

The Impact of Economic Reform  
on the Performance of Chinese State Enterprises:  
1980–1989

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### **Abstract**

The effectiveness of China's incremental industrial reform between 1980–89 is investigated using a panel data set of 272 state enterprises. This paper applies a method that measures marginal products of factors and changes in total factor productivity (TFP) by comparing actual changes in output to actual changes in inputs and in the institutional environment. This paper finds that there were marked improvements in the marginal productivity of factors and in TFP between 1980–89. More importantly, the evidence shows that over 87 percent of the TFP growth was attributable to improved incentives, intensified product market competition, and improved factor allocation.

# 1 Introduction

Starting in 1978, China implemented a series of changes in the administration of its state-owned industrial enterprises aimed at improving productivity. In contrast to the “big bang” reform in post-communist Eastern Europe and the former Soviet Union, the reform in China proceeded in a controlled but progressive manner. Instead of privatizing state-owned enterprises *en masse*, China concentrated on enterprise restructuring by consolidating enterprise property rights at the municipal government level and by adopting a new enterprise governance structure that stressed enterprise autonomy and incentives. Instead of liberalizing prices overnight, China instituted marginal economic liberalization and marketization by introducing the “dual-track system” in the state industrial sector and by lowering bureaucratic barriers to entry to the once state-monopolized industries.

How successful was the reform in China’s state industry? The purpose of this study is to make use of by far the most comprehensive enterprise-level panel data available to evaluate the effectiveness of the reform in China’s industry between 1980–89. In particular, this study attempts to address the following questions. Did the reform increase enterprise productivity? If so, how much of the productivity gain was attributed to improved factor allocation between enterprises, to improved incentives within enterprise, and to intensified competition in product markets?

The empirical method used in the paper extends Gordon and Li’s (1995) method by incorporating the implications of market power in the formulation. This method measures marginal products of factors, changes in total factor productivity (TFP), and improvements in factor allocation by comparing actual changes in output to actual changes in inputs and in the institutional environment. The advantage of this method is that it allows the production functions to differ arbitrarily across enterprises *a priori*, a necessary requirement for this study since the sample enterprises are drawn from 30 two-digit industries in China and presumably use different technologies.

This study finds that there were marked improvements in marginal productivity of factors, in TFP and in factor allocation between 1980–89. The marginal productivity of labor increased by over 54 percent between 1980–89. The increase in the rate of return to capital investment was also substantial. The marginal productivity of intermediate materials stayed roughly at the same level. Growth in TFP was 4.68 percent per year between 1980–89 and accounted for over 73 percent of output growth, which was 6.37 percent. The remaining 27 percent of output growth was attributable to increases in factor inputs. The shifts in resources from less productive enterprises to

more productive ones increased output growth by 1.79 percentage point per year between 1980–89 and accounted for over 28 percent of output growth and 38 percent of TFP growth. Growth in bonus per worker and increases in product market competition contributed 2.29 percentage points to TFP growth, accounting for 49 percent of TFP growth and 36 percent of output growth. This study also finds that the market power of state enterprises, measured by market price to marginal cost markup, eroded by 15 percent between 1980–89.

These findings have implications beyond simply providing a better understanding of the performance of Chinese state enterprises during the reform period. They suggest that enterprise restructuring can improve enterprise performance even without formal privatization, and that the marginal economic liberalization as practiced in China can improve resource allocation when entry barriers to the state-monopolized industries are also lowered to foster competition.

