0%
Average markup	1.130	1.136	0.4%	1.108	1.132	2.2%	1.117	1.133	1.4%
Labor share									
Aggregates	31.5%	17.4%	-14.1%	22.8%	18.7%	-4.1%	26.4%	18.4%	-7.9%
Means across firms	81.7%	45.9%	-35.8%	41.2%	35.3%	-5.8%	53.3%	35.8%	-17.5%

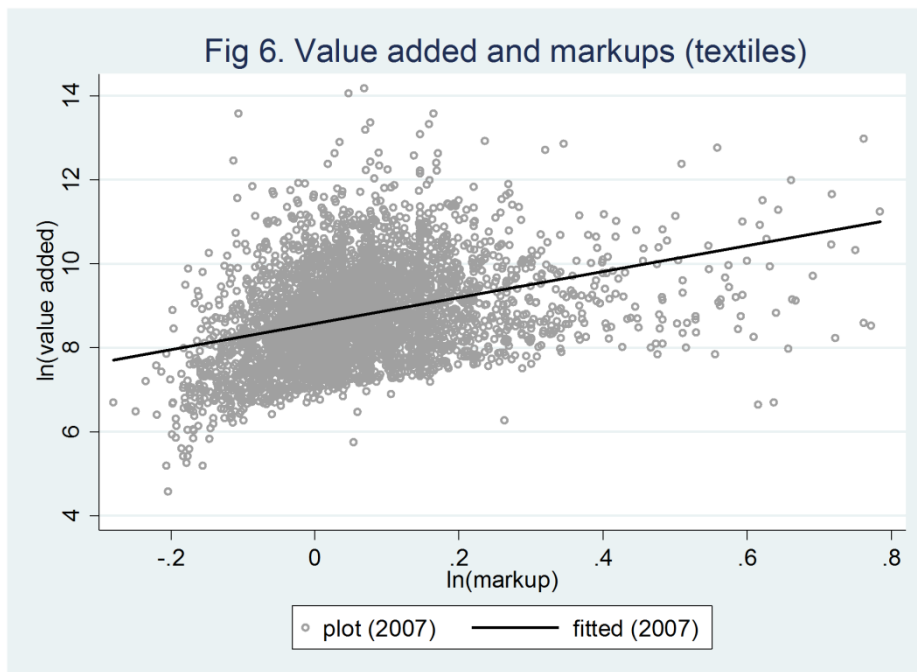
2. Balanced sample

	SOE			Private firms			All firms		
	1998	2007	change	1998	2007	change	1998	2007	change
Key variables									
The number of firms	5,990	3,539	-40.9%	22,373	24,824	11.0%	28,363	28,363	0.0%
Total value added (billion RMB)	253	645	154.8%	327	1,459	346.7%	580	2,104	262.9%
Total employee (1,000)	8,167	4,226	-48.3%	7,524	11,394	51.4%	15,691	15,620	-0.5%
Total real capital (billion RMB)	840	944	12.4%	536	1,293	141.1%	1,376	2,237	62.6%
Real capital/employee	0.103	0.223	117.2%	0.071	0.113	59.2%	0.088	0.143	63.3%
Average markup	1.142	1.156	1.2%	1.106	1.117	1.0%	1.121	1.129	0.7%
Labor share									
Aggregates	31.0%	17.6%	-13.4%	22.7%	18.4%	-4.3%	26.3%	18.1%	-8.2%
Means across firms	57.9%	49.4%	-8.6%	39.7%	36.9%	-2.8%	43.6%	38.5%	-5.1%

