CHANG-TAI HSIEH
University of Chicago

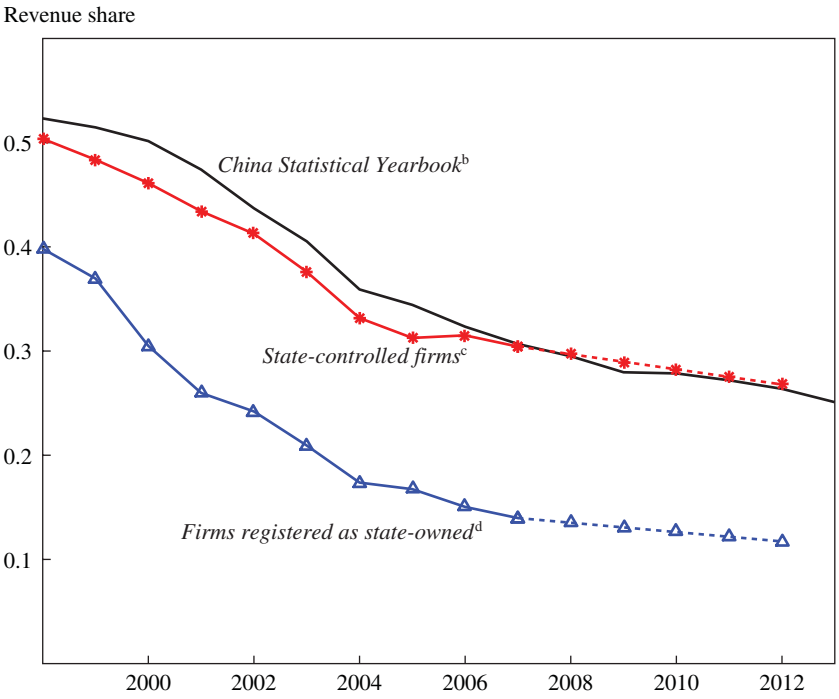
ZHENG (MICHAEL) SONG
Chinese University of Hong Kong

Grasp the Large, Let Go of the Small: The Transformation of the State Sector in China

ABSTRACT In the late 1990s, China's industrial sector was dominated by state-owned firms. We document how this changed after 1998. More than 80 percent of the state-owned firms in 1998 were shut down or privatized by 2007. Among firms we classify as state-controlled in 2007, many were restructured and registered as private firms with a controlling share held by a state-owned conglomerate or were new firms established after 1998. In 2007, almost half of the state-controlled firms were registered as private firms, and about 40 percent were new firms established after 1998. The privatization and convergence in labor productivity decelerated after 2007, but the establishment of new state-owned firms continued at roughly the same rate. When we interpret these facts through the lens of an equilibrium model of heterogeneous firms, we find that the transformation of firms that remained under state control and the creation of new state-controlled firms together account for 21 percent of China's growth from 1998 to 2007 and 18 percent of its growth from 2007 to 2012. However, the exit and privatization of state-owned firms had a negligible effect on aggregate growth.

A central feature of the industrial revolution in China over the last two decades is the decline of the state-owned sector. Figure 1 illustrates that the share of state-owned firms in industrial output declined from 50 percent in 1998 to 30 percent by 2005, and has continued to fall since then, albeit at a slower rate. This fact naturally suggests that China's growth was driven by the growth of the private sector and the reallocation of resources away from state-owned firms. According to a popular view, the growth of the private sector was only possible when, starting in the late

Figure 1. Revenue Share of State-Owned Firms, 1998–2013[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey and published tabulations from the *China Statistical Yearbook*.

a. Firm data are tabulations from China's Industrial Survey from 1998–2007 and 2012; firm data for 2008–2011 are missing.

b. State-owned firms in the industrial sector in the *China Statistical Yearbook*.

c. Firms we identify as state-owned but not necessarily registered as state-owned, based on firm data.

d. Firms formally registered as state-owned firms, based on firm data.

1990s, state-owned firms were shut down or privatized. The shutdown of loss-making state-owned firms released resources that were more profitably employed by private firms. Privatizing state-owned firms may have raised their productivity by more closely aligning control and cash-flow rights. The industrial revolution in China is thus nothing more than the triumph of "Markets over Mao," to quote the title of a recent book by Nicholas Lardy (2014).

Another view is that China's growth was driven by "state capitalism." Advocates of the role of state capitalism point out that although many state-owned firms were closed or privatized, the remaining state-owned firms are among the largest firms in China today. For example, 67 of the

69 Chinese companies in *Fortune's* 2014 list of the 500 largest companies in the world are state-owned. One can also point to the experience of specific state-owned companies. Consider, for example, the experience of the Baoshan Steel Company. Baoshan, a large steel manufacturer in Shanghai, became a publicly traded company in 2000.[1] The controlling share (75 percent) is held by a holding company (the BaoSteel Group) wholly owned by the Chinese central government.[2] Baoshan has done very well since the late 1990s. Total sales increased from USD 3.7 billion in 2000 to USD 23.1 billion by 2007. Profits increased by even more, from USD 527 million in 2000 to USD 2.2 billion by 2007. Baoshan is currently the largest steel producer in China and one of the largest steel producers in the world.[3] The experience of Baoshan is an example of how state-owned firms have changed. Such firms, which are among the largest companies in China today, have typically been partially privatized but always with a controlling share held by a large state-owned conglomerate. The term used in China for this ownership change is that large state-owned firms were "corporatized," not privatized. Furthermore, there is a widespread perception that such firms have been enormously successful, perhaps even too successful. For example, a new popular phrase in China is *guo jin min tui,* which translates roughly as "the state advances, the private sector retreats." Implicit in this slogan is the belief that state-owned firms have been successful, but their success has had negative aggregate effects.

What is missing in this debate is evidence, and this is what we provide in this paper. We use detailed firm-level data from China's Industrial Survey to measure the quantitative importance of the transformation of the state sector on aggregate productivity growth. First, we document the triumph of "Markets over Mao" in the Chinese industrial sector from 1998 to 2007: more than 83 percent of all state-owned firms in the industrial sector in 1998 were shut down or privatized by 2007, with higher rates among smaller state-owned firms. Second, we document the "corporatization" of the surviving state-owned firms: among firms we identify as

1. Technically, Baoshan was closed in 2000, and a new company called Baoshan Company Limited was established with the assets of the old state company and publicly listed on the Shanghai Stock Exchange.

2. Baoshan is legally controlled by the central government's State-Owned Assets Supervision and Administration Commission (SASAC), and Baoshan's senior executives are appointed by the Organization Department of the Chinese Communist Party.

3. These numbers are from Baoshan's annual reports. As we discuss later in the paper, Baoshan is only one of the firms in the BaoSteel Group.

state-controlled in 2007, almost half are officially registered as private firms. Third, we find that the labor productivity of surviving state-controlled firms and privatized firms converged to that of private firms by 2007, but that capital productivity among state-owned and privatized firms remained about 40 percent lower (compared to private firms). Fourth, we find that many new state-owned firms were established between 1998 and 2007: such firms accounted for approximately 36 percent of all state-owned firms in 2007. Finally, parts of this process decelerated after 2007: after that point there was less privatization of state-owned firms, and the growth in labor productivity of state-owned firms relative to that of private firms slowed down from 2007 to 2012 (compared to the 1998–2007 period), but the creation of new state-owned firms continued after 2007 at roughly the same rate, as in the earlier period.

We then interpret these facts through the lens of an equilibrium model of heterogeneous firms. We find that the exit and privatization of state-owned firms had negligible effects on aggregate output growth, accounting for about 3 percent of the aggregate growth in China's industrial sector from 1998 to 2007 and zero percent of growth from 2007 to 2012. Thus, a simple version of the "Markets over Mao" story for China's growth does not appear to be correct. The bulk of China's growth is driven (in a proximate sense) by two other forces. First, the "corporatization" of the surviving state-controlled firms and the establishment of new state-owned firms collectively accounts for 21 percent of the growth from 1998 to 2007 and 18 percent of the growth from 2007 to 2012. Second, the residual, which is due to the growth of private firms, accounts for 70 to 80 percent of aggregate growth after 1998. In sum, we find that the quasi-privatization "corporatization" of firms that remained under state control and the creation of new state-controlled firms played an important role in China's growth, but the biggest force behind China's growth is neither state capitalism nor the simple version of the "Markets over Mao" story.

The rest of the paper is organized as follows. Section I presents the facts regarding the characteristics of exiting firms, survivors, and entrants in the state sector relative to that of their private counterparts. In section II, we lay out a model to guide our empirical analysis. We then use the model in section III to back out firm-level productivity and distortions. We also explore the institutional forces behind the dramatic changes in the state sector in section IV. Section V quantifies the effect on aggregate GDP of the reallocation toward private firms through the exit and privatization of state-owned firms and the productivity improvements among surviving state-owned firms. Section VI concludes.

I. Grasp the Large, Let Go of the Small

This section describes the institutional background behind the state sector reforms that began in the late 1990s. We then present a comprehensive set of empirical facts found in China's industrial firm data. We pay special attention to the identification of state ownership, which is often disguised by the firms' legal registration.

The main data we use are the microdata from the Annual Survey of Industries conducted by China's National Bureau of Statistics from 1998 to 2007 and for 2012.[4] This survey is a census of all state-owned firms and non-state-owned firms (henceforth referred to as private firms) in the industrial sector that have more than 5 million RMB in revenues.[5] The unit of observation in the data is a registered firm. For the firms owned by the state-owned industrial groups, each firm is a separate observation in our data.

I.A. Institutional Background

The policy changes we describe below were formally announced in 1999 in the Fourth Plenum of the Communist Party's Central Committee.[6] The slogan adopted by the Communist Party to describe the proposed reforms was "Grasp the Large, Let Go of the Small." "Let Go of the Small" refers to the fact that small state-owned firms were to be closed or sold.

As for the large state-owned firms, the plan was that large firms were to be "grasped" by the state. By *grasp,* the central committee meant that large state-owned firms were to be merged into large industrial conglomerates, and the control over these conglomerates was to be 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 (BaoSteel Group, WuSteel Group, and AnSteel Group) and two by provincial governments (Hebei Iron

4. We do not have access to the microdata from 2008 to 2011.

5. The threshold was raised to 20 million RMB in 2011.

6. See Central Committee of the Communist Party of China (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, Ge, and Qui (2005) for an assessment of the initial experiments with reforms in corporate governance.

and Steel Group, and Shandong Steel Group). The BaoSteel Group, for example, controls six large steel manufacturers—three wholly owned by the group and three (including Baoshan) publicly traded 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 Automotive Industry Corporation (SAIC) Group owned by the Shanghai local government. The SAIC Group owns a controlling share of the equity (73 percent) of the original state-owned firm (SAIC Motor Co., Ltd.), which is now a publicly traded company. In turn, SAIC Motor Co., Ltd., holds 50 percent of the equity of two new companies jointly established with General Motors (Shanghai-GM) and Volkswagen (Shanghai-Volkswagen).[7]

A more fundamental goal of "Grasp the Large" was to transform the large state-owned firms into profit-maximizing firms under the control of the Chinese state. Two aspects of the reorganization of large state-owned firms were meant to accomplish this goal. First, state-owned firms were often incorporated as limited liability corporations, and the managers were to be held accountable for the firm's bottom line. The terminology used in China was that state-owned firms were to be "corporatized." The parent company, as the controlling shareholder, was to monitor the firm and be responsible for appointing and deciding the compensation of the firm's senior managers. In turn, the senior executives of the parent company (the industrial group) were to be 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).

In addition, although the plans laid out in the late 1990s did not mention the establishment of new state-owned firms, we will show that this was also an important part of what happened. Because the new state-owned firms are predominantly large firms, we will also label the creation of new state-owned firms as part of what was meant by "Grasp the Large."

The question is how the Chinese state chose to exercise its right of control over the industrial groups and, in particular, what criteria it used to reward and punish the groups' senior executives. In 2003, the State-Owned Assets Supervision and Administration Commission (SASAC) was set up

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

as the legal owner of the state-owned groups.[8] This body was set up simultaneously at the central- and local-government levels. However, the ultimate hiring and firing authority was kept in the hands of the Communist Party's Organization Department. We have little information on how the Organization Department exercised its authority. What we can do is measure the performance of these firms, which we do in the rest of section I.

I.B. State Ownership

Identifying state-owned firms is key to our analysis. A common way to identify state ownership in China is through the firm's legal registration. Specifically, firms in China are legally registered as state-owned, collectively owned, privately owned, limited-liability corporations, shareholding firms (including publicly traded), or foreign firms. In this system of classification, state ownership is typically defined as being legally registered as state-owned.

There are two problems with using a firm's legal registration to identify ownership, particularly for state-owned firms. First, many firms that are ultimately state-owned are legally registered as foreign firms. This can happen because firms in which at least a third of the ownership is foreign-held can be registered as foreign firms. For example, the joint ventures of the Shanghai local government with GM and Volkswagen (Shanghai-GM and Shanghai-Volkswagen) are registered as foreign firms. This can also happen when the firm is owned by a holding company registered outside of mainland China. For example, Lenovo and China National Offshore Oil Corporation (CNOOC) (a state-owned oil company) are owned by holding companies registered in Hong Kong and, thus, legally registered as foreign firms in China.

Second, many state-owned firms, particularly since 1998, are registered as limited-liability or publicly traded companies, albeit with the controlling stake held by a state-controlled holding company. The Baoshan Steel Company and SAIC Group's stand-alone car company (SAIC Motor Co., Ltd.) are examples of publicly listed companies and thus are registered as share-holding companies. However, for both companies a controlling stake is held by a holding company owned by the Chinese state (the central

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

government in the case of Baoshan and the local Shanghai government in the case of SAIC).

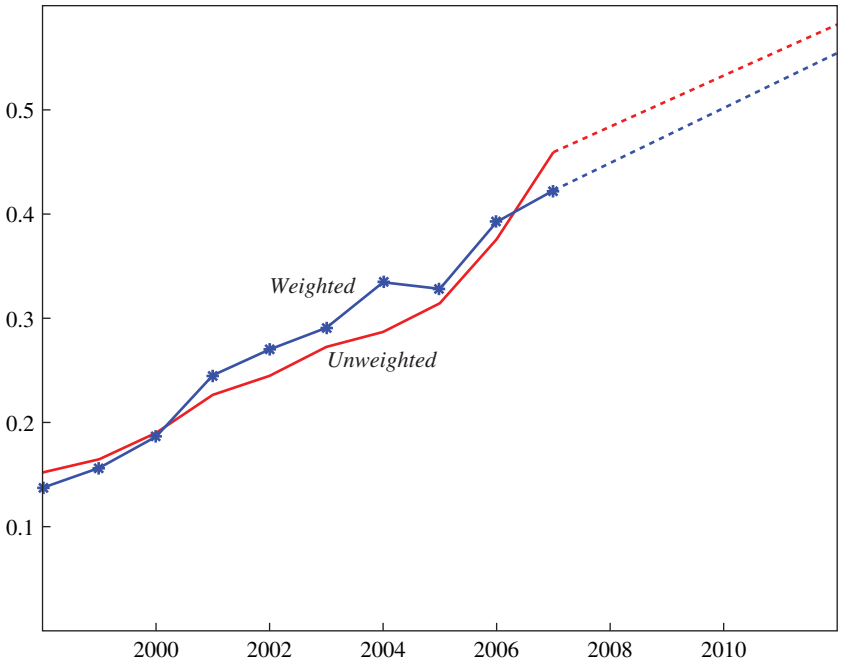
Instead of using the firm's legal registration to identify state ownership, we use another approach. First, our data provide the shares of the firm's registered capital that are owned by the state, by a collective, by "private persons," by foreigners, and by "legal persons." Here, a legal person can be another firm or a holding company. For example, publicly traded state-owned firms such as Baoshan and SAIC typically have a minority share of their registered capital held by private persons (the publicly traded share) and a majority share held by a legal person (the state-owned parent holding company). Our data do not provide additional information on the identity of such legal persons, but the share of the registered capital owned by legal persons in the Chinese industrial sector has increased since 1998, particularly among large firms.[9] Second, our data provide information on the firm's controlling shareholder. In particular, they classify the controlling shareholder of the firm as either the state, a collective, a foreigner, or a private person.