Numerous papers have been written on the effects of economic reform on the productivity of Chinese state-owned enterprises/industry. Chen *et al* (1988), Jefferson *et al* (1996), Groves *et al* (1994b), and Woo *et al* (1994), among others, estimated total factor productivity growth of state enterprises or state industry during the reform years. Gordon and Li (1995) estimated the impact of various enterprise governance systems on TFP. Groves *et al* (1994a) studied the effects of enterprise autonomy and incentives on labor productivity. This paper differs from these earlier papers in that it investigates the impact of a comprehensive set of reforms—changes in incentives, factor allocation, and product market competition—on changes in total factor productivity. In doing so, I hope to draw a more comprehensive picture of how the Chinese economic reform affected the performance of state-owned enterprises. This paper differs from earlier papers also in that it takes advantage of the rich price information in the data by measuring the value of output and intermediate inputs in *market* prices rather than in *mixed* prices—weighted averages of market prices and plan prices, which are used in previous studies. Since the extent of participation in the emerging market products varied across enterprises, different enterprises often had different mixed prices for an identical product. By using market prices, this paper eliminates the possible errors in measuring real output and real inputs caused by the variations in mixed prices due to the differential participation in the dual-track system both over time and across enterprises.

The remainder of the paper is organized as follows. Section 2 reviews the reform. Since the nature and the availability of data are important in determining the empirical method, I first describe the data in Section 3 and

then derive the estimation equation in Section 4. Section 5 discusses some econometric issues. Section 6 presents and discusses the estimation results. Section 7 concludes.

## **2 The Reform**

Although the reform of China's state industry was implemented in an incremental manner, the content of the reform was hardly piecemeal from a microeconomic perspective. The various reform measures—the decentralization of property rights over state enterprises, the changes in enterprise governance structure, and the marginal liberalization of product markets—formed a rather coherent package; see Gordon and Li (1991) and Naughton (1995).

### **2.1 Decentralization: Changes in Property Rights**

Prior to the reform, a typical enterprise in China was controlled by a multitude of bureaucrats both in central ministries and in various levels of local governments. The rights of control over state enterprises were ill-defined. The residual claim to enterprise earnings was also unclear. While local governments were allowed at various times to retain some of the earnings from enterprises within their jurisdictions, they often managed to exceed their allowances through uncompensated use of enterprise resources.

Beginning in the late 1970's, the Chinese government took serious steps to consolidate the control of state enterprises. By the end of 1983, the vast majority of enterprises was transferred to local governments, primarily at the municipal level. This change was followed immediately by a series of fiscal reforms which effectively gave the residual claim to enterprise earnings to local governments. Under the new fiscal system, local governments collected taxes and profits from enterprises in their jurisdictions, part of which were then turned over to the central government. The prevailing practice was for the local government to deliver to the center a lump sum amount plus a small percentage of realized earnings in excess of target earnings. Local governments were thus treated as if they were conglomerates facing low marginal tax rates. By pairing control rights with residual returns, China in effect transferred property rights of state enterprises to local governments. These new owners should have the incentive to maximize the value of their enterprises.

## 2.2 Changes in Enterprise Governance

In response to the changes in property rights, local governments began to change enterprise governance by introducing various “managerial responsibility systems.” Under the new systems of enterprise governance, managers were delegated power to make many decisions, and managers as well as workers were given financial incentives—primarily bonuses—tied to enterprise performance. In most cases, bonuses were tied to the sum of turnover taxes and profits, reflecting governments’ interest in maximizing the value of the enterprises, which was the stream of taxes and remitted profits. This arrangement represented an attempt to align the interests of the managers and workers to those of the owners.

## 2.3 Marginal Liberalization

The pre-reform economy in China was based on state ownership of all means of production, which allowed the state to extract investable surplus from the economy by systematically distorting the allocation of resources (Li (1995)). To maintain the monopolistic economic system, allocation of real resources had to be made unresponsive to the distorted relative prices, and entry into the lucrative processing industries had to be restricted to prevent competition. In addition to distorting resource allocation, monopoly power made it easier for bureaucrats, managers and workers to pursue “a quiet life” by engaging in slack (Hicks (1935)).