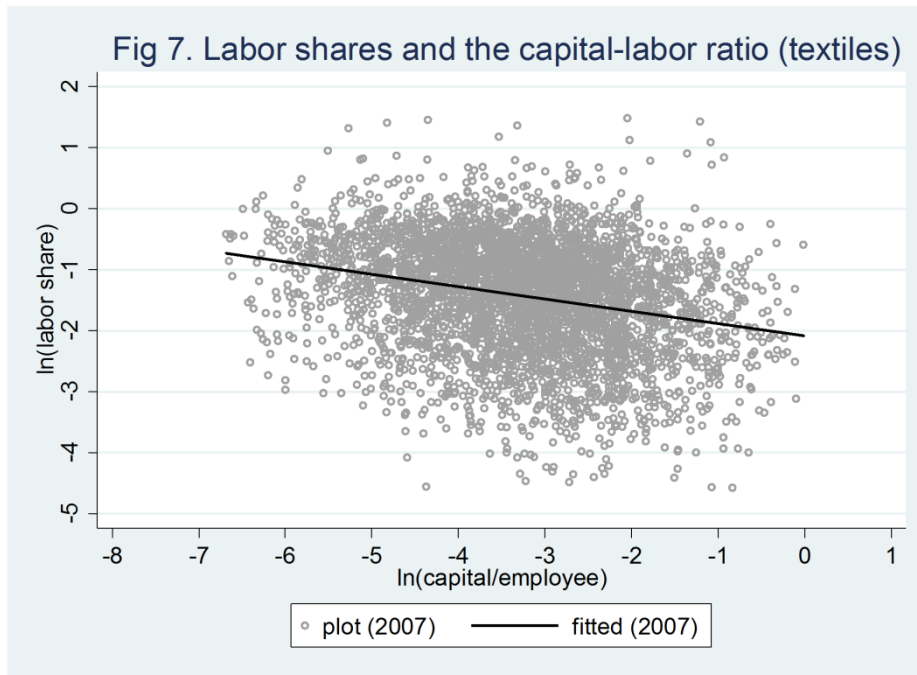
Notes: (1) Other firms include private, foreign and hybrid firms. (2) The aggregate value of markups is obtained from the estimated markup in the range of 0.41 to 1.649. We use the shares of value added as weights.



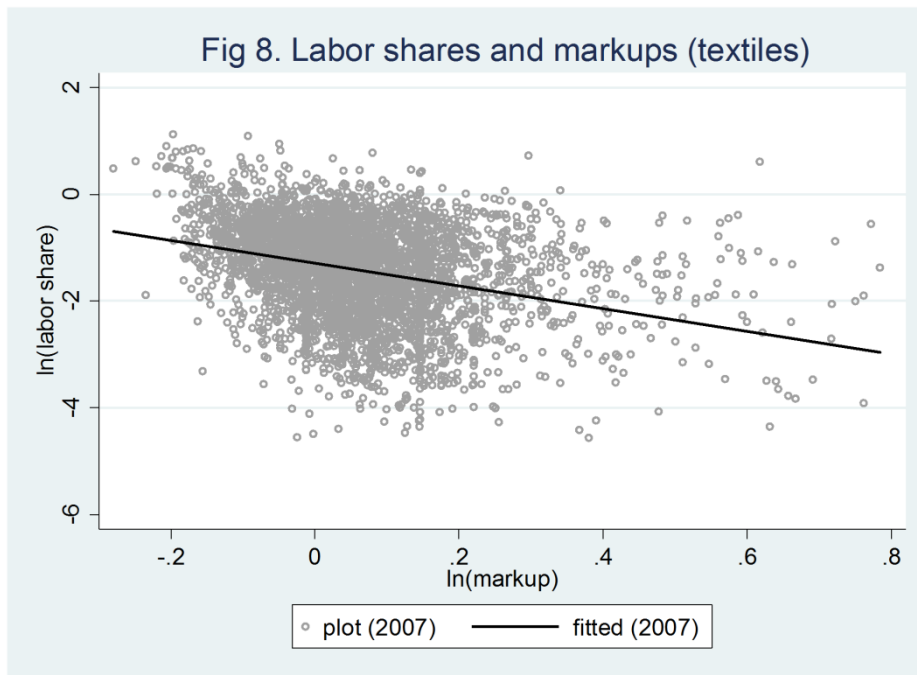
Notes: (1) We exclude the firms that are in the top and bottom 0.25% of the distribution of values for labor's share and the capital-labor ratio. (2) The slope of the fitted line is 0.155, which is statistically significant at the 1% confidence level.