We use these two variables to define state-owned firms. Specifically, we define a firm as state-owned when the share of registered capital held directly by the state exceeds or equals 50 percent or when the state is reported as the controlling shareholder. The former definition captures traditional state-owned firms when the state owns all or the majority of the firm's registered capital. The latter definition captures publicly traded firms when the state holds a controlling stake through a holding company, but excludes firms when the state may hold a minority share through a holding company.

We supplemented this definition of state ownership by manually checking the websites of all the industrial firms in the top one percentile of the firm-value-added distribution in 2007. We find that virtually all the firms that we identified as state-owned through this laborious procedure are also coded as state-owned using our definition. Interestingly, our forensic analysis indicates that of firms in the top one percentile, more than two-thirds are directly or indirectly controlled by SASAC, but almost half of these firms are legally registered as private firms. Our procedure might understate the state share if some companies do not publicly reveal the state's ownership stake on their websites. On the other hand, we might overstate the state

9. Among the firms that survived from 1998 through 2007, the legal person registered capital share was above 10 percent for 22 percent of them in 1998 and for 30 percent of them by 2007. Among the large firms with the initial value added in the top decile, the shares were 27 and 43 percent in 1998 and 2007, respectively.

Figure 2. Share of State-Controlled Firms Registered as Private Firms, 1998–2012



Source: Authors' calculations, based on microdata from China's Industrial Survey.

share if some SASAC firms are ultimately privately owned but use SASAC to mask their ownership stake. For example, the *Sydney Morning Herald* reported in 2011 that a large shadow bank in Chongqing (Chongqing International Trust) legally owned by the local government of Chongqing was in fact privately owned by an associate of the Party Secretary of Chongqing at the time.[10]

The top panel of figure 1 shows that the revenue share of state-owned firms, by our definition, is similar to that reported by the *China Statistical Yearbook.* The figure also shows that using the firm's legal registration to define state ownership would understate the size of the state sector. Figure 2 plots the number of state-owned firms that are registered as private firms as a share of the number of firms we define as state-owned. In 1998, approximately 15 percent of state-owned firms were registered as private firms. By

10. John Garnaut, "Bo Can Do! One Man Does His Bit to Be the Great Will of China," *Sydney Morning Herald,* August 7, 2011.

Table 1. Firms and Employment by Ownership, 1998–2007[a]

	No. of firms	*Employment*
State-owned in 1998		
Exit by 2007	38.1	15,077
State-owned in 2007	7.6	12,679
Private in 2007	5.0	3,196
Private in 1998		
Exit by 2007	58.2	11,871
Private in 2007	28.1	8,422
State-owned in 2007		
Entrant	4.2	2,475
State-owned in 1998	7.6	9,308
Private in 2007		
Entrant	199.4	30,767
State-owned in 1998	5.0	2,512
Private in 1998	28.1	11,549

Source: Authors' calculations, based on microdata from China's Industrial Survey.
a. Number of firms and employment is in thousands. Entrants in 2007 are the firms established between 1999 and 2007 (inclusive).

2007, almost half of the state-owned firms were registered as some form of privately owned firm. Among state-owned firms registered as private firms in 2007, approximately 60 percent were registered as limited-liability corporations, 16 percent were publicly traded companies, and 18 percent were registered as foreign firms.[11] This share has continued to rise since 2007; by 2012 almost 60 percent of the state controlled firms were registered as nonstate firms.

Table 1 presents the number and total employment of the firms in our sample in 1998 and 2007. Table 2 presents similar statistics for the sample in 2007 and 2012.[12]

I.C. Size, Labor, and Capital Productivity

We use firms' registration ID provided in the data to match firms over time. The registration ID may change when a firm is restructured or acquired

11. See the online appendix for details. Online appendixes to all papers in this volume may be found at the *Brookings Papers* web page, www.brookings.edu/bpea, under "Past Editions."

12. One issue with the data is that because of the size thresholds for inclusion in the sample, some firms that are not in the sample in a given year show up in the data in later years. In table 1, we restrict the 2007 data to firms that were either born after 1998 or that were present in the data in 1998. Similarly, in table 2, we restrict the 2012 sample to firms that were born after 2007 or were present in the data in 2007.

Table 2. Firms and Employment by Ownership, 2007–12

	No. of firms	*Employment*
State-owned in 2007		
Exit by 2012	9.2	4,591
State-owned in 2012	8.7	11,437
Private in 2012	1.4	759
Private in 2007		
Exit by 2012	158.9	20,822
Private in 2012	138.9	36,886
State-owned in 2012		
Entrant	2.7	1,189
State-owned in 2007	8.7	10,524
Private in 2012		
Entrant	70.1	15,052
State-owned in 2007	1.4	806
Private in 2007	138.9	50,937

Source: Authors' calculations, based on microdata from China's Industrial Survey.

by another firm. For the sample of firms that we cannot match over time with the registration ID, we also use the firms' names, addresses, and phone numbers to identify surviving firms that changed their registration ID.[13] About 95 percent of the panel is identified by the registration ID, while the remainder are matched by firm name, address, and phone number.

The other variables from the 1998–2007 data that we use are value added, employment, and the book value of the firm's capital stock net of depreciation. We define the real capital stock at time t as

$$K_t = (1 - \delta) K_{t-1} + \frac{BK_t - BK_{t-1}}{P_t^K},$$

where BK is the book value of capital and P^K is the price of capital.[14] Labor input is measured by employment, since our data do not include the composition of the firms' labor force. However, as a robustness check we use

13. We follow the procedure used by Brandt, Van Biesebroeck, and Zhang (2012).

14. We use Perkins and Rawski's (2008) estimates of the price of capital. The initial book value of capital stock is initial book value reported by the firm for firms established after 1998. For firms founded before 1998, we assume that the book value in 1998 is given by $BK_{t_0} = BK_{t_1}/(1 + g)^{t_1 - t_0}$, where BK_{t_0} is the projected initial book value of the capital stock in year t_0; BK_{t_1} is the book value of capital stock when the firm first appears in the data set in year t_1; and g is the average growth rate of the capital stock in the period we observe in the data after year t_1.

Table 3. Annual Exit Rate, 1991–2012
Percent

	1991–95	*1998–2007*	*2007–12*
State-owned[a]	0.9	13.2	15.8
Private	13.2	12.0	13.8

Source: The exit rates from 1998 to 2007 and from 2007 to 2012 are computed from China's Industrial Survey. The exit rate from 1991 to 1995 is computed from the 1996 *China Statistical Yearbook* and the microdata of the 1995 Industrial Census.

a. State-owned firms that were privatized are not considered exiting firms.

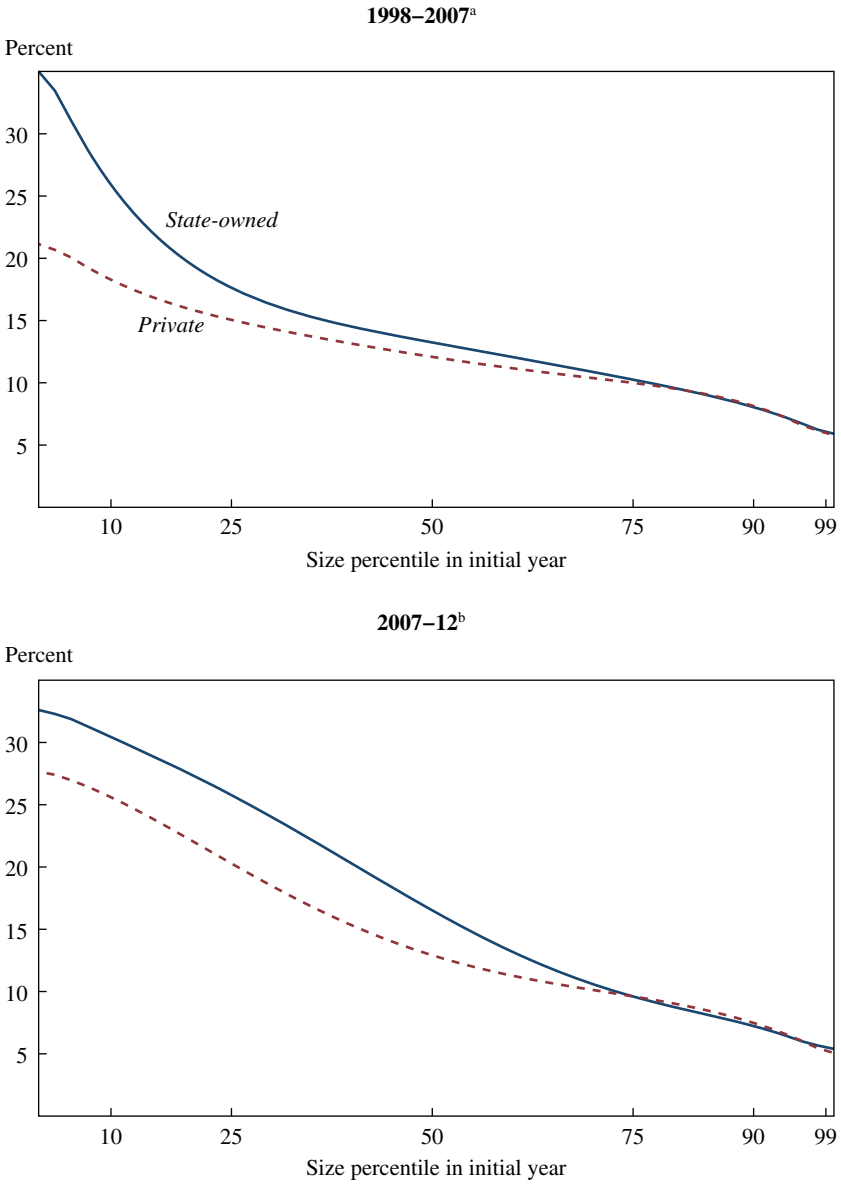
the firm-level records of the 2004 Economic Census (which has information on the educational composition of firms' labor force) to measure differences in labor quality across firms. The 2012 data do not have the value added or the net book value of the capital stock. In the 2007–12 panel, we use revenues instead of value added and the gross book value of the capital stock instead of the real capital stock.

To control for industry effects, all the firm-level variables we present are, unless otherwise stated, scaled by the median values of surviving private firms in the same two-digit industry.

EXITERS Table 3 presents the average annual exit rate for state-owned and privately owned firms for the 1991–95, 1998–2007, and 2007–12 time periods.[15] The average exit rate for state-owned firms was under one percent a year from 1991 to 1995 and increased to approximately 13 and 16 percent a year in 1998–2007 and 2007–12, respectively. Among private firms, the exit rate was roughly similar across the three time periods, at about 12 to 13 percent a year. Figure 3 presents the average annual exit rate from 1998 to 2007 (top panel) and 2007 to 2012 (bottom panel) of state-owned and private firms for each size bin as defined by the firms' value added in 1998 and 2007, respectively. Exit rates of smaller state-owned firms are higher than those of comparably sized private firms. The annual exit rate from 1998 to 2007 exceeds 30 percent among state-owned firms in the bottom 10th percentile of the size distribution, about 10 percentage points higher than comparably sized private firms over the same time period. Exit rates for small state-owned firms from 2007 to 2012 are also

15. The exit rates from 1998 to 2007 and from 2007 to 2012 are computed from the Industrial Survey. The exit rate from 1991 to 1995 is computed from the 1996 *China Statistical Yearbook* and the microdata of the 1995 Industrial Census. State-owned firms that were privatized are not considered exiting firms. See the online appendix for additional details.

Figure 3. Annual Exit Rate, 1998–2007 and 2007–12



Source: Authors' calculations, based on microdata from China's Industrial Survey.
a. Based on ownership in 1998; size is value added in 1998.
b. Based on ownership in 2007; size is value added in 2007.

Table 4. Firm Characteristics by Ownership, 1998[a]
(Weighted mean relative to surviving private firms)

	Value-added[b]	*Value-added/worker*[c]	*Value-added/capital*[d]
State-owned in 1998			
Exit by 2007	–0.830	–1.155	–1.250
	(0.013)	(0.009)	(0.011)
Privatized by 2007	0.288	–0.536	–0.870
	(0.021)	(0.015)	(0.018)
State-owned in 2007	1.128	–0.518	–1.060
	(0.017)	(0.012)	(0.014)
Private in 1998			
Exit by 2007	–0.578	–0.191	0.107
	(0.012)	(0.009)	(0.010)

Source: Authors' calculations, based on microdata from China's Industrial Survey.
a. The reference group in each column is private firms in 1998 that survived until 2007. All observations are weighted by employment. Standard errors are in parentheses.
b. Value added is log value added,
c. Value added/worker is log value added per worker.
d. Value added/capital is log value added per unit of capital.

