Grasp the Large, Let Go of the Small:

The Transformation of the State Sector in China*

Chang-Tai Hsieh† Zheng (Michael) Song‡

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VERY PRELIMINARY AND INCOMPLETE

Abstract

Starting in the late 1990s, China undertook a dramatic transformation of the large number of firms under state control. Most small state owned firms were privatized or closed. In contrast, large state owned firms were corporatized and merged into large industrial groups under the control of the Chinese state. Detailed firm level data shows that from 1998 to 2007, labor productivity of state owned firms converged with that of privately owned firms, total factor productivity growth of state owned firms was more than double that of private firms, and capital productivity of state owned firms continue to be lower than that of private firms (and did not change.) Counterfactual experiments suggest that "grasp the large" and "let go of the small" increase Chinese industrial output by about a third.

JEL Classification: O11, O16, O43

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†University of Chicago, Booth School of Business. Email: chsieh@chicagobooth.edu.

‡University of Chicago, Booth School of Business. Email: zheng.song@chicagobooth.edu.

1 Introduction

The industrial revolution in China is one of the most important events in the world in the last two decades. Yet, from the vantage point of the mid 1990s, the transformation that took place in China over the next 15 years seemed unlikely. The industrial sector was dominated by moribund loss-making state-owned enterprises (SOE henceforth). As recently as 1998, SOEs employed almost 60 percent of workers and more than 70 percent of the capital stock in the industrial sector. The average SOE generated huge losses, roughly equal to 8 percent of their value-added in 1998.

Things look very different only ten years later. Many observers have pointed to the closure and privatization of SOEs in the late 1990s and early 2000s as central to the transformation of the state-owned sector. The closure of SOEs released resources that may have been more profitably employed by new private firms. In addition, the privatized firms may have improved from a closer alignment of control and cash flow rights. Because the firms that were closed or privatized were typically smaller SOEs, this became known as "Let Go of the Small."

However, many SOEs, typically the larger ones, remained under state ownership. Despite this, firms that remained under state ownership look different from what they did in the late 1990s. Consider the experience of the Baoshan Company. Baoshan, founded in 1979 in Shanghai as a steel manufacturer, was a typical large state-owned dinosaur in the mid 1990s. However, as a large SOE, complete privatization of Baoshan was never on the table. Instead, Baoshan was publicly listed on the Shanghai Stock Exchange in 2000 but with a controlling share of the equity (75 percent) held by a holding company called the BaoSteel Group.[1] While we cannot say for sure why, Baoshan has done extraordinarily well since its public listing in 2000. Total sales increased from USD 2.8 billion in 1998 to USD 17 billion by 2007. Profits increased by even more, from USD 122 million in 1998 to USD 2.5 billion by 2007. Baoshan is currently the largest steel producer in China and the second largest steel producer in the world. It should be clear, however, that despite the fact that Baoshan is a publicly traded firm and perhaps became operated more like a private profit maximizing firm than what it was in the late 1990s, a controlling share of Baoshan's equity is still held by the Chinese state through its control over the parent company. The BaoSteel Group appoints and decides the compensation of Baoshan's senior executives. In turn, the senior executives of the BaoSteel Group are evaluated by the Central Government's State Assets Supervisory Committee (SASAC) and appointed by the Organization Department of the Chinese Communist Party.

[1] Technically, Baoshan was closed in 2000 and a new company called Baoshan Co. Ltd was established with the assets of the old state company.

The experience of Baoshan illustrates what has happened to large SOEs in China, what became known by the slogan "Grasp the Large."Since the late 1990s, large SOE have been "corporatized "and consolidated into large state-owned conglomerates. Many of these firms were publicly listed, but as the case of Baoshan illustrates always with a controlling share held by a parent company directly controlled by the Chinese State. These holding companies are the champions of the Chinese state's industrial policy. While there is significant controversy over exactly why, these conglomerates have grown enormously since the late 1990s. In 1995, for example, there were 3 Chinese firms on the Fortune 500 list. By 2012, there were 69 Chinese firms in the Fortune 500 list, and 64 of these firms are state-owned conglomerates such as the BaoSteel Group.

This paper uses detailed firm level data from China's Industrial Survey to provide basic descriptive statistics on the transformation of the state sector from 1998 through 2007. We report two key findings. Using a balanced panel dataset of industrial firms from 1998 through 2007, we show that value-added of state owned firms that were corporatized into state-owned conglomerates grew at a faster rate than that of privately owned firms since 2002. In contrast, we find that value-added of privatized SOEs grew at the same rate as that of private firms. In addition, we find that value-added per worker of the corporatized SOEs was significantly below that of private firms in 1998 but entirely converged with that of private firms by 2007. We also find an increase in revenue per worker of privatized SOEs (relative to private firms), but less than what we see in the SOEs that remained under state ownership. However, we find that the average revenue per unit of capital in both the corporatized and privatized SOEs was about 30% below that of private firms and did not change from 1998 through 2007.

We then interpret these facts through the lenses of a standard model of monopolistic competition with heterogeneous firms. We find the productivity of corporatized SOEs and privatized SOEs grew at twice the rate of private firms over this time period. In addition, from the fact that revenue per worker of corporatized SOEs and privatized firms converged to that of the private firms, we infer that the labor market has become more efficient. Finally, since the average product of capital of corporatized SOEs and the privatized firms remained roughly unchanged, we infer that both types of firms (including the privatized firms) continue to receive preferential access to capital.

[to be written]

2 Institutional Background

We will begin by describing in more detail the transformation of the Chinese state-owned sector that began in the late 1990s. The policy changes we describe below were formally announced in 1999 in the Fourth Plenum of the Communist Party's Central Committee.[2] The formal slogan adopted by the

[2]See CCP (1999) for the formal announcement. As is typical with all the major reforms implemented in China, the official decision in 1999 was preceded by several years of small scale experimentation. See Aivazian et al. (2005a and

Communist Party to describe the proposed reforms was "Grasp the Large, Let Go of the Small." The "Let Go of the Small" part of the slogan refers to the fact that small SOE were to be closed or sold. In practice, the firms that were privatized were typically sold at nominal prices to the managers of the firms. This process is well understood, although its quantitative importance is less clear. Later in the paper we will attempt to shed some light on this question.

As for the large SOE, the plan was that large firms were to be "grasped" by the state. Literally, what was meant by "grasp" was that large SOE were to be merged into giant industrial conglomerates and control over these conglomerates consolidated by the central government or by local governments. In the steel sector, for example, five large industrial groups were created in the late 1990s and early 2000s and ownership of the state-owned steel manufacturers was transferred to these groups. Three of these groups are owned by the Chinese central government (the BaoSteel Group, the WuSteel Group, and the AnSteel Group) and two by Provincial level governments (the Hebei Steel Group and the Shandong Steel Group). The BaoSteel Group, for example, controls six large steel manufacturers, three of which are wholly owned by the Group and three are publicly traded companies (such as Baoshan Co., Ltd.) with the Group as the controlling shareholder. The automobile industry provides another example. In this sector, state-owned automobile companies were consolidated into six state-owned conglomerates, the largest of which is the Shanghai Automobile Industrial Group (SAIC) owned by the municipal government of Shanghai. The SAIC Group owns a controlling share of the equity (73 percent) of the original SOE (SAIC Motor Co., Ltd.) that is now a publicly traded firm. SAIC Motor Co., Ltd., in turn, holds 50 percent of the equity of two new companies jointly established with General Motors (Shanghai-GM) and Volkswagen (Shanghai-Volkswagen).[3]

A more fundamental goal of "Grasp the Large" was to transform the large SOE into modern profit maximizing firms, albeit under the control of the Chinese State. There were two aspects of the reorganization of the large SOE that were meant to accomplish this goal. First, SOE were incorporated as limited liability corporations and the managers were to be held accountable for the firm's bottom line. Put differently, SOE were to be "corporatized." The parent company, as the controlling shareholder, was to monitor the firm and was responsible for appointing and deciding the compensation of the firm's senior managers. In turn, the senior executives of the parent company (the industrial groups) are directly appointed by the local government (in the case of groups owned by local governments such as the SAIC Group) or by the Central Organization Department of the Communist Party (in the case of groups owned by the central government such as the BaoSteel Group).

A key question is how the Chinese state chose to exercise their control right over the industrial groups and, in particular, the criteria used to reward and punish the groups' senior executives. In 2003

2005b) and Luo (2009) for assessments of these initial experiments with reforms in corporate governance.

[3]The SAIC Group also owns other companies but the biggest company under its control is SAIC Motor Co., Ltd.

the State-Owned Assets Supervision and Administration Commission (SASAC) was set up as the legal owner of the state-owned groups.[4] These bodies were set up simultaneously at the level of the central and local governments. The local SASACs provide little information on what they do, but Central SASAC provides more information about what they have done. Our reading of the evidence is that Central SASAC has focused on two things. First, it established an evaluation system where the senior managers of the industrial groups are ranked according to the economic performance of their group.[5] However, the key promotion decision and more broadly, the ultimate hiring and firing authority, was kept in the hands of the Communist Party's Organization Department. The goal was that SASAC's evaluation were to be a key input in the Organization Department's personnel decisions, but we do not know the extent to which this was the case or whether other criteria were used. Second, Central SASAC implemented institutional changes to facilitate monitoring of the groups. Specifically, it diversified the ownership of many of the firms via a public listing or by attracting minority private investors, implemented a common accounting standard and annual audits by private accounting companies, and pushed the groups to establish boards with outside directors. Here again, however, the reforms do not go all the way. Specifically, although there is the desire to introduce accountability, complete privatization is not and never was on the table.

A second important feature of the organizational design was to generate competition both within each group and also between the groups. In the case of the automobile industry Dunne (2011) describes how the main competition faced by GM's joint venture with the SAIC Group is the two auto giants owned by its joint-venture partner (the SAIC Group). For example, Dunne describes how Shanghai-Volkswagen introduced the Volkswagen Passat to undercut the Shanghai-GM's large profits from the Buick. Shanghai-GM also faced competition from other state-owned automobile groups. For example, another SOE Cherry stole the design of one of Shanghai-GM's cars and started to sell a car based on the stolen design six months before Shanghai-GM was able to bring its own car to the market. Cherry is a state-owned company owned by the Cherry-Wuhu Group. Importantly the Cherry-Wuhu Group is owned by the local government of Wuhu City that apparently faced high powered incentives to compete with the SOE owned by the local government of Shanghai (and GM). To take another example, this time from the steel industry, the BaoSteel Group controls six companies that are all major steel manufacturers and fierce competitors.

What we also see is that successful industrial groups are rewarded not only with higher profits

[4] With the exception of state-owned tobacco companies and state-owned financial institutions, the ownership of all state-owned groups was transferred to the SASACs in 2003. Tobacco companies are controlled by the State Tobacco Monopoly Administration and financial companies by a holding company (Huijin) controlled by China's Banking Regulatory Commission.

[5] According to the annual reports of Central SASAC, executives are scored based on a weighted average of profits, sales, and return to assets, where the scores range from A (the top category) to E (the lowest category). In 2004, 14% of the senior managers got an A, 41% a B, 36% a C, and 8% a D or an E. Executives with a score of "A" get a bonus equivalent to three times their annual salary and managers with a E get no bonus.

but with acquiring firms owned by other less successful industrial groups. Consider again the case of the BaoSteel Group. The Baoshan Co., Ltd. owned by the Group is perhaps the most successful steel manufacturer in China. Since 2007, the BaoSteel Group acquired three large steel manufacturers owned by other state-owned industrial groups.[6] One of these companies is ShaoSteel, a publicly traded steel manufacturer that was owned by a group controlled by the Provincial Government of Guangdong. After ShaoSteel suffered from losses totaling almost USD 400 million from 2008 to 2012, the BaoSteel Group reached an agreement in 2012 to purchase the company from the Provincial Government of Guangdong.[7] The case of the Nanjing Auto Group (owned by the local government of Nanjing) provides another example. This company also run perpetual deficits before the entire Group was acquired in 2007 by the SAIC Group. There is no systematic data on the extent of this reallocation, but some basic facts about the groups and firms owned by Central SASAC is instructive. When Central SASAC was first established in 2003, it was in charge of 189 industrial groups that controlled a total of 15,546 firms. By 2010, the number of industrial groups owned by SASAC had been whittled down to 124. At the same time, these 124 groups controlled a total of 23,738 firms. Put differently, due to this reallocation process, the number of firms controlled by the average Central SASAC Group increased from 82 in 2003 to 191 in 2010.

Although the media frequently discusses the size of the state-owned industrial groups, much of the increase in the revenues and profits of these groups could come simply from the increase in the number of firms controlled by the surviving groups driven by this reallocation process. Instead, what we want to measure is the performance of the individual firms. Put simply, did these reforms – the corporatization, the public listings, the competition between state firms and groups, the reallocation of firms from under-performing groups, among other changes – improve the productivity of the firms that were "grasped" by the Chinese state. Although the stated goal of the reform was to transform SOE into modern profit maximizing firms, we do not know the extent to which this has happened. For every anecdote on how these firms have changed, one can find another anecdote that illustrates how SOE are still the same. It is entirely possible that firm managers may have faced political pressure that were at odds with profit maximization and that the incentive structure they faced rewarded political loyalty rather than profits. And even if the goal is profit maximization, one might be skeptical of the ability of the Organization Department of the Communist (or of the Party Secretary of Shanghai) to monitor and choose the CEOs of the conglomerates. Furthermore, the fact that these firms are the champions of the Chinese state suggests that their growth could also be driven by other forces. First, many observers have mentioned these firms received and continue to receive preferential access to capital. Second, the growth and profits of these firms may also have been driven because they have been able to restrict

[6] Specifically, BaoSteel acquired the Bayi Steel in 2007, Ningbo Steel in 2007, and ShaoSteel in 2012.

[7] News report indicate that ShaoSteel's senior management was replaced after it was purchased by the Baosteel Group.

entry and exploit their monopoly power. We thus turn to an analysis of the facts to begin to answer these questions.

3 Data

The main dataset we use is the microdata from the Annual Survey of Industries conducted by China's National Bureau of Statistics from 1998 to 2007. This survey is a census of state owned industrial firms and non-state firms with more than 5 million RMB in revenues. The unit of observation in the data is a registered firm. A registered firm, which may be a multi-establishment firm. For the firms owned by the state owned industrial groups discussed earlier, each firm owned by the group is a separate observation in the data. In addition to the identifying information for the firm, the economic variables we use are value-added, employment, and the book value of the firm's capital stock. We define the real capital stock from the following formula:

$$K_{i,t} = (1-\delta)K_{i,t-1} + \left(BK_{i,t} - BK_{i,t-1}\right)/P_t,$$

where $BK_{i,t}$ is the book value of capital stock for firm i in year t; P_t is the price index of investment in fixed assets in year t constructed by Perkins and Rawski (2008); δ denotes the capital depreciation rate. The initial book value of capital stock is taken directly from the dataset for firms founded later than 1998. For firms founded before 1998, we assume the book value in 1998 is given by

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

where BK_{i,t_0} is the projected initial book value of capital stock when firm i was born in year t_0; BK_{i,t_1} is the book value of capital stock when firm i first appears in our dataset in year t_1; and g_i is the average capital stock growth rate of firm i for the period we observe from the data since year t_1.