Notes: (1) We exclude the firms that are in the top and bottom 0.25% of the distribution of values for labor's share and markup. (2) We limit the range of the log markup from -0.2 to 0.8. (3) The slope of the fitted line is 3.613, which is statistically significant at the 1% confidence level.



Notes: See note (1) in Fig 4. The slope of the fitted line is -0.199, which is statistically significant at the 1% confidence level.



Notes: See notes (1) and (2) in Fig 7. The slope of the fitted line is -2.463, which is statistically significant at the 1% confidence level.

Table 2: CES production function estimates for the 136 3-digit sectors

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

Table 3: Estimates for the SOEs' political benefit of excess employment

	Entire sample	Balanced sample with continuers
Implied political weight in 1998 ($1-1/\phi_{1998}$)	0.547	0.494
Estimated coefficient on $D^{SOE}D^{1998}$ (standard errors)	0.791*** (0.033)	0.681*** (0.048)
Implied political weight in 2007 ($1-1/\phi_{2007}$)	0.268	0.318
Estimated coefficient on $D^{SOE}D^{2007}$ (standard errors)	0.312*** (0.028)	0.383*** (0.046)
Observations	1,673,400	149,254
R-squared	0.272	0.313

Notes: (1) Clustered standard errors (3-digit sectors) are in the parentheses. (2) *** (**) indicates significance at the 1% (5%) confidence level. (3) The balanced sample with continuers is the subset of firms in the balanced sample that did not change their ownership during 1998-2007.

