NORTH-HOLLAND

China Economic Review 13 (2002) 65–88

China Economic Review

Profitability and productivity of Chinese industrial firms Measurement and ownership implications

Anming ZHANG[a,*], Yimin ZHANG[b], Ronald ZHAO[c]

[a]*Faculty of Commerce and Business Administration, University of British Columbia, Vancouver, BC, Canada V6T 1Z2*
[b]*Department of Economics and Finance, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China*
[c]*Department of Accounting and Business Law, Monmouth University, West Long Branch, NJ 07764-1898, USA*

Received in revised form 1 September 2001

Abstract

This paper assesses the reform of state-owned enterprises (SOEs) by examining the effect of ownership on the profitability and productivity of Chinese industrial firms. Several methodological issues concerning profit measurements of enterprises under different ownership structures are identified and discussed. Test results based on a panel data set provide evidence that capital structures, taxes, and welfare burdens have a significant effect on the financial performance of Chinese enterprises. After adjusting for these effects, SOEs still show poor financial performance, which, we show, is attributable to the effect of "soft loans." Although SOEs grew faster in productive efficiency during 1996–1998, their growth rate in profitability lagged behind that of firms with other ownership structures. © 2002 Elsevier Science Inc. All rights reserved.

JEL classification: L2; L3; P3; D2

Keywords: Profitability; Efficiency; Ownership; Accounting ratios

* Corresponding author. Tel.: +1 (604) 822-8420; fax: +1 (604) 822-9574.
E-mail address: anming.zhang@commerce.ubc.com (A. Zhang).

PII: S1043-951X(01)00060-8

1. Introduction

The reform of state-owned enterprises (SOEs) has been the centerpiece of China's economic reform since 1984. The reform policies of the 1980s and early 1990s were to "revitalize" SOEs through decentralization, improvement of internal managerial and incentive systems, and introduction of market competition, with a view to transforming state enterprises from cost centers to economic units responsible for a profit target. The Chinese government has intensified the reform of SOEs since the mid-1990s by encouraging merges and acquisitions, standardizing bankruptcy procedures, laying off redundant workers, and restructuring SOEs into limited liability companies or joint stock companies (Zhu, 1999). However, at the same time, the government has made clear its intention to retain a controlling stake in the country's largest SOEs.

A large number of academic studies have attempted to assess SOE reform. Economists outside of China mainly consider the effects of the reform on technical efficiency improvement, as measured by total factor productivity (TFP) growth. Their findings have been mixed. Woo, Hai, Jin, and Fan (1994), for example, found that TFP growth in SOEs was zero at best in the 1984–1988 period. This result stands in contrast to those of several other studies (Chen, Jefferson, Rawski, Wang, and Zheng, 1988; Dollar, 1990; Gordon & Li, 1995; Groves, Hong, McMillan, & Naughton, 1994; Jefferson & Xu, 1991; Jefferson, Rawski, and Zheng, 1992; Li, 1997; World Bank, 1992), all of which found significant improvements in the productivity of SOEs. The estimates of annual TFP growth in the late 1970s and 1980s given in these studies range from 2% to 5%, compared with almost 0% growth prior to reforms. Consistent with the productivity growth of SOEs, the Chinese economy grew at an average annual rate of 9.9% over the past two decades. Since this high growth rate has occurred under the dominance of public ownership, the Chinese experience has been cited by some economists as evidence that privatization is not a necessary precondition for efficiency (e.g., Stiglitz, 1994).

On the other hand, the prevalent view among Chinese economists seems to be that the SOE reform has not been very successful, at least in terms of accounting profitability measures (Zhang, 1997). Profitability is of vital concern to investors and creditors because profits provide funds for both dividend payments and debt coverage. It has been pointed out that the number of SOEs operating at a loss has been rising, and the amount of losses has been increasing. In 1996, the total losses by industrial SOEs were 79 billion yuan, while the losses in 1978 were only 4.2 billion yuan, implying an annualized growth rate of 17.7%. These substantial losses were absorbed mainly by government subsidies and loans from state banks. As a consequence, government subsidies for SOEs swelled, taking a 37% jump from 1986 to 1992. Furthermore, the contribution of SOEs to government revenue declined; the ratio of profit plus taxes over sales revenue for the SOEs dropped from 26% in 1980 to 12% in 1992 (Lin, 1996).

Thus, the existing literature on SOE reform assessment provides seemingly inconsistent results. From the social perspective, the increase in SOEs' TFP suggests the success of SOE reform.[1] But the state, as the owner and major debt holder of SOEs, does not seem to have

[1] Bai, Li, and Wang (1997) point out, however, that TFP growth rate might not be the appropriate measure for SOE performance during the reform. Specifically, using a simple model in the spirit of a counterexample, they show that when SOEs are not profit maximizers, increases in productivity may actually lead to lower economic efficiency. We discuss Bai et al. (1997) further in the concluding remarks.

directly benefited from the reform. This paper extends the literature by directly comparing both profitability and productivity between SOEs and enterprises with other ownership structures.[2] Such an analysis is made possible by the fact that China's economic reforms, apart from restructuring SOEs, have also led to the development of a nonstate sector; the state monopoly system has given way to a more diverse ownership structure so as to nurture market competition and economic development.[3] Our assumption is that if returns by SOEs are found to be similar to those by nonstate firms, then the SOE reform, largely in the form of revitalization rather than privatization, might be considered successful.

More specifically, to reconcile the conflicting evidence on SOE performance, we examine the effect of ownership on the profitability and productivity of Chinese enterprises based on a new firm-level data set. Our sample covers the period 1996–1998 and consists of a panel of 1838 firms in 26 industries. We use accounting ratios such as ROA to measure a firm's ability to generate earnings. The calculation of accounting ratios depends on a set of accounting conventions relating to the treatment of inventories, long-term investment, depreciation, tax treatment, funds set aside for bad debts, and so forth. For productivity, we use the "data envelopment analysis" (DEA) method to compute efficiency scores for each firm by industry. We then run regressions to test the effects of ownership on firms' profitability and productivity (both level and growth rate) after controlling for industry- and time-specific variables.

Our second objective in this paper is to discuss some methodological issues concerning profit measurements of Chinese enterprises. On a theoretical level, we use a stylized model to illustrate the potential bias of accounting profitability. In particular, the model predicts that since SOEs can often get "soft loans" from state banks and hence face a lower cost of capital than nonstate firms, SOEs will average lower efficiency levels in utilizing capital and lower rates of return on capital than nonstate firms. On the empirical level, direct comparison of profitability between SOEs and nonstate firms could be problematic, since they have different capital and tax structures (e.g., Lu & Tang, 1997) and play different roles in shouldering social welfare burdens. For example, SOEs often have a higher proportion of debt funding than would be advisable under private ownership. Therefore, a comparison based on firms' ROAs may be biased. This calls for an innovative, and compatible, profitability measurement, which takes into account different characteristics between state and nonstate firms.

[2] Recently, Zhang, Zhang, and Zhao (2001) compared productivity between SOEs and enterprises with other ownership structures. The present paper, on the other hand, emphasizes profitability comparison as well as the interaction between profitability and productivity in the Chinese context. One noticeable exception to the existing literature that focuses mainly on the productivity of SOEs is Chang, McCall, and Wang (2000). Using a unique data set on Chinese township and village enterprises (TVEs), they study the implications of introducing both managerial incentives and better-defined ownership for a firm's financial performance. They find that introducing managerial incentives had a positive but statistically insignificant effect on these firms' performance, measured by accounting return on assets (ROA) or return on equity (ROE). The study also finds that the performance is significantly better under ownership forms that provide better-defined rights than under community ownership, even when the latter is supplemented with managerial incentive contracts.

[3] By 1993, China's economy had become essentially a market economy, in the sense that more than two-thirds of the national output were produced by profit-seeking economic units.