Key to our analysis is the ownership of the firm. We use two variables in the data to classify the ownership of the firm. First, the data provides the share of the firm's registered capital owned by the state, private person, collective, foreigners, and legal person. A legal person is either another firm or simply a holding company. For example, a publicly traded state owned company (such as Baoshan and SAIC) will typically have a minority share of its registered capital held by "private persons" (the publicly traded share) and a majority share by a legal person (the state owned parent holding company). Although the data does not provide any additional information on the identity of the legal person, it classifies the "controlling shareholder" of the firm as the state, a collective, a foreigner, or a private person. We define a state owned firm as one where 1) the registered capital held directly by the state exceeds fifty percent and 2) where the data identifies the state as the controlling shareholder of the firm. This definition will capture traditional SOEs, where the state owns all of the firm's registered capital,

as well as SOEs such as Baoshan and SAIC that are now publicly traded. However, this definition excludes firms where the state may hold a minority share through a holding company.

A third variable in the data that can be used to identify ownership is the registration status of the firm. Specifically, firms in China are legally registered as state owned, collectively owned, privately owned, limited liability corporations, share holding companies, or foreign invested firms. For example, the published tabulations in the China Statistical Yearbook classifies a firm as state owned if the firm is registered as state owned. There are, however, two problems with using the firm's legal registration to identify ownership. First, a firm can be legally registered as a foreign invested firm if at least 25 percent of its registered capital is foreign owned. Second, even if the registered capital is owned by a company located outside of China, it is common for Chinese companies to set up holding companies outside of China as the legal owner. Lenovo and CNOOC (a Fortune 500 state owned oil company) are both registered in Hong Kong and thus are classified as foreign firms. A second problem with using the registration status of the firm for our purposes is that many state owned firms were "closed" and "reopened" as limited liability or shareholding companies. The Baoshan steel company, for example, was closed in 2000 and "reopened" as a shareholding company. The three largest automobile manufacturers in the Shanghai's SAIC Group (controlled by the Shanghai local government) are also not registered as state owned firms. The original state owned firm (SAIC) is a shareholding company and the two joint ventures (Shanghai-Volkswagen and Shanghai-GM) are legally registered as foreign firms.

Table 1 presents the number of the state owned firms using the registration status (column 2) and our definition (column 3).[8] In 1998, the two definitions yield a similar number of state owned firms. In the 2007, the difference between the two ways of classifying state owned firms is large. According to our definition of state ownership, state owned firms account for 33.7% of total value added in 2007 whereas they only account for 15.9% when state ownership is defined as firms registered as state owned firms.

Table 1: The Number of Firms in the NBS Data

[8] We drop firms with missing or non-positive value of employment, capital or value-added.

	Full Sample			1998-2007 Balanced Panel		
	(1)	(2)	(3)	(4)	(5)	(6)
	All Firms	SOE registration code	SOE our definition	All Firms	SOE registration code	SOE our definition
1998	137,716	43,055	50,614	37,572	8,543	10,778
1999	147,681	42,736	51,037	37,572	8,182	10,481
2000	143,656	34,416	42,401	37,572	7,634	9,948
2001	157,967	30,457	39,361	37,572	7,082	9,416
2002	166,716	26,170	34,615	37,572	6,619	8,916
2003	184,513	21,553	29,625	37,572	6,035	8,245
2004	260,450	20,140	28,214	37,572	5,334	7,304
2005	256,884	15,736	22,953	37,572	5,157	7,108
2006	280,990	13,777	22,054	37,572	4,894	7,171
2007	319,183	10,411	19,255	37,572	4,793	7,113

Table 1 reports the registration code distribution of firm that we identify as state owned but are not registered as state owned firms. As can be seen, most of these firms are registered as limited liability corporations, sharing-holding corporations, or foreign firms. In 2007, for example, these three groups of firms account for 94 percent of firms that we classify as state owned but are not registered as state owned. And these are precisely the firms that may have undergone the most dramatic changes in economic performance.

Table 2: The Registration Code Distribution of Diversified SOEs (%)

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

Note: Diversified SOEs refer to SOEs (by our definition) that are registered as private firms. "Others" include collectively-owned enterprises, cooperative enterprises, joint ownership enterprises (excluding firms with state ownership) and domestic private enterprises.

Finally, we use firm registration ID to match firms. Registration ID may change when a firm experiences restructuring, merger or acquisition. Following Brandt et al. (2012), we also use firm name, name of legal person, address, phone number and other information to match firms with different ID. Above 95 percent of the matches are obtained by firm registration ID. We then construct a balanced panel from 1998 through 2007, which covers 46,892 firms. Column (5) and (6) report the numbers of SOEs in the balanced panel. By our definition, there are 10,778 and 7,113 SOEs in 1998 and 2007, respectively. In other words, 3,665 firms that were state owned in 1998 but became private in 2007. These firms will be referred to as "privatized" SOEs. The remaining of the 7,113 SOEs in 2007 will be referred to as "corporatized" SOEs.

Figure 1 plots the distributions of state registered capital share for corporatized and privatized SOEs in the 1998-2007 balanced panel. Panel A shows that 76 percent of corporatized SOEs have 100 percent state registered capital share and, thus, are "wholly" state-owned in 1998. Most corporatized SOEs continue to be wholly state-owned in 2007, though the fraction drops to 59 percent (Panel B). A

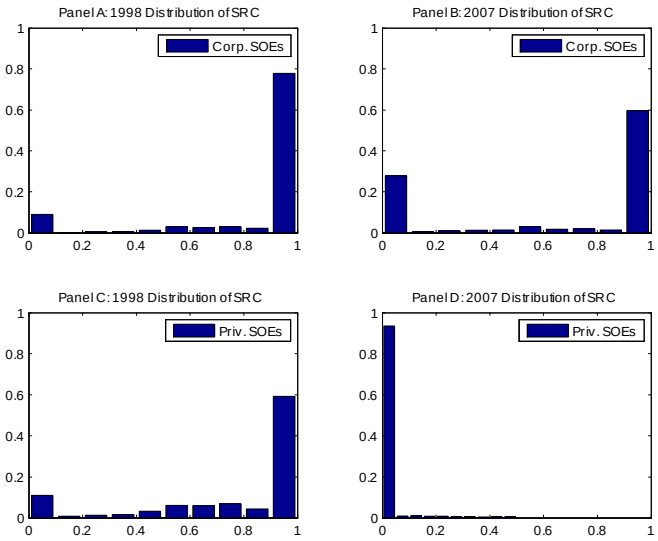


Figure 1: This figure plots the distribution of the state registered capital share (SRC) in the 1998-2007 balanced panel.

comparison between Panel C and D illustrates that privatized SOEs have undergone dramatic ownership transformation. In 1998, 56 percent of privatized SOEs are wholly state-owned, while only 10 percent of them have zero state registered capital. In 2007, firms with zero state registered capital account for 93 percent of privatized SOEs.[9]

Finally, it is worth documenting the relationship between ownership diversification/privatization and the initial firm size. Figure 2 groups all SOEs into percentiles by their 1998 value-added in the balanced panel. Panel A and B plot the share of diversified and Privatized SOEs in each percentile, respectively. One can see from Panel A that larger SOEs are more likely to experience ownership diversification, indicating that diversification is an important aspect of restructuring those large SOEs. On the other hand, in line with the spirit of "Grasp the Large," larger SOEs seem less likely to be privatized.[10]

4 Facts

Some important consequences of "grasp the large, let go of the small" can directly be seen from the NBS data. SOEs used to guarantee life-time job security, which is often referred to as "iron rice bowl," to their employees. Layoff was very difficult for SOEs before the late 1990s. The closure of a SOE was even harder, if not entirely inconceivable, at that time. Table 3 shows that the annual exit rate for SOEs is merely 0.9 percent from 1991 through 1995. Things have changed dramatically since then. The firms that were state-owned in 1998 have an exit rate of 13.2 percent from 1998 through 2007, which is

[9] Figure 10.1 in the appendix plots the distributions of legal person registered capital share in the balanced panel.

[10] Notice that SOEs in the bottom ten percentils also have low privatization rates. One possible explanation is that the productivity of these firms might be too low to attract private investors.

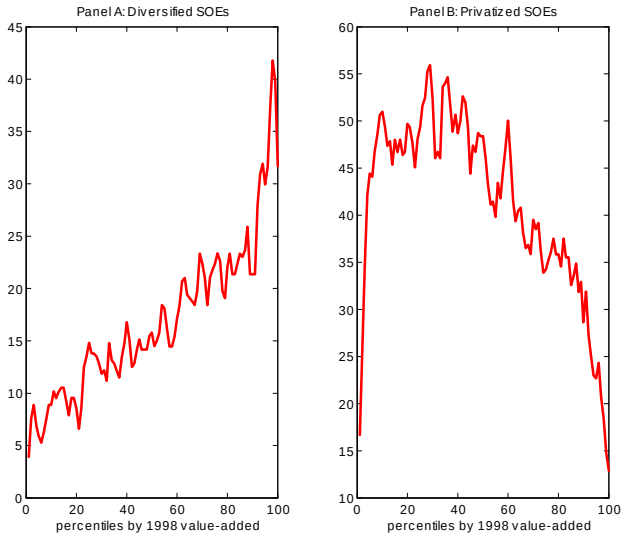


Figure 2: Panel A (B) of this figure plots the ratio of the number of diversified (privatized) SOEs as percentage of the number of all SOEs in each percentile by their 1999 value-added in the 1998-2007 balanced panel. We smooth the exit rates in the ith percentile by averaging the rates in the ith and its neighboring percentiles except for the top and bottom one percentiles where the original rates are plotted.

about 14 times as high as that from 1991 through 1995. The exit rate for private firms remain roughly the same over the two sample periods.

Table 3: Annual Exit Rates (%)

	State Firms	Private Firms
1991-1995	0.9	11.6
1998-2007	13.2	12.0

Note: See Appendix 10.2 for the estimation of the exit rates in the two sample periods.

We next group all firms in 1998 into percentiles by their value-added. Figure 3 reports the exit rates over 1998-2007 in each of the percentiles. The exit rates look similar for SOEs and private firms above the median size. Thanks to "let go of the small," the difference becomes visually distinguishable for firms below the median size. For SOEs in the bottom ten percentiles, their average exit rate is 30.6 percent, much higher than the rate of 20.0 percent for their private counterparts.

For notational convenience, we further classify SOEs into three categories. Privatized SOEs are referred to firms that are initially state-owned but become private in 2007. Exiting SOEs are referred to firms that are initially state-owned but drop out in 2007. We refer to all the remaining SOEs as corporatized SOEs. To understand how these different types of firms initially look like, Figure 4 plots the distributions of value-added, labor productivity and capital productivity in 1998. Panel A shows the distributions of log value-added for corporatized SOEs (solid line), privatized SOE (dash-dotted line), exiting SOE (dashed line) and private firms (dotted line), respectively. As expected, corporatized

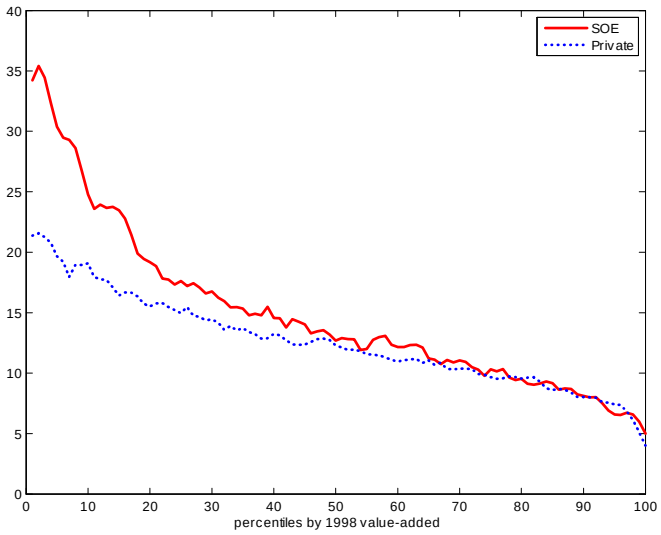


Figure 3: Exit Rates 1998-2007 (%). This figure plots the exit rates of SOEs (solid line) and private firms (dotted line) in each of the 1998 value-added percentiles, respectively. SOEs and private firms are classified by their 1998 ownership. The results are smoothed using the same moving average in Figure 2.

SOEs are, on average, larger than the other three types. Their median value-added is 22 percent higher than that of privatized SOEs. Consistent with the results in Figure 3, exiting SOEs are much smaller. The median value-added of corporatized SOEs is 4.8 times higher than that of exiting SOEs. Private firms are also small. The median value-added of corporatized SOE is 1.3 times higher than that of private firms.

Panel B shows the distributions of labor productivity (e.g., value-added per worker). In line with the impressionistic view that SOEs suffer from labor redundancy before the late 1990s, labor productivity is lower in all three types of SOEs than that in private firms. Corporatized and privatized SOEs have the same labor productivity, which is 65 percent of that of private firms. Labor productivity of exiting SOEs is lower, merely 36 percent of that of private firms. Panel C shows the distributions of capital productivity (e.g., the value-added capital ratio). The capital productivity gap between SOEs and private firms appears to be substantially larger than the labor productivity gap. Capital productivity of corporatized, privatized and exiting SOEs is 23, 35 and 26 percent of that of private firms, respectively.

We now move on to the 1998-2007 balanced panel. Figure 5 plots the distributions of log value-added, labor and capital productivity for corporatized SOEs, privatized SOEs and private firms in the balanced panel.[11] One can see from the left panels that the initial distributions in the balanced panel are qualitatively similar to those in Figure 4. The 2007 distributions are presented in the right panels. The upper right panel shows that SOEs continue to be larger than private firms. However, the gap has

[11] More precisely, private firms refer to those that are private in both 1998 and 2007. There are 867 firms that were private in 1998 but became state-owned in 2007.

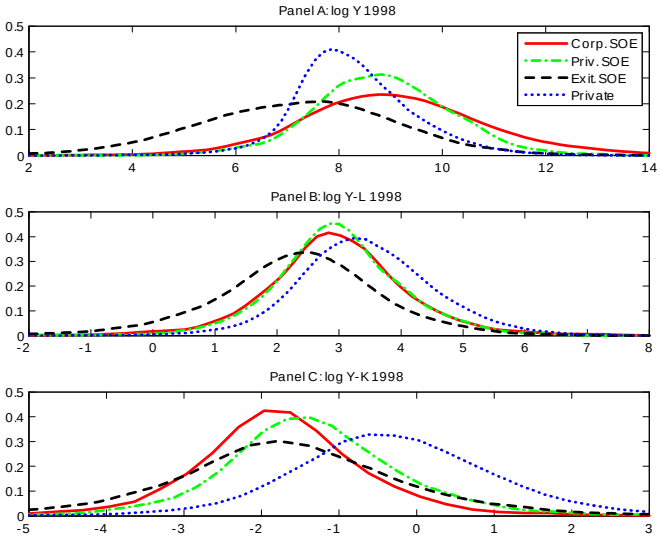


Figure 4: This figure plots the 1998 distributions of log value-added (Panel A), labor productivity (Panel B) and capital productivity (Panel C) for corporatized SOEs (solid line), privatized SOE (dashed line), exiting SOE (dash-dotted line) and private firms (dotted line), respectively.

been narrowing. In 1998, the median value-added of corporatized and privatized SOEs is 87 and 45 percent higher than that of private firms. In 2007, the differences drop to 53 and 2 percent, indicating that private firms have been outgrowing SOEs in the balance panel.