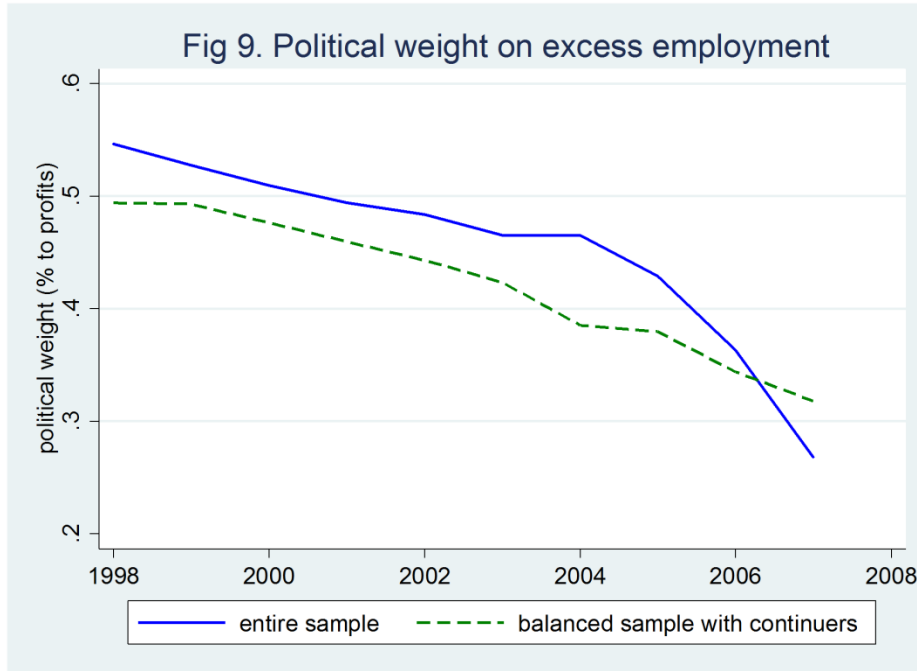


Table 4: Conditional means for log capital-labor ratio and log markup

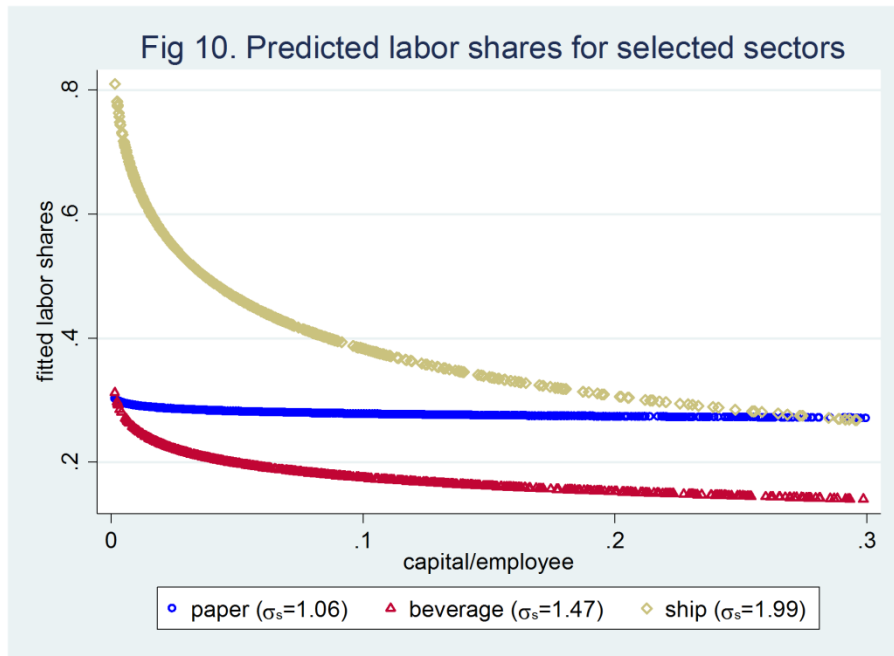
1. Log capital-labor ratio

	Entire sample			Balanced sample		
	SOE	Private	All	SOE	Private	All
Estimated difference from 1998 to 2007 (standard errors)	0.643*** (0.031)	0.384*** (0.028)	0.422*** (0.025)	0.411*** (0.019)	0.442*** (0.017)	0.417*** (0.014)
Observations	204,849	1,482,606	1,687,455	44,973	237,109	282,082
R-squared	0.152	0.144	0.169	0.221	0.213	0.250

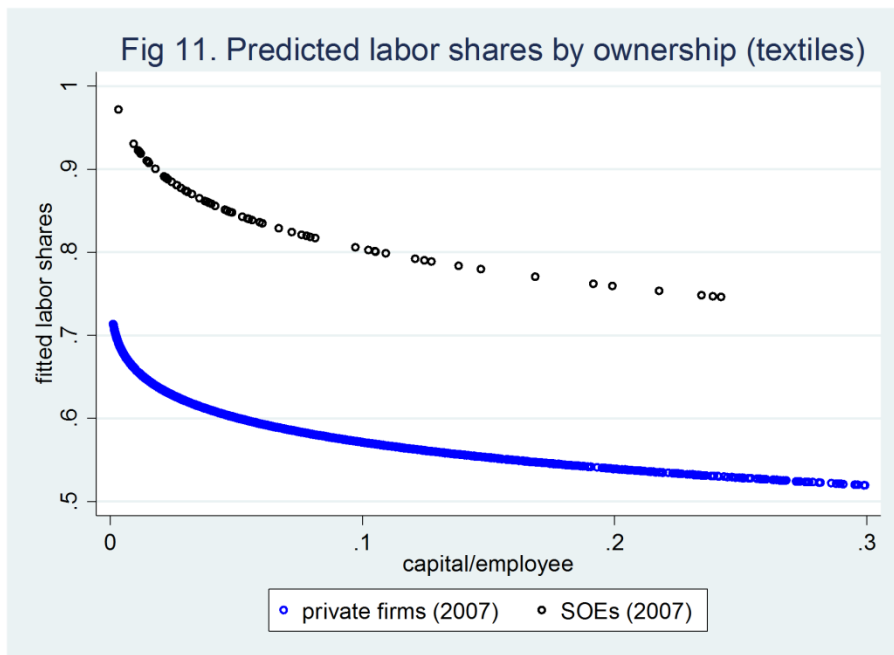
2. Log markup

	Entire sample			Balanced sample		
	SOE	Private	All	SOE	Private	All
Estimated difference from 1998 to 2007 (standard errors)	0.000 (0.006)	0.029*** (0.002)	0.025*** (0.003)	0.011* (0.006)	0.019*** (0.005)	0.019*** (0.004)
Observations	202,942	1,481,175	1,684,117	44,820	236,987	281,807
R-squared	0.079	0.142	0.129	0.136	0.146	0.138

