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Ownership, Productivity Change, and Financial  
Performance in Chinese Industry<sup>1</sup>

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### Abstract

This paper investigates Chinese industrial productivity from 1980 to 1996. Results include series for foreign-linked, shareholding, and private enterprises. We find long-term productivity increase, with growth rates declining during the 1990s. Productivity outcomes outside the state and collective sectors are modest, with shareholding enterprises suffering productivity declines. The paper examines differences in marginal factor productivity across ownership types, considers the impact of business cycles on the interpretation of productivity trends, and documents a statistical relationship between the profitability of state enterprises, relative productivity performance of state firms, and entry of new firms outside the state sector.

JEL classification: L60, O17, P20.

## 1. Introduction

China's diverse industrial system, which spans numerous ownership categories and nearly eight million enterprises, is engaged in a challenging process of technological development and institutional change. Formerly dominated by state-owned enterprises (SOEs), industry now consists of three major segments: the large but shrinking state sector; urban and rural collectives (COEs), public-sector firms largely controlled by local governments, including rural township-village enterprises (TVEs); and a fast-rising group of enterprises outside the state/collective system that Chinese statistical compilations categorize as "other ownership" (*qita suoyouzhi*). With few exceptions, e.g. Perkins, Zheng and Cao (1995), previous studies of productivity focus almost exclusively on state and collective firms. This limitation is unfortunate because of the growing importance of foreign-invested, shareholding, and private domestic firms, that produced one-third of 1996 industrial output, more than the formerly dominant state sector (Table 1).

This paper offers the first analysis of aggregate industrial productivity trends that encompasses all major ownership forms, including major sub-sectors of the other category. We extend earlier results to obtain consistent productivity measures for state and collective industry from 1980 to 1996. The new estimates confirm earlier findings of a broad rise in total factor productivity for Chinese industry. Results for all industry and for three major ownership segments, i.e. state, collective, and other, share this upward trend. Productivity outcomes are unexpectedly weak for foreign-invested firms and particularly for shareholding enterprises. Results for the 1990s show a deceleration of productivity growth, with total factor productivity falling in the state sector and among shareholding firms from 1992 to 1996, but rising elsewhere. Since China's economy

reached a peak in 1993 and then entered a protracted cyclical downturn, our results include a cyclical component that may conceal more robust productivity trends.

Four features are noteworthy. One is the growing dispersion of trends in single-factor productivity marked by sharp increases in output per worker and accelerating declines in output per unit of fixed assets. A second is the surprising productivity drop for shareholding firms. The third is the central role of relative SOE productivity performance in driving its lagging profitability. The fourth is the striking disparity in returns to capital across ownership types.

Research on industrial productivity began with studies of SOE value added, capital, and labor. Studies of aggregate productivity change include several extensions: improved capital stock measures, inclusion of collective industry, incorporation of intermediate inputs, and detailed analysis of deflators (Chen et al, 1988; Jefferson, Rawski, and Zheng, 1992, 1996). Studies using aggregate data find that productivity in state industry rose at a modest rate from the late 1970s into the early 1990s. Over the same period, collective sector TFP growth appears considerably higher, but data issues dilute the robustness of this finding. These results are sensitive to the choice of deflators for output, materials, and investment goods, as inappropriate deflators can deliver misleading results. A complementary approach uses enterprise data from sample surveys to analyze productivity change. Results show broad agreement with the findings of the aggregate studies (Wu, 1996; Jefferson et al, 1999).

These productivity outcomes for the 1980s and early 1990s provide the empirical underpinning for two basic features of China's industrial transition. First, modest productivity growth in state industry furnished critical support for China's incremental

reforms. Had state industry, which was China's principal source of industrial output, fiscal revenue, urban social services, and exports, failed to deliver rising productivity in the initial stages of reform, economic pressures might have foreclosed the option of gradual reform (Jefferson, 1999). Second, the interplay between old and new types of firms leads to the relative deterioration of SOE profitability via declining competitiveness associated with the relatively slow growth of productivity in state industry.

Extending productivity analysis through the mid-1990s is complicated by changes in institutional and economic structures. The gradual alignment of Chinese statistics with standard international concepts has altered the definition of important variables. Many firms have shifted ownership classifications, e.g. when state enterprises reorganize as joint ventures or shareholding companies. Government reform and economic change lead to administrative measures such as the 1993 revisions within the broad classification of other enterprises. Structural changes, including the shortened workweek and the new practice of furloughs (*xiagang*), have affected the conditions of employment. Although we have attempted to produce consistent series that adjust for these changes, the error margins surrounding the data and results for 1992 to 1996 should be larger than in previous years. As in earlier studies, concerns about upward bias in the TVE output figures suggest a particularly large error margin for results related to the collective sector.

The following sections of this paper lay out our data and methods, analyze results for single and total factor productivity, pursue extensions based on the productivity results and the underlying data, and summarize findings.

## 2. The Data

China's National Bureau of Statistics (NBS and formerly the State Statistics Bureau) compiles data for state firms (SOEs), collectives (COEs, including township and village enterprises), and for firms organized under other ownership (OTEs). Official figures partition the OTE sector into classifications that changed substantially in 1993. Annex A describes these classifications and explains how we aggregate them into three components: foreign-invested enterprises (FIEs), shareholding firms (SHEs) and other domestic enterprises (ODEs).<sup>2</sup> Our data include all forms of ownership, but not all industrial enterprises, as they are confined to enterprises with independent accounting (*duli hesuan*) at and above the township (*xiang*) level. The data exclude village-level enterprises, individual (*geti*) proprietorships employing seven or fewer workers, and establishments whose results are incorporated into the accounts of other units, e.g. universities or research institutes.