Private firms used to have substantially higher labor productivity. In 1998, their median labor productivity is 58 percent higher than that of corporatized and privatized SOEs, which have exactly the same median labor productivity. The distinction becomes much less distinguishable in 2007. The distributions of labor productivity seem almost identical across the three types of firms (Panel D). Private firms still have the highest median labor productivity. But the median labor productivity gap between private firms and corporatized (privatized) SOEs drops from 58 percent to 22 (13) percent.

Panel E and F plot the distributions of capital productivity. The capital productivity gap between SOEs and private firms is much bigger than the labor productivity gap. In 1998, the median capital productivity of private firms is 2.8 and 1.5 times higher than that of corporatized and privatized SOE, respectively. Moreover, the capital productivity distribution converges at a much lower rate than the labor productivity distribution. In 2007, the median capital productivity of private firms is still 1.6 times and 78 percent higher than that of corporatized and privatized SOE, respectively.

Figure 6 reports the input and output shares of corporatized SOEs (solid lines) and privatized SOEs (dotted lines) in the balanced panel. Panel A and B show that, not surprisingly, both labor and capital input shares of corporatized SOEs have been steadily declining over the sample period. Their labor and capital input shares, which are 50.2 and 67.6 percent in 1998, respectively, fall to 38.4 and 61.2

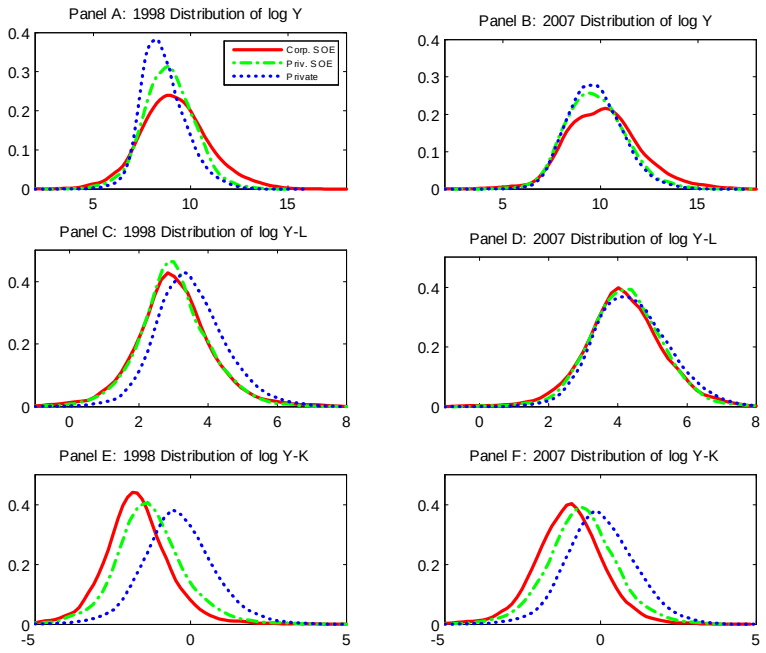


Figure 5: This figure plots the 1998 and 2007 distributions of log value-added (Panel A and B), labor productivity (Panel C and D) and capital productivity (Panel E and F) for for corporatized SOEs (solid line), privatized SOE (dashed line) and private firms (dotted line), respectively, in the 1998-2007 balanced panel.

percent in 2007, respectively. The labor input share of privatized SOEs also fall considerably, from 12.7 percent in 1998 to 10.4 percent in 2007. Their capital input shares remain essentially unchanged. The residuals in Panel A and B come from the input shares of private firms, which exhibit growing trends. Their employment and capital input shares increase from 37.1 and 23.1 percent in 1998 to 51.2 and 29.4 percent in 2007, respectively.

Panel C plots the value-added shares of corporatized and privatized SOEs, respectively. The output share of corporatized SOEs drops from 48.8 percent in 1998 to 42.1 percent in 2002 and but has rised slightly since then. The share of privatized SOE appears to be rather stable, staying between 9 and 10 percent, over the sample period. The residual is contributed by the value-added share of private firms, which exhibits an inverted U pattern, starting from 42.1 percent in 1998, peaking at 49.0 percent in 2002 and then droping to 47.1 percent in 2007.

The falling input shares and the U-shaped output shares imply that the productive efficiency of the corporatized SOE has actually been growing faster than the average level in the balanced panel since the early 2000s. The flat output and capital input shares, together with the falling employment input share, suggest the privatized SOEs have also improved their relative productive efficiency. These findings indicate a falling productive efficiency of private firms relative to their state counterparts in the balanced panel.

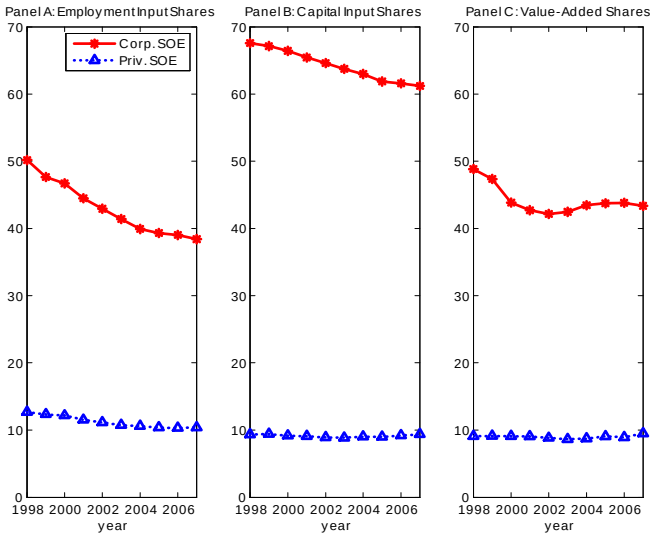


Figure 6: This figure plots the employment, capital and value-added shares of corporatized SOEs (solid line) and privatized SOEs (dotted line) as percentage of the total value-added in the balanced panel.

Finally, Figure 7 plots the difference of value-added growth rates between different types of SOEs and private firms by their initial size. The value-added growth of SOEs with initial size above the median level appears to be similar to that of their private counterparts. Among SOEs with initial size above the median level, corporatized SOEs have the highest growth rates. These corporatized SOEs have actually been growing even faster than their private counterparts.

5 The Model

This section presents a simple framework through which we can interpret the observed changes in the state sector and understand their welfare implications. Our benchmark is a standard monopolistic competition model with heterogeneous firms, which has often been adopted by the recent literature on misallocation (e.g., Hsieh and Klenow, 2009). We make two additional assumptions on the factor markets. First, following Song et al. (2011), we assume exogenous interest rates. The assumption captures a key open economy feature of China – i.e., perfectly elastic capital supply. Capital demand change manifests itself in capital flows and, hence, has no effect on domestic interest rates.[12] Second, the benchmark model assumes industry-specific labor. Accordingly, the equilibrium wage rates are industry-specific and labor reallocates within an industry. We will extend the model by allowing labor to reallocate across industries.

Firms are index by i in industry s, $i \in \{1, 2, \cdots, I_s\}$. Each firm produces differentiated goods by a

[12] Notice that saving has been outgrowing investment in China for more than a decade, leading to a big gap between bank deposits and loans and a rapid accumulation of foreign assets. Song et al. (2011) simply assume that Chin's interest rate follows the one in the world financial market.

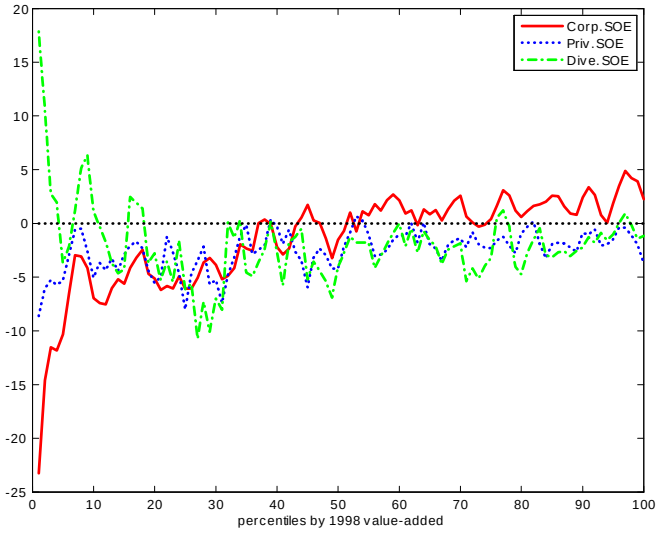


Figure 7: This figure plots the difference of the median annualized value-added growth rates between different types of SOEs and private firms in percentiles by their 1998 value-added in the 1998-2007 balanced panel.

Cobb-Douglas technology with constant returns to scale:

$$Q_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s},$$

where K_{si} and L_{si} denote capital and labor, respectively, A_{si} is firm TFP and α_s stands for the industry-specific capital share. Households maximize a CES aggregate of Q_{si},

$$Q_s = \left(\sum_i^{I_s} Q_{si}^{1-\eta} \right)^{\frac{1}{1-\eta}}, \tag{1}$$

where $1/\eta > 1$ is the elasticity of substitution. For notational convenience, we define $Y_{si} \equiv P_{si} Q_{si}$, where Y_{si} represents value-added. (1) implies that

$$Y_{si} = Y_s^{\eta} \left(A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s} \right)^{1-\eta}, \tag{2}$$

where Y_s stands for the total value-added of industry s.

We next introduce labor and capital distortions. Denote τ_{si}^L and τ_{si}^K firm-specific distortions that affect the marginal product of labor and capital, respectively. Denote T_{si} a lump-sum tax. Then, profits of each firm follow

$$\pi_{si} = Y_{si} - \left(1 + \tau_{si}^L\right) w_s L_{si} - \left(1 + \tau_{si}^K\right) r K_{si} - T_{si}, \tag{3}$$

where w_s and r denote the industry-specific wage rate and the exogenous interest rate, respectively. Firms' profit maximization gives the following first-order conditions:

$$MRPL_{si} \equiv (1 - \alpha_s)(1 - \eta) \frac{Y_{si}}{L_{si}} = \left(1 + \tau_{si}^L\right) w_s, \tag{4}$$

$$MRPK_{si} \equiv \alpha_s (1-\eta) \frac{Y_{si}}{K_{si}} = \left(1+\tau_{si}^K\right) r. \tag{5}$$

Two remarks are in order. First, within an industry, marginal revenue products of labor and capital, $MRPL_{si}$ and $MRPK_{si}$, are proportional to labor and capital productivity, respectively. Second, firms that face higher τ_{si}^L and τ_{si}^K are associated with higher $MRPL_{si}$ and $MRPK_{si}$.

It is important to understand the nature of the distortions in the context of China. Capital distortions are straightforward. τ_{si}^K reflects the extent to which a firm can get cheap credit. For instance, SOEs are often well-connected to the state-dominated banking sector and, thus, associated with lower τ_{si}^K than their private counterparts. Throughout the paper, we will interpret $\left(1+\tau_{si}^K\right) r$ as the actual capital price for firm i in industry s, denoted by r_{si}.

We refrain from interpreting $\left(1+\tau_{si}^L\right) w_s$ analogically as the actual wage rate. SOEs had, no average, lower labor productivity in the 1990s. However, there is no evidence that SOEs pay workers at a lower wage rate.[13] An alternatively interpretation is that τ_{si}^L entails firm-specific labor adjustment costs. One important source of such costs is government regulation that aims to curb unemployment. Tens of millions of "redundant workers" in the state sector in the 1990s suggest unusually high firing costs for SOEs at that time.

To formalize the interpretation, let us assume that firms will have to pay $f_{si} w_s \left(\bar{L}_{si} - L_{si}\right)$ if they want to cut L_{si} to certain level below $\bar{L}_{si}$, a threshold set by the government. Here, f_{si} is a firm parameter capturing the magnitude of the firing costs. Then, the profit of a firm follows

$$\pi_{si} = \begin{cases} Y_{si} - w_s L_{si} - \left(1+\tau_{si}^K\right) r K_{si} - f_{si} w_s \left(\bar{L}_{si} - L_{si}\right) & \text{if } L_{si} \leq \bar{L}_{si} \\ Y_{si} - w_s L_{si} - \left(1+\tau_{si}^K\right) r K_{si} & \text{otherwise} \end{cases}. \tag{6}$$

Notice that (3) nests (6): (6) is a special case of (3) if we let $\tau_{si}^L = -f_{si}$ and $T_{si} = f_{si} w_s \bar{L}_{si}$ for $L_{si} \leq \bar{L}_{si}$ and $\tau_{si}^L = T_{si} = 0$ otherwise. More importantly, that SOEs face higher f_{si} can reconcile three observations in the state sector: competitive wage rate, lower labor productivity and higher labor adjustment costs.[14] We will use the firing-costs interpretation for τ_{si}^L and T_{si} – i.e., $\tau_{si}^L = -f_{si}$, when it comes to the labor distortions that lower the average labor productivity of SOEs relative to that of private firms (see Section 6.2 below).

Finally, it is worth emphasizing that r_{si} and f_{si} have very different implications, though both of them manifest themselves in factor market distortions τ_{si}^L and τ_{si}^K. First, a higher r_{si} increases capital productivity by raising the marginal cost of capital. On the contrary, a higher f_{si} leads to overemployment, which reduces labor productivity. Moreover, the profit share is independent of r_{si}, the actual interest rate. However, the presence of f_{si} will affect the profit share since it also implies a

[13] Using urban household survey in 1996, Zhao (2002) shows that workers in SOEs earn more than those in private firms even after controlling for age and education.

[14] See Cooper et al. (2010) for evidence of higher labor adjustment costs in SOEs.

lump-sum labor adjustment cost, $T_{si} = f_{si} w_s \bar{L}_{si}$. A higher f_{si} in the state sector, therefore, will erode profit margins of SOEs.

5.1 Equilibrium Allocation

The equilibrium allocation is characterized by

$$Y_{si} \propto \left(\frac{A_{si}}{\left(1+\tau_{si}^K\right)^{\alpha_s} \left(1+\tau_{si}^L\right)^{1-\alpha_s}} \right)^{\frac{1-\eta}{\eta}}, \tag{7}$$

$$L_{si} \propto \frac{1}{1+\tau_{si}^L} \left(\frac{A_{si}}{\left(1+\tau_{si}^K\right)^{\alpha_s} \left(1+\tau_{si}^L\right)^{1-\alpha_s}} \right)^{\frac{1-\eta}{\eta}}, \tag{8}$$

$$K_{si} \propto \frac{1}{1+\tau_{si}^K} \left(\frac{A_{si}}{\left(1+\tau_{si}^K\right)^{\alpha_s} \left(1+\tau_{si}^L\right)^{1-\alpha_s}} \right)^{\frac{1-\eta}{\eta}}. \tag{9}$$

The size of a firm is increasing in A_{si} but decreasing in τ_{si}^L and τ_{si}^K.