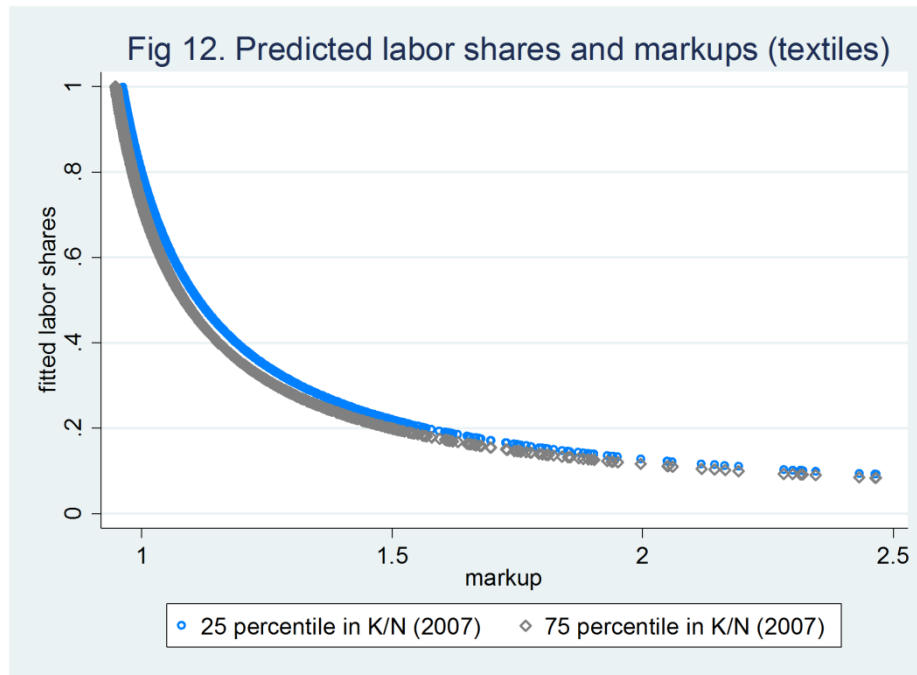
Notes: (1) Clustered standard errors (3-digit sectors) are in the parentheses. (2) *** (***) indicates significance at the 1% (5%) confidence level. (3) All specifications include sector-, province-, and year-fixed effects. All and private sample further include ownership-fixed effects. (4) We exclude the firms that are in the top and bottom 0.5% of the distribution of values for labor's share, markups, and the capital-labor ratio. (5) We set $\theta_{1998}=0$. Thus, the reported coefficients (θ_t) are relative to year 1998.



Notes: (1) We obtained the predicted labor shares for private firms using the estimated production parameters, the actual capital-labor ratio, and the median value of markups across all firms in each sector in 2007. (2) We limit the range of the capital-labor ratio from 0 to 0.3, which cover 96% in paper, 82 % in beverages, and 93% in shipbuilding. (3) The elasticity of substitution for beverages is close to median (1.47), that for paper products is close to 10 percentile value (1.06), and that for shipbuilding is close to 90 percentile value (1.99).



Notes: (1) We obtained the predicted labor shares using the estimated production parameters, the actual capital-labor ratio, and the median values of markups in 2007 (1.047 for private firms and 1.057 for SOEs). (2) The political weight is based on the results in Table 3 (balanced sample).



Notes: (1) We use only private firms. (2) The 25 (75) percentile value of markup across all textile private firms in 2007 is 0.985 (1.133).