Information for 1996 indicates that the data encompass 74 percent of gross industrial output (Table 1), but less than one-half million of China's nearly 8 million industrial enterprises (Table 2). A further difficulty arises because the number of independent accounting units within specific ownership categories changes, sometimes substantially, from year to year.<sup>3</sup> At the same time, focusing on independent accounting units reduces concerns about data quality. Chinese and international researchers have commented extensively on *shuifen* or upward bias in the output data for state and especially for collective industry (Woo et al, 1993; Jefferson, Rawski, and Zheng, 1996; Lardy, 1999). While sharp downward adjustments to TVE output following the 1995 industrial census confirm these suspicions, the greatest difficulties with collective

statistics probably arise at the village level, where many enterprises do not keep formal accounts (Wu Yunhe, 1994, 1997). Thus data limitations, while reducing the comprehensiveness of coverage, focus our analysis on the more reliable data segments.

Measurement of fixed capital begins with official data for the year-end original value of productive fixed assets, a category that excludes housing. First differencing provides annual data for gross additions to productive fixed assets. We subtract annual depreciation from these additions, deflate them using a price index for fixed assets (Table 3), and use the deflated figures to assemble the series for net (of depreciation), deflated, productive fixed assets shown in Table 4. Full details appear in Annex B.

Previous studies routinely use the number of workers to measure labor input. This ignores changes in labor quality and implicitly assumes a fixed workweek. New regulations that lowered the workweek from six to 5.5 days in 1994 and to five days in 1995 invalidate the assumption of a fixed workweek. Our adjustments to the labor data, described in Annex C, create a series of man-year equivalents based on the pre-1994 standard of a 6-day workweek.

The officially reported number of workers in mining, manufacturing, and utilities declined by 1.6 million (or 2.4 percent) in 1996, with SOE employment dropping by 2.7 percent (State Statistical Bureau, 1996, p. 96; State Statistical Bureau, 1997, p. 102). In addition, 1996 saw the first large-scale implementation of the furlough (*xiagang*) policy, under which workers are effectively laid off with reduced compensation. Prior to 1998, furloughed workers, most in the state sector, are classified as employed.<sup>4</sup> Therefore, our input measures in Table 4 overstate labor devoted to industrial production, especially for

SOEs, and especially in 1996. As we show in Annex C, this error has only a minor effect on our results.

China's economic reforms have altered the relative prices for industrial products and inputs. Therefore, we use separate price indexes to deflate outputs, material inputs, and new fixed assets to avoid the mistaken assumption of fixed relative prices. Data limitations prevent us from applying separate deflators to different ownership categories. The price indexes, shown in Table 3 and discussed in Annex D, come from surveys conducted since 1984 by the NBS Urban Survey Team.

China's 1995 industrial census introduced changes in the calculation of gross output, value-added, and intermediate inputs. We review these accounting changes in Annex E, which explains the adjustments made to create consistent output measures.

### **3. Single Factor Productivity**

By applying the methods outlined above and detailed in Appendices B through E, we obtain the time series for output and factor inputs shown in Tables 4a-c. This yields trends in single factor productivity for five ownership groups shown in Tables 5a-c.

We begin with productivity of fixed assets. Our previous study, focused on the period from 1988 to 1992, found that "China's financial system has permitted excessive allocation of investment funds to poorly selected industrial projects in the state sector" (Jefferson, Rawski, and Zheng 1996, p. 171). The present data reveal further declines in capital productivity after 1992, extending now to all sectors except collective industry. The decline in SOE capital productivity, which fell at an average annual rate of 3.42 percent from 1988 to 1992, accelerated to 7.72 percent per year between 1992 and 1996.

The annual decline in OTE capital productivity also accelerated from 6.27 percent during 1989-1992 to 18.83 percent between 1992 and 1996, led by a stunning drop of 30 percent per annum in capital productivity among shareholding firms from 1993 to 1996. Capital productivity also fell elsewhere in the OTE sector, with ODE and foreign-linked firms posting respective annual declines of 4.15 and 6.26 percent. The presence of sweeping, if uneven, reductions in capital productivity points to misallocation of investment funds as a central issue facing China's economic policy-makers.

In contrast to the broad decline in output per unit of fixed capital, labor productivity shows consistently rapid growth. With the exception of the shareholding sector, which enters the data only from 1993, growth of output per worker accelerated during 1992-1996 relative to the previous four years. SOE labor productivity grew at an 8.50 percent annual rate between 1992 and 1996, while the collective sector achieved a rate of 18.81 percent. The OTE sector recorded 9.76 percent annual gains, with advances in each category, although gains among SHE firms were the weakest. Rising labor productivity reflects initial efforts to eliminate redundant workers, especially in the state sector,<sup>5</sup> as well as continuing capital deepening. Rising output per worker indicates that some of the decline in capital productivity arises from substitution of capital for labor.

Growth of output per unit of materials was uniformly lower between 1992 and 1996 than during the previous four years. Productivity change in the state sector moved into negative territory, but productivity of intermediate inputs continued to grow in the collective and OTE sectors, although at a reduced pace.

Our review of single-factor productivity shows that, among the five ownership categories, only the collective sector exhibits rising productivity for all three inputs

between 1992 and 1996. Even here, modest downward adjustment of the output figures could push the growth of output per unit of capital and intermediates below zero. Within each sector, differentials between rates of single factor productivity growth have expanded, in some cases beyond 15 percentage points. Much has changed since the 1980s, when growth rates for individual single factor productivities were positive and more uniform. These new disparities make estimates of total factor productivity increasingly sensitive to the choice of weights used to combine the input indexes.

As mentioned above, classifications within the OTE sector changed in 1993. To ensure consistency within this sector, and also to explore the impact of changes in the macroeconomic environment on productivity outcomes, Tables 4 and 5 include measures of productivity performance covering 1993-1996 as well as 1992-1996. We first observe that moving the initial year forward from 1992 to 1993 causes virtually all measures of single factor productivity growth to decline. This is not unexpected, as 1993 represents a cyclical peak year. Comparison of productivity outcomes over 1993 to 1996 allows us to include the shareholding sector, for which data begin only in 1993. The weak performance of shareholding enterprises comes as a surprise, particularly the dramatic decline in output per *yuan* of fixed capital, which plunged in only three years from 1.56 to 0.62, a level far below the SOE average. Steeply declining capital productivity in the shareholding sector signals an important avenue for further research, especially since conversion to corporate organization was initially regarded as a privilege reserved for firms with strong management and superior financial performance.