Denote L_s, K_s and $A_s \equiv Y_s/L_s$ the total employment, capital and the average labor productivity in industry s. Since L_s is fixed and K_s is perfectly elastic, we will use A_s to measure the aggregate productive efficiency of industry s. Notice that the total value-added of the industry, Y_s, can be decomposed into

$$Y_s = \sum_i^{I_s} \frac{Y_{si}}{L_{si}} L_{si}. \tag{10}$$

(4) and (10) imply that

$$A_s = \frac{w_s \left(1+\tau_s^L\right)}{(1-\alpha_s)(1-\eta)}. \tag{11}$$

Here, τ_s^L represents the weighted average labor distortions, with

$$1+\tau_s^L \equiv \sum_i^{I_s} \left(1+\tau_{si}^L\right) \frac{L_{si}}{L_s}, \tag{12}$$

where L_{si} follows (8). The equilibrium wage rate follows

$$w_s = (1-\alpha_s)(1-\eta) \left(\frac{\alpha_s (1-\eta)}{r} \right)^{\frac{\alpha_s}{1-\alpha_s}} \left(\sum_i^{I_s} \left(\frac{A_{si}}{\left(1+\tau_{si}^K\right)^{\alpha_s} \left(1+\tau_{si}^L\right)^{1-\alpha_s}} \right)^{\frac{1-\eta}{\eta}} \right)^{\frac{\eta}{(1-\alpha_s)(1-\eta)}}. \tag{13}$$

[I am not sure if we should have the following discussion] Firm TFP and distortions determine the aggregate productive efficiency. Firm TFP, A_{si}, affects A_s via two channels. The first channel is standard: Holding the average labor distortions, τ_s^L, fixed, a higher A_{si} will increase A_s. In addition, A_{si} will affect τ_s^L and, thus, A_s, via the equilibrium labor allocation, as shown by (12). The effect on τ_s^L is ambiguous due to to a composition effect. If a firm is associated with sufficiently high τ_{si}^L, increasing A_{si} may result in a higher τ_s^L as more labor is now allocated to the firm subject to large labor distortions.

Firm labor distortions, τ_{si}^L, affects A_s in similar ways. Holding τ_s^L constant, lowering τ_{si}^L will increase A_s through the standard channel. But τ_{si}^L also affects τ_s^L. Moreover, the effect is ambigous since a lower τ_{si}^L raises L_{si} in (8). Finally, A_s is orthogonal to the average capital distortions due to the perfectly elastic capital supply. Reducing firm capital distortions, therefore, will unambiguously increase the aggregate productive efficiency.

6 TFP and Distortions

The above framework allows us to estimate TFP and distortions, which, in turn, determine the welfare implications of "Grasp the Large and Let Go of the Small." Using the NBS data, this section will provide a baseline estimation of firm-level TFP and distortions in each of the two-digit industries. Section 8 will check the robustness of the results in more general models.

6.1 TFP

According to (2), we can back out the firm TFP, A_{si}, by

$$A_{si} = \left(\frac{Y_{si}}{Y_s}\right)^{\frac{\eta}{1-\eta}} \left(\frac{Y_{si}}{K_{si}}\right)^{\alpha_s} \left(\frac{Y_{si}}{L_{si}}\right)^{1-\alpha_s}. \tag{14}$$

(14) shows that firm TFP manifests itself in three factors: the relative firm size, capital and labor productivity. Without distortions, there is a one-to-one mapping between the TFP and relative size.

Notice that A_{si} is physical productivity or TFPQ denoted by Foster et al. (2008). Our estimation sets $1-\alpha_s$ equal to the average labor income share of the corresponding two-digit industry.[15] Y_s equals the total value-added of industry s. $1/\eta$ is set to 7 in the benchmark case, corresponding to markups of 0.14. As robustness checks, we estimate α_s for each of the four-digit industries using the method in Ackerberg et al. (2006). We also experiment $1/\eta = 3$ or 5, following Hsieh and Klenow (2009). Our main findings are very robust to alternative values of α_s and $1/\eta$.[16]

Panel A of Figure 8 plots the distributions of log TFP for corporatized SOEs, privatized SOEs and private firms in the 1998-2007 balanced panel. The initial TFP of SOEs is much lower than private firms. The median TFP of corporatized and privatized SOEs is merely 32 and 41 percent of that of private firms in 1998, respectively. The TFP gap has been substantially narrowed over the sample period (Panel B). The median TFP of corporatized and privatized SOEs increases to 43 and 56 percent of that of private firms in 2007, respectively.[17] Panel C plots the median TFP growth rate of the three types of firms from 1998 to 2007. It turns out that except for 1999, the median TFP growth of both

[15] Appendix 10.3 provides the details of calculating the labor income share. In particular, we apply the method in Qian and Zhu (2012) to adjust potential biases in the data.

[16] Detailed results are available upon request.

[17] The TFP dispersion appears to be similar across different types of firms and over time. The standard deviation of log TFP is 1.19 (1.26), 1.23 (1.24) and 1.16 (1.21) for corporatized SOEs, privatized SOEs and private firms, respectively, in 1998 (2007).

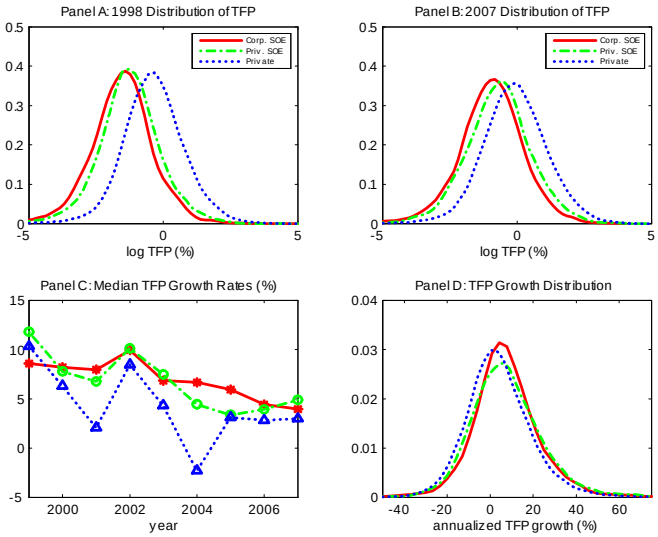


Figure 8: TFP Level and Growth in the 1998-2007 Balanced Panel. The solid, dashed and dotted lines are for corporatized SOE, privatized SOE and private firms, respectively. Panel A and B plot the distribution of log TFP in 1998 and 2007, respectively. Panel C plots the median growth rate of TFP and Panel D plots the distribution of TFP growth.

corporatized and privatized SOEs is actually faster than that of private firms.[18] Panel D plots the distribution of annualized TFP growth for the three types of firms. Corporatized and privatized SOEs have exactly the same median growth rate of 6.5 percent, more than doubling the rate of 3.2 percent for private firms. SOEs have slightly more dispersed TFP growth. The standard deviation of the TFP growth rate of corporatized and privatized SOEs equals 0.165 and 0.178, respectively. The standard deviation is 0.157 for private firms.

To control for the effect of the initial firm size, we next group firms into percentiles according to their 1998 value-added. Panel A and B of Figure 9 plot the median TFP levels for corporatized SOEs and private firms in each percentile in 1998 and 2007, respectively.[19] Panel C plots the median annualized TFP growth rates. The TFP of SOEs outgrows that of their private counterparts in most percentiles. The difference turns more pronounced as the initial firm size increases. The annualized TFP growth rate of SOE in the top one percentile is 4.6 percent, while the rate is -3.3 percent for private firms in the same percentile. It should be emphasized that high TFP growth does not necessarily imply high TFP level. In fact, Panel B shows that the TFP level of SOE is still substantially below that of private firms in 2007. For instance, after a decade of high growth, the median TFP of the top one percentile SOEs is only 42 percent of that of their private counterparts in 2007.

One shortcoming of the 1998-2007 balanced panel is that it excludes many new private firms, which

[18] There is no statistical evidence showing that the state ownership conversion helps to speed up TFP growth. Details are available upon request.

[19] We drop the lines for privatized SOEs from the figure as they are close to the lines for corporatized SOEs.

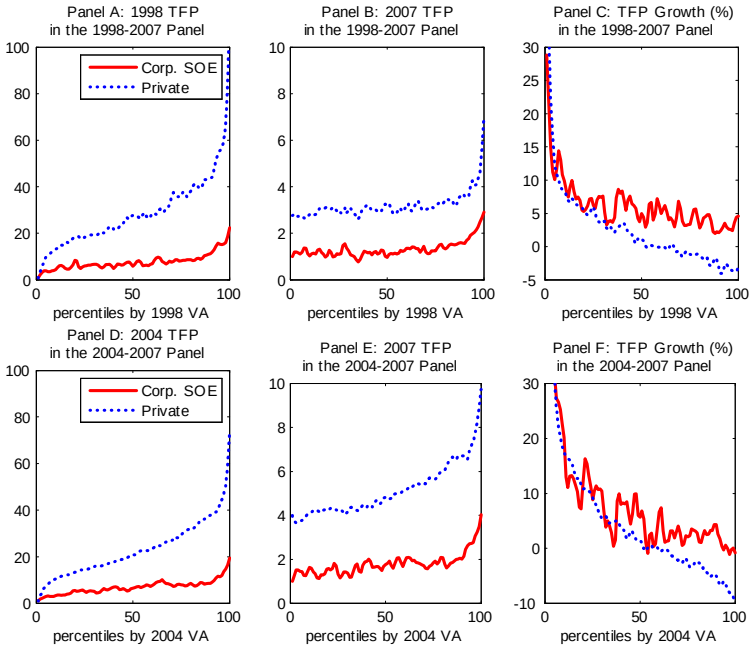


Figure 9: TFP Level and Growth. The TFP of SOE in the bottom percentile is normalized to unit in Panel A, B, D and E. We smooth the TFP level and growth using the same method in Figure 3.

may exhibit higher TFP growth than the existing private firms. As a robustness check, Panels D-F plot the results from the 2004-2007 balanced panel, where the number of private firms increases from 26,762 to 167,168. The main results are qualitatively similar: The TFP growth of SOEs with the initial size below the median level is comparable to that of their private counterparts, while SOEs with the initial size above the median level has substantially higher TFP growth. The median TFP growth rate of -0.8 percent for the top one percentile SOEs is probably not impressive. But it is much higher than the rate of -9.7 percent for the top one percentile private firms. In fact, 46.7 percent of the top one percentile SOEs managed to grow their TFP from 2004 to 2007, while only 31.8 percent of the top one percentile private firms achieved positive TFP growth over the same period.

6.2 Factor Market Distortions

(5) and (4) imply that

$$1 + \tau_{si}^{L} \propto \frac{Y_{si}}{L_{si}}, \tag{15}$$

$$1 + \tau_{si}^{K} \propto \frac{Y_{si}}{K_{si}}, \tag{16}$$

which allow us to back out firm-level labor and capital distortions. Notice that the absolute level of τ_{si}^{L} or τ_{si}^{K} is innocuous. What matters for the equilibrium allocation is the relative level, as one can see from (8) and (9).

We are also interested in estimating the average labor and capital distortions for the four types of firms. Define $1+\tau_s^L(J)$ and $1+\tau_s^K(J)$, in the same way as $1+\tau_s^L$, the average labor and capital distortions for type-J firms, where $J \in \left\{S^C, S^P, S^E, N\right\}$, representing corporatized SOEs, privatized SOEs, exiting SOEs and private firms, respectively.By (4) and (5), we have:

$$1+\tau_s^L(J) \propto \frac{Y_s(J)}{L_s(J)}, \tag{17}$$

$$1+\tau_s^K(J) \propto \frac{Y_s(J)}{K_s(J)}, \tag{18}$$

where $Y_s(J)$, $L_s(J)$ and $K_s(J)$ denote the total value-added, labor and capital of type-J firms, respectively. The relative average distortions determine the labor and capital productivity gap between SOEs and private firms.

We make an anchor for the average capital distortions by assuming $\tau_s^K\left(S^C\right)=0$. The assumption implies that corporatized SOEs face the average capital price of r.[20] Accordingly, $\left(1+\tau_s^K(J)\right)r$ represents the average capital price for other types of firms. Echoing the discussion in Section 5, we interpret $-\tau_s^L(J)$ as the average costs for type-J firms to fire a worker as percentage of her annual wage. In addition, we assume $\tau_s^L(N)=0$ as an anchor for the average firing costs for SOEs.

Let us first focus on corporatized SOEs and private firms. (17) and (18), together with the assumptions that $\tau_s^K\left(S^C\right)=\tau_s^L(N)=0$, pin down $-\tau_s^L\left(S^C\right)$ and $\tau_s^K(N)$. Panel A of Figure 10 plots $-\tau_s^L\left(S^C\right)$ of the two-digit industries in 1998 (x-axis) and 2007 (y-axis).[21] It can be seen that in 1998, most industries have $-\tau_s^L\left(S^C\right)>0$ and the median value of $-\tau_s^L\left(S^C\right)$ is 0.28. In 2007, $\tau_s^L\left(S^C\right)$ appears to be much closer to zero for most industries, with the median value plunging to 0.07. The initial average capital distortions are even larger in most industries. The median value of $\tau_s^K(N)$ is 1.24. There is only one industry, Tobacco, with $\tau_s^K(N)<0$ in 1998. $\tau_s^K(N)$ is also more persistent than $-\tau_s^L\left(S^C\right)$. In contrast to the diminishing $-\tau_s^L(S)$, the median value of $\tau_s^K(N)$ is 1.17 in 2007, almost identical to its 1998 value. Only two industries, Petroleum Extraction and Tobacco, have $\tau_s^K(N)<0$ in 2007.[22]

To make sense of the magnitude of the distortions and their dynamics at the aggregate level, we compute the weighted average $-\tau_s^L\left(S^C\right)$, $\sum_s -\tau_s^L\left(S^C\right)\frac{w_s L_s\left(S^C\right)}{\sum_s w_s L_s\left(S^C\right)}$, and the weighted average $\tau_s^K(N)$, $\sum_s \frac{\tau_s^K r K_s(N)}{\sum_s r K_s(N)}$. Panel C and D of Figure 10 plot the results. One can see from Panel C that the average $-\tau_s^L\left(S^C\right)$ is about 0.20 in 1998 and plunges to zero in 2007, indicating that firing costs for corporatized SOEs relative to private firms have vanished. The capital distortions are far more severe. The average

[20] We set $r=0.15$, which is calibrated to the sum of the capital depreciation rate of 0.10 and the annual bank loan rate of 5%.

[21] There are a total of 39 industries in the industrial sector. However, Industry 43 (Recycling and Disposal of Waste) does not have any firms until 2003.

[22] The estimation is less precise for the two industries since there are much fewer private firms. In fact, Petroleum Extraction and Tobacco are the only two industries with the state value-added share above 90% in both 1998 and 2007.

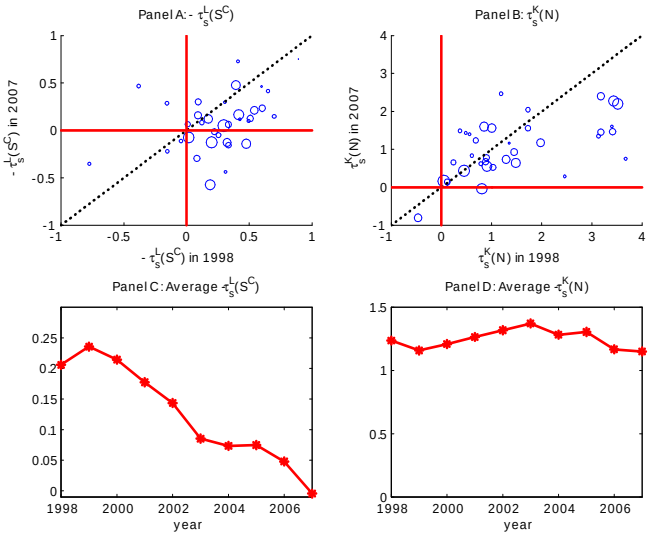


Figure 10: Distortions. Each dot in Panel A and B corresponds to $-\tau_s^L\left(S^C\right)$ and $\tau_s^K\left(N\right)$, respectively. $-\tau_s^L\left(S^C\right)$ stands for the average costs for corporatized SOEs to fire a worker as a share of her annual wage relative to those for private firms. $\tau_s^K\left(N\right)$ is the difference between the capital prices for private firms and corporatized SOEs. The dotted line is the 45 degree line. The size of each dot captures the size of the corresponding industry, measured by the average value-added weight of the industry from 1998 to 2007. Panel C and D plots the average $-\tau_s^L\left(S^C\right)$ and $\tau_s^K\left(N\right)$ across industries, respectively.

actual capital price for private firms aggregated across industries is 1.24 times higher than that for corporatized SOEs in 1998. The gap remains essentially unchanged over the sample period.