Table 5: Summary statistics for actual and predicted labor shares

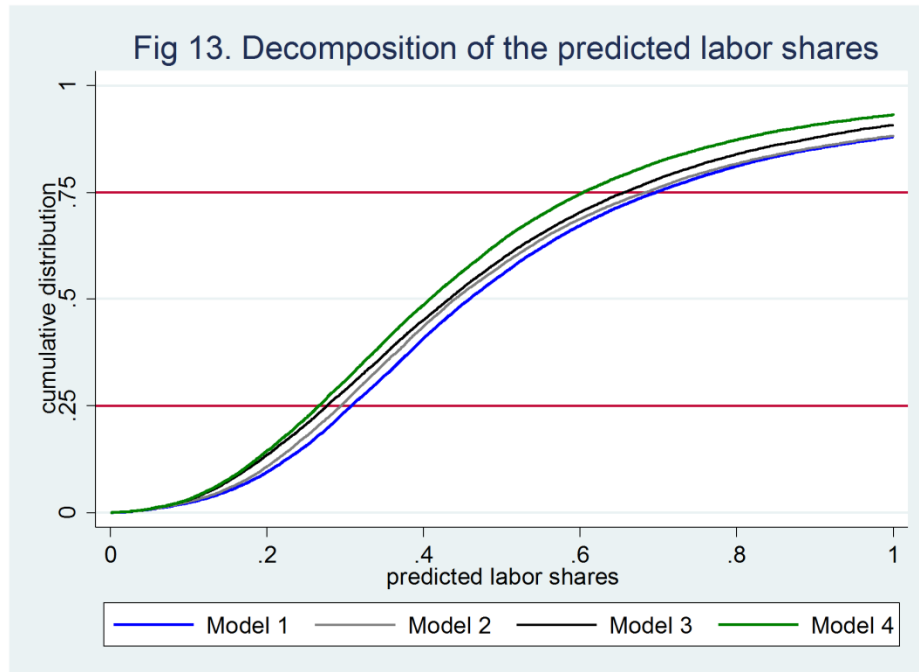
	1998-2002			2003-2007		
	Actual	Predicted	Adjusted	Actual	Predicted	Adjusted
Summary statistics						
Mean	0.396	0.598	0.645	0.374	0.482	0.646
Standard deviation	0.335	0.536	0.544	0.322	0.323	0.556
Skewness	3.66	3.78	3.65	3.46	1.85	3.45
Kurtosis	28.18	24.94	28.18	27.96	8.17	27.78
Percentiles						
25th percentile	0.193	0.308	0.315	0.172	0.266	0.297
50th percentile	0.325	0.459	0.530	0.300	0.408	0.519
75th percentile	0.497	0.697	0.811	0.478	0.604	0.826

Notes: (1) We have 27,727 observations from the balanced sample. (2) We use the average values of 1998-2002 and those of 2003-2007. (3) "Actual" is based on equation (1), "predicted" is based on equations (14) and (15), and "adjusted" refers to the adjustments made by Hsieh and Klenow (2009) and Brandt et al (2012) so that the aggregated firm-level labor share values are consistent with the national-level figures.

Table 6: Summary statistics for predicted labor shares

	Model 1	Model 2	Model 3	Model 4
Exogenous values				
Capital intensities	98-02	03-07	03-07	03-07
Markups	98-02	98-02	03-07	03-07
Political weights	98-02	98-02	98-02	03-07
Summary statistics				
Mean	0.598	0.586	0.523	0.482
Standard deviation	0.536	0.544	0.378	0.323
Skewness	3.78	3.90	2.29	1.85
Kurtosis	24.94	26.57	12.33	8.17
Percentiles				
25th percentile	0.308	0.295	0.277	0.266
50th percentile	0.459	0.440	0.433	0.408
75th percentile	0.697	0.684	0.657	0.604

Notes: (1) We use the balanced panel. (2) Model 1 uses the predicted value of labor shares using the 1998-2002 mean values of K/N, markup, and political weight; Model 2 uses 1998-2002 mean values of markup and political weight and 2003-2007 mean values of K/N; Model 3 uses 2003-2007 mean values of K/N and markup and 1998-2002 mean values of political weights; Model 4 uses 2003-2007 mean values of three variables.



Notes: Refer to Table 6 for the specifications of each model.