#### 4. Total Factor Productivity

We calculate total factor productivity by combining the measures of partial productivity into a single index. To generate the required weights, we estimate factor output elasticities under the assumption that a Cobb-Douglas production function adequately represents the underlying technology. To the extent possible, we estimate separate production functions for each ownership category. The functional form is:

$$\ln \text{GVIO}_i = \ln A + \alpha_K \ln K_i + \alpha_L \ln L_i + \alpha_M \ln M_i + \varepsilon_i \quad (1)$$

where GVIO is gross industrial output, K, L, and M are inputs of capital, labor, and intermediate inputs and  $\varepsilon$  is an error term with the usual statistical properties. We assume constant returns to scale, so that  $\sum \alpha_j = 1$ , (where  $j = K, L, M$ ). The  $\alpha_j$ 's are, therefore, the weights used to combine measures of single factor productivity into a composite Cobb-Douglas index of total factor productivity. We estimate equation (1) for each of three ownership categories using data from China's 1995 industrial census, which reports input and output data by branch for state, township, and foreign-linked firms (including wholly-owned foreign firms and joint ventures; see Industrial Census Office, 1997). In equation (1),  $i$  represents the  $i$ th industrial branch ( $i = 1, \dots, 190$ ).

Estimating equation (1) is complicated by under-utilization of fixed assets and labor. Data for 111 products from the 1995 census showed an average capacity utilization rate of only 70 percent (State Statistical Bureau, 1997, pp. 454-455). Moreover, redundant industrial labor, especially in the state sector, led to large-scale furloughs beginning in 1996. As a result of this slack, we expect estimated output

elasticities for capital and labor to understate their true values. We find little evidence that firms purchased excessive input supplies. In contrast to the allocation of capital and labor markets, markets in intermediate inputs appear relatively complete and unfettered.<sup>6</sup> To avoid distorting the ratios among the elasticities, we restrict the estimate of  $\alpha_M$  to equal its measured factor income share, i.e.  $(GVIO-VA)/GVIO$ , where both gross output (GVIO) and value added (VA) are measured at current prices using 1995 data from Industrial Census Office (1997).

Elasticity estimates based on 1995 data are shown in Table 6. We apply SOE weights to measure TFP among shareholding enterprises, most of which originated in the state sector. We use TVE elasticities to calculate productivity performance for all collectives and for the ODE sector, which consists mainly of small firms more akin to TVEs than to the generally larger and more capital-intensive state enterprises.

The initial results of our analysis appear in Table 7, which shows the average annual growth of total factor productivity for Chinese industrial enterprises organized under state, collective, and other ownership arrangements.<sup>7</sup> The SOE and COE series extend from 1980 to 1996. The figures for OTEs are limited to the years 1988 to 1996.<sup>8</sup>

These results confirm that China's state and collective industry has attained substantial increases in total factor productivity. As in many other studies, collective industry surpasses SOE productivity gains by a wide margin. As noted above, possible upward bias in the COE output data threatens the robustness of this outcome.

Our results include for the first time other ownership (OTE) firms, which account for a rapidly growing share of aggregate output. Expectations that rapid TFP growth is driving the expansion of OTE's share in Chinese industrial output turn out to be only

partially correct. The other domestic enterprise (ODE) sector sustained TFP growth in the 2 to 3 percent range from 1988 to 1996, surpassing the state sector and nearly matching collective sector TFP gains between 1992 and 1996. However, weak productivity growth among foreign-invested firms, which are widely seen as more efficient and productive than domestic enterprises, and among shareholding enterprises depress overall performance in the other enterprise sector.

From a shorter-term perspective, the results for recent years show a tendency for TFP growth to decline from peak rates attained between 1984 and 1988. Between 1992 and 1996, productivity change in state industry becomes negative. Deteriorating performance is not limited to state enterprises; productivity growth also declines in the foreign-invested sector. Indeed, the most recent figures show reductions in TFP for nearly every ownership category between 1993 and 1996.

A completely unexpected outcome is the dramatic annual TFP decline of 7.96 percent in the shareholding sector during 1993-96. Data for the level of TFP (not shown) indicate that SHE firms, many selected from the top ranks of state firms, stood 6.0 percent above the comparable SOE average for 1993. By 1996, the TFP level among shareholding enterprises had fallen to 9.8 percent below the (declining) SOE figure.

We use sectoral gross value weights to combine the productivity results for state, collective, and other (OTE) ownership firms into a comprehensive TFP measure. The results, shown in Table 8, mirror the long-term trends for individual ownership categories. Estimated productivity shows a substantial increase of 57 percent between 1980 and 1996. Productivity growth accelerates during the 1980s, reaching a peak annual rate of 4.7 percent during the period 1984 to 1988. After falling back between

1988 and 1992 to rates attained in the early 1980s, aggregate productivity growth stalls after 1992, and turns negative after 1993.

With coverage amounting to 74 percent of 1996 industrial output, this initial estimate probably captures the overall pattern of productivity change, with acceleration during the 1980s followed by deceleration and near-stagnation in the 1990s. However, as Table 1 indicates, our data provide fuller coverage for the state sector than for the collective and other (OTE) ownership sectors. In 1996, state firms contribute 43.2 percent of sample output but only 28.5 percent of aggregate production. The segments omitted from our data include portions of the collective and other (OTE) sectors, particularly individual proprietorships and village-level industries, that have grown faster than the national totals. Although there is no direct link between output growth and productivity trends, we expect that truly comprehensive data would generate stronger productivity performance than the outcomes shown in Table 9, especially for the 1990s.