The dynamic pattern of the average labor distortions on privatized SOEs is similar to those of corporatized SOEs. $-\tau_s^L\left(S^P\right)$ is 0.28 in 1998 and then drops to 0.06 in 2007. Moreover, the actual capital prices for privatized SOEs are also close to r, with $\tau_s^K\left(S^P\right) = 0.22$ and 0.28 in 1998 and 2007, respectively. We find substantially larger initial average labor distortions for exiting SOEs. $-\tau_s^L\left(S^E\right)$ amounts to 0.43 in 1998. The capital price for exiting SOEs is even lower than that for corporatized SOEs, with $\tau_s^K\left(S^E\right) = -0.09$ in 1998.

7 Counterfactural Experiments

To quantify the effect of "grapsing the large, letting go of the small," we conduct the following three counterfactural experiments. The benchmark experiment corresponds to the case in which the main features of the state sector remain unchanged as they use to be. Three counterfactual conditions are introduced. First, we shut down TFP growth for all SOEs:

$$\hat{A}_{si} = \begin{cases} \min\left\{A_{si}, A_{si,0}\right\} & \text{if firm } i \text{ is a SOE} \\ A_{si} & \text{otherwise} \end{cases}. \tag{19}$$

Here, $\hat{A}_{si}$ denotes the TFP in the counterfactual experiment. A_{si} is the estimated TFP from (14) and $A_{si,0}$ stands for the initial TFP when the firm shows up in the dataset for the first time. Notice that if the current TFP of a SOE is lower than its initial level, we will set $\hat{A}_{si}$ equal to $A_{si,0}$.

Second, we shut down the reduction in $-\tau_s^L(S)$:

$$1+\hat{\tau}_{si}^L = \begin{cases} \left(1+\tau_{si}^L\right)\frac{1+\max\left\{\tau_{s,0}^L(S),\tau_s^L(S)\right\}}{1+\tau_s^L(S)} & \text{if firm } i \text{ is a SOE} \\ 1+\tau_{si}^L & \text{otherwise} \end{cases}, \tag{20}$$

where $\tau_{s,0}^L(S)$ denotes the first-period $\tau_s^L(S)$. The idea is that the reduction in the $-\tau_s^L(S)$ reflects a policy shift, which reduces firing costs for all SOEs in an industry. Notice that if the current $-\tau_s^L(S)$ is higher than its initial level, we will set $1+\hat{\tau}_{si}^L$ equal to $1+\tau_{si}^L$. (20) guarantees that the current labor distortions imposed on SOEs in the counterfactual, captured by $-\hat{\tau}_s^L(S)$, are no lower than the initial labor distortions estimated from the data.

Finally, we assume that [to be rewritten]

$$\hat{A}_{si} = A_{si,0},\ \ \hat{\tau}_{si}^L = \tau_{si,0}^L,\ \ \hat{\tau}_{si}^K = \tau_{si,0}^K, \tag{21}$$

for SOEs that have exited and report negative total profits in the exiting period. The exiting of these loss-making are likely to be prompted by "letting go of the small." (21) brings back these SOEs to the sample by assuming their TFP, labor and capital distortions to be equal to the initial levels.

Based on the benchmark experiment, we next introduce two changes. First, the "resurrected" SOEs are dropped. Second, the privatized SOEs are allowed to grow their TFP and to reduce labor distortions as observed in the data. Specifically, we let

$$\hat{A}_{si} = A_{si},\ \ \hat{\tau}_{si}^L = \tau_{si}^L, \tag{22}$$

for the privated SOEs after privatization. This is referred to as the let-go-of-the-small experiment since it captures the closure of SOEs and the main consequences of the privatization of SOEs. Column (1) of Table 1 reports that the ratio of the total value-added in the let-go-of-the-small experiment to that in the benchmark experiment in 2007. The ratio reveals the effect of "letting go of the small" on the aggregate productive efficiency in each industry. For instance, the ratio of 1.10 in the steel industry (Smelting and Pressing of Ferrous Metals), to which Baoshan belongs, suggests that "letting go of the small" increases the total value-added by 10% in 2007. In other words, the total value-added would be 10 percent lower if (i) the existing SOEs were still alive; and (ii) the privatized SOEs had no TFP growth or improvement in labor distortions. Moreover, the ratio is above one in almost all industries, indicating that "letting go of the small" unambiguously contributes to the aggregate productive efficiency.

[Insert Table 1]

We then apply (22) for corporatized SOEs in the benchmark experiment. This is referred to as the grasp-the-large experiment since it captures the main consequences of the corporatization of SOEs. Column (2) of Table 1 reports that the ratio of the total value-added in the grasp-the-large experiment to that in the benchmark experiment in 2007. That the ratio is above one in almost all industries suggests that "grasping the large" also unambiguously contributes to the aggregate productive efficiency. The effect of "grasping the large" is quantitatively much larger than the effect of "letting go of the small." The median ratio in Column (2) is 1.13, more than doubling the median ratio of 1.05 in Column (1). Moreover, the effect of "grasping the large" appears to be even larger in the nine important industries, where the state sector is more sizable. For instance, the ratio of 1.59 in the steel industry implies that the total value-added would be 59 percent lower if the corporatized SOEs had no TFP growth or improvement in labor distortions.

The last experiment combines the grasp-the-large and let-go-of-the-small experiments together. By construction, this replicates the data. Column (4) reports the total value-added relative to that in the benchmark experiment.

To make sense of to what extent "grasping the large" and "letting go of the small" contribute to the aggregate value-added in the industrial sector, we sum the total value-added over all industries.[23] The time-series results are plotted in Figure 7, where the dotted, dash-dot, dashed and solid lines represent the aggregate value-added in the benchmark experiment, let-go-of-the-small experiment, grasp-the-large experiment and data, respectively. The 1998 aggregate value-added is normalized to unity. In 2007, for instance, the aggregate value-added in the let-go-of-the-small and grasp-the-large experiments is 11.8 and 21.0 percent higher than that in the benchmark experiment, respectively. The last experiment that replicates the data shows that a joint of "grasping the large" and "letting go of the small" would increase the benchmark aggregate value-added by 34.7 percent.

[To Be Revised]

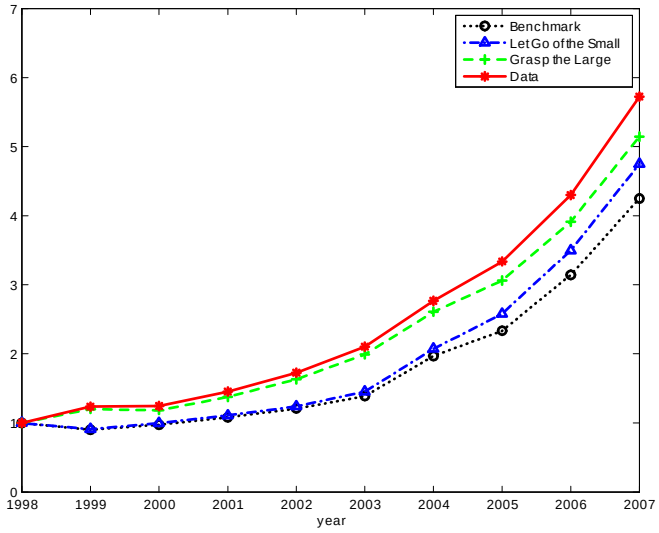
7.1 Maximizing Aggregate or State Revenue?

- Benchmark + 10% reduction in capital distortions discriminating private firms and SOE

Table: 2007 Results

	Aggregate Revenue	State Revenue Share
Benchmark	1.00	19%
Exp II	1.35	34%
Exp III	1.35	red**13%**black

[23] For simplicity, we assume a flat demand curve such that the total value-added of an industry does not affect the relative industry prices. As a robustness check, we will allow the industry prices to vary by imposing a Cobb-Douglas preference structure at the industry level.



8 Extension

8.1 Heterogeneous Markups

We would like to check the robustness of our results to heterogeneous markups. To this end, we assume a two-level CES aggregate of Q_{si},

$$Q_s = \left(\sum_{i \in I_s(N)} Q_{si}^{1-\eta} + Q_s(S)^{1-\eta} \right)^{\frac{1}{1-\eta}}, \tag{23}$$

where

$$Q_s(S) = \left(\sum_{i \in I_s(S)} Q_{si}^{(1-\theta)(1-\eta)} \right)^{\frac{1}{(1-\theta)(1-\eta)}}, \quad \theta \in [0,1).$$

Here, $Q_s(S)$ is a CES aggregate of goods produced by SOE, $I_s(S)$ and $I_s(N)$ denote the set of SOE and private firms in industry s, respectively. When $\theta = 0$; i.e., (23) will collapse to (1). The idea of (23) is that the goods produced by state firms are less substitutable for each other than those of SOE. As we will show below, (23) generates higher markups for SOE. For notational convenience, we define $Y_s(S) \equiv \sum_{i \in I_s(S)} Y_{si}$, $L_s(S) \equiv \sum_{i \in I_s(S)} L_{si}$ and $K_s(S) \equiv \sum_{i \in I_s(S)} K_{si}$, representing the total value-added, labor and capital of SOEs in industry s, respectively. Likewise, $Y_s(N) \equiv \sum_{i \in I_s(N)} Y_{si}$, $L_s(N) \equiv \sum_{i \in I_s(N)} L_{si}$ and $K_s(N) \equiv \sum_{i \in I_s(N)} K_{si}$ stand for the total value-added, labor and capital of private firms in industry s, respectively.

The budget constraint can be rewritten accordingly.

$$\sum_{i}^{I_s} P_{si} Q_{si} = \sum_{i \in I_s(N)} P_{si} Q_{si} + P_s(S) Q_s(S) = Y_s, \tag{24}$$

where $P_s(S) \equiv \left(\sum_{i \in I_s(S)} P_{si}^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}} \right)^{\frac{1-(1-\theta)(1-\eta)}{(1-\theta)(1-\eta)}}$ and $Y_s \equiv \sum_{i \in I_s} P_{si} Q_{si}$.

The demand curve and sales function for goods produced by private firms remain the same as (**??**) and (2), respectively. Consequently, we have the same Y-L and Y-K ratios as those in (4) and (5). The new CES aggregate changes the demand curve for goods produced by SOE:

$$Q_{si} = \frac{Y_s(S)}{P_s(S)} \left(\frac{P_{si}}{P_s(S)} \right)^{-\frac{1}{1-(1-\theta)(1-\eta)}}. \tag{25}$$

(25) shows that if $\theta > 0$, SOE would face a lower price elasticity and, thus, higher markups than the private firms. The value-added function of SOE should be now rewritten as

$$Y_{si} = \left(Y_s(S)^{\frac{1-(1-\theta)(1-\eta)}{(1-\theta)(1-\eta)}} P_s(S) A_{si} K_{si}^{\alpha_s} L_{si}^{(1-\alpha_s)} \right)^{(1-\theta)(1-\eta)}. \tag{26}$$

Two results are important. First, profit maximization leads to

$$\frac{Y_{si}}{K_{si}} = \frac{\left(1+\tau_{si}^K\right) r_s}{\alpha_s (1-\theta)(1-\eta)}, \tag{27}$$

$$\frac{Y_{si}}{L_{si}} = \frac{\left(1+\tau_{si}^L\right) w_s}{(1-\alpha_s)(1-\theta)(1-\eta)}. \tag{28}$$

Comparing (27) and (28) with (4) and (5), one may find that the present model predicts a smaller gap of the Y-K and Y-L ratios between SOE and private firms. Thanks to the higher markups, SOE charge higher prices, resulting in higher marginal revenue products. By (27), (28), (4) and (5), the estimation of τ_{si}^L and τ_{si}^K follows

$$\begin{aligned} 1+\tau_{si}^L &= \Theta_{si} \frac{Y_{si}/L_{si}}{\tilde{Y}_s/L_s}, \\ 1+\tau_{si}^K &= \Theta_{si} \frac{Y_{si}/K_{si}}{\tilde{Y}_s/K_s}, \end{aligned}$$

where $\Theta_{si} = 1$ for $i \in I_s(N)$ and $\Theta_{si} = 1-\theta$ for $i \in I_s(S)$, $\tilde{Y}_s \equiv \sum_{i \in I_s(N)} Y_{si} + \sum_{i \in I_s(N)} (1-\theta) Y_{si}$.[24] Note that $\tilde{Y}_s = Y_s$ when $\theta = 0$. The above two equations show that a positive θ actually implies a widened gap of factor prices for SOE and private firms.

Second, the estimation of TFP for SOE becomes more complicated. Appendix 10.9 shows that for $i \in I_s(S)$,

$$A_{si} = \frac{Y_s(S)^{-\frac{\theta}{(1-\theta)(1-\eta)}} Y_s^{-\frac{\eta}{1-\eta}} Y_{si}^{\frac{1}{(1-\theta)(1-\eta)}}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}. \tag{29}$$

Comparing (29) with (14), we find that (14) would overestimate the level of A_{si} for SOE if $\theta > 0$. The intuition is straightforward. (14) neglects the higher markups of SOE which allow them to set higher prices. However, (14) would give unbiased estimates of the TFP growth as long as Y_{si} and $Y_s(S)$ share the same growth rate. The TFP growth of a SOE would be overestimated (underestimated) if its output growth is below (above) the output growth of all SOE.

[24] We maintain the assumption that $\sum_i^{I_s} \left(1+\tau_{si}^K\right) K_{si} = K_s$ and $\sum_i^{I_s} \left(1+\tau_{si}^L\right) L_{si} = L_s$ to pin down r_s and w_s.