When the rights of control of state enterprises were transferred to local governments, the once monopolistic industrial structure was effectively broken up into hundreds of regional conglomerates, immediately creating a competitive environment in which municipalities competed against each other. The bureaucratic barriers to entry into industries monopolized by state enterprises were also lowered gradually. Entrepreneurial local governments, collectives, private firms, and foreign investors responded swiftly by entering the lucrative processing industries to compete head-on against incumbent state firms. The newly founded firms operated mostly outside of planning by selling their output directly to buyers at market clearing prices. State enterprises were also permitted to sell their above-the-plan output to the emerging product markets after they fulfilled their plan quotas. These changes led to the emergence of the “dual-track system” in which the plan and the market co-existed, with the market allocating resources at the margin (Byrd (1989), Li (1996)). Under the dual-track system, state enterprises were directly exposed to increasingly active competition in the

emerging product markets, which should have reduced allocative distortions and managerial slack.

### 3 The Data

The panel data set used in this paper comes from an enterprise survey conducted by the Chinese Academy of Social Sciences (CASS) in 1990. Annual data from 769 state-owned enterprises between 1980–89 were collected, covering 321 variables that give details of enterprises’ real and financial accounts, price information, and internal incentives. The sample enterprises represent 36 two-digit industries in mining, logging, utilities, and manufacturing and are located in four provinces (Jiangsu, Jilin, Shanxi, and Sichuan). The same data set was used by Groves *et al* (1994a and 1995).

#### 3.1 Prices, Output and Inputs

In order to measure accurately the productivity of Chinese state enterprises, it is necessary to correct price differences both across time and *across enterprises*. While movement of prices across time, *i.e.*, inflation, exists in all economies, variation in price of an identical product due to factors other than transport costs and taxes was one of the unique characteristics of China’s transition economy. Under the “dual-track system,” an enterprise could pay different prices for the same input and sell the same output at different prices. As a result, the reported sales, the reported value of output and the reported expenditure on inputs were measured in mixed prices—weighted averages of market prices and plan prices. Since the extent of participation in the market varied over time for an enterprise and varied across enterprises, the mixed prices for an identical product would differ both over time and across enterprises in a complicated manner.

The CASS survey data contain detailed price information, which allows the construction of enterprise-specific indexes of mixed prices for output, raw materials, and the ratios of market prices to mixed prices for output and for raw materials. The enterprise-specific indexes of market prices for output and for raw materials can then be constructed. With the detailed price data on output and raw materials, the real value of output and raw materials (measured in market prices in 1989 and adjusted for inflation) can be compared both across time for any given enterprise and across enterprises at any given time more accurately in this study than in any previous study. The data, however, do not contain information about market prices of capital or enterprise-specific mixed prices of capital. An aggregate index

Table 1: Growth by Year (Percent)

Year	Output in 1989 Market Prices	Output in 1980 Plan Prices	Labor	Capital in 1989 mixed prices	Materials in 1989 market prices
1980–1	-0.1	4.5	6.2	7.1	5.1
1981–2	6.9	12.8	3.8	6.0	5.2
1982–3	7.8	11.7	1.0	6.1	6.8
1983–4	10.2	13.7	1.4	8.2	3.3
1984–5	5.1	10.2	2.3	7.4	7.1
1985–6	6.6	6.9	3.4	5.8	2.9
1986–7	12.0	14.4	2.1	6.5	5.9
1987–8	8.3	16.1	1.6	7.0	-1.6
1988–9	1.2	2.1	-0.3	5.7	0.3
1980–9	6.4	10.2	2.4	6.7	3.8

of mixed prices for capital is used here to deflate capital stock. Labor and capital are measured by what the enterprise has in place for production use. No adjustment is made for labor redundancy and capital under-utilization, which were common among state enterprises but are unobserved in the data. A brief discussion of the behavior of prices, and the definition of output and inputs is given in the Data Appendix.

Table 1 reports the average annual growth rates of output, capital and material input measured in 1989 prices and labor. For comparison, the table also lists average annual growth rates of output based on 1980 constant prices. Compared with the output growth rates measured in 1989 market prices, annual output growth rates measured in 1980 constant prices are on average biased upward by 3.8 percentage points between 1980–89!