The results summarized in Tables 7 and 8 display an unprecedented dispersion of outcomes across ownership groups. Prior to 1992, we see a uniform pattern of rising TFP in each ownership category. After 1992, both state enterprises and firms operating under other ownership (OTE) suffer declines in measured productivity. The fragility of recent TFP gains for collectives and for the ODE and FIE components of the other category is evident from Table 7. Shifting the time frame from 1992-1996 to 1993-1996 sharply reduces estimated TFP growth in every ownership category.

This decline in TFP growth during the 1990s arises in part from cyclical factors. On the basis of reported rates of inflation and real output growth, Chinese industry attained cyclical peaks in 1985 (21.4 percent real growth), 1988/89 (14.6 percent) and

1993 (27.3 percent). Cyclical troughs appear in 1981 (4.3 percent real growth), 1986 (11.7 percent), and 1990 (7.8 percent). The terminal year of this study, 1996, forms part of an extended downturn during which reported real growth has fallen continuously from the 1993 peak (Industry Yearbook Editorial Committee, 1998, p. 21).

The results in Tables 7 through 9 understate trend rates of productivity growth by comparing performance in 1993, a year of high growth, steep inflation, and local TFP maxima, with 1996, a year of relatively slow growth, declining inflation, and low capacity utilization. To counteract this bias, Table 10 summarizes peak-to-peak and trough-to trough measures of TFP across two peak-to-peak and two trough-to trough cycles as well as the still incomplete trough-to-trough cycle beginning with 1990. These figures confirm the long-term trend of rising productivity. Our aggregate measure of TFP shows average annual growth of 2.99 percent measured from the 1981 trough to 1996. Once we avoid peak-to-trough measures, the earlier pattern of modest, and at times robust, productivity growth continues into the 1990s, at least until the 1993 peak. Table 10 also confirms the wide dispersion of productivity outcomes for the 1990s. The results suggest that slower productivity growth in state industry may not arise solely from cyclical fluctuations.

## **5. Extensions**

These productivity estimates and the underlying calculations can illuminate the operation of China's industrial system. We explore two extensions: interactions between productivity and profitability, and trends in marginal factor products.

Time-series data for Chinese industry display an apparent paradox between rising productivity and declining profitability. Some authors have sought to resolve the issue by attributing apparent productivity growth to errors of measurement (Woo et al, 1993). The present results strengthen the case for long-term growth of TFP during the reform era. Market-based interaction among different types of enterprises offers a more promising explanation of divergent trends in productivity and profits.

In prior work, we used 1990 enterprise data to show how financial pressures arising from market competition can function as effective inducements to reform (Jefferson and Rawski, 1995, p. 148). Singh, Ratha and Xiao (1993) found that SOE profitability is lower in provinces with rapid growth of industry outside the state sector, and that low provincial shares of SOE output are associated with high TFP levels in state firms, suggesting that robust rivals squeeze SOE profits and motivate greater SOE efficiency.

With observations for state and collective industry now extending from 1980 to 1996, it is possible to deploy time series data to further investigate the puzzling relationship between generally rising productivity and generally falling profitability. We identify two channels that have eroded the competitive advantage of state industry. One is a decline in the relative productivity of state industry, noted in a number of studies. The second is the erosion of barriers to entry, which led to a steep increase in the number of industrial enterprises (Table 2) and a concomitant erosion of SOE market power (Naughton, 1992). Specifically, we hypothesize that changes in SOE profitability, measured as the ratio of profit plus tax to gross output, are driven by differences in relative rates of productivity and by enterprise formation.

We test this hypothesis with the following simple regression model:

$$\text{PRORAT}_{\text{SOE},t} = \alpha + \beta \text{TFP}_{\text{SOE},t} + \gamma \text{TFP}_{\text{COE},t} + \theta \text{NUM}_t + \varepsilon_t \quad (2)$$

where  $\text{PRORAT}_{\text{SOE}}$  is the ratio of profit plus taxes to gross output in state industry,  $\text{TFP}_{\text{SOE}}$  and  $\text{TFP}_{\text{COE}}$  represent the indexes of total factor productivity for state and collective industry,  $t$  denotes time, and  $\text{NUM}$  is the number of industrial firms classified as independent accounting units outside the state sector. All variables are measured as natural logs of three-year moving averages.<sup>9</sup>

The estimation results, shown in Table 11, are consistent with the intuition that a rise in SOE productivity, holding COE productivity fixed, raises SOE profitability. Conversely, a rise in COE productivity with no corresponding increase in SOE productivity erodes competitiveness and profitability in state industry. The unexpected result is that, holding productivity fixed throughout industry, an increase in the number of enterprises outside state industry raises rather than reduces state industry profitability.

We anticipated that, by shifting out the supply function of the competing non-state sector, the entry of new firms would erode monopoly profits within the state sector. This perspective overlooks the dual role of new firms. Competition from newcomers may undercut the profitability of incumbent producers. But new firms may enhance the profitability of established producers by assuming complementary roles as suppliers or sub-contractors, thereby diminishing the excessive vertical integration characteristic of China's plan system. Our results show that, after controlling for productivity changes, new entrants served to enhance profitability in state industry from 1980 to 1996.

Bai, Li, and Wang (1997) attribute the apparent paradox of rising productivity and falling profitability in China's state sector to declining returns to scale and weak pursuit of profits within the state sector. This explanation, already challenged on empirical grounds by Jefferson, Zhang, and Zhao (1999), rests entirely on the internal governance of state enterprises. Our result, which explains SOE profitability in terms of relative productivity change and the establishment of new firms outside the state sector, underscores the importance of market competition and institutional diversity within China's industrial sector. This result supports the view that productivity offers a more reliable gauge of long-term industrial performance than profitability, particularly in transition economies.