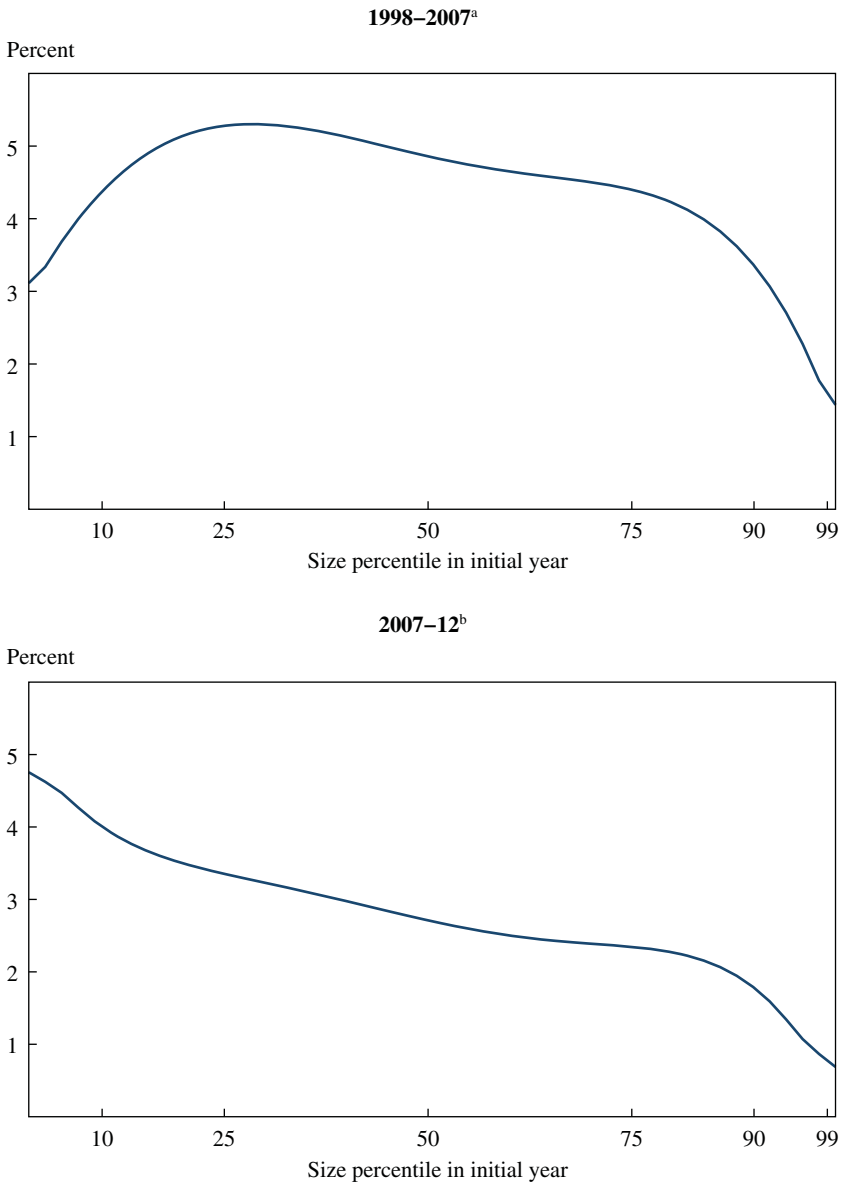
higher than those of comparably sized private firms over the same period, but the difference is not as large as in the earlier period (1998 to 2007).

Table 4 quantifies the characteristics of state-owned firms in 1998 (relative to private firms that survived until 2007). Comparing the first row (exiting state-owned firms) with the third row (surviving state-owned firms), we can see that value added, labor productivity, and capital productivity are generally lower among exiting state-owned firms than among surviving state-owned firms. These patterns are roughly consistent with the goal implicit in the slogan "Let Go of the Small," although the implementation seems far from perfect. Many small state-owned firms were not closed and some large state-owned firms were closed.

SURVIVORS We now turn to the balanced panel of firms between 1998 and 2007 and between 2007 and 2012. We focus on three groups of surviving firms in the two balanced panels: state-owned, privatized state-owned, and private firms.

We begin with the balanced panel of firms between 1998 and 2007. Figure 4 plots the fraction of the state-owned firms that were privatized over the two time periods. Specifically, figure 4 plots the annual average over each time period of the fraction of state-owned firms that were privatized from 1998 to 2007 (top panel) and from 2007 to 2012 (bottom panel) in bins defined by percentiles of the firms' value added in 1998 (top panel) and

Figure 4. Annual Privatization Rate of State-Owned Firms, 1998–2007 and 2007–12



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Number of state-owned firms in 1998 that were private in 2007 relative to the number of state-owned firms in 1998 that survived until 2007 (including state-owned firms in 1998 that were privatized by 2007) divided by nine (number of years between 1998 and 2007). Size is value added in 1998.

b. Number of state-owned firms in 2007 that were private in 2012 relative to the number of state-owned firms in 2007 that survived until 2012 divided by five (number of years between 2007 and 2012). Size is value added in 2007.

2007 (bottom panel). From 1998 to 2007, there is an inverse U-shaped relationship between the probability of privatization and the initial size of the state-owned firms in 1998. Although the goal was that small state-owned firms were to be closed or privatized ("let go"), many of the smallest state-owned firms were kept under state control. From 1998 to 2007, only 30 to 35 percent of the surviving state-owned firms in the bottom decile of the size distribution were privatized. The privatization rate is highest among midsized state-owned firms and lowest among the largest state-owned firms, which is consistent with the officially stated goal that large firms were to be kept under state control ("grasped" by the Chinese state). But again, implementation was highly imperfect, as many small state-owned firms were not privatized or closed.

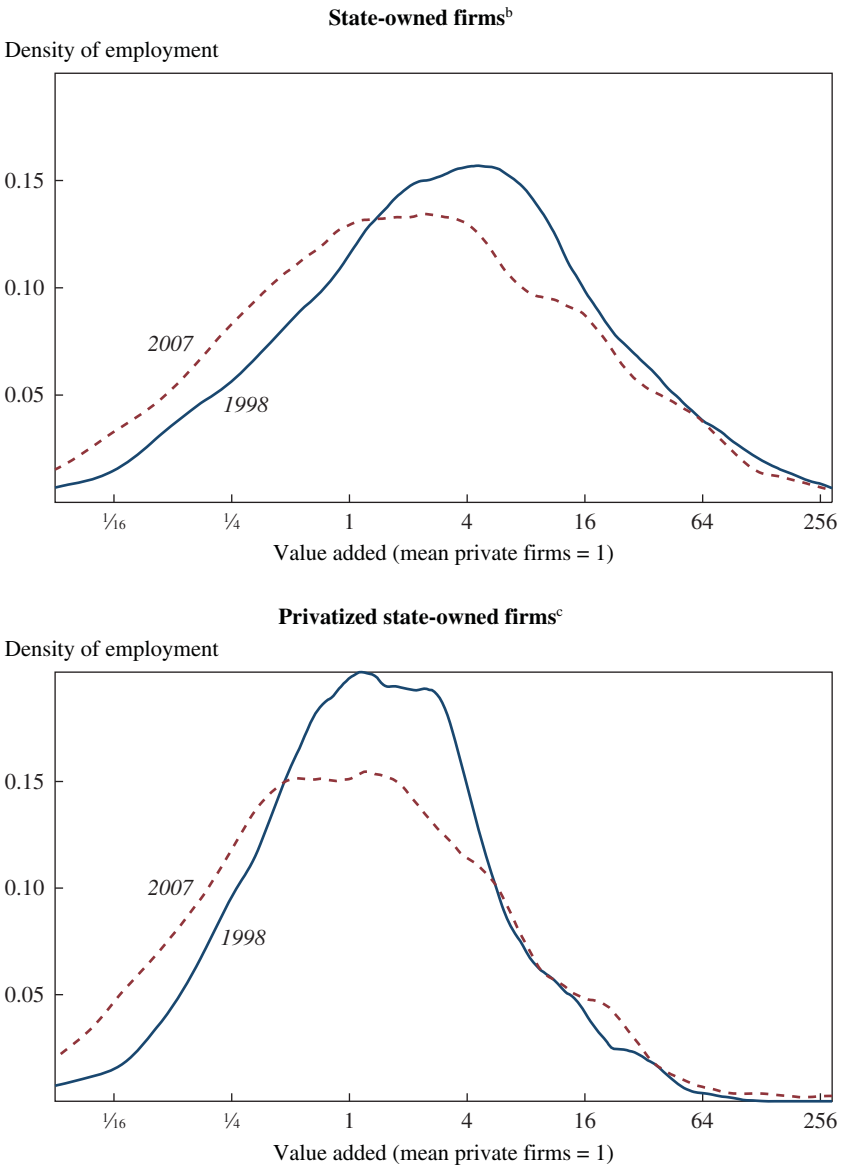
The pattern of privatization from 2007 to 2012 is different in two respects. First, the overall privatization rate is lower than from 1998 to 2007. Second, there is no longer the inverse U shape seen in the earlier period. The probability of privatization after 2007 strictly decreases according to the initial size of the state-owned firms in 2007.

Figure 5 presents the distribution of employment by value added among state-owned (top panel) and privatized firms (bottom panel) in 1998 and 2007. The size distribution of state-owned and privatized firms shifted slightly to the left from 1998 to 2007, relative to the value added of private firms in each year. Furthermore, the change in size distribution is similar for state-owned and privatized firms.

Figure 6 plots the corresponding distribution of employment by labor productivity (value added/employment) in 1998 and 2007. The figure shows that the labor productivity of the two groups of state-owned firms was significantly lower than that of private firms in 1998. The difference in 1998 was about 40 percent (table 4). By 2007, the gap in labor productivity had narrowed significantly, about equally for firms that remained under state control and those that were privatized by 2007. Table 4 quantifies the characteristics of state owned firms in 2007 relative to incumbent private firms (firms that were also in operation in 1998). The difference in labor productivity between the two groups of firms narrowed between 1998 and 2007, rising from about 60 percent of the labor productivity of private firms in 1998 to 75 percent in 2007.

Figure 7 plots the distribution of capital productivity (value added/capital). The capital productivity of state-owned firms is also significantly lower than that of private firms in 1998. Table 4 indicates that the average capital productivity of state-owned firms was about 35 percent of that of private firms in 1998. By 2007, the gap in capital productivity had

Figure 5. Value Added of State-Owned and Privatized Firms, 1998 and 2007[a]



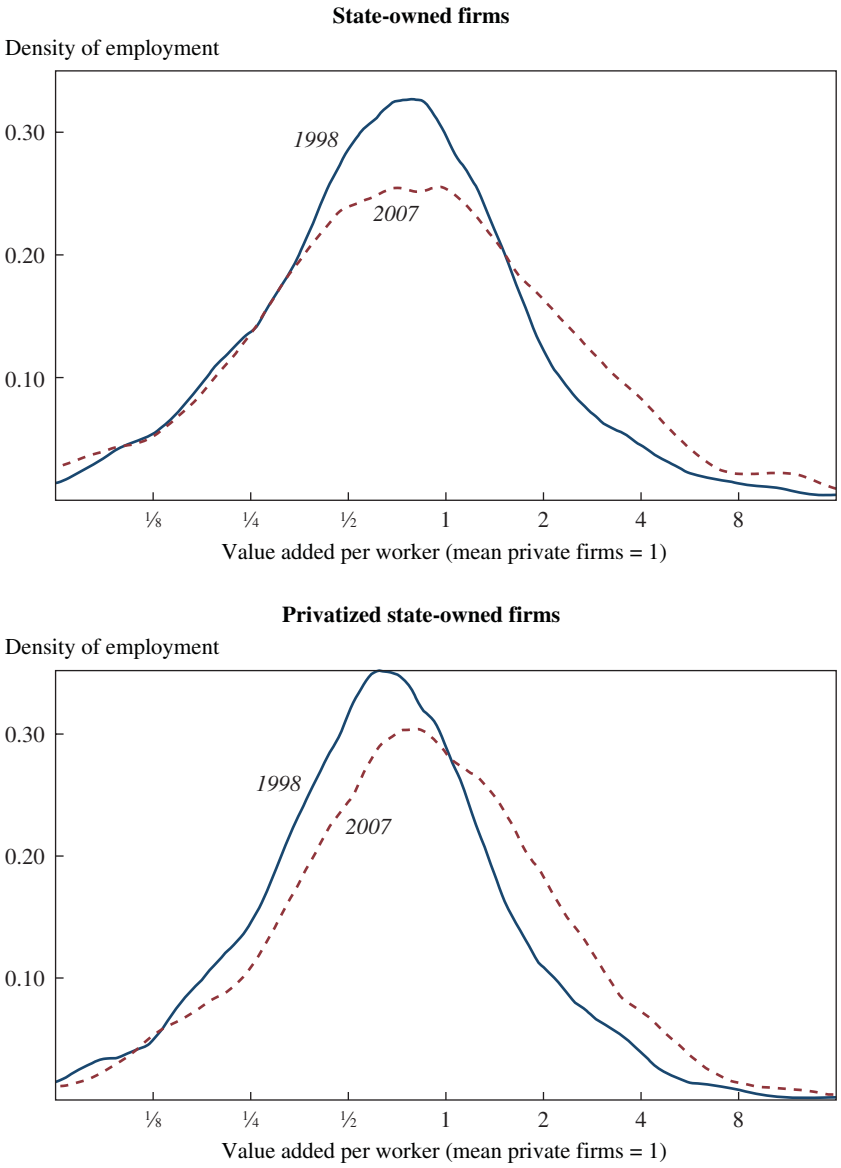
Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is the balanced panel from 1998 to 2007. Size is measured by firm value added normalized by mean of value added of private firms in each year. Observation for each firm is weighted by employment.

b. State-owned firms are state-owned in 1998 and 2007.

c. Privatized firms are state-owned in 1998 and privately owned in 2007.

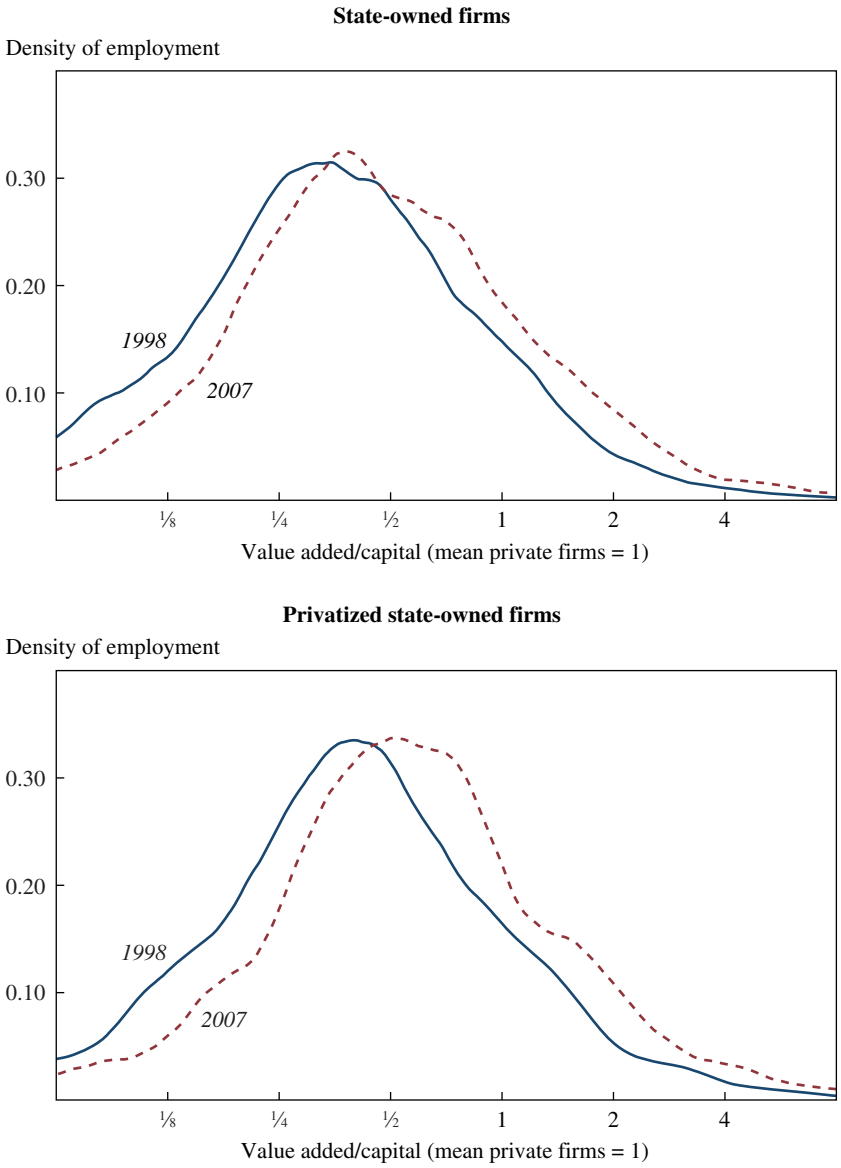
Figure 6. Labor Productivity of State-Owned and Privatized Firms, 1998 and 2007[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is the balanced panel from 1998 to 2007. Labor productivity is normalized by employment weighted mean of labor productivity of surviving private firms in each year. Observation for each firm is weighted by firm employment. See figure 5 notes for definition of state-owned and privatized state-owned firms.