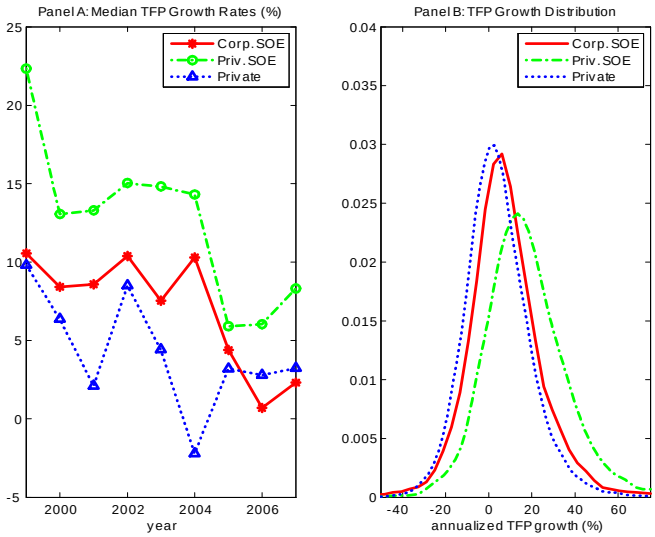
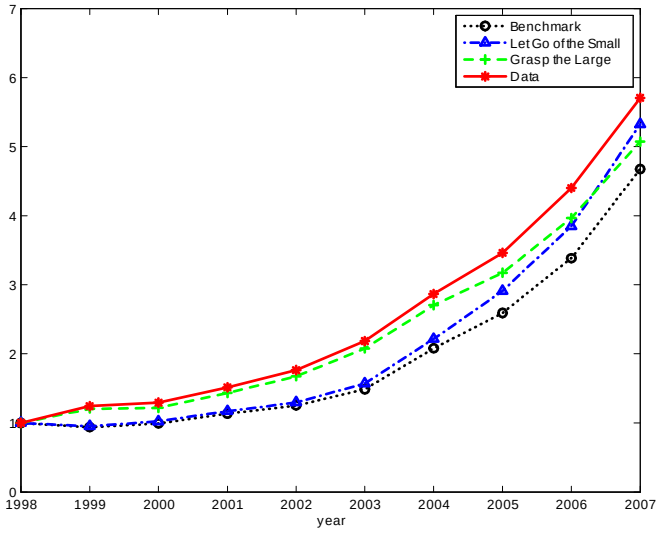


Figure 11: TFP Growth in the 1998-2007 Balanced Panel. The solid, dashed and dotted lines are for corporatized SOE, privatized SOE and private firms, respectively. Panel A plots the median growth rate of TFP and Panel B plots the distribution of TFP growth.

We set $\theta = 1/12$ to increase SOE markups by half. Using (29), Figure 11 reports the same lines as those in Figure 8. One can see that our main findings are still there. The median TFP growth rates of SOE are still above those of private firms in most years (except for 2006 and 2007). The annualized median growth rates over the sample period remain the same for corporatized SOE (6.6%) and private firms (3.1%). The only major difference is that privatized SOE exhibit a much fast TFP growth. Notice that these firms are assumed to have the same markups as private firms after privatization. Therefore, privatization would naturally lead to a jump in the estimated TFP.

Figure 8.1 redoes Figure 7 using the distortions and TFP calibrated by the model with $\theta = 1/12$. Intuitively, "letting go of the small" tends to have a bigger effect on the aggregate productivity efficiency as it reallocate labor from SOEs with higher markups to private firms with lower markups. On the contrary, that markups are higher for SOEs tends to weaken the effect of "grasping the large," which causes labor to flow from private firms to SOEs. In 2007, for instance, the aggregate value-added in the let-go-of-the-small is 13.9 percent higher than that in the benchmark experiment. The increase is slightly larger than 11.8 percent increase in the benchmark model. The effect of "grasping the large" turns out to be substantially smaller. In 2007, for instance, the aggregate value-added in the grasp-the-large experiment is merely 8.5 percent higher than the benchmark experiment. Recall that the increase amounts 21 percent in the benchmark model. Accordingly, the overall effect of "grasping the large" and "letting go of the small" becomes weaker: It would increase the benchmark aggregate value-added by 22.1 percent, down from 34.7 percent in the benchmark model.



XXX to be revised XXX

Another concern is whether large SOE have been gaining more market monopoly power. Figure 6 shows that the value-added share of SOE in the NBS data fell from 51% in 1998 to 31% in 2007. The shrinking of the state sector is well documented in the literature (e.g., Song et al., 2011). However, it is less well-known that much of the change has been taking place at the extensive margin. The entry rate is around 20% per annum and most of the new firms are private (Brandt et al., 2011). The massive entry of private firms suggests a falling monopoly power of SOE.

Although many industries have been open for competition, one may still argue that some industries remain to be dominated by the state sector. There are nine so-called "strategic" and "pillar" industries in the industrial sector (see Appendix 10.5 for details), which account for 44.3% and 50.2% of the total industrial value-added in 1998 and 2007, respectively. Figure 13 plots the ratios of the number of the top one percentile SOE or private firms to the number of all top one percentile firms in each of the key industries. The left and right bars refer to the ratios in 1998 and 2007, respectively. One can see that large SOE continue to dominate large private firms in three out of the four strategic industries: Coal, Petroleum Extraction and Power. The top one percentile SOE used to dominate their private counterparts in all the pillar industries except IT. However, until 2007, the top one percentile private firms had outnumbered their state counterparts in all the pillar industries but Auto. Despite the efforts of maintaining the preponderance in the strategic and pillar industries, we find that large SOE have actually been less important in most of the industries.[25] In other words, no evidence suggests that SOE have been building up market monopoly powers in the industrial sector.

[25] Power is the only exception, where the ratio of the number of the top one percentile SOE to that of their non-state counterparts increased from 2.3 in 1998 to 3.8 in 2007.

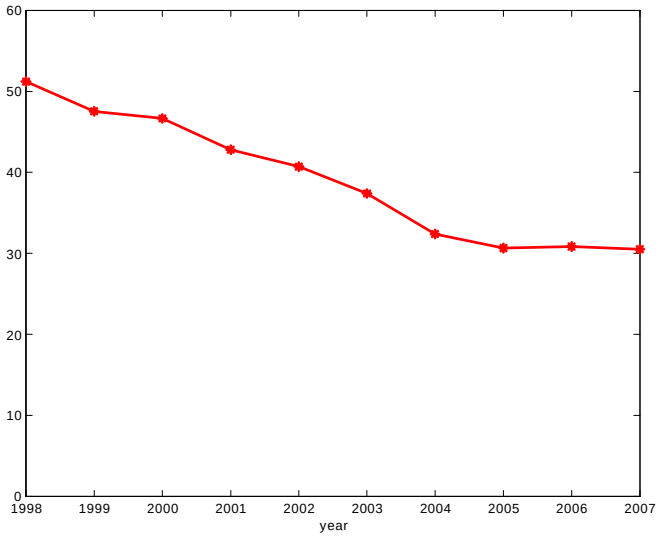


Figure 12: Value-Added of SOE as Percentage of Aggregate Value-Added in the NBS Data 1998-2007

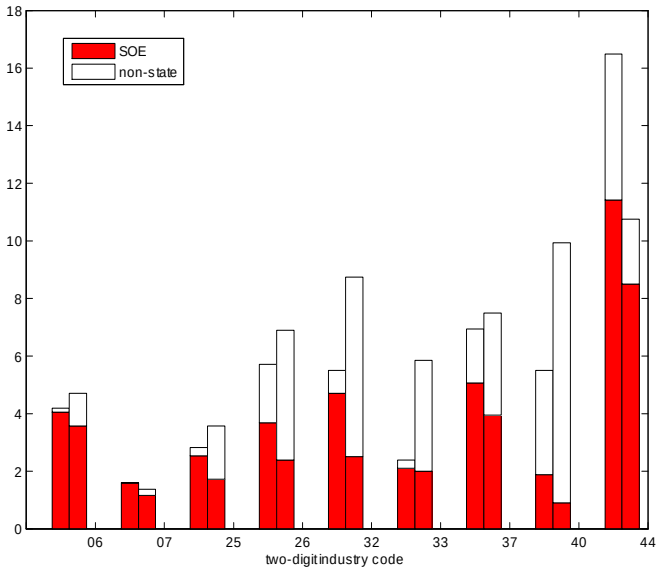


Figure 13: The Number of the Top One Percentile SOE or Non-State Firms in the Key Industries as Percentage of the Number of All the Top One Percentile Firms in 1998 and 2007

9 Conclusion

To be written

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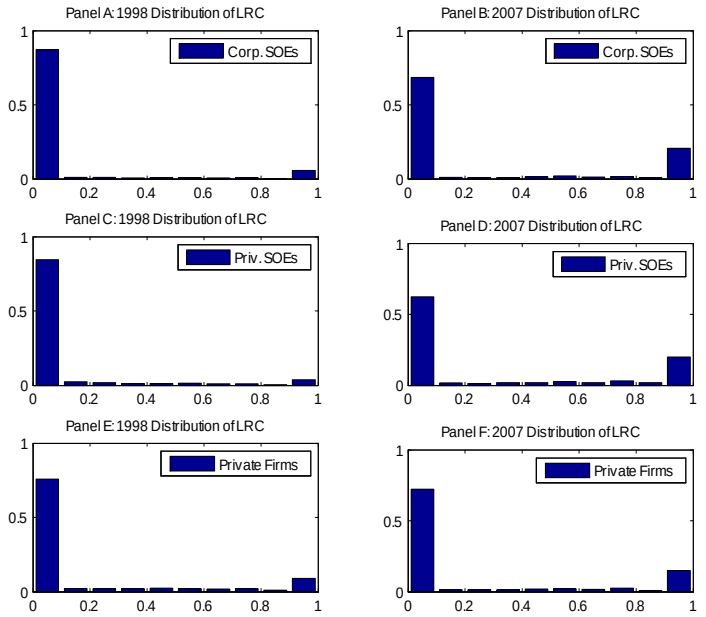
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10 Appendix

10.1 Legal Person Registered Capital Share Distribution



This figure plots the distribution of the legal person registered capital share (LRC) in the 1998-2007 balanced panel.

10.2 Exit Rates

We first estimate the annual exit rates using firm numbers from 1991 through 1995. According to China Statistical Yearbook 1996, there are 104.7 and 118.0 thousand industrial SOEs (by registration status) in 1991 and 1995, respectively. The same source reports 7.97 and 7.22 million non-state industrial firms in 1991 and 1995, respectively.[26] We assume no state ownership transformation before 1995. Therefore, all firms that were state (private) in 1991 and survived through 1995 remained to be state (private) in 1995. To back out the exit rates from firm numbers, we need to know the numbers of entry from

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

1992 through 1995. Our 1995 NBS data suggest that 4.7, 5.3, 4.2 and 3.2 thousand SOEs (again, by registration status) established in 1992, 1993, 1994 and 1995, respectively, and survived in 1995. The numbers for non-state firms are 644.3, 865.2, 681,1 and 625.9 thousand, respectively.[27] Finally, assume that all firms with ownership type J are subject to the same exit rate, denoted by $x(J)$, we can back out $x(J)$ by the following equation:

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

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

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

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

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

10.3 Labor Income Share

We first calculate labor compensation for each firm as the sum of wage, benefits and payment for labor insurance, pension, health insurance, public housing fund, unemployment insurance and unemployed insurance. It is well-know that labor income share, measured as total labor compensation as a share of value-added, is unusually low the NBS data. As illustrated by Qian and Zhu (2012), this is largely due to the discrepancy between the reported value-added and the reported income. We will not take a stand on whether value-added is overreported or income is underreported. Instead, following Qian and Zhu (2012), we use the following formula to calculate labor income share:

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

The denominator on the right-hand side is the reported income, which should be identical to the reported value-added in theory. Here, the assumption is that the ratio of the reported labor income to the actual labor income is identical to the ratio between the reported value-added and income.

Figure 14 plots the weighted average labor income share of SOE and private firms over the two-digit industries. The weight is set equal to the mean of the value-added share of each industry over 1998-2007, to control for the composition effect driven by time-varying industry size.

[27] Notice that Since our 1995 NBS sample has substantially fewer firms that those implied by China Statististical Yearbook 1996. Specifically, our 1995 NBS data covers 87.9 thousand SOEs and 422.4 thousand non-state firms. The numbers of entry reported in the text are adjusted by the sample sizes of state and non-state firms, to make them consistent with firm numbers in China Statististical Yearbook.

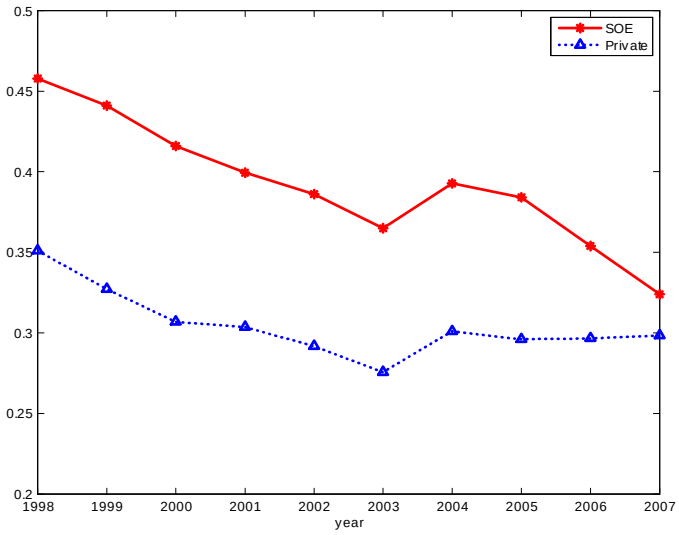


Figure 14: Weight Average Labor Income Shares. The solid and dotted lines represent for SOE and private firms, respectively. We use the mean of the value-added share of each industry from 1998 to 2007 as weight to average labor income shares of SOE and private firms over the two-digit industries.

10.4 Two Types of Labor Distortions

To formalize the overemployment constraint, we assume that the government requires SOE to hire $\underline{L}_{si}$ workers. Private firms are exempted from the constraint. Then, the profit maximization of SOE solves

$$\pi_{si} = \max_{L_{si},K_{si}} Y_{si} - \left(1+\tau_{si}^{K}\right) r_s K_{si} - \left(1+\hat{\tau}_{si}\right) w_s L_{si}, \tag{30}$$

subject to

$$L_{si} \geq \underline{L}_{si}. \tag{31}$$

Here, $\hat{\tau}_{si}$ represents the labor distortions other than the employment constraint (31). We assume the constraint to be always binding. Then, $\hat{\tau}_{si}$ can be rewritten as

$$1+\hat{\tau}_{si}^{L} = \lambda_{si}\left(1+\tau_{si}^{L}\right), \tag{32}$$

where τ_{si}^{L} still follows (15) and

$$\lambda_{si} \equiv \frac{L_{si}/Y_{si}}{L_{si}^{*}/Y_{si}^{*}} \geq 1,$$

with L_{si}^{*} and Y_{si}^{*} representing the desired employment and output level in the absence of the constraint (31), respectively. Two remarks are in order. First, the difference between L_{si}/Y_{si} and L_{si}^{*}/Y_{si}^{*} entails not only the direct effect of the constraint, but a general equilibrium effect through the factor prices. Second, λ_{si} measures the magnitude of the employment constraint, which contributes to the estimate of τ_{si}^{L} in (15). In other words, a lower λ_{si} would manifest itself as a lower estimated τ_{si}^{L}.

Although both a reduction in labor subsidies and a relaxed employment constraint lower the estimated τ_{si}^L, they have different implications on the labor income share, denoted by θ_{si}. In the case of labor subsidies, $\theta_{si} = (1+\tau_{si}) w_s L_{si}/Y_{si}$ and is always equal to $(1-\alpha_s)(1-\eta)$ for all firms. A binding employment constraint implies a higher labor share:

$$\theta_{si} = (1-\alpha_s)(1-\eta)\lambda_{si}. \tag{33}$$

Moreover, a relaxation in the constraint, shown up as a reduction in λ_{si}, would lead to a lower labor income share for SOE. Therefore, comparing labor shares across SOE and private firms provides a simple way of disentangling the two channels.