Analysis of marginal factor returns offers a separate avenue for extending the application of information underlying the TFP results. Table 12 shows the value of marginal factor products for 1996 across five ownership groups. We interpret the ratio of maximum to minimum returns as indicative of the relative efficiency of factor markets.

Data for 1996 show that the value of marginal product for material inputs is similar across five ownership categories. This extends an earlier finding showing close correspondence between marginal returns to material inputs in state and collective industry during the 1980s (Jefferson, Rawski, and Zheng 1992, p. 255). These figures confirm that China has developed well-functioning markets for industrial materials.

Results for labor and capital are strikingly different. For labor, the 1996 value of marginal product in the ODE sector is more than 2.5 times the figure for SOEs. The marginal product of capital within the foreign-invested sector in 1996 is 3.38 times that of the SHE sector and more than twice that of the state sector. Wide dispersion in the

marginal returns to labor and capital across ownership types points to misallocation of labor and capital as constraints on industrial productivity growth. Massive layoffs of redundant workers, most in the state sector, began in 1996 and may have contributed to a convergence of marginal returns to labor. No comparable reform has affected capital allocation. Investment funds continue to flow mainly into SOE and shareholding firms, even though these sectors have the lowest returns to capital. Evidence of large gaps between the marginal product of fixed assets in different ownership groups, coupled with negative real interest rates (Rawski, 1999, Xie, 1999) and large-scale excess capacity (Guo, 1999, Rawski, 2000), signals the continuation of inefficient investment decisions that could lead to cumulative deterioration of productivity outcomes.

## **6. Conclusion**

Efforts to reform and restructure industry, the largest sector of China's economy, must confront issues of agency, monitoring, deregulation and institution-building that straddle the core of socialist transition. Measures of industrial productivity change have attracted considerable attention because they offer a convenient, albeit partial, metric for the progress of reform. Productivity studies can also identify promising directions for research built on complementary methodologies.

Previous research focuses on state and collective industry and neglects new types of firms that now contribute over one-third of China's industrial output. This paper systematically examines productivity outcomes across a universe that encompasses all major ownership forms, including the private, foreign-linked, and shareholding entities that have achieved the fastest growth during the 1990s. In addition to expanding the

range of productivity research, we also extend the period of analysis to cover the years 1980 to 1996.

Looking at the entire reform period from 1980 to 1996, we find consistent evidence of a rising trend in total factor productivity for the entire industrial sector and for each of three major ownership categories. We also find indications of productivity slowdown during the 1990s. By combining results from different ownership categories, we create an initial measure of aggregate TFP spanning all major ownership systems in China's sprawling and diverse industrial sector. This new aggregate measure reinforces earlier findings of long-term productivity growth. It also confirms the impression of a recent decline in productivity growth conveyed by separate measures for specific ownership types. Although cyclical factors obscure the exact dimensions of weakening productivity performance, it now appears that the 1990s witnessed an erosion of productivity momentum in China's industrial sector.

Among ownership categories, the collective sector consistently achieves the strongest productivity outcomes, although data concerns limit the robustness of this observation. Total factor productivity in the state sector grows modestly in the long term but declines between 1992 and 1996. Relatively weak productivity outcomes in the state sector are in part attributable to the transfer of high-performance firms and resources to new entities in the foreign-linked and shareholding sectors and to China's limited capacity to restructure failing enterprises by means of bankruptcy or mergers. Despite these institutional complexities, regression analysis linking trends in state sector profitability to changes in relative productivity and to new entry outside the state sector

shows that a complex web of market interactions affects financial outcomes in specific ownership groups.

The rapid increase in the output share of firms outside the state and collective sectors raises the possibility that this group, a heterogeneous composite of foreign-linked firms, shareholding companies, and (mostly private) non-shareholding domestic enterprises, might have greatly surpassed the productivity accomplishments of the traditional state and collective enterprises. Our findings do not confirm these expectations. Except for distinctively high labor productivity, neither the level nor the growth of productivity within this new sector differs widely from the accomplishments of China's state enterprises. Within the other ownership (OTE) group, firms that we classify as other domestic enterprises (ODE), a category dominated by unincorporated private firms employing eight or more workers, show the best results, with TFP levels comparable to the collective sector and 40 to 50 percent above the average for state enterprises.

Productivity outcomes for foreign-linked firms, presumably bolstered by their access to offshore funds, imported technology, and international management skills, are unexpectedly weak. Other than high labor productivity, results for foreign-linked firms reveal only a modest advantage over outcomes for the state sector. The TFP level for foreign-linked firms is consistently about 15 percent above comparable SOE figures. Both groups delivered anemic TFP growth between 1988 and 1996.

Except for high labor productivity, results for shareholding enterprises, which enter the data beginning in 1993, are uniformly poor. The data for 1993 to 1996 show a steep drop in output per unit of fixed assets and a sharp decline in TFP. By 1996, the

level of TFP as well as output per unit of capital and materials for shareholding firms, which were initially selected from the upper echelons of the state sector, had fallen below comparable averages for the state sector. If confirmed by subsequent research, these consistently weak results represent a serious threat to China's reform agenda, which depends heavily on the expectation that shareholding arrangements, which are key elements in the restructuring of both state enterprises<sup>10</sup> and rural collectives (TVEs),<sup>11</sup> can provide effective mechanisms for monitoring enterprise managers and operations.

Our finding of lackluster productivity growth across several key ownership sectors raises complex questions of causation. Weak productivity performance may arise from composition effects. The increased frequency of enterprise conversions and the acceleration of entry and exit may obscure associations between ownership and productivity based on the aggregate data used in this study. Until it becomes possible to track the performance of fixed samples of firms in different ownership categories, we cannot eliminate the possibility that enterprise conversions may have influenced our comparison of productivity differences over time and across ownership groups.