Figure 7. Capital Productivity of State-Owned and Privatized Firms, 1998 and 2007[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is the balanced panel from 1998 to 2007. Labor productivity is normalized by employment weighted mean of labor productivity of surviving private firms in each year. Observation for each firm is weighted by firm employment. See figure 5 notes for definition of state-owned and privatized state-owned firms.

Table 5. Firm Characteristics by Ownership, 2007[a]
(Weighted mean relative to surviving private firms)

	Value added[b]	*Value added/worker*[c]	*Value added/capital*[d]
State-owned in 2007			
Entrant	0.526	0.107	–0.282
	(0.022)	(0.015)	(0.016)
State-owned in 1998	0.812	–0.322	–0.751
	(0.015)	(0.010)	(0.012)
Private in 2007			
Entrant	–1.035	–0.065	0.460
	(0.009)	(0.006)	(0.007)
State-owned in 1998	–0.003	–0.278	–0.557
	(0.020)	(0.013)	(0.015)

Source: Authors' calculations, based on microdata from China's Industrial Survey.
a. The reference group is surviving private firms in 2007 (that also existed in 1998). All observations are weighted by employment. Entrants are firms established after 1998. Standard errors are in parentheses.
b. Value added is log value added.
c. Value added/worker is log value added per worker.
d. Value added/capital is log value added per unit of capital.

narrowed slightly: capital productivity of state-owned firms was then about 47 percent of that of private firms (table 5). And, perhaps surprisingly, there was still a significant gap in capital productivity between privatized and private firms in 2007.

The fact that the size distribution of state-owned and privatized firms shifted to the left suggests that the effects may have been different for small compared with large state-owned firms. When we look explicitly at growth rates for firms of different sizes (based on their size in 1998), we find that state-owned firms that were small (large) in 1998 grew at a slower (faster) rate compared to private firms with the same initial size. The heterogeneity across the size distribution carries over when we look at relative labor productivity growth but is less pronounced for the relative capital productivity growth. This evidence suggests that despite the government's goal of converting surviving state-owned firms into profit-maximizing firms, among those that remained under state control this may have only happened among the larger state-owned firms.

We end this section by showing the changes in revenues, labor productivity, and capital productivity among state-owned firms operating in 2007 and in 2012. The main limitation is that the 2012 data do not include firm value added or the net book value of the capital stock. In the absence of these data, we measure firm size by revenues, labor productivity as the ratio of revenues to employment, and capital productivity as the ratio of revenues

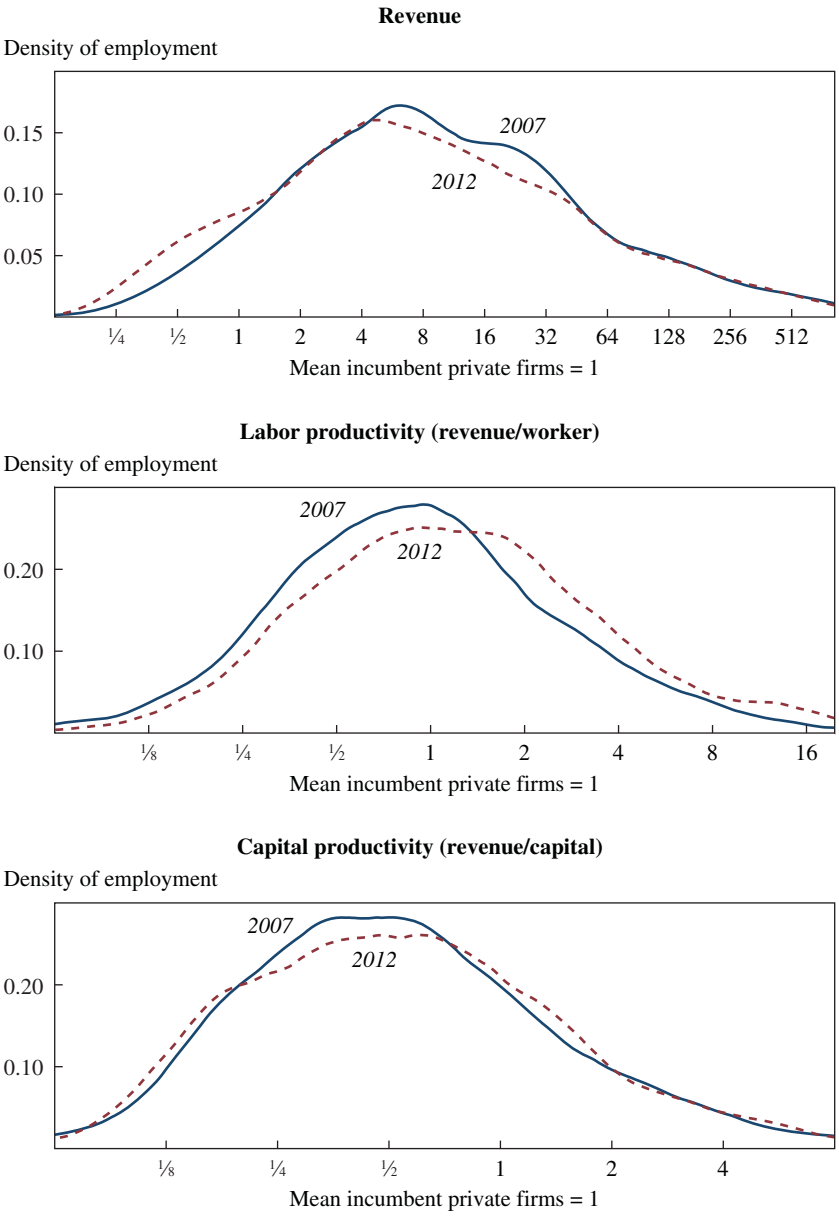
to the gross book value of the capital stock. We present the distribution of revenues, labor productivity, and capital productivity of state-owned firms in 2007 and 2012 in figure 8 (normalized by the relevant statistic of incumbent private firms). To be clear, the sample is the balanced panel of firms that were operating and state-owned during those two years. As can be seen in the top panel, relative size of incumbent state-owned firms was roughly the same in 2012 compared to 2007. The middle panel shows that average labor productivity of the state-owned firms continued to increase from 2007 to 2012 relative to incumbent private firms, albeit at a lower rate than in the 1998 to 2007 period. Finally, the bottom panel shows that there is little convergence in capital productivity after 2007.

ENTRANTS We now turn to entrants. In the 1998–2007 panel, entrants are defined as firms created after 1998. Table 1 indicates that such entrants account for about a third of the state-owned firms in 2007. In terms of employment, state-owned entrants account for more than 20 percent of total employment of state-owned firms in 2007. Figure 9 plots the distribution of value added (top panel), labor productivity (middle panel), and capital productivity (bottom panel) of state-owned entrants and private entrants. As before, we normalize by the corresponding statistic for surviving private firms. The top panel shows that new state-owned firms are significantly larger than new private firms. The middle panel shows that the labor productivity of new state-owned firms and new private firms is about the same as that of surviving private firms. The bottom panel shows that the capital productivity of new state-owned firms is lower than that of surviving private firms, while the capital productivity of new private firms is about the same.

Table 2 indicates that state-owned entrants in 2012 (defined as state-owned firms created after 2007) account for about 10 percent of employment among state-owned firms in 2012. On an annualized basis, the entry rate of state-owned firms is only slightly lower in 2007–12 compared to the entry rate in 1998–2007.[16] Figure 10 plots the distribution of revenues (top panel), labor productivity (middle panel), and capital productivity (bottom panel) of new state-owned firms and private firms in 2012. As in 2007, the labor productivity of new state-owned firms is about the same as in new private firms and capital productivity is lower in new state-owned firms. What is different is that new state-owned firms are now much bigger relative to new private firms (compared to 2007).

16. 10 percent over 5 years = 2 percent per year in 2007–12, whereas 21 percent over 9 years = 2.3 percent per year in 1998–2007.

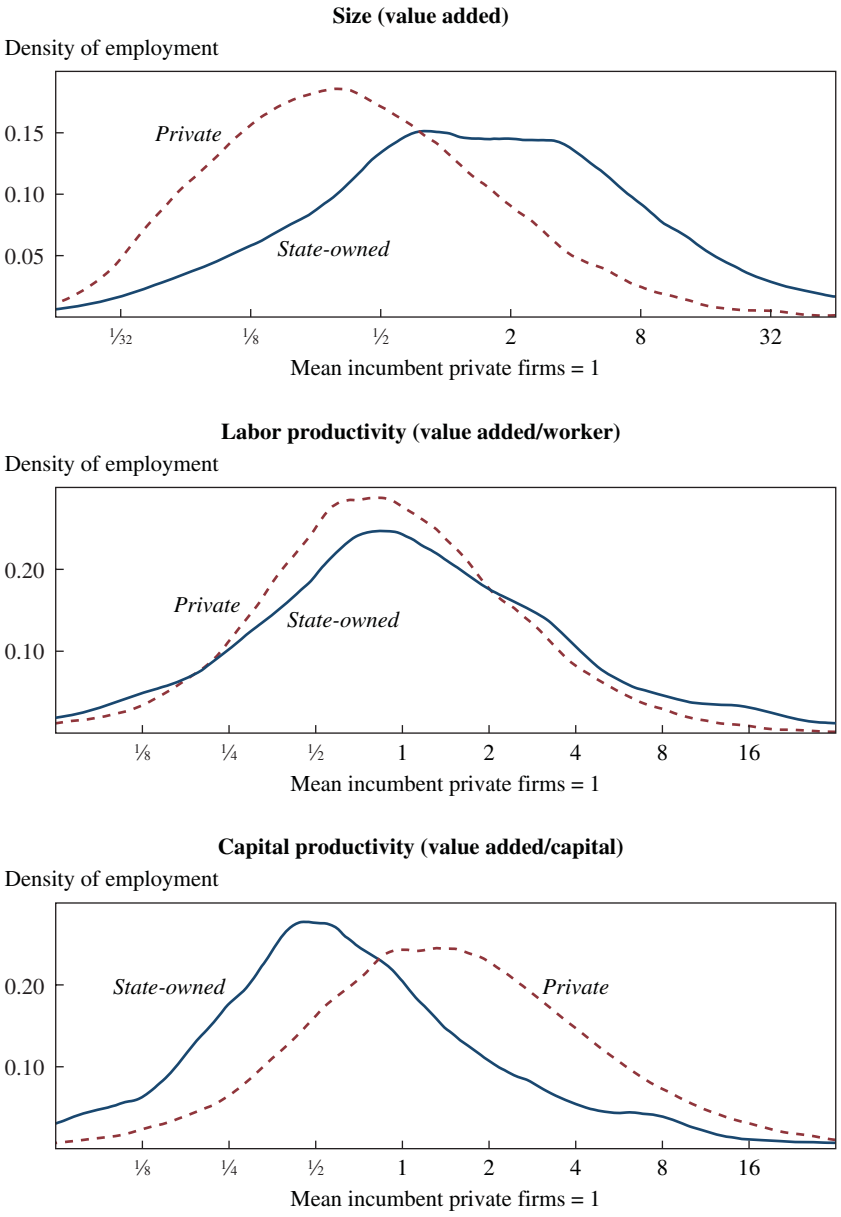
Figure 8. Size and Productivity of State-Owned Firms, 2007 and 2012[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is firms in 2007 established after 1998. Observations are weighted by employment and normalized by weighted mean of incumbent private firms in 2007.

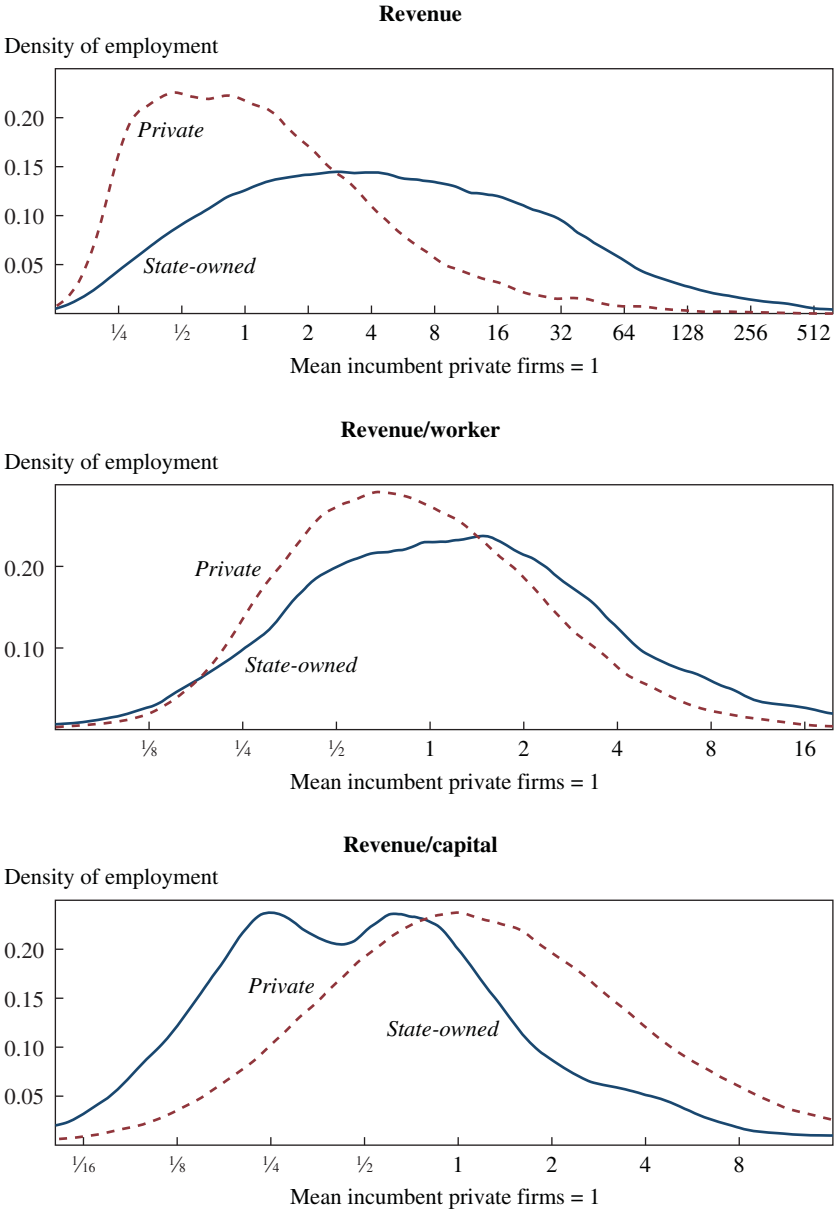
Figure 9. Size and Productivity of Entrants in 2007[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is the balanced panel of state-owned firms from 2007 to 2012. Observation for each firm is weighted by employment and normalized by weighted mean of surviving private firms in each year. State-owned firms are state-owned in 2007 and 2012.