Figure 14 in Appendix (10.3) plots the average labor income share of SOE and private firms from 1998 to 2007. We use the mean of the value-added share of each industry as weight, to control for the composition effect driven by time-varying industry size. Private firms have a rather stable labor share around 0.3. SOE have a substantially higher labor share at the beginning of the sample period. The difference becomes much less pronounced in 2007. The converging labor shares between SOE and private firms implies that the relaxation of the employment constraint plays an important role in the falling T^L as shown in Panel C of Figure 10.

We next quantify the magnitude of the two types of labor distortions. Once again, consider SOE and private firms in an industry as two representative firms. Then, $\lambda_{si} = \lambda_s$ for all SOE. (33) suggests a simple way of calibrating λ_s:

$$\lambda_s = \frac{\theta_s(S)}{\theta_s(N)}. \tag{34}$$

Moreover, we can further back out $\hat{\tau}_s^L$ by (32). Panel A of Figure 15 plots $\hat{T}^L \equiv \frac{\sum_s \hat{\tau}_s^L w_s L_s(N)}{Y(N)}$. Comparing with Panel C of Figure 10, one can see a much smaller $\hat{T}^L$ after teasing out the effect of overemployment. The negative value of $\hat{T}^L$ after 2002 indicates the labor distortion captured by $\hat{\tau}_s^L$ has turned in favor of private firms since then.[28]

We measure the cost of λ_s for SOE in a conceptually similar way. Consider the following profit maximization problem:

$$\pi_{si} = \max_{L_{si},K_{si}} Y_{si} - \left(1+\tau_{si}^K\right) r_s K_{si} - \frac{1+\hat{\tau}_{si}}{\lambda_s} w_s L_{si} - \tau_{si}, \tag{35}$$

where τ_{si} is a lump-sum tax. When $\tau_{si} = (1-1/\lambda_s)(1+\hat{\tau}_{si}) w_s L_{si}$, the results from above the above program would be identical to those from (30). The cost of λ_s can thus be measured by T, the total lump-sum taxes as a share of the total output of SOE. In the case of a representative SOE and a representative private firm,

$$T = \frac{\sum_s (1-1/\lambda_s) w_s L_s(S)}{Y(S)}.$$

[28] One explanation is that private firms are easier to evade tax payment. For instance, using the same NBS data, Song et al. (2012) show that private firms pay much less pension contribution than SOE.

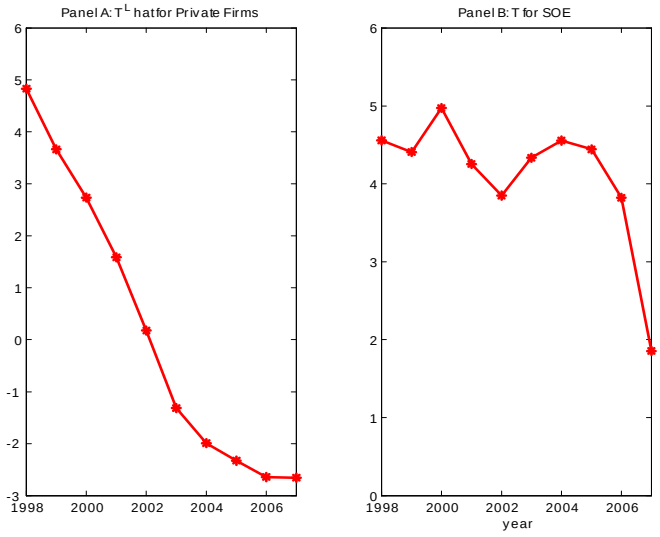


Figure 15: Costs of Labor Distortions. Panel A plots $\hat{T}^L$, the labor "tax" imposed on private firms, net of the effect of overemployment, as a percentage of the total output of private firms. Panel B plots T, the lump-sum tax imposed on SOE due to overemployment as a percentage of the total output of SOE.

Panel B of Figure 15 plots T. Overemployment costs 4.6% and 1.9% of the total output of SOE in 1998 and 2007, respectively. Notice that the profit rate is always equal to $\eta = 0.14$ in the absence of the constraint (31). Overemployment due to a binding constraint would reduce the profit rate by exactly the magnitude of T. Hence, the above results also suggest that the profit rate of SOE would be lowered by 4.6 percentage points due to overemployment in 1998. The relaxation of the employment constraint alone may account for 2.7 percentage points increase in the profit rate of SOE.

10.5 Industry

One important aspect of "grasping the large and letting go of the small" is to prompting large SOE in some key industries (see "The Decision" and the discussion in Section 2). More specifically, the key industries are referred to as the strategic or pillar industries. The "strategic" industries are defense, electric power and grid, petroleum and petrochemical, telecommunication, coal, civil aviation and shipping. The "pillar" industries are equipment manufacturing, auto, information technology, construction, iron and steel, non-ferrous metals, chemicals, and surveying and design.[29] There are a total of nine two-digit key industries in the industrial sector: Mining and Washing of Coal (code 06, Coal henceforth), Extraction of Petroleum and Natural Gas (code 07, Petroleum Extraction henceforth), Processing of Petroleum, Coking, Processing of Nuclear Fuel (code 25, Petroleum Processing henceforth) and Production and Supply of Electric Power and Heat Power (code 44, Power henceforth) are categorized into strategic industries. Pillar industries include Manufacture of Raw Chemical Materials

[29] See Szamosszegi and Kyle (2011) for a more detailed discussion.

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

Table A5 reports some important information about all the 39 two-digit industries in the industrial sector.

[Insert Table A5]

10.6 Proof of Lemma ?? and ??

The reallocation effect in (**??**) can be rewritten as

$$\begin{aligned}\text{the reallocation effect} &= \alpha_s(1-\eta)\frac{Y_{si}}{K_{si}}\frac{\partial K_{si}}{\partial A_{si}} + (1-\alpha_s)(1-\eta)\frac{Y_{si}}{L_{si}}\frac{\partial L_{si}}{\partial A_{si}} \\ &\quad + \sum_{j(j\neq i)}\alpha_s(1-\eta)\frac{Y_{sj}}{K_{sj}}\frac{\partial K_{sj}}{\partial A_{si}} + \sum_{j(j\neq i)}(1-\alpha_s)(1-\eta)\frac{Y_{sj}}{L_{sj}}\frac{\partial L_{sj}}{\partial A_{si}}.\end{aligned}$$

For notational ease, we define

$$T_{si}^L \equiv \left(1+\tau_{si}^K\right)^{-\frac{\alpha_s(1-\eta)}{\eta}}\left(1+\tau_{si}^L\right)^{-\frac{1-\alpha_s(1-\eta)}{\eta}},$$

$$T_{si}^K \equiv \left(1+\tau_{si}^K\right)^{-\frac{\alpha_s(1-\eta)+\eta}{\eta}}\left(1+\tau_{si}^L\right)^{-\frac{(1-\alpha_s)(1-\eta)}{\eta}}.$$

So, (8) and (9) can be rewritten as

$$L_{si} = \frac{\left(A_{si}\right)^{\frac{1-\eta}{\eta}}T_{si}^L}{\sum_j^{I_s}\left(A_{sj}\right)^{\frac{1-\eta}{\eta}}T_{sj}^L}L_s, \quad K_{si} = \frac{\left(A_{si}\right)^{\frac{1-\eta}{\eta}}T_{si}^K}{\sum_j^{I_s}\left(A_{sj}\right)^{\frac{1-\eta}{\eta}}T_{sj}^K}K_s.$$

Then,

$$\frac{\partial K_{si}}{\partial A_{si}} = \frac{1-\eta}{\eta}\frac{K_{si}}{A_{si}}\frac{K_s-K_{si}}{K_s},$$

and

$$\frac{\partial K_{sj}}{\partial A_{si}} = -\frac{1-\eta}{\eta}\frac{K_{si}}{A_{si}}\frac{K_{sj}}{K_s}.$$

Similarly, we have $\frac{\partial L_{si}}{\partial A_{si}} = \frac{1-\eta}{\eta}\frac{L_{si}}{A_{si}}\frac{L_s-L_{si}}{L_s}$ and $\frac{\partial L_{sj}}{\partial A_{si}} = -\frac{1-\eta}{\eta}\frac{L_{si}}{A_{si}}\frac{L_{sj}}{L_s}$. Substituting these results back into the reallocation effect yields

$$\begin{aligned}\text{the reallocation effect} &= \alpha_s(1-\eta)\frac{Y_{si}}{K_{si}}\frac{1-\eta}{\eta}\frac{K_{si}}{A_{si}}\frac{K_s-K_{si}}{K_s} + (1-\alpha_s)(1-\eta)\frac{Y_{si}}{L_{si}}\frac{1-\eta}{\eta}\frac{L_{si}}{A_{si}}\frac{L_s-L_{si}}{L_s} \\ &\quad - \sum_{j(j\neq i)}\alpha_s(1-\eta)\frac{Y_{sj}}{K_{sj}}\frac{1-\eta}{\eta}\frac{K_{si}}{A_{si}}\frac{K_{sj}}{K_s} - \sum_{j(j\neq i)}(1-\alpha_s)(1-\eta)\frac{Y_{sj}}{L_{sj}}\frac{1-\eta}{\eta}\frac{L_{si}}{A_{si}}\frac{L_{sj}}{L_s}\end{aligned}$$

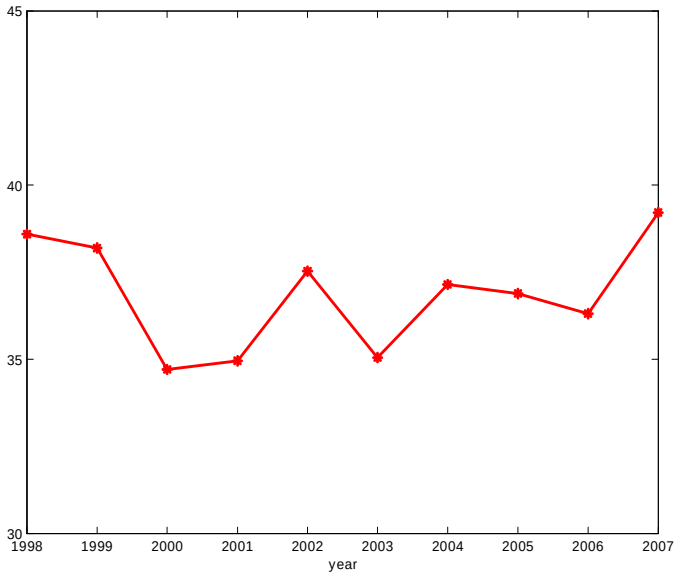


Figure 16: Value-Added Share of Distorted SOE (%)

$\Rightarrow$

$$\begin{aligned}\text{the reallocation effect} &= \frac{\alpha_s(1-\eta)^2}{\eta}\left(\frac{Y_{si}}{A_{si}}\frac{K_s-K_{si}}{K_s}-\frac{K_{si}}{A_{si}}\frac{1}{K_s}\sum_{j(j\neq i)}Y_{sj}\right)\\ &+\frac{(1-\alpha_s)(1-\eta)^2}{\eta}\left(\frac{Y_{si}}{A_{si}}\frac{L_s-L_{si}}{L_s}-\frac{L_{si}}{A_{si}}\frac{1}{K_s}\sum_{j(j\neq i)}Y_{sj}\right)\end{aligned}$$

$\Rightarrow$

$$\begin{aligned}\text{the reallocation effect} &= \frac{\alpha_s(1-\eta)^2}{\eta}\frac{Y_{si}}{A_{si}}\frac{Y_s}{K_s}\left(\frac{K_s}{Y_s}-\frac{K_{si}}{Y_{si}}\right) \qquad (36)\\ &+\frac{(1-\alpha_s)(1-\eta)^2}{\eta}\frac{Y_{si}}{A_{si}}\frac{Y_s}{L_s}\left(\frac{L_s}{Y_s}-\frac{L_{si}}{Y_{si}}\right)\\ &= (1-\eta)\frac{Y_{si}}{A_{si}}\left(\frac{\alpha_s(1-\eta)}{\eta}\left(1-\frac{Y_s}{K_s}\frac{K_{si}}{Y_{si}}\right)+\frac{(1-\alpha_s)(1-\eta)}{\eta}\left(1-\frac{Y_s}{L_s}\frac{L_{si}}{Y_{si}}\right)\right).\end{aligned}$$

By (36), (**??**) can be rewritten as

$$\frac{\partial Y_j}{\partial A_{sj}}=\frac{1-\eta}{\eta}\frac{Y_{si}}{A_{si}}\left(1-\alpha_s(1-\eta)\frac{Y_s/K_s}{Y_{si}/K_{si}}-(1-\alpha_s)(1-\eta)\frac{Y_s/L_s}{Y_{si}/L_{si}}\right).$$

(15) and (16) guarantee that $\tau_{si}^K>0$ and $\tau_{si}^L>0$ lead to $Y_{si}/K_{si}>Y_s/K_s$ and $Y_{si}/L_{si}>Y_s/L_s$.

10.7 Distorted SOE

Figure 16 plots the value-added share of the distorted SOE as a percentage of the total value-added of SOE in the NBS data.

10.8 The Non-Monotonicity of A_{si}^*

To illustrate how the distortions affect the threshold TFP A_{si}^*, let us look at a very simple case where there are two firms in an industry and no labor distortions. Then, we can analytically solve A_{s1}^* from the following equation:

$$\alpha_s (1-\eta) \frac{Y_s/K_s}{Y_{s1}^*/K_{s1}^*} = 1,$$

which is implied by (**??**) in Lemma **??**. Substituting (**??**) for Y_{s1}^*/K_{s1}^* yields

$$\left(\alpha_s (1-\eta) - \frac{1+\tau_{s1}^K}{1+\tau_{s2}^K}\right) \frac{A_{s2}^{\frac{1-\eta}{\eta}}}{\left(1+\tau_{s2}^K\right)^{\frac{\alpha_s(1-\eta)}{\eta}}} = (1-\alpha_s(1-\eta)) \frac{\left(A_{s1}^*\right)^{\frac{1-\eta}{\eta}}}{\left(1+\tau_{s1}^K\right)^{\frac{\alpha_s(1-\eta)}{\eta}}}.$$

One can see the two opposite forces affecting A_{s1}^*. On one hand, a lower $1+\tau_{s1}^K$ will reduce Y_{s1}/K_{s1}, making firm 1 more likely to be "distorted." This would increase the threshold value of A_{s1}^*. On the other hand, a lower $1+\tau_{s1}^K$ also increases the distortion-adjusted TFP, making the firm larger and pushing Y_{s1}/K_{s1} closer to Y_s/K_s. To see it more explicitly, we solve the above equation.

$$A_{s1}^* = \left(\frac{\alpha_s(1-\eta) - \frac{1+\tau_{s1}^K}{1+\tau_{s2}^K}}{1-\alpha_s(1-\eta)}\right)^{\frac{\eta}{1-\eta}} \left(\frac{1+\tau_{s1}^K}{1+\tau_{s2}^K}\right)^{\alpha_s} A_{s2}.$$

It is immediate that $\partial A_{s1}^*/\partial \tau_{s1}^K \lesseqgtr$ if and only if

$$\left(\frac{\eta}{1-\eta} + \alpha_s\right) \frac{1+\tau_{s1}^K}{1+\tau_{s2}^K} \gtreqless \alpha_s^2 (1-\eta).$$

10.9 The Derivation of Equation 29

(26) implies that

$$A_{si} = \frac{Y_s(S)^{-\frac{1-(1-\theta)(1-\eta)}{(1-\theta)(1-\eta)}} P_s(S)^{-1} Y_{si}^{\frac{1}{(1-\theta)(1-\eta)}}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}. \tag{37}$$

Since

$$Y_s(S) \equiv \sum_{i \in I_s(S)} P_{si} Q_{si} = Y_s P_s(S)^{1-\frac{1}{\eta}},$$

we have

$$P_s(S) = \left(\frac{Y_s}{Y_s(S)}\right)^{\frac{\eta}{1-\eta}}. \tag{38}$$

Substituting the above equation back into (37) yields (29).