What explains this upward bias? The 1980 constant prices were the prevailing plan prices on January 1, 1980, which given the price distortions in China, tended to overvalue processed goods relative to raw materials. With the economic liberalization, entrepreneurial local governments and non-state firms poured more resources into the lucrative processing sectors than into the primary goods sectors, fueling faster growth in the processing sectors. Since the output index based on 1980 constant prices gives exaggerated weights (the distorted 1980 prices in the processing sectors) to the faster

growing sectors, it is not surprising that this index overestimates output growth. Moreover, this upward bias in output growth might have led to upward biases in measured productivity in previous studies that measured real output using the 1980 constant prices,

### 3.2 Reform Variables

Since the consolidation of property rights and the delegation of power to managers affected almost all enterprises at roughly the same time, I use year dummies to capture their effects.

To measure the change in incentives that workers and managers faced, I use the annual growth rate of bonuses per worker. Measured in 1989 yuan after adjusting for changes in the cost of living, bonuses per worker among the sample enterprises stayed around 400 yuan between 1980–85 but rose quickly to 1013 yuan in 1989 after the administrative cap on bonuses was relaxed in 1985. Bonuses as a form of profit sharing were the most widely used explicit incentive in China,<sup>1</sup> and were certainly one of the most important incentives that an average enterprise employee faced. Bonuses were usually tied to the *sum* of turnover taxes and after-turnover-tax profits if this sum was positive or to a loss-reduction target if the sum was expected to be negative. Given that turnover taxes were highly distortionary, tying bonuses to the sum of turnover taxes and after-turnover-tax profits while subsidizing loss-makers by reimbursing part of the turnover taxes tended to undo tax distortions, an effect often neglected in the literature.

In order to study the effects of market competition on enterprise productivity, it is necessary to measure the change in market power for each enterprise over time. The markup ratio—the ratio of price to marginal cost—is an ideal measure of market power (Bresnahan (1988)). This measure, however, is not directly observable. There is nevertheless an observable variable that can serve as a proxy. This variable, call it  $C_{nt}$ , is the difference in year  $t$  between enterprise  $n$ 's inflation rate of market output prices ( $\pi_{nt}$ ) and its inflation rate of market prices of intermediate materials ( $\pi_{nt}^m$ ). That is,  $C_{nt} = \pi_{nt} - \pi_{nt}^m$ . By definition,  $C_{nt}$  represents the change in output prices relative to material input prices. Holding the unobserved implicit prices of capital and labor constant, a decrease in  $C_{nt}$  reflects a deterioration of en-

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<sup>1</sup>There are, of course, other ways to measure the extent of profit sharing by employees, but they are usually unsatisfactory. For example, the marginal rate of profit retention tends to exaggerate the extent of profit sharing, since part of the retained profits must be reinvested. A more serious flaw is that the rate of profit retention loses its incentive effects when the enterprise is expected to be a loss-maker based on after-turnover-tax profits.

enterprise  $n$ 's "terms of trade" relative to other enterprises and a squeezing of its profit margin. Therefore, for any given implicit prices of capital and labor,  $C_{nt}$  should be positively correlated with the change in enterprise  $n$ 's markup ratio.

## 4 Methodology

Measuring total factor productivity in a non-market economy is more difficult than in a developed market economy. The added difficulty arises because methods that are applicable in a market economy are *conditional* on certain assumptions that are not justifiable in the context of a non-market economy. For example, the most widely used method measures productivity growth using the Divisia index  $\dot{Q}/Q - \sum_i S_i \dot{X}_i/X_i$ , where  $Q$  represents output,  $X$  a vector of inputs used in production, and  $S_i$  is input  $i$ 's imputed share of output.<sup>2</sup> To estimate the imputed share  $S_i$ , the following two assumptions, which are unique to a canonical market economy, are usually made. First, the producers are cost-minimizers or profit-maximizers. Second, the economy is a mature market economy with developed product and factor markets, operating in a long-run competitive equilibrium. Under these assumptions,  $S_i$  can be easily estimated as  $W_i X_i/PQ$ , where  $W_i$  is the market price for the service of input  $i$ , and  $P$  the market price of output.<sup>3</sup> However, it is a widely accepted view that these assumptions are incompatible with a reforming socialist economy, such as the Chinese economy between 1980-1989. Hence the traditional method is not applicable here.