Figure 10. Size and Productivity of Entrants in 2012[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is firms in 2012 established after 2007. Observations are weighted by employment and normalized by weighted mean of surviving private firms in 2012.

I.D. Main Facts

The main facts may be summarized as follows.

Exit rates: Exit rates increased after 1998 among state-owned firms, particularly for small state-owned firms.

Privatization: Large state-owned firms were kept mostly under state control, but the smallest state-owned firms that survived were also kept under state ownership. Midsized state-owned firms were the most likely to be privatized from 1998 to 2007. After 2007, privatization rates declined on average but increased for small state-owned firms.

State-owned vs. privatized firms: The performance of the average state-owned firm is similar to that of the average privatized firm. For both groups of firms, from 1998 to 2007, the labor productivity gap with surviving private firms narrowed significantly and the capital productivity gap narrowed by much less. Capital productivity was still less than 50 percent of that of private firms. The growth of labor productivity of state-owned firms relative to that of private firms slowed down after 2007. There was little convergence in capital productivity from 2007 to 2012.

Small vs. large state-owned firms: The labor productivity gap with surviving private firms narrowed significantly between 1998 and 2007 for large state-owned firms and widened for small state-owned firms.

New state-owned firms: Many new state-owned firms were established after 1998. New state-owned firms are larger, have the same labor productivity, and have lower capital productivity compared to new private firms.

II. A Model-Based Accounting Framework

This section presents a standard model of heterogeneous firms with monopolistic competition. We use this framework to quantify the effect of the different forces behind China's growth. Aggregate output is a constant-elasticity-of-substitution (CES) aggregate of the output of individual firms,

$$Q = \left(\sum_{i}^{N} Q_i^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{1}$$

Here, i indexes the firm; N is the number of firms; Q_i is firm output; and $1/\eta > 1$ is the elasticity of substitution between varieties. Firm output is given by

$$Q_i = A_i K_i^{\alpha} L_i^{1-\alpha},$$

where A_i denotes firm-specific total factor productivity (TFP).

Each firm chooses factor inputs, output, and revenue to maximize current profits

$$\pi_i = P_i Q_i - (1 + \tau_i^L) w L_i - (1 + \tau_i^K) r K_i, \tag{2}$$

where P_i is the firm-specific output price; L_i and K_i denote labor and capital inputs; w and r denote the common undistorted cost of labor and capital; and $\tau^L{}_i$ and $\tau^K{}_i$ denote firm-specific distortions to the cost of labor and capital. To be clear, we do not believe that $\tau^L{}_i$ and $\tau^K{}_i$ are necessarily explicit taxes or subsidies. Rather, they are a stand-in for a variety of departures from standard competitive markets, such as preferential access to capital for certain types of firms or political pressures to maintain employment within state-owned firms.

Profit maximization yields these standard first-order conditions:

$$MPL_i \equiv (1 - \alpha)(1 - \eta)\frac{P_i Q_i}{L_i} = (1 + \tau_i^L) w, \tag{3}$$

$$MPK_i \equiv \alpha(1 - \eta)\frac{P_i Q_i}{K_i} = (1 + \tau_i^K) r. \tag{4}$$

This says that the values of the marginal product of labor (MPL_i) and the marginal product of capital (MPK_i) are proportional to average labor productivity and capital productivity, respectively. Crucial to this result is the assumption of common markups and capital elasticities. Furthermore, marginal and average products of labor and capital are higher in firms with higher labor and capital costs, as represented by τ_i^L and τ_i^K.

Equilibrium allocations are as follows:

$$P_i Q_i \propto \left(\frac{A_i}{(1 + \tau_i^K)^{\alpha} (1 + \tau_i^L)^{1-\alpha}} \right)^{\frac{1-\eta}{\eta}}, \tag{5}$$

$$L_i \propto \frac{1}{1 + \tau_i^L} \left(\frac{A_i}{(1 + \tau_i^K)^{\alpha} (1 + \tau_i^L)^{1-\alpha}} \right)^{\frac{1-\eta}{\eta}}, \tag{6}$$

$$K_i \propto \frac{1}{1 + \tau_i^K} \left(\frac{A_i}{(1 + \tau_i^K)^{\alpha} (1 + \tau_i^L)^{1-\alpha}} \right)^{\frac{1-\eta}{\eta}}. \tag{7}$$

It is useful to combine equations 3, 4, and 5 to express firm revenue in terms of variables that can be measured in the data:

$$P_iQ_i \propto \left[\frac{A_i}{\left(\frac{P_iQ_i}{L_i}\right)^{\alpha}\left(\frac{P_iQ_i}{K_i}\right)^{1-\alpha}} \right]^{\frac{1-\eta}{\eta}}. \tag{8}$$

This says firm revenue is increasing in A_i and decreasing in average labor and capital productivity. Intuitively, the firms with high labor and capital productivity are the ones with high marginal products of labor and capital, which reduce input demand and firm size (holding A_i fixed).

Equation 3 interprets low average product of labor as reflecting low marginal product of labor. However, consider a production function that incorporates overhead labor, f_i:

$$Q_i = A_i K_i^{\alpha} (L_i - f_i)^{1-\alpha}. \tag{9}$$

Here, f_i has a straightforward interpretation for state-owned firms: It represents the redundant workers who produce zero marginal product but cannot be fired. With overhead labor, the marginal product of labor is no longer proportional to the average product of labor. We denote $\hat{\tau}_i^L$ as the distortions that affect MPL, while τ_i^L still stands for the distortions that affect labor productivity. To see the relationship between the two distortions, the first-order condition for labor can be expressed this way:

$$\frac{P_iQ_i}{L_i} \propto 1 + \tau_i^L = \left(1 - \frac{f_i}{L_i}\right)(1 + \hat{\tau}_i^L). \tag{10}$$

The gap in the average product of labor, as represented by τ_i^L, can be decomposed into two components: f_i and $\hat{\tau}_i^L$. A reduction in f_i will not affect the marginal product of labor but will increase the average product. In what follows, we will note wherever the distinction matters between the marginal-product and the overhead-cost interpretations of the average product.

To close the model, we assume labor supply is fixed (and normalized to one). In addition, we assume r is exogenous and given by the world interest

rate. We later consider an alternative where the supply of capital in China is fixed.

After we impose profit maximization and market clearing, aggregate output is

$$Y = \left(N^{\frac{\eta}{1-\eta}} A^* Z\right)^{\frac{1}{1-\alpha}}, \tag{11}$$

where

$$A^* \equiv \left(\frac{1}{N}\sum_i A_i^{\frac{1-\eta}{\eta}}\right)^{\frac{\eta}{1-\eta}},$$

$$Z \equiv \left[\sum\left(\frac{\overline{MP}}{MP_i}\right)^{\frac{1-\eta}{\eta}} Y_i^*\right]^{\frac{\eta}{1-\eta}},$$

$$Y_i^* \equiv \frac{1}{N}\left(\frac{A_i}{A^*}\right)^{\frac{1-\eta}{\eta}},$$

$$MP_i \equiv MPK_i^{\alpha} MPL_i^{1-\alpha},$$

$$\overline{MP} \equiv r^{\alpha}\,\overline{MPL}^{1-\alpha},$$

and $\overline{MPL}$ denotes the average marginal product of labor.

The first term, $N^{\frac{\eta}{1-\eta}}$, in equation 11 is the standard variety effect. More entry and less exit, all else equal, will increase aggregate output. The second term, A^*, is a harmonic mean of firm TFP and reflects the direct effect of firm TFP. The third term, Z, measures the effect of resource misallocation: more dispersed marginal products across firms, all else equal, lower the aggregate output. This term equals one when the marginal product of labor and capital is the same across firms. The exponent, $1/1-\alpha$, measures the effect of endogenous capital accumulation. If we drop the assumption that the cost of capital is exogenous and, instead, assume a fixed supply of capital, this effect would not be there and the exponent would be one.

To see the effect of entry and exit on aggregate growth between times t and $t + 1$, we group firms into those that exit after year t, those that enter between t and $t + 1$, and incumbent firms that exist during the two years, and we denote each group by these subscripts: *exit* for the exiting firms, *ent*

for the entering firms, and *inc* for the incumbent firms. The ratio of aggregate output at time $t + 1$ to aggregate output at time t is:

$$\frac{Y_{t+1}}{Y_t} = \left[\frac{N_{ent,t+1}\left(A^*_{ent,t+1} Z_{ent,t+1} \frac{\overline{MP}_{t+1}}{\overline{MP}_{ent,t+1}} \right)^{\frac{1-\eta}{\eta}} + N_{inc,t+1}\left(A^*_{inc,t+1} Z_{inc,t+1} \frac{\overline{MP}_{t+1}}{\overline{MP}_{inc,t+1}} \right)^{\frac{1-\eta}{\eta}}}{N_{exit,t}\left(A^*_{exit,t} Z_{exit,t} \frac{\overline{MP}_{t}}{\overline{MP}_{exit,t}} \right)^{\frac{1-\eta}{\eta}} + N_{inc,t}\left(A^*_{inc,t} Z_{inc,t} \frac{\overline{MP}_{t}}{\overline{MP}_{inc,t}} \right)^{\frac{1-\eta}{\eta}}} \right]^{\frac{\eta}{1-\eta}\frac{1}{1-\alpha}}, \tag{12}$$

Here, A^* is a harmonic mean of firm TFP and N the number of firms of each group (exiters, entrants, and incumbents), Z is the index of allocative efficiency within each group of firms, and $\overline{MP}$ denotes the weighted average of the marginal product of each group. We can use equation 12 to map the effect of entry and exit of state-owned firms on aggregate growth.

The effect of exit on aggregate productivity growth can be seen by adding $N_{exit}\left(A^*_{exit,} Z_{exit}\, \overline{MP}/\overline{MP}_{exit}\right)^{\frac{1-\eta}{\eta}}$ to Y_{t+1}, as if the exiters survived at $t + 1$. There are two main effects. First, exit implies a loss of varieties, and the effect on aggregate output is given by the product of the number of exiting firms N_{exit} and the productivity of the average exiting firm A^*_{exit}.

Second, exit may also affect overall allocative efficiency. The term Z_{exit} captures the allocative efficiency among exiters. The effect on the allocative efficiency between exiters and incumbents is captured by $\overline{MP}/\overline{MP}_{exit}$, which measures the gap between the marginal product among exiters and the average marginal product among all firms in the economy. If the marginal product of resources used by the exiting firm is equal to the average marginal product, then the envelope theorem applies and there is no net welfare gain from the reallocation of resources. In that case, the effect of exit on aggregate output is unambiguously negative. However, if the marginal product of exiting firms is lower than the average marginal product—when $\overline{MP}/\overline{MP}_{exit} > 1$—then the reallocation of resources from exiting firms increases MP and therefore increases aggregate output. The net effect on aggregate output depends on whether the gain from reallocation exceeds the direct effect of the loss of productive firms.

The mechanisms by which entry affects aggregate growth are similar. Here, the effect of entrants is captured by $N_{ent,t+1}\left(A^*_{ent,t+1} Z_{ent,t+1}\, \overline{MP}_{t+1}/\overline{MP}_{ent,t+1}\right)^{\frac{1-\eta}{\eta}}$. First, the direct effect of entry on aggregate growth is given by $N_{ent} A^*_{ent}$. More entry, and entry of more productive firms, increases aggregate

output. In addition, there can be general equilibrium effects on other firms depending on the gap between the marginal product of entrants relative to the average, which is captured by $\overline{MP}_{t+1}/\overline{MP}_{ent,t+1}$. When the marginal product of entrants is the same as that of other firms, the envelope theorem applies again and there is no additional effect of entry. However, when the marginal product of entrants exceeds the average—when $\overline{MP}/\overline{MP}_{ent} < 1$—the reallocation of resources toward entrants improves overall resource allocation, which increases aggregate output.

We can also use equation 12 to analyze the effect of incumbent firms on aggregate growth. The effect of incumbent firms on aggregate output growth is given by $N_{inc,t+1}\left(A^{*}_{inc,t+1}Z_{inc,t+1}\,\overline{MP}_{t+1}/\overline{MP}_{inc,t+1}\right)^{\frac{1-\eta}{\eta}}$. For instance, privatization of state-owned firms may improve firm TFP, and the effect on aggregate output is given by

$$\frac{\partial Y}{\partial A_i} = \frac{1}{1-\alpha}\left[\underbrace{\frac{Y_i}{A_i}}_{\text{the direct effect}} + \underbrace{\frac{1}{\eta}\frac{L_i}{A_i}\left(MPL_i - \overline{MPL}\right)}_{\text{the reallocation effect}}\right]. \tag{13}$$

The first term of equation 13 captures the effect of A_i on the productivity of the representative firm, holding the efficiency of resource allocation fixed. We think of this as the direct effect of TFP. The second term measures the effect of higher firm TFP on the efficiency of resource allocation. The reallocation effect is negative if the firm's MPL is below the average MPL, and it is positive otherwise. Intuitively, labor is reallocated to firms with higher TFP. This reallocation has no effects on allocative efficiency if the firm's marginal product of labor is the same as that of other firms. This would be the case if the average product of labor of the firm that experiences TFP growth is the same as the average, or if the gap in the average product of labor entirely reflects overhead costs rather than differences in the marginal cost of labor. However, if the marginal product of labor in the firm is lower than the average, higher TFP increases employment in the low-marginal-product firm, which worsens the overall efficiency of resource allocation. If the gap in marginal products is sufficiently large, the negative reallocation effect can dominate the technological effect. Specifically, equation 13 can be expressed as:

$$\frac{\partial Y}{\partial A_i} = \frac{1}{1-\alpha}\frac{1}{\chi\eta}\frac{L_i}{A_i}\left(MPL_i - \chi\overline{MPL}\right), \tag{14}$$

where $\chi \equiv \frac{(1-\eta)(1-\alpha)}{1-\alpha(1-\eta)} < 1$. If $MPL_i < \chi\overline{MPL}$, an increase in the firm's TFP will lower aggregate output. Whether higher TFP increases or lowers aggregate output depends on the gap between the firm's MPL and the average marginal product (and the value of χ).