10.10 Equilibrium Allocation in the Model with Heterogeneous Markups

Denote $L_s(N)$ the total labor in private firms:

$$\sum_{i \in I_s(N)} L_{si} = L_s(N).$$

Analogous to (8), the resource allocation follows

$$L_{si} = \frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}} / \left(1+\tau_{si}^{L}\right)}{\sum_{j\in I_s(N)} \tilde{A}_{sj}^{\frac{1-\eta}{\eta}} / \left(1+\tau_{sj}^{L}\right)} L_s(N), \tag{39}$$

for private firms with $i \in I_s(N)$. $L_s(N)$ is endogenous and will be determined below. Likewise, K_{si} is the same as before for private firms.

$$K_{si} = Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^{K}} \tilde{L}(N)^{\frac{(1-\alpha_s)(1-\eta)}{1-\alpha_s(1-\eta)}} \left(\frac{\alpha_s(1-\eta)}{r}\right)^{\frac{1}{1-\alpha_s(1-\eta)}},$$

where

$$\tilde{L}(N) \equiv \frac{L(N)}{\sum_{j\in I(s)} \frac{\tilde{A}_{sj}^{\frac{1-\eta}{\eta}}}{1+\tau_{sj}^{L}}}.$$

Therefore,

$$\begin{aligned} Q_{si} &= Y_s^{\frac{\alpha_s\eta}{1-\alpha_s(1-\eta)}} \tilde{Q}_{si} \\ &\equiv Y_s^{\frac{\alpha_s\eta}{1-\alpha_s(1-\eta)}} A_{si} \left(Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^{K}} \tilde{L}(N)^{\frac{(1-\alpha_s)(1-\eta)}{1-\alpha_s(1-\eta)}} \left(\frac{\alpha_s(1-\eta)}{r}\right)^{\frac{1}{1-\alpha_s(1-\eta)}} \right)^{\alpha_s} L_{si}^{1-\alpha_s}. \end{aligned}$$

For SOEs, we have

$$L_{si} = \frac{\left(\tilde{A}_{si}\right)^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}} / \left(1+\tau_{si}^{L}\right)}{\sum_{j\in I_s(S)} \left(\tilde{A}_{sj}\right)^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}} / \left(1+\tau_{sj}^{L}\right)} \left(L - L_s(N)\right). \tag{40}$$

Substitute (38) for $P_s(S)$ in (26) yields

$$\begin{aligned} Y_{si} &= Y_s(S)^{\theta} Y_s^{\eta(1-\theta)} Q_{si}^{(1-\eta)(1-\theta)} \\ &= Y_s(S)^{\theta} Y_s^{\eta(1-\theta)} \left(A_{si} K_{si}^{\alpha_s} L_{si}^{(1-\alpha_s)}\right)^{(1-\eta)(1-\theta)}. \end{aligned} \tag{41}$$

A combination of (41) and (27) implies

$$Y_s(S)^{\theta} Y_s^{\eta(1-\theta)} \left(A_{si} L_{si}^{(1-\alpha_s)}\right)^{(1-\eta)(1-\theta)} = \frac{\left(1+\tau_{si}^{K}\right) r}{\alpha_s(1-\theta)(1-\eta)} K_{si}^{1-\alpha_s(1-\theta)(1-\eta)}$$

$\Rightarrow$

$$\left(Y_s(S)^{\theta} Y_s^{\eta(1-\theta)}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}} \left(A_{si} L_{si}^{(1-\alpha_s)}\right)^{\frac{(1-\eta)(1-\theta)}{1-\alpha_s(1-\theta)(1-\eta)}} \left(\frac{\alpha_s(1-\theta)(1-\eta)}{\left(1+\tau_{si}^{K}\right) r}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}} = K_{si}$$

$\Rightarrow$

$$\left(Y_s(S)^{\theta} Y_s^{\eta(1-\theta)}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}} A_{si}^{\frac{(1-\eta)(1-\theta)}{1-\alpha_s(1-\theta)(1-\eta)}} \frac{A_{si}^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)} \frac{(1-\alpha_s)(1-\theta)(1-\eta)}{1-\alpha_s(1-\theta)(1-\eta)}}}{\left(1+\tau_{si}^{K}\right)^{\alpha_s \frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)} \frac{(1-\alpha_s)(1-\theta)(1-\eta)}{1-\alpha_s(1-\theta)(1-\eta)}} \left(1+\tau_{si}^{L}\right)^{\left((1-\alpha_s)\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}+1\right)\frac{(1-\alpha_s)(1-\theta)}{1-\alpha_s(1-\theta)(}}$$

$$\left(\frac{1}{1+\tau_{si}^{K}}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}}\tilde{L}\left(S\right)^{\frac{(1-\alpha_s)(1-\theta)(1-\eta)}{1-\alpha_s(1-\theta)(1-\eta)}}\left(\frac{\alpha_s\left(1-\theta\right)\left(1-\eta\right)}{r}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}}=K_{si},$$

where

$$\tilde{L}\left(S\right)\equiv\frac{L-L_s\left(N\right)}{\sum_{j\in I_s(S)}\left(\tilde{A}_{sj}\right)^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}}/\left(1+\tau_{sj}^{L}\right)}.$$

Since

$$\begin{aligned}
&\frac{\left(1-\eta\right)\left(1-\theta\right)}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}+\frac{\left(1-\theta\right)\left(1-\eta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\frac{\left(1-\alpha_s\right)\left(1-\theta\right)\left(1-\eta\right)}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}\\
=&\frac{\left(1-\eta\right)\left(1-\theta\right)}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}\left(1+\frac{\left(1-\alpha_s\right)\left(1-\theta\right)\left(1-\eta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\right)\\
=&\frac{\left(1-\eta\right)\left(1-\theta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}
\end{aligned}$$

and

$$\begin{aligned}
&\alpha_s\frac{\left(1-\theta\right)\left(1-\eta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\frac{\left(1-\alpha_s\right)\left(1-\theta\right)\left(1-\eta\right)}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}+\frac{1}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}\\
=&\frac{1}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}\left(\frac{\alpha_s\left(1-\theta\right)\left(1-\eta\right)\left(1-\alpha_s\right)\left(1-\theta\right)\left(1-\eta\right)+1-\left(1-\theta\right)\left(1-\eta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\right)\\
=&\frac{1}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}\left(\frac{\alpha_s\left(1-\theta\right)\left(1-\eta\right)\left(1-\alpha_s\right)\left(1-\theta\right)\left(1-\eta\right)+1-\left(1-\theta\right)\left(1-\eta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\right)\\
=&\frac{1}{1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)}\frac{\left(1-\alpha_s\left(1-\theta\right)\left(1-\eta\right)\right)\left(1-\left(1-\alpha_s\right)\left(1-\eta\right)\left(1-\theta\right)\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\\
=&\frac{1-\left(1-\alpha_s\right)\left(1-\eta\right)\left(1-\theta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}\\
=&\alpha_s\frac{\left(1-\eta\right)\left(1-\theta\right)}{1-\left(1-\theta\right)\left(1-\eta\right)}+1,
\end{aligned}$$

we have

$$K_{si}=\left(Y_s\left(S\right)^{\theta}Y_s^{\eta(1-\theta)}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}}\frac{\tilde{A}_{si}^{\frac{(1-\eta)(1-\theta)}{1-(1-\theta)(1-\eta)}}}{1+\tau_{si}^{K}}\tilde{L}\left(S\right)^{\frac{(1-\alpha_s)(1-\theta)(1-\eta)}{1-\alpha_s(1-\theta)(1-\eta)}}\left(\frac{\alpha_s\left(1-\theta\right)\left(1-\eta\right)}{r}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}}. \tag{42}$$

(41) and (42) imply

$$\begin{aligned}
\sum_{i\in I_s(S)}Y_{si}&=Y_s\left(S\right)=Y_s\left(S\right)^{\theta}Y_s^{\eta(1-\theta)}\sum_{i\in I_s(S)}Q_{si}^{(1-\eta)(1-\theta)}\\
&=Y_s\left(S\right)^{\theta}Y_s^{\eta(1-\theta)}\left(Y_s\left(S\right)^{\theta}Y_s^{\eta(1-\theta)}\right)^{\frac{\alpha_s(1-\eta)(1-\theta)}{1-\alpha_s(1-\theta)(1-\eta)}}\sum_{i\in I_s(S)}\tilde{Q}_{si}^{(1-\eta)(1-\theta)}\\
&=\left(Y_s\left(S\right)^{\theta}Y_s^{\eta(1-\theta)}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}}\sum_{i\in I_s(S)}\tilde{Q}_{si}\left(S\right)^{(1-\eta)(1-\theta)}
\end{aligned}$$

where

$$\tilde{Q}_{si}\left(S\right)=A_{si}\left(\frac{\tilde{A}_{si}^{\frac{(1-\eta)(1-\theta)}{1-(1-\theta)(1-\eta)}}}{1+\tau_{si}^{K}}\tilde{L}\left(S\right)^{\frac{(1-\alpha_s)(1-\theta)(1-\eta)}{1-\alpha_s(1-\theta)(1-\eta)}}\left(\frac{\alpha_s\left(1-\theta\right)\left(1-\eta\right)}{r}\right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}}\right)^{\alpha_s}L_{si}^{1-\alpha_s}.$$

Therefore,

$$Y_s(S) = Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \left(\sum_{i \in I_s(S)} \tilde{Q}_{si}(S)^{(1-\eta)(1-\theta)} \right)^{\frac{1-\alpha_s(1-\theta)(1-\eta)}{(1-\theta)(1-\alpha_s(1-\eta))}}$$

Following (2), we have

$$\sum_{i \in I_s(N)} Y_{si} = Y_s - Y_s(S) = Y_s^{\eta} Y_s^{\frac{\alpha_s \eta(1-\eta)}{1-\alpha_s(1-\eta)}} \sum_{h \in I_s(N)} \tilde{Q}_{si}(N)^{1-\eta} = Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \sum_{h \in I_s(N)} \tilde{Q}_{si}(N)^{1-\eta},$$

where

$$\tilde{Q}_{si}(N) = A_{si} \left(\frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^K} \tilde{L}(N)^{\frac{(1-\alpha_s)(1-\eta)}{1-\alpha_s(1-\eta)}} \left(\frac{\alpha_s(1-\eta)}{r} \right)^{\frac{1}{1-\alpha_s(1-\eta)}} \right)^{\alpha_s} L_{si}^{1-\alpha_s}.$$

A combination of the above two equations solves

$$Y_s = Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \left(\sum_{h \in I_s(N)} \tilde{Q}_{si}(N)^{1-\eta} + \left(\sum_{i \in I_s(S)} \tilde{Q}_{si}(S)^{(1-\eta)(1-\theta)} \right)^{\frac{1-\alpha_s(1-\theta)(1-\eta)}{(1-\theta)(1-\alpha_s(1-\eta))}} \right)$$

$\Rightarrow$

$$Y_s = \left(\sum_{h \in I_s(N)} \tilde{Q}_{si}(N)^{1-\eta} + \left(\sum_{i \in I_s(S)} \tilde{Q}_{si}(S)^{(1-\eta)(1-\theta)} \right)^{\frac{1-\alpha_s(1-\theta)(1-\eta)}{(1-\theta)(1-\alpha_s(1-\eta))}} \right)^{\frac{1-\alpha_s(1-\eta)}{(1-\eta)(1-\alpha_s)}}, \tag{43}$$

$$Y_s(S) = \left(\sum_{h \in I_s(N)} \tilde{Q}_{si}(N)^{1-\eta} + \left(\sum_{i \in I_s(S)} \tilde{Q}_{si}(S)^{(1-\eta)(1-\theta)} \right)^{\frac{1-\alpha_s(1-\theta)(1-\eta)}{(1-\theta)(1-\alpha_s(1-\eta))}} \right)^{\frac{\eta}{(1-\eta)(1-\alpha_s)}} \left(\sum_{i \in I_s(S)} \tilde{Q}_{si}(S)^{(1-\eta)(1-\theta)} \right)^{\frac{1-\alpha_s(1-\theta)}{(1-\theta)(1-\alpha}} \tag{44}$$

Now we can write down the algorithm. Guess $L_s(N)$. Then, (43) and (44) give Y_s and $Y_s(S)$. The next step is to check whether

$$\frac{Y_{si}}{\left(1+\tau_{si}^L\right) L_{si}} = \frac{(1-\theta) Y_{sh}}{\left(1+\tau_{sh}^L\right) L_{sh}}. \tag{45}$$

is satisfied.

No Analytical Solution:

Note that

$$\begin{aligned}
\tilde{Q}_{si}(N) &= A_{si} \left(Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^K} \tilde{L}(N)^{\frac{(1-\alpha_s)(1-\eta)}{1-\alpha_s(1-\eta)}} \left(\frac{\alpha_s(1-\eta)}{r} \right)^{\frac{1}{1-\alpha_s(1-\eta)}} \right)^{\alpha_s} \left(\frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^L} \tilde{L}(N) \right)^{1-\alpha_s} \\
&= A_{si} \left(Y_s^{\frac{\eta}{1-\alpha_s(1-\eta)}} \frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^K} \left(\frac{\alpha_s(1-\eta)}{r} \right)^{\frac{1}{1-\alpha_s(1-\eta)}} \right)^{\alpha_s} \left(\frac{\tilde{A}_{si}^{\frac{1-\eta}{\eta}}}{1+\tau_{si}^L} \right)^{1-\alpha_s} \tilde{L}(N)^{\frac{1-\alpha_s}{1-\alpha_s(1-\eta)}}
\end{aligned}$$

and

$$\begin{aligned}
\tilde{Q}_{si}(S) &= A_{si} \left(\frac{\tilde{A}_{si}^{\frac{(1-\eta)(1-\theta)}{1-(1-\theta)(1-\eta)}}}{1+\tau_{si}^K} \tilde{L}(S)^{\frac{(1-\alpha_s)(1-\theta)(1-\eta)}{1-\alpha_s(1-\theta)(1-\eta)}} \left(\frac{\alpha_s(1-\theta)(1-\eta)}{r} \right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}} \right)^{\alpha_s} \left(\frac{\tilde{A}_{si}^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}}}{1+\tau_{si}^L} \tilde{L}(S) \right)^{1-\alpha_s} \\
&= A_{si} \left(\frac{\tilde{A}_{si}^{\frac{(1-\eta)(1-\theta)}{1-(1-\theta)(1-\eta)}}}{1+\tau_{si}^K} \left(\frac{\alpha_s(1-\theta)(1-\eta)}{r} \right)^{\frac{1}{1-\alpha_s(1-\theta)(1-\eta)}} \right)^{\alpha_s} \left(\frac{\tilde{A}_{si}^{\frac{(1-\theta)(1-\eta)}{1-(1-\theta)(1-\eta)}}}{1+\tau_{si}^L} \right)^{1-\alpha_s} \tilde{L}(S)^{\frac{1-\alpha_s}{1-\alpha_s(1-\theta)(1-\eta)}}.
\end{aligned}$$