Enterprise governance may contribute to a productivity slowdown. Weak performance of foreign-invested firms and shareholding enterprises may signal that recent ownership reforms, including new public-private partnerships as well as restructuring within the public sector, have failed to deliver significant improvements in performance. These findings lend credence to critics who claim that neither joint ventures nor the new network of asset management companies established to exercise public ownership rights can eliminate the agency problems embedded in public ownership. Even so, strong productivity results for collective firms, many now

reorganized as "shareholding cooperatives" (*gufen hezuoshe*), often with partial government ownership, caution against hastily dismissing mixed ownership as unworkable. A balanced judgment on the viability of Chinese experiments with hybrid ownership forms must await the outcome of statistical research based on time-series data from stable enterprise samples as well as field studies that probe the operation of the new enterprise structures and associated institutions.

Evidence of a general productivity slowdown may reflect constraints imposed by the economic environment, particularly the legal, financial, and regulatory systems that frame China's enterprise system, rather than difficulties associated with specific forms of ownership. Limited progress toward the completion of reforms that facilitate routine transfer of resources from losers to winners may undermine industrial performance regardless of ownership.

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## Annex A

## Ownership Matrix

Table A-1 lays out the ownership categories used by China's National Bureau of Statistics (NBS) to classify industrial enterprises outside the state and collective sectors between 1988 and 1996. The classification system was restructured beginning in 1993. The new system eliminated some categories, e.g. joint ventures between collectives and domestic private firms, and introduced others, e.g. shareholding enterprises. The result of this complex and shifting classification structure is that desirable data categories cannot always be created. For example, since the shareholding category, which first appears in the data for 1993, includes firms with and without foreign investment, it is not possible to create a data category for 1993 to 1996 that includes all firms with some degree of foreign investment.

Faced with these complications, we adopt two approaches. First, we compile a data set that includes all available data for enterprises located outside the state and collective ownership systems. We call this the other enterprise (OTE) sector. In principle, the OTE data set includes all independent accounting units at or above the township (*xiang*) level that are neither state nor collective enterprises. The OTE sector is extremely heterogeneous. OTE firms include affiliates of giant multinational enterprises, e.g. Hitachi, small private Chinese firms, joint ventures between state- and collective-owned enterprises, and large shareholding corporations created by transferring assets from the state sector. As a result, overall OTE productivity trends can easily conceal large variations in the performance of different types of firms. Accordingly, we have

decomposed the OTE sector into three components.

The first, other domestic enterprises (ODEs), includes domestic firms outside the shareholding sector. The ODE component includes officially registered private firms employing 8 or more workers as well as shareholding cooperatives that are not part of the collective sector. The second category, foreign invested firms (FIEs), includes enterprises with direct foreign investment. The FIE category includes various types of joint ventures with overseas participation, as well as firms wholly controlled by overseas investors. The final component, shareholding firms (SHEs), is available only from 1993. This component is limited to enterprises officially recognized as shareholding companies. This includes enterprises whose shares trade on China's domestic stock exchanges or on international exchanges. The shareholding category also includes firms whose shares are not traded on any exchange; these shares are typically held by government agencies or state enterprises. The SHE category does not include the numerous small firms, many now identified as shareholding cooperatives (*gufen hezuoshe*) that have issued non-traded shares to employees and managers.

Table A-1  
Data Structure for Enterprises Outside the State and Collective Sectors, 1988-1996

| Data Categories,<br>1988-92   | Data Categories,<br>1993-1996   | Our Database<br>For 1988-1992  | Our Database<br>For 1993-1996                          |
|---|---|--|--|
| Domestic:<br>SOE-COE JV [1]<br>SOE-dom. Private JV [2]<br>COE-dom. Private [3]  | Domestic:<br>Private [a]<br>Domestic JV [b]   | Other Domestic<br>ODE<br>= 1 + 2 + 3 + 9                                   | Other Domestic<br>ODE<br>= a + b + f                   |
| Foreign-linked:<br>SOE -HQ JV [4]<br>COE- HQ JV [5]<br>JV with non-Chinese [6]<br>Control by HQ [7]<br>Foreign control [8] <sup>a</sup> | Foreign-linked:<br>Non-Chinese [c]<br>Overseas Chinese [d]<br>Shareholding [e]<br>Other firms [f] | Foreign-link FIE<br>= 4 +5 + 6 +7 +8<br>Shareholding SHE<br>No information | Foreign-link FIE<br>= c + d<br>Shareholding SHE<br>= e |
| Other firms [9]   |   |  |  |

<sup>a</sup> indicates foreigners who have no Chinese ethnicity or heritage

Note: JV = joint venture; HQ = Overseas Chinese (*huaqiao*)

## Annex B

## Measuring Industrial Capital

We begin with NBS figures for the year-end value of productive fixed assets at original cost (OPF\*) for a specific base year. In this study, 1979 serves as the base year for the state and collective sectors. Within the other ownership (OTE) sector, 1987 is the base year for other domestic (ODE) and foreign-invested (FIE) firms. For the shareholding sector (SHE), which first appears in 1993, we assume zero value for OPF\* at year-end 1992. The category of productive fixed assets refers to assets that are used in the production process (*shengchan yong*); it excludes housing, schools, hospitals, and other non-industrial facilities. The NBS data for OPF, like other fixed asset data, are not deflated to a consistent price base. Annual additions are added to the asset stock at current prices.