Privatization may also change the gap in the average product of capital and labor of the privatized firms (relative to the other firms). In equation 12 this is captured by the change in $\overline{MP}/\overline{MP}_{inc}$. For example, if state-owned firms had been forced to employ more workers than necessary, the average product of labor of state-owned firms could decline after they were privatized and no longer faced political constraints to keep unproductive workers on the payroll. Similarly, privatized state-owned firms might no longer have preferential access to capital, which is modeled here as a decline in τ_i^K. The effect of a change in the gap in MPL relative to the average on aggregate output is given by

$$\frac{\partial Y}{\partial \tau_i^L} = -\frac{1-\alpha}{\chi\eta}\frac{L_i}{1+\tau_i^L}\left(MPL_i - \overline{MPL}\right). \tag{15}$$

This says that a narrowing of the gap between a firm's average product of labor and the overall average product of labor always increases aggregate output. Although equation 15 assumes that the change in the average product of labor is driven by a change in marginal labor costs, the effect on aggregate output would be the same if the change in the average product of labor were driven by the elimination of redundant labor in state-owned firms. Similarly, the effect on aggregate output of a change in a given firm's MPK follows:

$$\frac{\partial Y}{\partial \tau_i^K} = -\frac{\alpha}{\chi\eta}\frac{L_i}{1+\tau_i^K}\left(MPL_i - \chi\overline{MPL}\right). \tag{16}$$

The reason this looks different from the effect of changes in MPL is the assumption that capital is available elastically at world interest rates. A decline in MPK of a firm is like a positive TFP shock, and the TFP shock can have a negative effect on aggregate output if it significantly worsens the allocation of labor.

The "corporatization" of state-owned firms could have two effects on aggregate output. First, firm TFP could increase, although the effect of an improvement in firm TFP on aggregate output is ambiguous and would

depend on whether the direct effect of higher TFP exceeded the effect of changes in resource allocation. Second, state-owned firms could increase their average product of labor by shedding surplus labor, which would unambiguously increase aggregate output.

In this paper, we use equation 12 to measure the effect on aggregate output of three forces: (i) exit and privatization of state-owned firms; (ii) "corporatization" of incumbent state-owned firms; and (iii) entry of new state-owned firms. To be sure, these three forces will only explain (in a proximate sense) a fraction of the aggregate output growth in China's industrial sector. The residual is aggregate growth driven by the private sector.

Measuring the components of this residual is beyond the scope of this paper, but equation 12 also lays out what these components might be. First, there is the effect of the entry of new private firms, an effect that is increasing in both the number and the productivity of the new private firms. Second, there is the direct effect of the productivity growth of incumbent private firms. Third, if the marginal product of private firms is higher than that of state firms, private entry and productivity growth will have the additional effect of improving the allocation of resources. Fourth and finally, private sector growth can also be driven by an improvement in the efficiency of resource allocation within private firms (such as due to an overall improvement in the efficiency of capital markets).

Finally, it is useful to compare the data-inference exercise based on equation 12 with a commonly used accounting decomposition of aggregate growth. There are many variants of this decomposition, but a common one decomposes growth in aggregate output per worker into growth due to reallocation toward firms with high output per worker and growth in output per worker within each group of firms.[17] The former is interpreted as the gain from reallocation, and the latter as firm TFP growth. Specifically, in a model where labor is the only factor of production, aggregate growth in output per worker y is given by

$$\frac{y_{t+1}}{y_t} = \frac{y_{ent,t+1}(1 - l_{t+1}) + y_{inc,t+1} l_{t+1}}{y_{exit,t}(1 - l_t) + y_{inc,t} l_t}. \tag{17}$$

As before, the subscripts *ent, exit,* and *inc* refer to entrants, exiters, and incumbents, and l refers to the employment share of incumbent firms.

17. This decomposition was first used by Baily, Hulten, and Campbell (1992). See Brandt, Van Biesebroeck, and Zhang (2012) for an application of this decomposition to productivity growth in China.

Equation 17 suggests the following inferences from the microdata. First, reallocation increases aggregate output when the employment share of high y firms increases, and it decreases aggregate output otherwise. For example, firm exit increases aggregate output only if the output per worker of exiting firms is lower than that of incumbent firms. Among incumbent firms, an increase in the employment share of private firms raises aggregate output if the output per worker of private firms is higher than that of state-owned firms. Second, the change in output per worker of a group of firms (such as incumbent firms, state-owned firms, or private firms) would be interpreted as the result of TFP growth. For example, if output per worker growth is higher among private firms compared to state-owned firms, then TFP growth must have been higher among private firms compared to state-owned firms.

The inferences based on equation 12 differ in both aspects. First, the equation also indicates that reallocation toward high y firms or sectors increases aggregate output, but for a different reason. In the equilibrium model of heterogeneous firms, such reallocation increases aggregate output by lowering the dispersion in the marginal product of resources across firms and not by increasing the employment share of high TFP firms. In fact, an increase in the employment share of high TFP firms could lower output if the marginal product of resources of high TFP firms were low. Second, we interpret an increase in y of a given group of firms as reflecting either an increase in the marginal product or as an elimination of redundant labor and not necessarily as evidence of increases in TFP.

These differences stem from the different assumptions underlying the two approaches. The accounting approach assumes that differences in y across firms reflect firm TFP and is unclear about what exactly drives differences in the employment share. Our approach assumes that differences in y only reflect differences in the marginal product of labor, while differences in TFP across firms show up as differences in the employment share.

Ultimately the validity of any approach depends on whether the assumptions are reasonable. Equation 12 is based on a specific equilibrium model of heterogeneous firms. Some of the assumptions (common factor elasticities and markups across firms, for example) may be unrealistic, but we can assess whether the results are sensitive to alternative assumptions (see Song and Wu 2014). A decomposition based on equation 17 may also provide the correct answers, but to our knowledge the precise assumptions behind this approach, such as what determines the equilibrium allocation of resources between firms and the conditions under which differences in y reflect differences in firm TFP, have never been spelled out. Understanding

the conditions under which inferences based on equation 17 are correct is an important task that we leave for future work.

III. Productivity and Distortions of State-Owned and Privatized Firms

We now interpret the facts presented in section I through the lens of the model in section II. We apply the model to each industry and then aggregate industry output into aggregate output. To capture the industry effects, we allow δ, w, and α to be industry-specific. We also assume the labor force to be fixed in an industry.[18]

We begin with the differences in labor productivity between state and private firms. According to equation 3, differences in the average product of labor reflect differences in the marginal revenue product of labor. The convergence in labor productivity from 1998 to 2007 between state-owned and private firms shown in figure 6 indicates that the marginal product of labor in state-owned firms converged to that of private firms over this time period.[19] Similarly, equation 4 indicates that the gap in the average product of capital between state-owned and privatized firms relative to private firms reflects differences in the marginal product of capital. Therefore, the evidence in figures 7 and 8 indicates that the marginal product of capital in state-owned firms was lower than that of private firms, and that much of this gap was still present in 2007 and 2012. Furthermore, there is little difference in average product of labor and capital between state-owned firms that remained under state control and those that were privatized. In particular, the marginal product of capital of the privatized firms in 2007 was almost the same as that of the state-owned firms, as if the privatized firms continued to have access to capital on the same terms as the state-owned firms. And among the new state-owned firms, figures 9 and 10 indicate the average product of labor is similar to that of private firms, but the average product of capital is substantially lower.

The fact that the average product of capital is lower among state-owned and privatized state-owned firms, and has remained low, is not surprising if the low average product of capital reflects low marginal product of capital. In turn, the low marginal product of capital may reflect preferential access

18. We can generate a fixed labor supply in an industry by assuming that aggregate output is a Cobb-Douglas aggregate of aggregate industry output.

19. See also Kamal and Lovely (2013) for the convergence of the average product of labor between state and private firms.

to capital among state-owned and privatized firms. Preferential access to capital increases the profits of firms with access. Under this interpretation, it appears that formerly state-owned firms, even after they are privatized, continue to benefit from preferential access to capital.

In contrast to the patterns in capital productivity, there is significant convergence of labor productivity between state-owned and private firms. We see this among the surviving state-owned firms, among the newly established state-owned firms, and even among the privatized state-owned firms. This finding is hard to interpret if lower labor productivity reflects a lower marginal cost of labor, but it is easy to interpret if state-owned firms had a substantial amount of redundant labor. The fact that the average product of labor is lower among state-owned firms in 1998 could be due to overstaffing in these firms.[20] The political pressure to employ redundant workers declined after 1998, as state-owned firms became corporatized and presumably were incentivized to maximize profits. In our data, employment in the surviving state-owned firms declined by 3.6 million workers from 1998 to 2007, about 40 percent of their initial employment. We do not know how many of these workers were redundant workers, but note that a decline in the number of redundant workers will show up as a decline in the average product of labor and in the labor share. Specifically, we can rewrite equation 10 as follows:

$$\underbrace{\frac{\left(1+\hat{\tau}_i^L\right) wL_i}{Y_i}}_{\text{Labor Share}} \propto \frac{1}{1-f_i/L_i}. \tag{18}$$

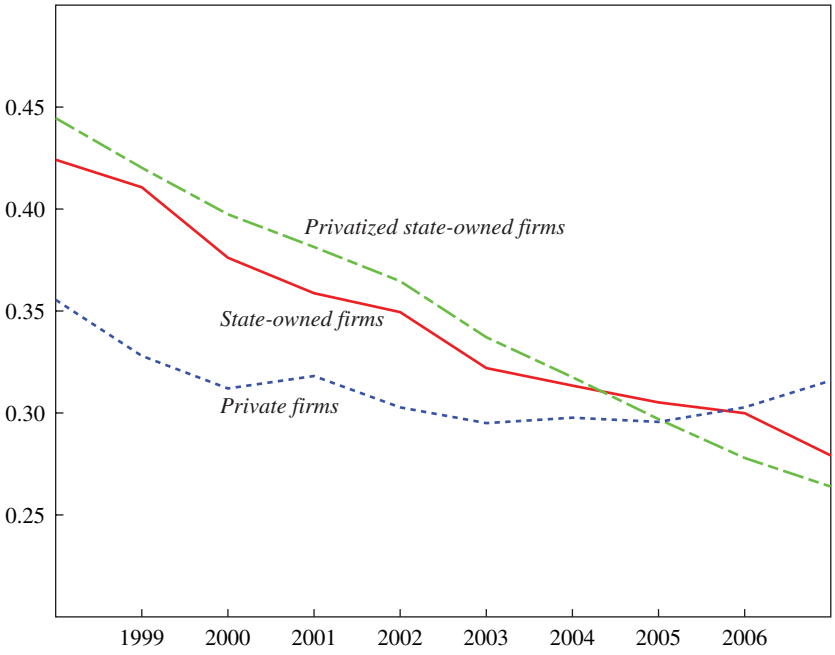
Equation 18 shows that the labor share falls when f_i/L_i falls. Figure 11 plots the average labor shares of state-owned, privatized, and private firms in the 1998–2007 balanced panel.[21]

Finally, from equation 8, firm productivity A can be measured as the residual of firm value added after controlling for the effect of the average product of capital and labor. We use the labor share of private firms in each

20. According to a survey conducted by the Chinese Academy of Social Science in 1995, the narrowly defined redundant workers—that is, those who are idle and have no definite position—accounted for more than 10 percent of total employment in about half of the state-owned firms (Dai 1996).

21. We use value added shares of an industry (averaged over 1998–2007) as the weight to aggregate labor shares. The initial labor shares of state-owned and privatized firms were considerably higher than those of private firms. Moreover, the labor shares of state-owned and privatized firms fell substantially after 1998.

Figure 11. Labor Share, 1998–2007[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

two-digit industry to measure industry-specific α where we adjust the labor share in each sector such that we match the labor share in China's industrial sector.[22] We use a baseline value of $1/\eta = 7$, corresponding to a markup of 1.17.[23] To calculate 2012 firm TFP, we convert revenues to value added by the average industry value added revenue ratios in 2004–07. Firm TFP presented below is scaled by the median TFP of surviving private firms in the same industry.[24]

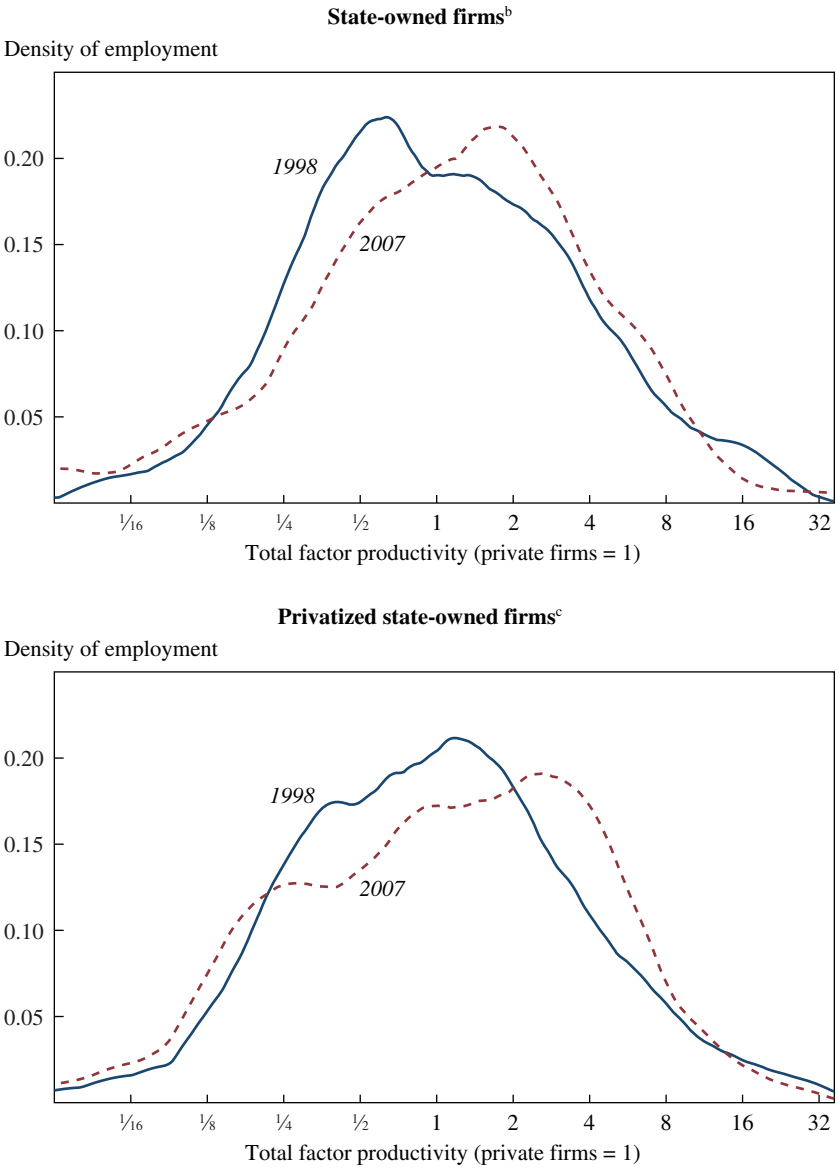
We find A of exiting state-owned firms to be about half of that of surviving state-owned firms in 1998–2007, while there are no clear differences in A across entrants with different ownership types. Figure 12 plots the

22. See the online appendix. We use the labor share of private firms because distortions may bias the labor share of state-owned firms.

23. We later show the results with different values of $1/\eta$ as well as allowing markups to differ across state-owned and private firms.

24. We drop industries that have less than ten surviving private firms. The five industries are Extraction of Petroleum and Natural Gas, Mining of Other Ores, Manufacture of Tobacco, Recycling and Disposal of Waste, and Production and Supply of Gas.