We first compute accounting ROAs for firms in the sample, and then introduce modified ROA (ROA*) as profit measurements so as to adjust for effects arising from different capital structures, preferential taxes, welfare burdens, and soft loans. Comparisons based on ROA suggest that SOEs and collective-owned enterprises (COEs) were on average the worst performers in profitability. The financial performance of SOEs as measured by ROA is consistent with our findings on productivity, where SOEs also exhibited the lowest efficiency scores. Subsequent analysis based on modified profitability measurements suggests that effects of capital structures, taxes, and welfare burdens were significant in determining financial performance of Chinese enterprises. After controlling for these effects, both SOEs and COEs showed improvement in their performance, but that of SOEs was still dismaying in terms of asset turnover (AT). This fact suggests that the effect of "soft loans" was significant, which accounts for SOEs' inferior financial performance compared to the performance of nonstate firms. Finally, although in general SOEs had a faster growth rate in productive efficiency during 1996–1998, their growth rate in profitability was lower than that for firms of other ownership structures.

The paper is organized as follows. Section 2 describes the data and reports firms' profitability based on ROA measurement. Section 3 analyzes the relationship between profitability and productivity through an illustrative model. Section 4 discusses the main empirical findings based on profitability and productivity levels. Section 5 further examines the changes in profitability and efficiency levels. Section 6 offers some concluding remarks.

2. Data and preliminary analysis

The data set used in this study includes all industrial enterprises located in Shanghai. Shanghai, with a population of 13 million, is the most important business and industrial center in China. It accounts for 5% of national GDP and 10% of China's external trade. A sample from Shanghai presents a comprehensive panorama of enterprise performance while controlling for the impact of regional factors on productivity in China.[4]

The data were obtained from the State Statistic Bureau of China (SSBC). Its computerized microeconomic database stores firm-level statistics from the mandatory annual reports submitted by all government and business organizations in China. Our data set covers a 3-year period between 1996 and 1998. The starting date for this data period was determined by significant revisions made in 1996 to the classification criteria and statistic presentation categories; the revisions make pre- and post-1996 data incomparable. The reporting format has, however, remained unchanged since 1996.[5] Three major changes resulting from the 1996 revision are worth noticing. First, firms began to report cost of direct material input without which material input efficiency cannot be estimated. Second, the new reporting system adjusted revenue for value-added tax, for which revenue had not been adjusted prior to 1996.

[4] Chen (1996) and Li, Li, and Zhang (2000) found that there is a significant regional impact on enterprise productivity in China.

[5] The data for 1999 and 2000 are not yet available, however.

Finally, SSBC for the first time publicized its ownership definitions in that year (*China Statistical Yearbook*, 1996). A clear ownership classification is of prime importance for investigating the effect of types of ownership on firm performance.

Based on the SSBC categorization scheme, we divide Chinese enterprises into five groups. Their SSBC definitions are as follows:

- SOEs: enterprises, institutions, government administrative organizations at various levels, and social organizations with state ownership of production means;
- COEs: enterprises and institutions with collective ownership of production means, including rural economic organizations, TVEs, collective enterprises, and institutions run by cities, counties, and town and street committees;
- Private-owned enterprises (POEs): economic units owned by private individuals, including individually owned private enterprises, jointly owned private enterprises, and privately owned limited liability companies;
- Foreign-owned enterprises (FOEs): enterprises established by foreigners on the Chinese mainland, including equity joint ventures, cooperative joint ventures, and solely owned subsidiaries; and
- Hong Kong–Macau–Taiwan-owned enterprises (HMTs): enterprises established by oversea Chinese from Hong Kong, Macau, and Taiwan on the Chinese mainland, including equity joint ventures, cooperative joint ventures, and solely owned subsidiaries.

Under the previous central planning system, the Chinese industrial sector was dominated by SOEs, which basically acted as cost centers to fulfill production quotas and to provide life-long employment (the "iron rice bowl"). Economic reform in China has been characterized by a gradual approach toward fostering new economic elements outside of the state sector, instead of an overall privatization of SOEs, as a means to change the ownership landscape. COEs, which are organized by local authorities, are similar to SOEs in that they were also under (local) government control and were encouraged to provide stable employment to their employees. However, COEs had greater autonomy and harder budget constraints than SOEs. Since economic reforms began, managers of COEs have been under increasing pressure to become efficient and, as a result, COEs have to lay off employees. COEs include many TVEs. TVEs, which typically began from a small base, were allowed to grow with few of the restrictions that hobbled state-run enterprises, and they have expanded rapidly.[6]

POEs, FOEs, and HMTs have emerged since the early 1980s, when China began to open up its markets. POEs, which have come into being to meet the demand of the deregulated domestic markets, have been the fastest growing sector in China. Although they were almost nonexistent in the early 1980s, there were 8 million POEs in 1993, with an industrial output of 386 billion yuan. POEs have demonstrated a high degree of entrepreneurship, with 53% of POEs having entered into international trade and 23%

[6] A number of studies have examined the success of TVEs (e.g., Chang & Wang, 1994; Li, 1996; Weitzman & Xu, 1994).

having formed joint ventures with foreign partners. In order to benefit from foreign capital, advanced technology and management expertise and to boost exports, the government has encouraged the establishment of FOEs and HMTs. By 1994, foreign, Hong Kong, Macau, and Taiwan investors had injected a total of US$100 billion investment into 198,000 joint ventures. Many FOEs and HMTs are located in special economic zones and are restricted by regulations from participating in domestic markets. Thus, FOEs and HMTs are mainly engaged in export business: in 1994, for example, they accounted for 37% of China's total exports.

To study the financial performance of Chinese enterprises with different ownership structures, we start with the most popular measure of profitability, the ROA (Eq. (1)), which is defined as:

$$\mathrm{ROA} = \frac{\mathrm{NI}}{\mathrm{TA}} \tag{1}$$

where NI is the net income, which is obtained by subtracting costs of labor and materials, depreciation, and administrative expenses, interest expenses, and taxes from total sales; TA (total assets) represents the total amount of capital invested in the firm, including both equity and debt.

After deleting firms with missing values for the variables required and industries that have fewer than 20 firms, our sample consisted of a panel of 1838 firms in 26 industries. Descriptive statistics of the sample are given in Table 1. As can be seen from Table 1, SOEs form the largest group in the sample with a total of 937 firms, followed by 407 HMTs and 276 FOEs. There are 213 COEs and 105 POEs. On average, HMTs are largest by sales revenue, followed by POEs, SOEs, FOEs, and COEs, although SOEs have the largest number of employees and are second largest by assets. Using the table, we can compute average revenue per employee for each group. HMTs had, on average, the highest revenue per employee (463,938 yuan), followed by POEs (348,398), FOEs (241,764), SOEs (137,513), and COEs (66,448). Thus, the "labor productivity" of HMTs and POEs was about 3.4 times that of SOEs and 7 times that of COEs.

Table 1 also shows the sample mean of firms' ROA by ownership type. Unsurprisingly, SOEs and COEs are on average the worst performers: SOEs have a mean ROA of −2%

Table 1
Sample mean: ROAs by ownership

Ownership	SOEs	COEs	POEs	FOEs	HMTs
Number of firms	937	213	105	276	407
Average sales	91,996	11,429	134,830	61,408	141,501
Average number of employees	669	172	387	254	305
Average total assets	160,866	13,891	158,002	87,740	169,861
ROA	−0.02	−0.03	0.02	−0.01	0.00

Sales and total assets are in terms of thousand yuan.
ROA is defined as net income/total assets.

and COEs −3%. POEs seem to be the best performer in the sample, with an average ROA of 2%. FOEs and HTMs are in the middle, with an average ROA of −1% and 0%, respectively. Do these ROA figures give an accurate description of the performance of Chinese enterprises? What may have contributed to the low profitability of SOEs (and COEs) relative to firms of other ownership types? We will provide a closer examination of these questions in Sections 3 and 4.