Notwithstanding the difficulties just mentioned, the available data put an additional constraint on methodology. The sample enterprises cover many different two-digit industries and four provinces in China. They presumably

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<sup>2</sup>See Solow (1957) and Jorgenson and Griliches (1967). This method measures productivity growth from the output perspective, *i.e.*, based on the production function. Other methods measure productivity growth using the cost functions (Caves *et al* (1980)), or cost frontier functions (Atkinson and Cornwell (1994)), or profit frontier functions (Lovell and Sickles (1983)). These approaches require that the firms under study be cost-minimizers or profit-maximizers, hardly realistic in the context of this study. In addition, they require the use of market prices for capital and labor, which are unavailable since there were no functional markets for labor or capital in the 1980s in China.

<sup>3</sup>These assumptions can be a bit too strong even in a developed market economy. The marginal products of quasi-fixed factors (*e.g.*, capital stock) may deviate from market prices in the short-run due to adjustment costs. Firms can have substantial market power in product markets. Modifications to the conventional method have been advanced to deal with these "imperfections." See Morrison and Diewert (1990) and the references cited there. These modified approaches, however, still require well-functioning factor markets.

used quite different technologies and were subject to the control of different governments. Therefore, an appropriate method should also have the flexibility to allow production functions to differ *arbitrarily* from one enterprise to another.

Unfortunately, this requirement rules out existing methods that do not rely on the market-economy assumptions. For instance, one such method postulates a parametric production function that is identical across firms,<sup>4</sup> in which the productivity is either measured as the regression residual (in the case of neutral technical changes) or as parameters in the production function (in the case of non-neutral technical changes). Since this method does not require the market-economy assumptions, it is applied not only to market economies but also to non-market economies. Its applications to China's economy are numerous; see for example, Chen *et al* (1988), Jefferson *et al* (1996), Groves *et al* (1994b), and Woo *et al* (1994) among others.

This section derives a method for measuring productivity in a non-market economy that allows production functions to differ arbitrarily across enterprises. This method extends Gordon and Li's (1995) method by incorporating the implications of market power in the formulation. It departs from the traditional approaches in that it estimates the value marginal products of factors directly from quantity data rather than using observed factor prices.

#### 4.1 Production Function

Enterprise output is determined not only by factor inputs, but also by the institutional environment that the enterprise faces.<sup>5</sup> Given labor  $L_{nt}$  and capital  $K_{nt}$  it has available, intermediate inputs  $M_{nt}$  it consumes, and the vector of institutional environment  $R_{nt}$  it faces, enterprise  $n$ 's output in year  $t$  can be written as

$$Q_{nt} = F_n(L_{nt}, K_{nt}, M_{nt}, R_{nt})A_{nt} \quad (1)$$

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<sup>4</sup>Other existing methods that do not require the market-economy assumptions but require identical production technology across firms include the production frontier function approach (Førsund *et al* (1980) and many others), and the distance function approach or the Malmquist index approach (Färe *et al* (1994)).

<sup>5</sup>It may be assumed that the enterprise output is determined by tangible factor inputs and the "effort levels" of enterprise managers and workers. The institutional production function can thus be thought of as a reduced form production function in which the "effort levels" of enterprise managers and workers are "maximized out" given the institutional environment that they face. See McMillan *et al* (1989).

where  $F_n$  is an enterprise-specific production function, and  $A_{nt}$  represents an enterprise- and time-specific random productivity shock. Allowing the production function to vary across enterprises captures the heterogeneity in production technology and the heterogeneity in enterprise response to the changing institutions. The production function can exhibit either increasing, decreasing or constant returns to scale with respect to factor inputs. This specification attributes productivity growth to institutional innovations or the reform,  $\Delta R_{nt} = R_{nt} - R_{n,t-1}$ , and technological innovations,  $\Delta A_{nt} = A_{nt} - A_{n,t-1}$ . It also attributes productivity gains to increased utilization of existing labor and capital, since labor and capital are measured by what the enterprise has in place, *i.e.*, the potential work hours of labor and capital or their opportunity costs, but not the actual work hours (Gordon and Li (1995)).