Figure 12. Total Factor Productivity in State-Owned and Privatized Firms, 1998 and 2007[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Total factor productivity is normalized by mean of surviving private firms in each year. The sample is the balanced panel from 1998 to 2007.

b. Firms that were state-owned in 1998 and 2007.

c. Privatized firms that were state-owned in 1998 and privately owned in 2007.

resulting distribution of *A* of state-owned firms (top panel) and privatized firms (bottom panel) in the balanced panel from 1998 to 2007. The top panel indicates that *A* of state-owned firms was lower than that of private firms in 1998. By 2007, the gap in *A* between state-owned firms and private firms had narrowed. Similarly, *A* of privatized firms was lower compared to private firms, but the gap had also declined by 2007. Specifically, the weighted average TFP of surviving state-owned firms relative to that of surviving private firms increased from approximately 55 to 75 percent. The relative TFP of surviving privatized firms increased from approximately 60 to 77 percent.

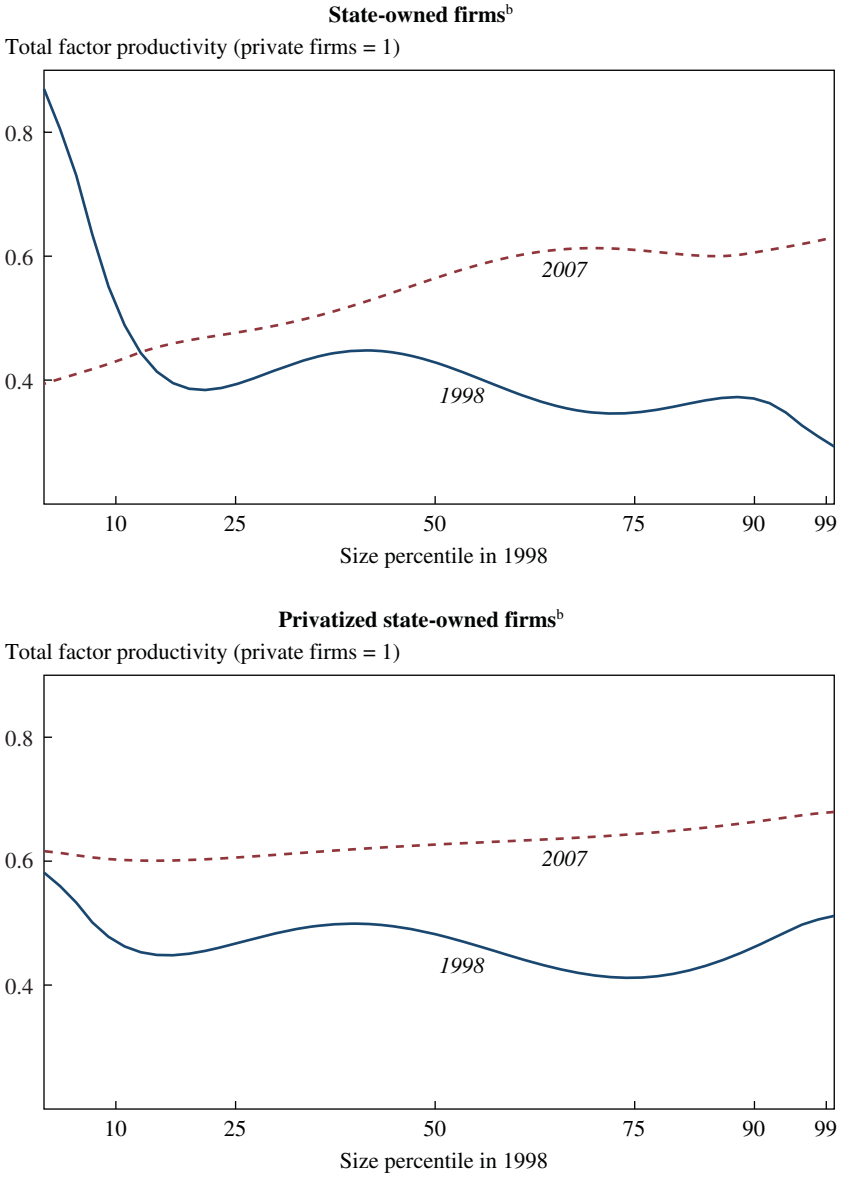
We next examine heterogeneity in the change in *A* across the size distribution. The top panel of figure 13 plots the ratio of *A* of state-owned firms relative to private firms in bins defined by the value added in 1998 (top panel). This figure indicates that *A* of state-owned firms in the top decile in firm size in 1998 was 30 to 40 percent of that of the privately owned firms of comparable size in 1998. By 2007, among the top decile of state-owned firms, *A* had increased to about 60 percent of that of the same group of private firms. For small state-owned firms, the pattern is exactly the opposite. In 1998, *A* of the smallest state-owned firms was 80 to 90 percent of that of private firms of comparable size. By 2007, *A* among state-owned firms had dropped to about 40 percent of that of the same group of private firms. The bottom panel plots the relative *A* of the privatized firms. Here, there is less heterogeneity across the size distribution. On average, *A* of privatized firms grows at faster rates than that of private firms, and this is the case throughout the size distribution. These findings are the mirror images of the facts documented in section I.C.

Finally, subject to the caveats about the limitations of the 2012 data mentioned previously, figure 14 plots the distribution of TFP in a balanced panel of state-owned firms in 2007 and 2012. As can be seen, the figure shows that TFP of state-owned firms continues to grow at a faster rate after 2007 compared to private firms.

In summary, we find high growth rates of TFP and reduction in labor distortions among state-owned and privatized firms since the late 1990s. However, the return to capital continues to be significantly lower among state-owned and privatized firms than among private firms. Large state-owned firms have particularly high growth rates in TFP relative to their private counterparts, but the opposite is true for small state-owned firms.

We end this section with three sets of robustness checks. First, we measure labor input by employment, which implicitly assumes that labor quality is the same across firms. However, the gap in labor productivity

Figure 13. TFP Growth of State-Owned and Privatized Firms Relative to Private Firms by Initial Size, 1998 and 2007[a]

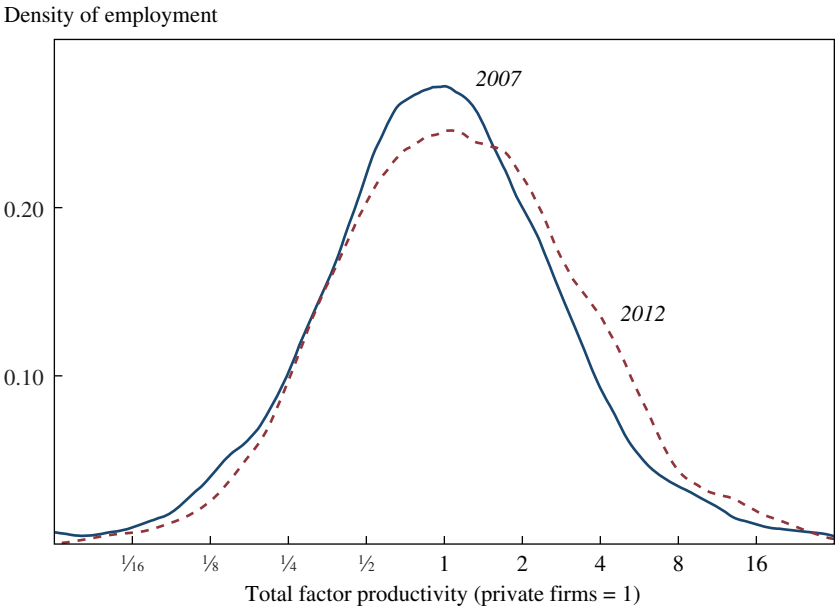


Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Sample is the balanced panel in 1998 and 2007. TFP in each percentile is normalized by median TFP of surviving private firms in the percentile in each year. Size in 1998 is defined as value added.

b. See figure 12 notes.

Figure 14. Total Factor Productivity of State-Owned Firms, 2007 and 2012[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Total factor productivity is normalized by mean of surviving private firms in each year. Sample is the balanced panel of state-owned firms from 2007 to 2012; firms identified as state-owned in 2007 and 2012.

between state and private firms shown in figure 9 may be due to differences in worker quality. To check this, we use data from the 2004 Economic Census to measure the differences in worker quality between state and private firms. The 2004 Census indicates that workers in state-owned firms have, on average, 1.3 more years of schooling than workers in private firms.[25] When we adjust for the implied gap in worker quality (using estimates of the Mincerian return to schooling), this reduces labor productivity among surviving privatized state-owned firms by about 10 percent. The convergence of labor productivity between state and private firms is not affected, though.

Second, the convergence of TFP is robust to alternative assumptions on markups. Lowering $1/\eta$ to 3 gives essentially the same relative TFP growth of surviving state-owned firms. Our calculations assume that markups are the same for all firms. We now consider the possibility that

25. The 2004 Economic Census provides data on the educational composition of employment in each firm. See the online appendix.

state-owned firms have higher markups than private firms. This has two effects on the empirical results.[26] First, although higher markups among state-owned firms change the implied levels of TFP, τ_i^L, and τ_i^K for these firms, they do not change their implied growth rates. Second, if we assume that markups among privatized state-owned firms decline after becoming privatized, then the implied growth rate of TFP among privatized firms would be higher than shown in figure 10. In addition, the implied reduction in labor and capital distortions among the privatized firms would be larger than shown in figures 6 and 7.

Finally, the evidence presented above suggests that the convergence of labor productivity between state-owned and private firms can be explained by the reduction in the number of surplus workers in the state sector (instead of an increase in the marginal product of labor in state-owned firms). Notice that with the presence of surplus labor, A_i has to be adjusted by f_i.

We consider a scenario in which (i) redundant workers exist only in the firms that are initially state-owned and have labor productivity below the average of surviving private firms in the same industry; and (ii) the labor productivity gap entirely reflects the number of redundant workers. These assumptions are rather extreme, implying massive labor redundancy that accounts for approximately 54 and 35 percent of state employment in 1998 and 2007, respectively. In this scenario, the TFP growth of state-owned firms has to be adjusted downward by falling surplus labor. In the benchmark case, the weighted average TFP of surviving state-owned firms relative to that of surviving private firms grew by approximately 36 percent from 1998 through 2007, while in the scenario adopting the above assumptions on f_i the growth would decrease to approximately 26 percent. Despite this, the TFP convergence between state and private firms would remain qualitatively unchanged.

IV. Why Have State-Owned Firms Changed?

We now turn to institutional forces that may be behind the patterns presented in the last section.

First, governance may have improved among large state-owned firms. Figure 2 shows that almost half of the state-owned firms in 2007 and nearly 60 percent of them in 2012 were legally registered as private firms. For a

26. See the online appendix for details on the model with variable markups, as well as the empirical results.

subset of these firms for which we can put together detailed ownership information, the typical form this takes is that of state-owned firms "corporatized" with a minority share traded in the stock market and merged into a large state-owned conglomerate. We do not have information on the precise ownership structure of all the firms in the data, but we do know the share of registered capital held by "legal persons." For the sample of state-owned firms for which we have ownership information, the legal person share in the data matches the equity share of the state-owned conglomerate. Figure 15 shows that the average share of registered capital held by legal persons increased dramatically among all state-owned firms after 1998.

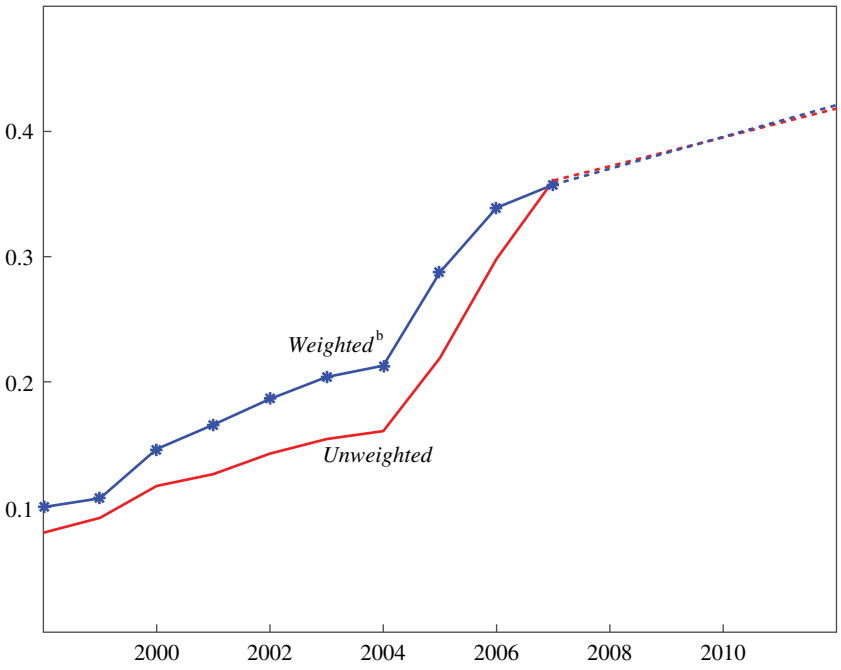
Second, there is clear evidence that state-owned firms face greater competition from private firms. Although the goal of the Chinese government was to restrict entry by private firms in the strategic or "pillar" industries, private firms have actually entered in many of the industries where the state has sought to maintain the dominance of state-owned firms.[27] Table 6 presents the value-added share for state-owned firms in nine such industries (these industries account for about half of China's industrial output) in 1998 and 2007 and the revenue share in 2007 and 2012 (remember that the 2012 data do not report value added, only revenue). Although state-owned firms have a dominant share in most of these industries, the state's share has shrunk in all sectors (except for Electric and Heat Power). Furthermore, the decline of the state share continued after 2007. The decline in the other (nonstrategic) sectors is even more dramatic: The overall value added share of state-owned firms in the industrial sector fell from approximately 55 to 34 percent from 1998 to 2007.

Table 7 examines the correlation of private-sector entry with productivity growth in the state sector across two-digit sectors. We define the private entry rate as the number of new private firms created within a single year relative to the number of all private firms in that year. The private entry rate averaged 7.6 percent in the 1998–2007 period, with a standard deviation of eight percentage points across industries. Column 1 shows that the private-sector entry rate is positively correlated with productivity growth. The effect is independent of ownership.

Third, many of the state-owned firms after 1998 were newly established. As figures 9 and 10 show, these firms were large and also enjoyed preferential access to capital. Such firms may also have provided competition to the surviving state-owned firms. The entry rate of state-owned firms after 1998

27. See the online appendix for details on "strategic" and "pillar" industries.

Figure 15. State-Owned Firms with "Legal Person" Ownership Share Greater than 50 Percent, 1998–2012[a]



Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. This figure plots the number of state-owned firms with legal person share above or equal to 50 percent as a share of the number of all state-owned firms in each year.

b. Weighted by revenue share.