We calculate annual net additions to the stock of productive fixed assets by subtracting consecutive year-end values for OPF\* to obtain gross additions to productive fixed assets and deducting depreciation allowances (capital consumption, CC):

$$\text{Net Investment at current prices} = \text{NI}(t) = \text{OPF}^*(t) - \text{OPF}^*(t-1) - \text{CC}(t) \quad (\text{B-1})$$

We then deflate each year's net investment, using the investment goods price deflator ( $p_{kk}$ ) (see Annex D and Table 3):

$$\text{Net Investment at 1990 prices} = \text{DNI}(t) = \text{NI}(t) / p_{kk} \quad (\text{B-2})$$

We reconstruct a year-end measure of deflated net capital stock as follows:

$$\begin{array}{l} \text{Deflated year-end net value} \\ \text{of productive fixed assets} \\ \text{(at 1990 prices)} \end{array} = \text{DNPF}^*(t) = \text{DNPF}^*(t-1) + \text{DNI}(t) \quad (\text{B-3})$$

Finally, we construct an average annual measure of the deflated net capital stock by calculating the arithmetic average of successive year-end values:

$$\begin{array}{l} \text{Average annual net value} \\ \text{of productive fixed assets} \\ \text{(at 1990 prices)} \end{array} = \text{DNPF}(t) = [\text{DNPF}^*(t) + \text{DNPF}^*(t-1)]/2 \quad (\text{B-4})$$

The resulting series for the average annual net value of productive fixed assets for various ownership categories appear in Table 4.

## Annex C

## Measuring Labor Input

The NBS data refer to average annual employment in various ownership categories. The unit of measure is numbers of workers. Three issues arise. The first concerns non-industrial labor. Chinese industrial enterprises deliver large quantities of housing, education, medical care, and other non-industrial services to employees and their families. The value of these services is omitted from industrial output, but the input data include the resources devoted to non-industrial services. To eliminate this asymmetry, productivity analysis should either increase output value to reflect the delivery of services or reduce inputs by eliminating resources devoted to the delivery of services. We have consistently attempted the latter course.

The NBS data for fixed assets include series for the original value of productive fixed assets, i.e. assets used for production (*shengchan yong*). This series provides a straightforward and plausible means of removing housing and other non-industrial fixed assets from our analysis. Unfortunately, the labor data include no comparable series. We have attempted a downward adjustment of the labor data to remove personnel assigned to non-industrial duties in the following way. In an earlier study (Jefferson, Rawski, and Zheng 1996) we used data from China's 1985 industrial census and from subsequent World Bank enterprise surveys to estimate that non-industrial service (*fuwu*) tasks occupied 16% of SOE workers and 8% of COE workers fall in 1992. We apply the same percentages to the SOE and COE labor data for 1993 to 1996. We assume that enterprises in the other enterprise (OTE) sector do not assign significant numbers of

employees to non-industrial tasks, and make no adjustment to the reported employment totals on this account.

A second issue arises from recent changes in the length of the workweek. Studies of Chinese industrial productivity routinely use the number of workers to measure labor input. This approach ignores possible changes in labor quality and also assumes a fixed workweek. Beginning in 1994, the latter assumption is no longer tenable. Until 1994, a six-day, 48-hour week was the norm for workers throughout Chinese industry. On February 3, 1994, the State Council issued regulations that took effect on March 1, 1994 specifying that "staff and workers work eight hours a day and 44 hours, on the average, a week" (New Law Digest 1994, p. 8). On March 25, 1995, the State Council announced further changes, effective from May 1, 1995, specifying that "staff and workers shall work eight hours a day and forty hours a week" (New Law Digest 1995, p. 7).

For 1993 and all prior years, we assume that the typical work-year consists of fifty 48-hour weeks, or 2,400 annual hours. The typical work year declines to  $50 \times 44 = 2,200$  hours after March 1, 1994 and to  $50 \times 40 = 2,000$  hours from May 1, 1995. We estimate the typical work-year for 1994 as  $2400 \times (2/12) + 2200 \times (10/12) = 2,233$  hours, or 7 percent below the 1993 figure. For 1995, the typical work year is  $2200 \times (4/12) + 2000 \times (8/12) = 2067$  hours, 13.8 percent below the 1993 figure. For 1996, the work year is 2,000 hours, or 16.7 percent below the 1993 figure. Our adjustment for reductions in the workweek consists of deducting these amounts from the NBS work force totals. Although longer hours continue in some firms (Couzin 1999), published sources and interview data indicate that the new regulations have been widely implemented in all ownership categories, including private businesses. We therefore apply these

adjustments to all categories of firms.

Implementation of the furlough (*xiagang*) policy for reducing redundant personnel represents a third issue surrounding the measurement of industrial labor. Beginning in 1993, Chinese enterprises, particularly in the state sector, began to implement a new policy called furlough (*xiagang*) under which workers were relieved of their duties but continued to receive partial wage payments from their employers. NBS officials confirm that furloughed workers continued to be included in the industrial data as workers and employees (*zhigong*) prior to 1998. Beginning with the data for 1998, the number of workers and employees is explicitly restricted to personnel who are on the job (*zaigang zhigong*; State Statistical Bureau 1999, p. 177).

Although we have no precise data, the order of magnitude the *xiagang* phenomenon is well established. A typical report states that the number of furloughed urban workers had reached 8.15 million by the end of 1996, of whom 5.42 million were furloughed from state enterprises (Yang Yixiong 1998, p. 220). The unadjusted SOE labor data for 1996 show average annual employment of 42.05 million. We speculate that 5.4 million or 12.8 percent of these workers had been furloughed. Adjusting the labor data to reflect the impact of *xiagang* would raise the figures for SOE labor productivity and TFP during 1993-96, with the largest adjustment coming in the terminal year. However the impact on TFP trends is not decisive.<sup>12</sup> Since this adjustment does not alter the broad performance trend in the state sector, where furlough activity is heavily concentrated, we have made no adjustment to reflect the impact of *xiagang* on TFP measurement.

## Annex D

### Price Deflators

Because price trends for industrial products and for material inputs have diverged substantially during the reform period, we continue our practice from previous papers (Jefferson, Rawski, and Zheng 1992, 1996) of separately deflating the time series for industrial output, intermediate inputs, and fixed assets. We use price deflators which, since 1984, have been calculated by the State Statistics Bureau's Urban Survey Team. The lack of price data specific to ownership categories obliges us to ignore possible differences among price trends affecting different segments of industrial production. The implicit assumption of identical price trends is particularly inappropriate for foreign-linked firms, whose reliance on imported materials and export sales exposes them to price trends that may differ from those facing other firms.