3. An illustrative model

In this section, we use a stylized model to illustrate that not only does there exist differences between productivity and profitability measures, but the traditional accounting measure of profitability may also lead to bias. As indicated earlier, the industrial reform in general has a positive effect on the productivity growth of SOEs. On the other hand, the number of loss-making SOEs is rising. Productivity and profitability differ to the extent that they focus on different aspects of a firm's performance. However, other things being equal, profitability is presumably related positively to productivity.

The model is based on the observation that SOEs often have a higher proportion of debt funding than would be advisable under private ownership. Government guarantees (either explicitly or implicitly) provide an incentive for more use of debt, as the firms can obtain a higher debt rating and incur lower interest costs. In the Chinese context, state banks often pump "soft loans" into SOEs to avoid their possible closure (Steinfeld, 1998). This is because SOEs play an important role in providing a wide range of social services to employees and their families and in maintaining social stability (Bai, Li, Tao, & Wang, in press). As a result, state firms face a lower cost of capital relative to nonstate firms.

Suppose that all firms produce a single output, y, with two inputs: labor, x, and capital, k. Denote the production function as $y=f(x,k)$. For individual firms, the actual output produced and the inputs used may be fitted to the production function with a parameter θ, $0<\theta\leq 1$, such that (Eq. (2))

$$y = f(\theta x,\theta k) \tag{2}$$

Clearly, for efficient firms that are located on the production frontier, $\theta=1$. For less efficient firms, $\theta<1$, which implies that the firms are using more inputs than an efficient firms would require to produce the given amount of outputs. Put differently, given the actual inputs, x and k, and the output of a firm, say Firm A, an efficient firm could produce the same output with only a fraction θ of the inputs used by Firm A. Therefore, parameter θ can be used as a measure of the firm's productive efficiency.

Next, consider firms' profitability. A common measure of profitability, the rate of return on the capital of the firm, can be defined as (Eq. (3)):

$$R = (py - wx)/k \tag{3}$$

where p is the price of output and w is the price of labor. Given the prices of outputs and inputs, an efficient, profit-maximizing firm will choose the inputs so as to:

$$\max_{x,k} \pi = py - wx - rk$$

$$\text{s.t. } y = f(x,k) \tag{4}$$

where r is the price of capital (cost of capital). The first-order conditions are:

$$p\frac{\partial f}{\partial x} = w, \quad p\frac{\partial f}{\partial k} = r \tag{5}$$

Assuming the following second-order conditions hold,

$$\frac{\partial^2 f}{\partial x^2} < 0, \quad \frac{\partial^2 f}{\partial k^2} < 0, \quad \frac{\partial^2 f}{\partial x^2}\frac{\partial^2 f}{\partial k^2} - \frac{\partial^2 f}{\partial x \partial k}\frac{\partial^2 f}{\partial x \partial k} > 0,$$

then Eq. (5) implicitly determines the optimal input bundle (x^*,k^*), which is a function of the factor prices w and r. One can clearly see that the optimal quantity of an input depends negatively on the price of the input. For example, differentiating Eq. (5) with respect to r and solving for $\partial k^*/\partial r$ using the second-order conditions yields: $\partial k^*/\partial r < 0$, i.e., the optimal amount of capital declines as the price of capital increases.

In the case of SOEs, which typically have access to "soft loans" from government-controlled funding sources to finance their operations, the availability of low-cost capital induces them to substitute more capital for other inputs. For firms of other ownership types, especially POEs, the situation is different. Since it is difficult for them to obtain loans at discount rates, their cost of capital is higher than that of SOEs. Consequently, these firms will tend to operate with a lower capital/labor ratio than SOEs.

What will be the effect of the differential price of capital on the profitability of different types of firms? First, let (x^*,k^*) be the optimal input bundle for an efficient firm facing a nondiscriminating capital market. Then consider the change of the firm's profit if it can access "soft loans" and hence enjoy a lower price of capital. Differentiate the firm's profit with respect to the capital price (Eq. (6)):

$$\frac{d\pi^*}{dr} = \frac{d}{dr}[pf(x^*,k^*) - wx^* - rk^*]. \tag{6}$$

By the envelope theorem (Eq. (7)),

$$\frac{d\pi^*}{dr} = \frac{\partial \pi^*}{\partial r} = -k^* < 0. \tag{7}$$

Hence, a lower price of capital will lead to higher profits.

On the other hand, the effect of capital price on profitability as measured by the rate of return on capital is not straightforward. Differentiating the rate of return on capital with respect to r yields:

$$\frac{dR^*}{dr} = \frac{d}{dr}\left[\frac{pf(x^*,k^*) - wx^*}{k^*}\right]$$

$$= \left[\frac{p\partial f/\partial x^* - w}{k^*}\right]\frac{\partial x^*}{\partial r} + \left[\frac{p\partial f/\partial k^*}{k^*} - \frac{pf(x^*,k^*) - wx^*}{k^{*2}}\right]\frac{\partial k^*}{\partial r} \tag{8}$$

Using the first-order condition (Eq. (5)), Eq. (8) can be simplified as (Eq. (9)):

$$\frac{dR^*}{dr} = \frac{r - R^*}{k^*}\frac{\partial k^*}{\partial r} \tag{9}$$

Since $R^* \geq r$ (otherwise the firms will be losing money) and $\partial k^*/\partial r < 0$, we have (Eq. (10)):

$$\frac{dR^*}{dr} \geq 0. \tag{10}$$

Hence, for an efficient firm, a lower price of capital would lead to a lower rate of return on capital.

In conclusion, if firms in the state and nonstate sectors are both efficient, then SOEs, which have access to soft loans, will have higher total profits but lower profitability as measured by the rate of return on capital than nonstate firms. However, if nonstate firms were technically more efficient with regard to the labor input (higher labor productivity) than state firms, then comparison of profitability would yield ambiguous results. Specifically, if POEs were as efficient as SOEs, we would expect the profitability of POEs to be higher than SOEs. On the other hand, if COEs were less efficient than POEs and SOEs, then the profitability of COEs would be lower than that of POEs and might even be lower than that of SOEs. Our illustrative model also predicts that if the effect of soft loans is significant, SOEs should on average be less efficient in utilizing capital, and should have a lower rate of return on capital than nonstate firms. This prediction is empirically investigated in the next section.

4. Empirical results

The above discussions suggest that several factors may have contributed to relatively bad performance of SOEs (and COEs) as measured by ROA. First, there may exist general slackness in management due to incentive problems, which may lead to low productive efficiency or the so-called X-inefficiency. For example, Schleifer and Vishny (1997) have pointed out that firms controlled by bureaucrats have at best only an indirect interest in profits; this could lead to inefficiencies in many situations.[7] Second, net income may be affected by capital structure of the firm and the tax policy by the government, so ROA might not reflect true profitability. Specifically, firms with a high level of debt will have higher interest payments and a relatively lower net income than firms with a low level of debt, although operating profits may be the same. Similarly, firms under preferential tax treatment from governments will show a better net income relative to firms that do not receive tax breaks. Third, there is the effect of welfare burdens. SOEs and, to a lesser extent, COEs

[7] Zhang (1997) contains a very interesting analysis of managerial incentives and firm performance of Chinese SOEs when top management of SOEs remains to be appointed by bureaucrats.

provide employees and their families with a wide range of benefits such as housing, medical care, childcare, and education. These non-production-related welfare expenses are financial burdens to these firms and may affect their profitability. Fourth, there is the effect of soft loans, which would induce SOEs to use capital excessively and hence inefficiently. We now discuss each of these four effects.