Table 6. Share of State-Owned Firms in Strategic Sectors

Percent

	Value-added share		*Revenue share*	
	1998	*2007*	*2007*	*2012*
Mining of coal	82	66	66	61
Extraction of petroleum	100	97	98	91
Processing of petroleum	88	63	75	70
Chemical	51	24	27	20
Ferrous metals	79	46	45	37
Nonferrous metals	54	34	34	36
Transport equipment	65	49	51	44
Communication equipment	42	8	6	9
Electric and heat power	86	88	91	93

Source: Authors' calculations, based on microdata from China's Industrial Survey.

Table 7. Total Factor Productivity Growth and Market Entry, 1998 to 2007[a]

	(1)	*(2)*	*(3)*
Dependent variable = Total factor productivity growth, state-owned firms[b]			
Private entry rate[c]	0.737		
	(0.251)		
State entry rate[d]		3.613	
		(1.019)	
Δ State Herfindahl[e]			–0.160
			(0.0711)
R^2	0.213	0.282	0.137
Dependent variable = Total factor productivity growth, privatized firms[f]			
Private entry rate	0.874		
	(0.236)		
State entry rate		3.419	
		(0.947)	
Δ State Herfindahl			–0.183
			(0.0671)
R^2	0.307	0.296	0.189
Dependent variable = Total factor productivity growth, private firms[g]			
Private entry rate	1.284		
	(0.337)		
State entry rate		1.587	
		(1.707)	
Δ State Herfindahl			–0.0266
			(0.110)
R^2	0.312	0.026	0.002

Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. Dependent variables are average annual TFP growth rates of median firms of each type in the balanced panel from 1998 to 2007. Each observation is a two-digit industry (N=34). Standard errors clustered by industry in parentheses.

b. State-owned firms are state-owned in 1998 and 2007.

c. Number of new private firms/total private firms in each year.

d. Number of new state-owned firms/total state-owned firms in each year.

e. Δ State Herfindahl is the average change in the Herfindahl index for state-owned firms in the balanced panel.

f. Firms that were stated-owned in 1998 and privately owned in 2007.

g. Firms that were privately owned in both 1998 and 2007.

is about 2.1 percent per year, with a standard deviation of 0.8 percentage points across two-digit sectors (the correlation between the private entry rate and state firm entry rate is approximately 0.6). Column 2 in table 7 shows that the entry rate of state-owned firms is also positively correlated with the TFP growth of state-owned firms. Comparing the R^2 in columns 1 and 2, it appears that the entry of new state-owned firms explains more of the variation in TFP growth among surviving state-owned firms. The entry

rate of state-owned firms is also positively correlated with TFP growth in the privatized state-owned firms, but not in the surviving private firms.

More generally, an explicit goal of the central government's industrial reorganization plans was to generate competition among the state-owned firms. In the case of the automobile industry, Dunne (2011) argues that the main competition faced by Shanghai-GM (GM's joint venture with the state-owned SAIC Group) is between the two large automobile companies owned by its joint-venture partner SAIC Group. For example, Dunne (2011) describes how SAIC's joint venture with Volkswagen introduced the Volkswagen Passat to undercut Shanghai-GM's profits from the Buick. To capture this force, we measure the market power of state-owned firms using the Herfindahl index. Column 3 in table 7 shows that TFP growth among surviving state-owned firms is lower in sectors in which the Herfindahl index of surviving state-owned firms increases. This fact also suggests that the high TFP growth rate among surviving state-owned firms is not simply mismeasured monopoly power. If it were, then we should find a positive correlation between the market concentration of state-owned firms and the same firms' TFP growth. However, the facts suggest that the exact opposite is true.

Finally, there is some evidence that unsuccessful state-owned conglomerates are forced to sell their firms to other state-owned conglomerates. For example, the Baoshan Steel Company, discussed earlier, is perhaps the most successful steel manufacturer in China. Since 2007, its parent company (the BaoSteel Group) has acquired three large steel manufacturers owned by other state-owned industrial groups.[28] One of these companies is ShaoSteel, a publicly traded steel manufacturer that was owned by local governments in Guangdong Province. After ShaoSteel suffered losses totaling almost USD 400 million between 2008 and 2012, the BaoSteel Group acquired the firm in 2012.[29] The case of the Nanjing Automotive Group (owned by the local government of Nanjing) is another example. This company also ran perpetual deficits before the SAIC Group acquired it in 2007.

There are no systematic data on the extent of this reallocation, but some basic facts about the groups and firms owned by the central SASAC suggest this may have been important. When the central SASAC was first

28. Specifically, BaoSteel acquired Bayi Steel in 2007, Ningbo Steel in 2007, and ShaoSteel in 2012.

29. The data on losses from 2008 to 2012 is from ShaoSteel's annual reports. News reports indicate that ShaoSteel's senior management was replaced after the firm was acquired by the BaoSteel Group.

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 it owned 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 about 82 in 2003 to 191 in 2010.

V. Implications for Aggregate Output

We now turn to the assessment of the aggregate implications of the changes observed in the state sector. Although it might seem that high TFP growth and a reduction in labor distortions in the state sector would have positive effects on aggregate welfare, there will be offsetting effects in general equilibrium. As discussed in the theoretical model in section II, depending on the parameter values, the effect on allocative efficiency of TFP growth among firms where marginal products are low offsetting effects may be large enough that aggregate output is lower when state-owned firms increase TFP.

We start with the 2007 data and then calculate aggregate output under two counterfactuals, which we will call "Let Go of the Small" and "Grasp the Large," defined this way:

— "Grasp the Large" assumes that (i) TFP and distortions of surviving state-owned firms would be the same as their initial values; and (ii) no new state-owned firms would be established.
— "Let Go of the Small" assumes that (i) TFP and distortions of privatized firms would be the same as their initial values; and (ii) exiting state-owned firms would survive, with TFP and distortions equal to their initial values.

In each counterfactual, we start with the 2007 data and calculate the hypothetical level of aggregate output under each scenario. We keep the aggregate labor supply fixed and assume that the aggregate supply of capital is available elastically at an exogenously determined world interest rate in the benchmark calculation (we relax this assumption later).

Table 8 presents the percentage decline in aggregate output in 2007 in each scenario. The first column, "No surplus labor," assumes that τ_i^L represents gaps in the marginal product of labor, so here any increases in TFP among firms with a sufficiently low average product of labor may lower aggregate output. The first three rows present the effect of the closure and privatization of state-owned firms. The first row shows that 2007 aggregate

Table 8. Productivity Gains from "Grasp the Large, Let Go of the Small," 1998 to 2007[a]

	Open economy		*Closed economy*	
	No surplus labor	*Surplus labor*	*No surplus labor*	*Surplus labor*
"Let Go of the Small"	1.6	3.2	0.0	0.9
Exit	0.3	–0.5	0.4	0.0
Privatization	1.4	3.7	–0.4	0.9
"Grasp the Large"	10.0	18.4	–3.5	0.9
Surviving state firms	6.1	13.2	–4.6	–0.9
New firms	5.3	7.2	0.5	1.6
"Grasp the Large" + "Let Go of the Small"	11.4	21.0	–3.0	1.9

Source: Authors' calculations, based on microdata from China's Industrial Survey.

a. This table reports the percentage increase of 2007 aggregate output in each counterfactual relative to that in the benchmark case.

output in the "Let Go of the Small" counterfactual is 1.6 percent lower. The next two rows present the effects of exit versus the effects of privatization.

Exit has a positive effect, increasing aggregate output by 0.3 percent. Privatization alone raises aggregate output by 1.4 percent. Both results deserve comment. The reason the effect of privatization is relatively small despite firms' TFP gains is that output per worker among privatized firms is still lower than the average. Since we assume that lower average product reflects lower marginal product, higher TFP among these firms worsens the allocation of labor, which offsets the effect of higher TFP on aggregate output.[30] The positive effect of exit on aggregate output is also driven by the same force. In the model we use, exit always lowers aggregate output when resources are allocated efficiently. However, when the marginal product of labor in exiting firms is low, which is the case in China, exit improves the allocation of labor. In the Chinese context, the marginal product of labor is low enough that the effect of improved allocation due to exit more than offsets the direct effect of exit on aggregate output.

The next three rows present the effect of "Grasp the Large," which accounts for 10 percent of 2007 aggregate output. The reforms among surviving state-owned firms raise the 2007 aggregate output by 6.1 percent,

30. Our benchmark parameterization implies a mean of 0.78 for χ across industries (see equation 14). We have shown that the labor productivity of state-owned and privatized firms was about half and three-quarters that of private firms in 1998 and 2007, respectively. Therefore, many state-owned and privatized firms would easily satisfy the condition.

and the creation of new state-owned firms accounts for 5.3 percent of the aggregate output in 2007. The fact that newly formed state-owned firms contribute almost as much to aggregate output as surviving state-owned firms may be surprising, given that total value added of surviving state-owned firms in 2007 was about four times larger than that of the new state-owned firms. The difference in the contribution of these groups of large state-owned firms stems from the fact that average labor productivity among new state-owned firms is about the same as that of the average private firm, so the entry of these firms does not worsen the allocation of labor. In contrast, the average product of labor among state-owned firms in 2007 was still lower than that of the average private firm. Consequently, as in the case with privatized state-owned firms, here higher TFP among state-owned firms worsens the allocation of labor, which offsets the effect of higher firm TFP on aggregate output.

The estimates in column 1 assume that gaps in the average product of labor reflect differences in the marginal product. However, the evidence presented in section III suggests that the convergence of labor productivity between state-owned and private firms can be explained by the reduction in the number of surplus workers in the state sector (instead of an increase in the marginal product of labor in state-owned firms). In column 2, we assume that (i) gaps in the average product of labor between state-owned and private firms entirely reflect the number of redundant workers in the state sector but that the marginal product of labor is the same in the two sectors;[31] and (ii) redundant workers in the state sector have zero productivity and, hence, reducing f_i does not affect labor supply. With those assumptions, TFP growth in firms with low labor productivity does not worsen the allocation of labor. As can be seen, the effects on aggregate output are now almost twice as large (compared to the estimates in column 1). "Let Go of the Small" accounts for 3.2 percent of aggregate output in 2007, and "Grasp the Large" accounts for 18.4 percent. The two reforms together, shown in the last row, account for 21.0 percent of aggregate output in 2007.

We have so far assumed that the aggregate supply of capital in China is perfectly elastic. This can be the case because of capital mobility or because a consumption Euler equation generates a constant interest rate. Zheng Song, Kjetil Storesletten, and Fabrizio Zilibotti (2011) document that savings have exceeded investments in China, suggesting that an open economy with an elastic supply of capital is a reasonable assumption for the country.

31. f_i/L_i is assumed to be the same among state-owned firms.

In addition, Chong-En Bai, Chang-Tai Hsieh, and Yingyi Qian (2006) find that the return to capital among nonstate firms was roughly constant over this time period, which is consistent with a fixed cost of capital.

Nonetheless, it is useful to examine the welfare effects when we assume a fixed capital stock at the aggregate level. The results are reported in the last two columns. Since the marginal product of capital is lower among surviving state-owned firms, privatized state-owned firms, and newly established state-owned firms, the implication of a fixed capital stock is that higher productivity growth among these firms raises the equilibrium interest rate and worsens the allocation of capital. Column 3 further assumes that low labor productivity reflects low marginal product, so the effect of TFP growth among low-labor-productivity firms also worsens the allocation of labor. This is the worst-case scenario, because higher TFP growth among state-owned firms potentially worsens the allocation of both labor and capital. As can be seen, the effect of this alternative assumption is dramatic. For example, the effect of higher TFP growth among surviving state-owned firms worsens aggregate output by almost 5 percent. Intuitively, the marginal products of capital and labor were low enough in these firms in 2007 that the effect of higher TFP on resource misallocation should overwhelm the direct effect of higher TFP on aggregate output. This effect is less strong among the newly established state-owned firms. This is because the creation of these firms worsens the allocation of capital (the average productivity of capital is lower in these firms) but not the allocation of labor (their average productivity of labor is about the same as the average).

The last column assumes that gaps in labor productivity reflect redundant workers (as in column 2). Here, higher TFP growth in low-labor-productivity firms has no effect on the efficiency of labor allocation. Thus, comparing columns 2 and 4 isolates the effect of TFP on capital allocation. The effect of worse capital allocation due to TFP growth in low-capital-return firms is very large. The effect of worse capital allocation due to TFP growth among surviving state-owned firms lowers aggregate output by more than 14 percent (13.2 + 0.9). The effect of worse capital allocation due to the entry of state-owned firms that have high TFP but low capital return lowers aggregate output by 5.6 percent (7.2 – 1.6).

In summary, the magnitude of the welfare gain depends on how elastic the capital supply is. If the reality is that the cost of capital to private firms does not change due to the reform of state-owned firms, the effect of the reform is likely to have increased aggregate output significantly. Similarly, the effect of TFP growth also depends on the extent to which it worsens the allocation of labor. Although we present evidence that the convergence

between state and private firms in labor productivity is due to the reduction in redundant workers, we do not know whether the remaining gap in 2007 reflects differences in the marginal product of labor or in the number of redundant workers.

Finally, following the same steps as described above, we find that the exit and closure of state-owned firms from 2007 to 2012 had a negligible effect on aggregate output growth over this time period. In turn, the transformation among incumbent state-owned firms and the creation of new state-owned firms over this time period (their "corporatization") account for approximately 18 percent of aggregate growth from 2007 to 2012.[32] Thus, the transformation of the state sector continues to play an important role in China's growth, but its importance relative to other forces has remained small since 2007.

VI. Conclusion

We document the dramatic transformation of Chinese state-owned firms after the late 1990s. Smaller state-owned firms were closed or privatized; large state-owned firms were corporatized and merged into large state-owned holding companies; and new state-owned firms were created. We show that labor productivity and TFP increased in the privatized and surviving state-owned firms. In contrast, there was little convergence in the capital productivity of state-owned and privatized firms after 1998. Among the newly established state-owned firms, we show that TFP and labor productivity of state-owned firms are about the same as those of their private counterparts, while capital productivity of state-owned firms is significantly lower.

Although these changes unambiguously increase state-sector profits, the effects on welfare are more ambiguous. If higher TFP in state-owned firms does not worsen resource allocation, then the reform of the state sector was potentially responsible for 20 percent of aggregate output in 2007. However, if the aggregate supply of capital is fixed, the effect of higher TFP and the creation of new high-TFP state-owned firms could have worsened the allocation of capital by enough that the net effect on aggregate output may be negative. Likewise, if the marginal product of labor among state-owned firms is low, higher TFP can also lower aggregate output by reallocating workers away from private firms, where the marginal product of labor is presumably higher.

32. We conduct counterfactuals for 2007–12 in an open economy with no surplus labor.

We end with three suggestions for future work. First, although we provide suggestive evidence that changes in corporate governance, competition from private firms and other state-owned groups, and reallocation of assets between state-owned groups may have been important drivers of the changes observed in state-owned firms, the evidence is far from conclusive. Second, our analysis of the welfare effect of "Grasp the Large, Let Go of the Small" relies on a specific model, but the effect may be different with a different model. Finally, although our estimates suggest that the transformation of the state sector, particularly the corporatization of state-owned firms and the creation of new state-owned firms, was an important force behind China's growth, it is clear that the main driver of China's growth is something else. Figuring out the unexplained residual in this paper is clearly a central question for future work.

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