The deflators used in this study extend price indexes developed in our prior work (Jefferson, Rawski, and Zheng 1996), which terminate with data for 1992. Price indexes for subsequent years come from the following sources:

Output: State Statistical Bureau 1997, p. 283 (ex-factory price for all industrial goods).

Fixed Assets: Investment Yearbook Editorial Committee (1997), pp. 7-8 (for 1992-1995) and Price Yearbook Editorial Committee (1997), p. 424 (for 1996).

Intermediate inputs: data provided by the National Bureau of Statistics.

## Annex E

## Accounting Changes in the Measurement of Industrial Output

Since the early 1950s, Chinese statistics for industrial output have focused on the gross value of industrial output (*zongchanzhi*). In connection with the national industrial census of 1995, NBS introduced a revised method of calculating gross value (Industrial Census Office 1996). The gross output data for 1995 appear in two forms: figures calculated according to the old method (*yuan guiding*) and figures based on the new method (*xin guiding*). Beginning in 1996, all figures are based on the new method (Industrial Census Office 1996).

Since our series covers 1980 to 1996, the easiest (and in reality, the only feasible) approach is to construct a consistent series of industrial output (GVIO) by converting the 1996 figures to the old method. To do this, we simply (1) multiply the 1996 gross value figures (new method) by the 1995 ratio of GVIO (old method) to GVIO (new method); and (2) add value-added tax to the resulting total. We make this conversion separately for each ownership category.

Symbols for Jefferson-Rawski-Wang-Zheng TFP paper – text  
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|               |   |
|---------------|---|
| ln            | natural logarithm   |
| <b>GVIO</b>   | <b>gross value of industrial output (GVIO) in</b>   |
|               | <b>current</b>  |
|               | <b>prices</b>   |
| K             | net value of fixed assets in original prices  |
| L             | total end-of-year labor input (persons)   |
| M             | intermediate inputs in current prices   |
| $\varepsilon$ | a stochastic error term   |
| $\alpha_j$    | weight used to combine measures of<br>single factor productivity, where $j = K, L,$<br>and $M$ .  |
| SOE           | state-owned enterprise  |
| COE           | collective-owned enterprise   |
| FIE           | foreign-invested enterprise   |
| OTE           | other-ownership enterprise  |
| ODE           | other domestic enterprise   |
| SHE           | shareholding enterprise   |
| PRORAT        | ratio of profits plus taxes to gross output   |
| TFP           | total factor productivity   |
| NUM           | number of industrial firms outside the state sector<br>classified as independent accounting units |
| $\beta$       | the estimated coefficient on $TFP_{SOE}$ in the<br>PRORAT equation.                               |
| $\gamma$      | the estimated coefficient on $TFP_{COE}$ in the<br>PRORAT equation.                               |
| $\theta$      | the estimated coefficient on NUM in the<br>PRORAT equation.                                       |

Additional symbols – Annex

|       |  |
|-------|--|
| OPF*  | year-end value of productive fixed assets at original<br>cost              |
| CC    | depreciation allowance (capital consumption)                               |
| NI    | net investment in current prices   |
| DNI   | net investment in 1990 prices  |
| pkk   | investment goods price deflator  |
| DNPF* | deflated year-end net value of productivity fixed<br>assets at 1990 prices |
| VA    | value added in current prices  |



## NOTES

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<sup>2</sup> The ODE component includes domestic private enterprises (*siying*) employing 8 or more workers, domestic joint ventures (*lianying*), and a small residual (*qita*) category.

<sup>3</sup> The number of SOEs rose from 79,731 to 87,905 in 1994/95 before declining in 1996. The combined total of independent units the FIE, SHE, and ODE categories rose five-fold from 12,534 in 1992 to 67,476 in 1996.

<sup>4</sup> Employment figures exclude inactive workers starting in 1998 (State Statistical Bureau 1999, p. 140).

<sup>5</sup> Recall that employment figures include workers on furlough (*xiagang*).

<sup>6</sup> Note the uniformity of returns to intermediate inputs across ownership types (Table 12).

<sup>7</sup> Because the growing divergence among trends in single-factor productivity makes TFP measures increasingly sensitive to variations in input weights, we made a second TFP calculation with weights derived from our 1987 cross-section analysis of SOE and COE firms, supplemented by 1995 weights for foreign-linked firms. The outcome did not differ substantially from the results shown here.

<sup>8</sup> The weights for the OTE sector are a linear combination of the elasticities used for the other domestic (TVE or collective elasticities), foreign-invested, and shareholding (SOE elasticities) sectors, weighted by gross output shares for the relevant year.

<sup>9</sup> We attempt other specifications, including one-year observations and various

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autocorrelation corrections (since the Durbin-Watson statistic falls in the indeterminate area). Alternative specifications generate similar outcomes, but the coefficient for SOE productivity loses some of its robustness.

<sup>10</sup> According to NBS official Xing Junling, restructuring had affected 20 percent of state enterprises as of 1996.

<sup>11</sup> Regional information illustrates the scope of TVE restructuring. In one district of Guangzhou, officials expected that collective enterprises would be “basically non-existent” by the end of 1998 (May 1998 interview). In Hunan, 72 percent of rural collectives have been restructured (Liu 1999) and “there aren’t many collective firms left” (Hunan Provincial TVE Management Office, 1999, p. 5). In Rugao, Jiangsu, the strategy is to “sell firms first and then turn them into shareholding entities” (Huang and Xu 1998, p. 7).

<sup>12</sup> Multiplying the adjusted SOE labor input for 1996 (Table 4A) by 0.872 to remove 12.8% of workers on furlough raises average annual TFP growth from -1.11 percent to -0.84 percent for 1992 to 1996, from -2.91 percent to -2.55 percent for 1993 to 1996, and from 1.72 percent to 1.78 percent for 1980 to 1996.