4.1. Effect of X-inefficiency

As shown in Section 3, a firm's productive efficiency is reflected in the relationship between the output it produces and the input it uses in a given period of time. DEA is a technique used to measure the efficiency of a firm when there are multiple inputs and outputs whose relative weights cannot be predetermined.[8] DEA gives an efficiency score for each firm in a given industry. For the input-oriented model, the efficiency score has a value between 0 and 1. Firms with an efficiency score of unity (100%) are located in the efficient frontier, in the sense that their inputs cannot be reduced without a corresponding decrease in output. Firms with an efficiency score below 100% are inefficient. The DEA model defines the efficiency score of any firm as the fraction of the firm's inputs that is necessary for a firm in the efficient frontier to produce the same level of output.

In principle, the production frontier may be obtained in piece-linear form by connecting observations of best-practice firms. The efficiency measure θ, defined in the Section 3, can then be calculated for any firm in reference to the piece-linear production frontier. In this paper, we calculate the efficiency measure θ by the standard DEA method (Eq. (11)):

$$\begin{aligned} &\max_{u_j,v}\theta_0 = vy_0 \\ &\text{s.t.} \sum_j u_j x_{ji} - vy_i \geq 0; \qquad i = 1,\ldots,N \\ &\sum_j u_j x_{j0} = 1 \\ &u_j \geq 0, \quad v > 0 \end{aligned} \tag{11}$$

In the above problem, θ_0 is the efficiency score, y_0 is the output, and x_0 is the input (vector) of the firm being evaluated. N is the number of firms in the industry, while u_j and v are, respectively, the weights of the input and output defining the efficient frontier. The linear programming is solved N times to estimate efficiency scores for all firms in the industry. We use a firm's nominal sales revenue as a measure of its output in a given year. Three inputs are assessed to determine the firm's efficiency: labor, capital, and materials. Labor is measured by the number of employees, capital by nominal value of net productive assets, and materials by

[8] Useful references on DEA include, among others, Banker, Charnes, and Cooper (1984), Banker, Charnes, Cooper, Swarts, and Thomas (1989), Charnes, Cooper, and Rhodes (1978, 1981), Farrell (1957), Lovell (1993), and Seiford and Thrall (1990).

Table 2
Regression analysis of DEA efficiency scores

DEA	Coefficient	S.E.	*T* statistic	Prob.>*T*
Intercept	45.24	1.15	39.38	.0001***
COEs	12.79	1.03	12.47	.0001***
POEs	12.36	1.14	10.85	.0001***
FOEs	12.34	1.10	11.20	.0001***
HMTs	16.05	0.86	18.72	.0001***
Adjusted R^2	.22			

The table reports the results of the regression (Eq. (12)). The estimates for industry dummies and year dummies are omitted here for brevity.
The intercept term represents the base case of SOEs, while the other coefficients represent the *differences* to the base case.
***The *t* ratio of the coefficient exceeds the 1% critical value.

the nominal value of direct material input of each firm in a given year. While these nominal values may be subject to biases from accounting practices and imperfect markets, the DEA score gives a relative measure of the firm's efficiency in reference to the best practice of the industry so long as these biases are not systematic.

After obtaining efficiency scores for all the firms in our sample, we then run the following regression to see the effects of ownership structure on the productive efficiency of the firms:

$$\theta = \alpha + \sum \beta_{1i}\text{Ownership}_i + \sum \beta_{2j}\text{Industry}_j + \sum \beta_{3t}\text{Year}_t + \varepsilon \qquad (12)$$

where θ is the DEA efficiency score; Ownership: i=1, …, 5 for SOE, COE, POE, FOE, and HMT, respectively; Industry: i=1, …, 26 for general machine building, special equipment, transportation equipment, instruments, other manufacturing, chemical, pharmaceutical, printing, plastic, furniture, sports equipment, nonferrous metal, garment and fabric, wooden products, rubber products, electronic and communication equipment, electric engineering, fur and leather, textile, paper products, metallic products, nonmetallic mineral products, food manufacturing, food processing, beverage manufacturing, and ferrous metal industries, respectively; Year: t=1,2,3 for 1996, 1997, and 1998, respectively; and ε is the disturbance term.

The dummy variables for SOEs ($\text{Ownership}_{i=1}$), the general machine-building industry ($\text{Industry}_{j=1}$), and Year 1996 ($\text{Year}_{t=1}$) are omitted from the regression to avoid perfect collinearity. As a result, the coefficient estimates of all the variables should be interpreted with reference to the performance of SOEs in the general machine-building industry for 1996 as the base case.

The results of the regression are given in Table 2.[9] Of the five groups, SOEs have on average the lowest efficiency. COEs, POEs, and FOEs have similar mean efficiency scores, which are about 12–13% higher than those of SOEs. The most efficient group appears to be HMTs, which have a mean efficiency score 16% higher than that of SOEs. These results

[9] To save space, the estimates of the industry and year dummies are omitted in Table 2 and in later tables; they are available from the authors upon request.

suggest that X-inefficiency may be an important contributing factor to the low profitability of SOEs measured by ROA. However, they cannot explain the low profitability of COEs. Further analysis will therefore be conducted below.

4.2. Effects of capital structure and taxes

Apart from X-inefficiency, firms' profitability may also be affected by capital structure and taxation. The latter could distort the values of profitability measured for different firms even if firms have the same X-inefficiency. In conventional ROA measurement, net income is obtained by subtracting costs of labor and materials, depreciation and administrative expenses, interest expenses, and taxes from total sales. Net income is in fact income distributable to shareholders only. The denominator "total assets," however, represents the total amount of capital invested in the firm, including both equity and debt. Thus, ROA does not reflect the profitability of the total capital invested, because interest paid to debt holders has already been deducted from net income while debt capital remains in total assets. Therefore, comparison of ROA between firms with different debt levels may be biased.

Furthermore, the Chinese government has provided some incentive packages to attract foreign investments. As a result, the effective tax rate varies among domestic and foreign firms, a fact that further reduces the fairness of ROA as a measure of performance. To put the comparison of financial performance of firms of different ownership types on an equal footing and to capture the true return on total capital invested, we arrive at the following ROA* as a measure of profitability:

$$\text{ROA*} = \frac{\text{EBIT}}{\text{TA}} \tag{13}$$

where EBIT stands for earnings before interest and taxes. Since EBIT, which represents operating profits, is the sum of net income (profits distributable to shareholders), interest (profits paid to debt holders), and taxes (profits claimed by governments), ROA* should measure total return on capital invested, regardless of the capital structure and/or preferential tax treatment facing different firms.

Eq. (13) may be written, using the Dupont identity, as (Eq. (14)):

$$\text{ROA*} = \frac{\text{EBIT}}{\text{TA}} = \frac{\text{EBIT}}{\text{Sales}}\frac{\text{Sales}}{\text{TA}} = \text{PM} \cdot \text{AT} \tag{14}$$

where PM stands for "profit margin" and AT for "asset turnover." As ROA* represents the return on the capital investment of a firm, the above identity decomposes profitability of capital into two components: AT and PM. AT captures efficiency of capital in the production of output, while PM captures the efficiency of other factors, such as labor and materials, in the production of output because EBIT is derived by deducing costs of production (including the costs of labor, materials, and other variable inputs) from sales.

Table 3 lists the sample statistics of the ROA*, PM, and AT for Chinese industrial firms by ownership type. On average, COEs have the highest profitability measured by ROA* (17.6%) while FOEs and HMTs have the lowest profitability (10.4% and 11.0%, respectively).

Table 3
Sample statistics of ROA*

Ownership	SOEs	COEs	POEs	FOEs	HMTs
Number of firms	937	213	105	276	407
ROA*	0.122	0.176	0.139	0.104	0.110
	(0.126)	(0.182)	(0.134)	(0.127)	(0.134)
PM	0.167	0.173	0.148	0.111	0.103
	(0.309)	(0.293)	(0.238)	(0.283)	(0.297)
AT	0.701	1.039	0.861	0.785	0.783
	(0.572)	(0.839)	(0.656)	(0.649)	(0.571)

The first row for each item is the mean and the second row (in parenthesis) is the standard deviation.
ROA* is defined as EBIT/TA, PM as EBIT/Sales, and AT as Sales/TA. TA is the total assets.