Appendix Figures and Tables

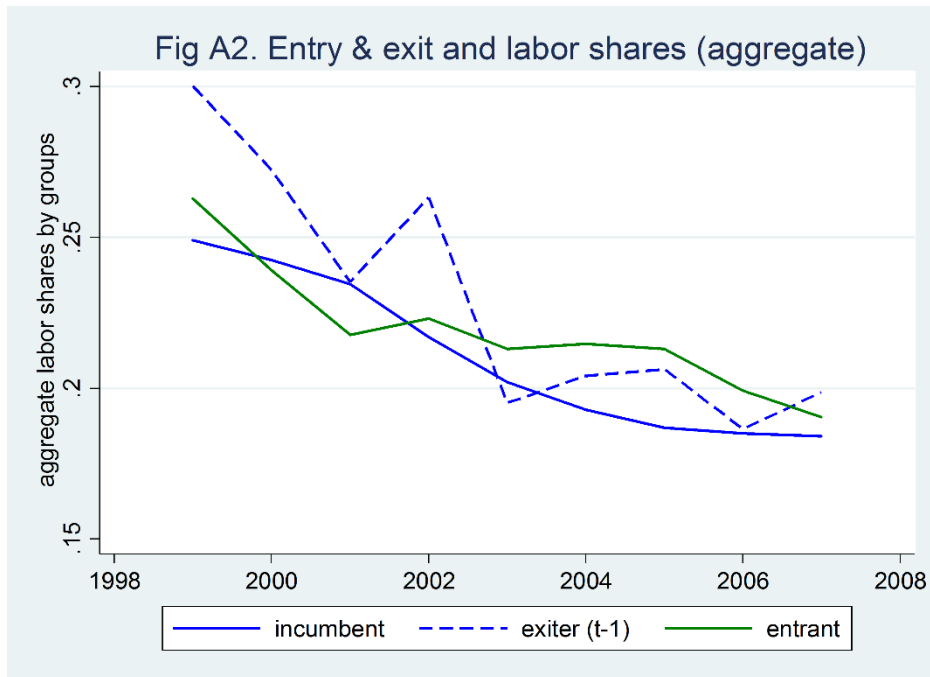
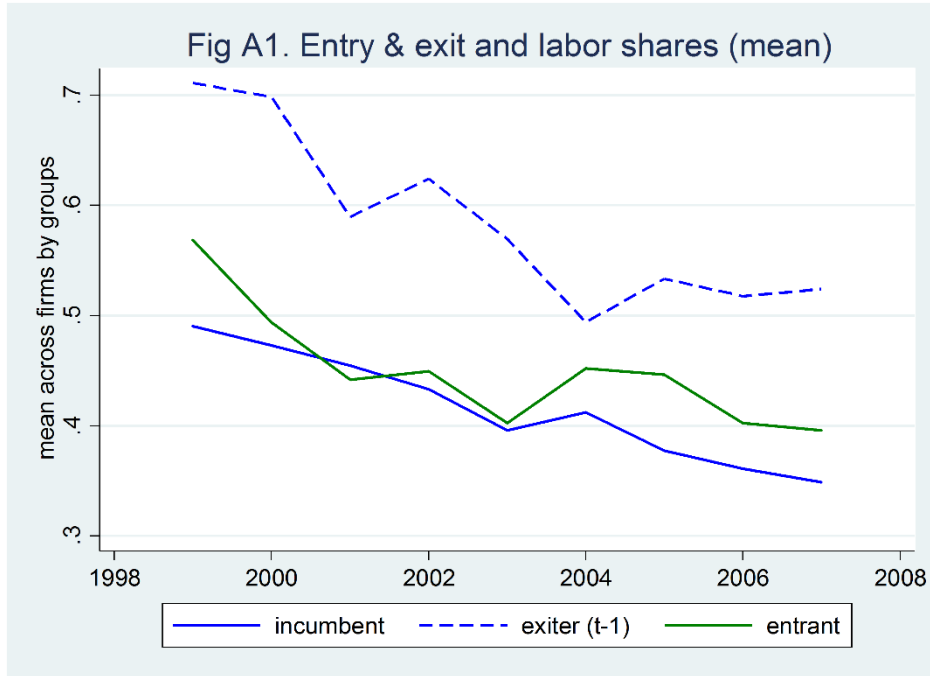