Somewhat surprisingly, SOEs and POEs are in the middle, with mean ROA* of 12.2% and 13.9%, respectively. After controlling for capital structure and tax factors, both SOEs and COEs showed improved financial performance. Comparing ROA* with the conventional ROA in Table 1 thus reveals that SOEs and COEs appear to have suffered from high interest charges and/or taxes relative to firms of other ownership types.

Decomposing ROA* into PM and AT, we find that COEs are the best performers in both PM and AT, whereas POEs are in the middle for both measures. SOEs have a mean PM close to the level of COEs, but their ROA* is dragged down by their low AT. Relative to COEs and POEs, FOEs and HMTs have lower mean values in both PM and AT.

The comparison of ROA* across ownership structures may not tell the whole story, however, because ROA* as well as PM and AT may also be affected by industry-specific factors. For example, other things being equal, products with cyclical demand (high business risk) should on average have high ROA* to compensate for high business risk, while products with stable demand (low business risk) should have low ROA*. To make the comparison more meaningful, we use the following regression to control for industry- and year-specific effects:

$$\text{ROA*} = \alpha + \sum \beta_{1i}\text{Ownership}_i + \sum \beta_{2j}\text{Industry}_j + \sum \beta_{3t}\text{Year}_t + \varepsilon \tag{15}$$

The regression results are reported in Table 4(A). They show that, on average, ROA* of FOEs and HMTs was statistically indistinguishable from ROA* of SOEs. In contrast, COEs and POEs performed significantly better than SOEs, with mean ROA* 5.3% and 1.8% higher, respectively, than that of SOEs.

Next, we run the same regression with PM and AT as dependent variables. From Table 4(B), we see that after controlling for industry- and year-specific factors, the PMs of COEs and POEs were statistically indistinguishable from those of SOEs, whereas the PMs of FOEs and HMTs were significantly lower than those of SOEs. For AT, as Table 4(C) indicates, the ATs of SOEs were significantly lower than those of all of the other categories of firms, as predicted by the theoretical model of Section 3. We also note that the ATs of COEs and POEs were clearly higher than those of FOEs and HMTs.

In sum, the results seem to suggest that performance of the sample firms may be contrasted between the domestic nonstate sector and the foreign sector: COEs and POEs outperformed

Table 4
Regression analysis of ROA*

	Intercept	COEs	POEs	FOEs	HMTs
(A) ROA*	0.133***	0.053***	0.018***	−0.004	−0.006
	(0.006)	(0.004)	(0.005)	(0.005)	(0.004)
(B) PM	0.222***	0.002	−0.015	−0.029**	−0.051***
	(0.012)	(0.010)	(0.011)	(0.012)	(0.009)
(C) AT	0.584***	0.346***	0.153***	0.073***	0.075***
	(0.025)	(0.021)	(0.024)	(0.025)	(0.019)

The table reports the results of the regression (Eq. (15)). The estimates for industry dummies and year dummies are omitted here for brevity.
The first row for each item is the mean and the second row (in parenthesis) is the standard deviation.
The intercept term represents the base case of SOEs, while the other coefficients represent the *differences* to the base case.

* is defined as EBIT/TA, PM as EBIT/Sales, and AT as Sales/TA. TA is the total assets.

** The t ratio of the coefficient exceeds the 5% critical value.

*** The t ratio of the coefficient exceeds the 1% critical value.

FOEs and HMTs according to revised profitability measures. This finding stands in contrast to the finding of Section 4.1 that foreign firms, especially HMTs, were on average more efficient than domestic firms. It is likely that the contrast reflects the preferential tax rates towards foreign-funded firms,[10] for the revised profitability measure already adjusts for preferential tax treatment. As for domestic SOEs, their PM was similar to other nonstate domestic firms, owing perhaps to their monopoly positions, but their AT was so much lower than that of COEs and POEs that SOEs were placed along with the foreign group in terms of overall ROA*.

4.3. Effects of welfare burden and soft loans

An SOE is in many ways like a small society. It provides not only employment but also all kinds of social welfare to its employees and their families. As a result, parts of the firm's assets are "nonproductive" assets that may include the enterprise hospital, dormitories, nurseries, and school facilities.[11] Such welfare costs raise the operating costs of the firm. Therefore, both "AT based on total assets" and "PM after welfare expenses" are measures that are biased against SOEs (and, to some extent, COEs) because of their higher welfare burdens.

Another factor that may distort the productive efficiency and profitability assessment is, as demonstrated earlier, the soft-loans effect. Since SOEs (and to a lesser extent, COEs) provide a major share of employment to Chinese population, failures of SOEs or COEs might cause

[10] The practice is well documented in Lu and Tang (1997, especially in Appendix A).

[11] In 1993, SOEs' social expenses accounted for 6% of their total costs or 40% of wages. SOE reform has led to a greater concern for operating efficiency, and welfare outlays are considered nonproductive. For example, when an SOE is selected to become a limited liability stock company for listing on the stock exchange, one required condition for IPO is the elimination of most of its welfare assets and outlays.

social unrest. Therefore, it is not surprising that state banks continue to extend loans to SOEs, although their ability to pay back the loans is questionable. Banks in China are predominantly state-owned, and bank loans are the main, and in many cases, the only source of financing for SOEs (and COEs). As SOEs can expect to get soft loans from state banks, SOEs in fact face a lower cost of capital relative to firms that do not have access to soft loans. As shown in Section 3, owing to soft loans, SOEs should on average have lower AT and ROA than firms of other ownership types.

It is then natural to ask how large the effect of welfare burden is, and to what extent the effect of soft loans might affect firms' efficiency and profitability. To examine these issues, we define the "productive return on assets" (PROA) as (Eq. (16)):

$$\text{PROA} = \frac{\text{EBIT} + W}{\text{PA}} \tag{16}$$

where PA refers to net productive assets, W is welfare expenses, and EBIT+W is operating profit before welfare expenses. Welfare expenses include both direct welfare expenses and depreciation on nonproductive assets. Due to data limitations, we were only able to estimate depreciation on nonproductive assets by taking a portion of total depreciation, based on the ratio of nonproductive fixed assets to total fixed assets.

Similarly, we define the productive profit margin (PPM) and productive asset turnover (PAT) as follows (Eq. (17)):

$$\text{PROA} = \frac{\text{EBIT} + W}{\text{PA}} = \frac{\text{EBIT} + W}{\text{Sales}} \frac{\text{Sales}}{\text{PA}} = \text{PPM} \cdot \text{PAT} \tag{17}$$

Notice that PPM and PAT should have purged the effect of welfare burden, but PAT is still subject to the effect of soft loans.

Using these productive profitability measures, we run regression Eq. (4) again. The results are reported in Table 5. From Table 5(A), we see that SOEs now performed significantly better than FOEs and HMTs. In effect, measured by PROA, the performance of SOEs was close to the performance of POEs. Furthermore, COEs performed significantly better than POEs. These observations imply that welfare burdens were indeed significant and that SOEs and COEs had suffered more from such burdens than nonstate firms, either domestic or foreign. Finally, Table 5(B,C) show that in terms of PPMs, COEs, and SOEs were statistically indistinguishable from each other but were significantly better than both domestic and foreign nonstate firms. However, SOEs still showed the worst performance in PAT.

Based on these results, we may conclude that welfare burdens are an important factor affecting the performance of SOEs and COEs as measured by conventional ROA. After controlling for welfare burdens, however, the performance of SOEs is still dismaying in terms of AT. This is consistent with our model prediction with respect to the soft-loans problem faced by SOEs. On the other hand, it does not appear that COEs had excess capital (low AT), suggesting that COEs might also have easy access to soft loans.

Table 5
Regression analysis of PROA

	Intercept	COEs	POEs	FOEs	HMTs
(A) PROA	0.168***	0.051***	0.009	−0.022***	−0.022***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
(B) PPM	0.265***	−0.003	−0.026**	−0.053***	−0.067***
	(0.012)	(0.010)	(0.011)	(0.011)	(0.009)
(C) PAT	0.653***	0.315***	0.144***	0.028	0.039**
	(0.026)	(0.021)	(0.024)	(0.025)	(0.019)

The table reports the results of the regression (Eq. (15)) with ROA* being replaced by PROA. The estimates for industry dummies and year dummies are omitted here for brevity.
The first row for each item is the mean and the second row (in parenthesis) is the standard deviation.
The intercept term represents the base case of SOEs, while the other coefficients represent the *differences* to the base case.
PROA is defined as (EBIT + *W*)/PA, PPM as (EBIT + *W*)/Sales, and AT as Sales/PA. *W* is welfare expenses and PA is net productive assets.

** The *t* ratio of the coefficient exceeds the 5% critical value.

*** The *t* ratio of the coefficient exceeds the 1% critical value.

4.4. Profitability and productive efficiency: a reconciliation

Now we try to put all the pieces together. We have argued that the conventional measurement of profitability, namely ROA, gives a biased measure of performance due to the effect of capital structure and differential taxes, and that therefore a better measurement is called for. An adjusted ROA based on earnings before interest and taxes may be more appropriate for performance comparisons across firms with different ownership structures. The revised performance measurement, ROA*, presents a quite different picture to that presented by conventional measurements: somewhat surprisingly, according to ROA*, the domestic nonstate sector outperformed the foreign-funded sector during the 1996–1998 period. This result stands in stark contrast to the efficiency difference measured by conventional performance criteria in Section 4.1.

How can one reconcile this apparent contradiction between productive efficiency and profitability? Consider first the effect of welfare burdens. It was noted that welfare expenses and nonproductive assets affected mostly SOEs and COEs and had little influence on private firms, either domestic or foreign. Besides, without considering welfare burdens, the two members in the domestic nonstate sector, namely COEs and POEs, had similar profitability. After purging the effect of welfare burdens, however, the PMs between the two are driven apart. This interesting phenomenon sheds a different light on the contrast between the private and nonprivate sectors. Perhaps the welfare burdens are not the burdens that they appear to be on the surface. Given the fact that the income of the Chinese working population is generally low, wage income alone might not be sufficient to support the workers and their families without the welfare subsidies by the enterprises. Therefore, in a sense, welfare support could be considered as an inseparable part of compensation to the workers. This suggests that the welfare expenses and nonproductive assets of SOEs and COEs may be part of the true cost of labor, rather than an exogenously imposed burden.

On the other hand, the domestic and foreign private firms must pay a wage at ''market rates'' to compensate for not offering permanent employment and extensive welfare services. Private firms are relatively new in China, so their wages must contain a risk premium in order to be competitive in the labor market. Therefore, SOEs and COEs may still enjoy a lower effective cost of labor despite their welfare burdens. We thus conclude that if all the firms were equally efficient, then the private firms would show a lower profitability owing to high labor costs relative to SOEs and COEs.

However, firms are not equally efficient. In particular, SOEs were on average less efficient than firms in all the other categories of ownership. SOEs employed excessive amount of capital as compared with other firms including COEs. This may be due largely to the soft-loans problem, leading to excessive capital investment, which has not only lowered SOEs' productive efficiency, but has also depressed their AT and profitability.

5. Growth in profitability and productivity

Having examined levels of profitability and productivity for firms of various ownership structures, we now turn to the changes in the level of profitability and productivity. This investigation is useful in that if SOEs' lower level of profitability and productivity is due to their low starting point at the beginning of industrial reform, then a faster growth rate in SOEs' profitability and productivity following the reform should reduce and eliminate the gap. Furthermore, Ehrlich, Gallais-Hamonno, Liu, and Lutter (1994) distinguished between the influence of ownership on firms' productivity levels and their growth rates, arguing that even facing the same production possibilities and having access to similar markets, enterprises of different ownership types may experience systematic differences in productivity growth rates. Therefore, it is also important to evaluate the productivity growth rates of Chinese enterprises under different ownership types.

We express profitability growth rates as the first difference of corresponding level measures. Given the analysis in Section 4, we shall use PROA as the level measure. As for the growth rate in productive efficiency, we use the Malmquist index, defined as (Eq. (18)):

$$M_{\mathrm{o}}^{t+1}(x^{t+1},y^{t+1},x^{t},y^{t}) = \left[\frac{D_{\mathrm{o}}^{t}(x^{t+1},y^{t+1})}{D_{\mathrm{o}}^{t}(x^{t},y^{t})}\frac{D_{\mathrm{o}}^{t+1}(x^{t+1},y^{t+1})}{D_{\mathrm{o}}^{t+1}(x^{t},y^{t})}\right]^{1/2} \tag{18}$$

where D_{o} is an input distance function. The distance function is the inverse of the input-oriented efficiency score, which is calculated using the DEA method (Fare, Grosskopf, & Lovell, 1994). The superscript on D_{o} indicates the time period for which the efficiency score is calculated. The superscripts on x and y, respectively, indicate the time period of the data used in the calculation of the efficiency score. The Malmquist index is commonly expressed in the following form:

$$M_{\mathrm{o}}^{t+1}(x^{t+1},y^{t+1},x^{t},y^{t}) = \frac{D_{\mathrm{o}}^{t+1}(x^{t+1},y^{t+1})}{D_{\mathrm{o}}^{t}(x^{t},y^{t})}\left[\frac{D_{\mathrm{o}}^{t}(x^{t+1},y^{t+1})}{D_{\mathrm{o}}^{t+1}(x^{t+1},y^{t+1})}\frac{D_{\mathrm{o}}^{t}(x^{t},y^{t})}{D_{\mathrm{o}}^{t+1}(x^{t},y^{t})}\right]^{1/2}. \tag{19}$$

Eq. (19) represents a decomposition of productivity growth into two component parts: the technological progress of the industry (the ratios inside the brackets on the right side) and the change in the firm's technical efficiency (the ratio outside the brackets). A change in the firm's technical efficiency is in reference to the production frontier in the two periods. A ratio of less than unity indicates an improvement in a firm's technical efficiency from period t to t+1. Likewise, for technological progress, a ratio of less than unity also implies that the technology of the industry has progressed from period t to t+1. Similar to the interpretation of its components, a Malmquist index of less than unity suggests an increase in the overall efficiency of the firm.

Table 6 presents the descriptive statistics for profitability and productivity growth rates (2-year averages). As can be seen, POEs had the highest growth rate in efficiency measured by the Malmquist index, although they also had the lowest AT, implying that their efficiency improvement mainly came from the increase in efficiency of labor and material inputs. Consistent with their productivity performance, POEs also had the highest growth rate in profitability as measured by PROA. HMTs had the lowest productivity growth rate of the five groups, but had average growth rates in PROA, owing to their best performance in AT. SOEs had the second best productivity growth rate but the second worst growth rate in PROA.