Table A1: Decompositions to the between and within effects

1. Decompositions based on aggregated values (entire sample)			
	Between effect	Within effect	Total Change
Ownership	-1.06%	-6.88%	-7.94%
Export status	-0.17%	-7.77%	-7.94%
3-digit industry	0.70%	-8.64%	-7.94%
Province	-0.38%	-7.56%	-7.94%
Firm	-1.92%	-6.02%	-7.94%

2. Decompositions based on firm-level values (balanced sample)			
	Between effect	Within effect	Total Change
Ownership	-0.90%	-7.29%	-8.20%
Export status	0.15%	-8.34%	-8.20%
3-digit industry	-0.07%	-8.13%	-8.20%
Province	-0.09%	-8.11%	-8.20%
Firm	-2.38%	-5.82%	-8.20%

Table A2: Log labor shares panel estimations with firm-fixed effects

	OLS		Fixed Effects		AR(1)		Difference GMM		System GMM	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 10	Model 11
Sample	All	Balanced	All	Balanced	All	Balanced	All	All	All	All
Endogenize the two effects	-	-	-	-	-	-	No	Yes	No	Yes
Output elasticity of labor (δ^o)	1.031*** (0.089)	1.194*** (0.103)	0.928*** (0.086)	1.074*** (0.106)	0.925*** (0.006)	0.958*** (0.014)	0.872*** (0.016)	0.844*** (0.015)	0.953*** (0.016)	0.975*** (0.014)
Markup effect (δ^u)	-0.470*** (0.011)	-0.455*** (0.015)	-0.579*** (0.006)	-0.568*** (0.009)	-0.589*** (0.001)	-0.588*** (0.002)	-0.635*** (0.002)	-0.606*** (0.001)	-0.662*** (0.001)	-0.613*** (0.001)
Political weight (δ^p_{1999})	0.753*** (0.029)	0.542*** (0.036)								
Political weight (δ^p_{2007})	0.322*** (0.023)	0.350*** (0.029)								
Lagged labor share							0.163*** (0.004)	0.071*** (0.002)	0.274*** (0.002)	0.170*** (0.002)
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector- and province-fixed effects	Yes	No	No	No	No	No	No	No	No	No
Observations	1,673,400	280,333	1,673,400	280,333	1,219,874	251,983	826,032	826,032	1,177,725	1,177,725
Number of firm fixed effects			453,526	28,350	341,349	28,337	253,379	253,379	336,472	336,472
# of instrumental variables							39	111	47	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) Clustered standard errors are in the parentheses. (3) All coefficients are statistically significant at the 1% confidence level. (4) We drop the top and bottom 0.25% of observations for labor share, markup term, and elasticity term as outliers.

Table A3: Robustness checks for CES estimations

1. Kmenta's Approach

1.1 28 2-digit sectors

	Estimated parameters				% of sectors	
	Mean	St.dev	Min	Max	5% significant	$\sigma_s > 1$
σ_s (implied elasticity of substitution)	1.252	0.173	0.844	1.809	-	92.9%
β_s^n	0.100	0.026	0.058	0.167	100.0%	-
β_s^k	0.082	0.023	0.028	0.125	100.0%	-
β_s^{nk}	-0.007	0.005	-0.012	0.010	92.9%	-

1.2 136 3-digit sectors (no convergences for 3 sectors)

	Estimated parameters				% of sectors	
	Mean	St.dev	Min	Max	5% significant	$\sigma_s > 1$
σ_s (implied elasticity of substitution)	1.282	0.356	0.428	2.765	-	82.7%
β_s^n	0.099	0.037	0.031	0.247	100.0%	-
β_s^k	0.081	0.028	-0.018	0.158	98.5%	-
β_s^{nk}	-0.006	0.012	-0.026	0.093	46.6%	-

2. Non-Linear Least Squares

2.1 28 2-digit sectors (no convergence for 1 sector)

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

2.2 136 3-digit sectors (no convergences for 15 sectors)

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