Table 7 presents the regression results of productive efficiency growth rates. On average, COEs have a Malmquist value that is 0.0631 higher than that of SOEs, and HMTs have a Malmquist value 0.0541 higher than that of SOEs. Both differentials are statistically significantly different from zero. FOEs and POEs have Malmquist values similar to SOEs and the differentials are statistically insignificant. The analysis thus suggests that the overall

Table 6
Descriptive statistics of profitability and productivity growth rates

	SOEs	COEs	POEs	FOEs	HMTs
PROA	−41.6	−28.2	−22.7	−53.0	−31.5
	(145.5)	(113.2)	(100.4)	(160.3)	(140.5)
PPM	−57.3	−35.0	−25.9	−68.5	−42.9
	(201.8)	(149.9)	(176.2)	(217.9)	(181.4)
PAT	−9.8	−10.3	−11.1	−8.7	−3.7
	(28.3)	(30.1)	(27.4)	(28.9)	(28.1)
Malmquist index	1.0266	1.0983	0.9985	1.0450	1.0987
	(0.4557)	(0.4610)	(0.3393)	(0.3456)	(0.4671)
Technical progress	1.0252	1.0239	1.0182	1.0536	1.0610
	(0.2552)	(0.2327)	(0.2467)	(0.2115)	(0.2359)
Technical efficiency	1.0510	1.1148	1.0228	1.0157	1.0733
	(0.5329)	(0.4697)	(0.4263)	(0.3486)	(0.4968)

The first row for each item is the mean, and the second row (in parenthesis) is the standard deviation.
PROA is defined as (EBIT+W)/PA, PPM as (EBIT+W)/Sales, and AT as Sales/PA. W is welfare expenses and PA is net productive assets.
The negative growth rates in PROA, PPM, and PAT are primarily due to the deflation experienced by the Chinese economy during the 1996–1998 period.

Table 7
Regression analysis of productivity growth rate

	Coefficient	S.E.	*T* statistic	Prob.>*T*
Malmquist index				
Intercept	1.0140	0.0249	40.752	.0001***
COEs	0.0631	0.0233	2.706	.0068***
POEs	−0.0135	0.0390	−0.346	.7291
FOEs	0.0037	0.0222	0.167	.8675
HMTs	0.0541	0.0187	2.895	.0038***
F value	2.900			
Prob.>*F*	.0001			
Adjusted R^2	.0146			
Technology progress				
Intercept	1.0033	0.0124	80.688	.0001***
COEs	−0.0077	0.0117	−0.661	.5084
POEs	0.0249	0.0195	−1.278	.2013
FOEs	0.0005	0.0111	0.047	.9627
HMTs	0.0117	0.0093	1.255	.2097
F value	29.385			
Prob.>*F*	.0001			
Adjusted R^2	.1812			
Technical efficiency				
Intercept	1.0449	0.0276	37.848	.0001***
COEs	0.0488	0.0259	1.885	.0595*
POEs	−0.0480	0.0433	−1.109	.2677
FOEs	−0.0272	0.0246	−1.103	.2699
HMTs	0.0235	0.0207	1.135	.2565
F value	3.3611			
Prob.>*F*	.0001			
Adjusted R^2	.0181			

The table reports the results of the regression (Eq. (15)) with ROA* being replaced by Malmquist index, technology progress, and technical efficiency, respectively. The estimates for industry dummies and year dummies are omitted here for brevity.

The intercept term represents the base case of SOEs, while the other coefficients represent the *differences* to the base case.

* The *t* ratio of the coefficient exceeds the 10% critical value.

*** The *t* ratio of the coefficient exceeds the 1% critical value.

efficiency of SOEs has, on average, improved relative to that of COEs and HMTs during 1996–1998, although as shown in Section 4.1, SOEs still had a lower efficiency level than COEs and HMTs.

The decomposition of the Malmquist index provides a way to detect the sources of the efficiency catch-up by SOEs. As can be seen from the second part of Table 7, the technological progress of SOEs is on average better than the firms in other ownership categories, except for COEs, although none of the differentials are significant. For technical

efficiency, however, SOEs have made greater progress than COEs and HMTs. The differential with respect to COEs (0.00488) is statistically significant. Thus, the catch-up in productivity by SOEs is attributable to technical efficiency improvement (rather than technological progress) vis-à-vis COEs, and it is attributable to both technical efficiency improvement and technological progress vis-à-vis HMTs.

Table 8
Regression analysis of PROA growth rate

	Coefficient	S.E.	*T* statistic	Prob.>*T*
PROA				
Intercept	−32.0249	4.0119	−7.983	.0001***
COEs	14.0828	7.2035	1.955	.0507*
POEs	25.4836	10.7646	2.367	.0180**
FOEs	−9.0091	7.1508	−1.260	.2078
HMTs	12.2235	5.9472	2.055	.0399**
F value	3.533			
Prob.>*F*	.0001			
Adjusted R^2	.0205			
PPM				
Intercept	−43.8314	5.5248	−7.934	.0001***
COEs	21.7325	9.9200	2.191	.0285*
POEs	43.2274	14.8240	2.916	.0036***
FOEs	−7.8106	9.8474	−0.793	.4277
HMTs	17.8418	8.1899	2.178	.0294**
F value	5.234			
Prob.>*F*	.0001			
Adjusted R^2	.0208			
PAT				
Intercept	−7.4624	0.8251	−9.0442	.0001***
COEs	−0.2447	1.4677	−0.167	.8676
POEs	0.3915	2.1965	0.178	.8585
FOEs	1.4996	1.4736	1.018	.3089
HMTs	6.6902	1.2135	5.513	.0001***
F value	13.042			
Prob.>*F*	.0001			
Adjusted R^2	.0214			

The table reports the results of the regression (Eq. (15)) with ROA* being replaced by PROA, PPM, and PAT, respectively. The estimates for industry dummies and year dummies are omitted here for brevity.
The intercept term represents the base case of SOEs, while the other coefficients represent the *differences* to the base case.
PROA is defined as (EBIT+*W*)/PA, PPM as (EBIT+*W*)/Sales, and AT as Sales/PA. *W* is welfare expenses and PA is net productive assets.

* The *t* ratio of the coefficient exceeds the 10% critical value.
** The *t* ratio of the coefficient exceeds the 5% critical value.
*** The *t* ratio of the coefficient exceeds the 1% critical value.

The regression results of PROA, PPM, and PAT growth rates are given in Table 8. On average, SOEs have significantly lower PROA and PPM growth rates than firms in other ownership categories except FOEs. In the case of FOEs, the differentials are statistically insignificant. Further, SOEs are in general worse than the other firms in PAT growth. In summary, SOEs showed generally a higher growth rate in productivity but a lower growth rate in profitability than firms of other ownership structures.

6. Concluding remarks

Our investigation has shown that an analysis of different measurements provides useful insight on the operating characteristics of Chinese enterprises under different ownership structures. The basic observation is that SOEs suffered from several structural problems that in general were not encountered by firms of other ownership structures. For example, SOEs were obligated to provide a wide range of social services to employees and their families by investing in many nonproductive assets. Our analysis suggests that the profitability measure based on profits before interest and taxes may be more appropriate for performance comparisons across Chinese industrial firms. The subsequent analysis, based on revised profitability measurements, suggests that the effects of capital structures, taxes, and welfare burdens were significant in determining firm performance. After controlling for these effects, both SOEs and COEs showed improved financial performance, although SOEs still lagged behind other Chinese firms in the profit level and profit growth.

Our analysis uncovers a cause for SOEs' poor financial performance. We find, as in Zhang et al. (2001), that SOEs exhibited the lowest efficient scores in productivity among the five ownership categories. Using the Dupont analysis, we further find that SOEs had adequate PMs, but they had poor ATs. After controlling for effects of capital structures, taxes, and welfare burdens, this phenomenon persists, suggesting that subsidized "soft loans" cause SOEs to employ excessive amount of capital, which is also a prediction of our stylized model, and lead to SOEs' inferior financial performance. This result provides support for treating banking reform as a priority item of the reform agenda.

Our analysis suggests two areas for further study. First, somewhat surprisingly, we have found that, according to revised profitability measures, domestic nonstate enterprises outperformed the foreign-funded enterprises during the 1996–1998 period. This finding stands in stark contrast to the finding of Section 4.1 that foreign firms, especially HMTs, were on average more efficient than domestic firms. Second, we find that although SOEs on average had a faster growth rate in productive efficiency than both COEs and HMTs during 1996–1998, they generally showed a lower growth rate in profitability than the firms of other ownership structures. A better understanding of this divergence between productivity growth and profitability growth has important implications not only for the assessment of the SOE reform but also for policy directions intended to deepen reform.

The divergence between profitability and productivity performance is closely related to three basic aspects of the SOE reform. The first aspect is the introduction of market competition, which includes competition from the nonstate sector. This "competition effect"

is consistent with our result that SOEs showed greater improvement in productivity than profitability in response to increasingly competitive markets. Second, many Chinese state enterprises during the reform are not profit maximizers. Given the "nonprofit maximization" assumption, Bai et al. (1997) point out that higher productivity can induce distorted managerial behavior that offsets the efficiency gain. For example, when the manager of an SOE is biased toward increasing output, high productivity may induce the manager to deviate further from profit-maximizing output level. Bai et al. demonstrate that, if the firm's output bias is sufficiently strong, an increase in productivity can lead to lower profit and, with additional qualifications, lower efficiency.

The third cause for the divergence derives from the "agency effect," as outlined by Zhang (1997). Since SOE reform may be characterized as a process of reassigning decision rights and residual claims from the state to the enterprise insiders, this motivates managers and workers to improve efficiency and pursue profits. On the other hand, managerial discretion brought by the decentralization can be abused to the extent that managers become actual residual claimants, although the state is the legal residual claimant of the enterprise. Due to information asymmetry and high monitoring costs, managers may reduce the profits submitted to the state by overstating costs and/or underreporting revenues. They also have many opportunities to spend the enterprise's resources for their own benefit. As a result, we have simultaneous improvement in SOE efficiency and decline in their profits. Empirical assessment of these three "theoretical" effects (competition, nonprofit maximization, and agency effects) would be a natural extension of the analysis presented here, although it is beyond the scope of the present paper.

Acknowledgments

We thank two anonymous referees and Chun Chang (coeditor) for very helpful comments and Andy Leung for excellent research assistance. Financial support from the City University of Hong Kong and the Research Grant Council of Hong Kong (Nos. 9040320 and 9040384) is gratefully acknowledged.

References

Bai, C., Li, D. D., Tao, Z., & Wang, Y. (2001). A multi-task theory of the state enterprise reform. *Journal of Comparative Economics* (in press).

Bai, C., Li, D. D., & Wang, Y. (1997). Enterprise productivity and efficiency: when is up really down? *Journal of Comparative Economics*, *24*, 265–280.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*, 1078–1092.

Banker, R. D., Charnes, A., Cooper, W. W., Swarts, J., & Thomas, D. A. (1989). An introduction to data envelopment analysis with some of its models and their uses. In J. L. Chan (Ed.), *Research in government and nonprofit accounting*, *vol. 5* (pp. 125–164). Greenwich, CT: JAI Press.

Chang, C., McCall, B., & Wang, Y. (2000). *Incentive contracting versus ownership reforms: evidence from China's township and village enterprises* (Working Paper). Carlson School of Management, University of Minnesota.

Chang, C., & Wang, Y. (1994). On the nature of the Chinese township–village enterprises. *Journal of Comparative Economics*, *19*, 434–452.

Charnes, A., Cooper, W. W., & Rhodes, E. L. (1978). Measuring the efficiency of decision-making units. *European Journal of Operation Research*, *2*, 429–444.

Charnes, A., Cooper, W. W., & Rhodes, E. L. (1981). Evaluating program and managerial efficiency: an application of data envelopment analysis to program follow through. *Management Science*, *27*, 668–697.

Chen, Y. (1996). Impact of regional factors on productivity in China. *Journal of Regional Science*, *36*, 417–436.

Chen, K., Jefferson, G. H., Rawski, T. G., Wang, H., & Zheng, Y. (1988). Productivity change in Chinese industry: 1953–1985. *Journal of Comparative Economics*, *12*(4), 570–591.

China statistical yearbook (1996). *China statistical yearbook*. Beijing: China Statistical Publishing House.

Dollar, D. (1990). Economic reform and allocative efficiency in China's state-owned industry. *Economic Development and Cultural Change*, *39*(1), 89–105.

Ehrlich, I., Gallais-Hamonno, G., Liu, Z., & Lutter, R. (1994). Productivity growth and firm ownership: an analytical and empirical investigation. *Journal of Political Economics*, *102*(5), 1006–1038.

Fare, R., Grosskopf, S., & Lovell, C. A. K. (1994). *Production frontiers*. Cambridge: Cambridge University Press.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistics Society, Series A: General*, *120*, 253–281.

Gordon, R. H., & Li, W. (1995). The change in productivity of Chinese state enterprises, 1983–1987. *Journal of Productivity Analysis*, *6*(1), 5–26.

Groves, T., Hong, Y., McMillan, J., & Naughton, B. (1994). Autonomy and incentives in Chinese state enterprises. *Quarterly Journal of Economics*, *109*, 183–209.

Jefferson, G. H., & Xu, W. (1991). The impact of reform on socialist enterprises in transition: structure, conduct, and performance in Chinese industry. *Journal of Comparative Economics*, *15*, 45–64.

Jefferson, G. H., Rawski, T. G., & Zheng, Y. (1992). Growth, efficiency and convergence in China's state and collective industry. *Economic Development and Cultural Change*, *40*(2), 239–266.

Li, D. D. (1996). Ambiguous property rights in transitional economics: the case of Chinese non-state sector. *Journal of Comparative Economics*, *23*, 1–19.

Li, S., Li, S., & Zhang, W. (2000). The road to capitalism: competition and institution change in China. *Journal of Comparative Economics*, *28*, 269–292.

Li, W. (1997). The impact of economic reform on the performance of Chinese state enterprises. *Journal of Political Economy*, *105*, 1080–1106.

Lin, J. Y. F. (1996). *State intervention, ownership and state enterprise reform in China.* Paper presented at the 23rd Pacific Trade and Development Conference, Taipei.

Lovell, C. A. K. (1993). Production frontiers and productive efficiency. In H. O. Fried, C. A. K. Lovell, & S. S. Schmidt (Eds.), *The measurement of productive efficiency: techniques and applications* (pp. 3–67). New York: Oxford University Press.

Lu, D., & Tang, Z. (1997). *State intervention and business in China*. Cheltenham, UK: Edward Elgar.

Schleifer, A., & Vishny, R. W. (1997). A survey of corporate governance. *Journal of Finance*, *52*, 737–783.

Seiford, L. M., & Thrall, R. M. (1990). Recent developments in DEA: the mathematical programming approach to frontier analysis. *Journal of Econometrics*, *46*, 7–38.

Steinfeld, E. S. (1998). *Forging reform in China: the fate of state-owned industry*. Cambridge: Cambridge University Press.

Stiglitz, J. E. (1994). *Whither socialism?* Cambridge, MA: MIT Press.

Weitzman, M. L., & Xu, C. (1994). Chinese township–village enterprises as vaguely defined cooperatives. *Journal of Comparative Economics*, *18*, 121–145.

Woo, W. T., Hai, W., Jin, Y., & Fan, G. (1994). How successful has Chinese enterprise reform been? Pitfalls in opposite biases and focus. *Journal of Comparative Economics*, *18*(3), 410–437.

World Bank (1992). *Reform in 1990 and the Role of Planning*,Washington, DC.
Zhang, A., Zhang, Y., & Zhao, R. (2001). Impact of ownership and competition on the productivity of Chinese enterprises. *Journal of Comparative Economics*, *29*, 327–346.
Zhang, W. (1997). Decision rights, residual claim and performance: a theory of how the Chinese state enterprise reform works. *China Economic Review*, *8*, 67–82.
Zhu, T. (1999). China's corporatization drive: an evaluation and policy implication. *Contemporary Economic Policy*, *17*, 530–539.