## 4.2 Measuring Changes in Total Factor Productivity

I take a finite difference of (1) between year  $t$  and year  $t-1$ , and divide both sides by  $Q_{n,t-1}$ . By applying a first-order approximation, I decompose the rate of output growth as:

$$\frac{\Delta Q_{nt}}{Q_{n,t-1}} = \sum_{X=L,K,M} P_{nt} A_{nt} \frac{\partial F_n}{\partial X_{nt}} \frac{\Delta X_{nt}}{P_{nt} Q_{n,t-1}} + \sum_j \frac{A_{nt}}{Q_{n,t-1}} \frac{\partial F_n}{\partial R_{jnt}} \Delta R_{jnt} + \frac{\Delta A_{nt}}{A_{n,t-1}} \quad (2)$$

The ‘‘coefficient’’ of  $\Delta X_{nt}/P_{nt} Q_{n,t-1}$ , that is,  $P_{nt} A_{nt} \frac{\partial F_n}{\partial X_{nt}}$ , is a first order approximation to the marginal product of factor X valued at year  $t$ ’s market price. The only element of approximation here arises from the use of finite rather than infinitesimal differences.

The marginal products of factors are evaluated in current market prices, which vary over time with inflation. In order to compare the value marginal product across time while preserving the changes in relative prices across enterprises, I multiply and divide the terms behind the first summation sign in (2) by  $P_{89}^*/P_t^*$ , where  $P_t^*$  is an aggregate index of market output prices. This yields,

$$\frac{\Delta Q_{nt}}{Q_{n,t-1}} = \sum_{X=L,K,M} W_{nt}^X x_{nt} + \sum_j \frac{A_{nt}}{Q_{n,t-1}} \frac{\partial F_n}{\partial R_{jnt}} \Delta R_{jnt} + \frac{\Delta A_{nt}}{A_{n,t-1}} \quad (3)$$

where

$$W_{nt}^X = \frac{P_{89}^*}{P_t^*} P_{nt} A_{nt} \frac{\partial F_n}{\partial X_{nt}}, \quad x_{nt} = \frac{\Delta X_{nt}}{P_{nt} Q_{n,t-1}} \frac{P_t^*}{P_{89}^*} \quad (4)$$

By definition,  $W_{nt}^X$  is the value marginal product of factor  $X$  in 1989 constant yuan and  $x_{nt}$  represents the change in factor  $X$  normalized by output.

If each factor is allocated efficiently, then its value marginal product will be equated across enterprises in each year, regardless of the difference in production technology. In general, however, the value marginal product will differ across enterprises. To identify the source of the variation, I factor  $W_{nt}^X$  into two parts:

$$W_{nt}^X = \frac{P_{nt}}{MC_{nt}} \cdot \left[ MC_{nt} A_{nt} \frac{\partial F_n}{\partial X_{nt}} \frac{P_{89}^*}{P_t^*} \right] \quad (5)$$

where  $MC_{nt}$  is enterprise  $n$ 's marginal cost in year  $t$ . The first part,  $P_{nt}/MC_{nt}$ , is the markup ratio. It varies across enterprises if the market structure and governmental regulations they faced were different. The second part is the value marginal product evaluated at marginal cost and then converted into 1989 constant yuan. It varies over time, if the economic reform had any impact on factor allocation. It varies across enterprise, if factors were misallocated. Misallocation of factors would have occurred if enterprises failed to maximize profits or to minimize costs, due perhaps to poorly assigned property rights, bureaucratic interference, and poorly aligned incentives for managers and workers. Variation in value marginal products across enterprises may have also arisen due to heterogeneity in factors, factor fixity, and possible approximation errors.

In order to test the hypotheses that there were improvements in factor allocation and that competition in the emerging product markets had disciplinary effects on the behavior of state enterprises, I postulate a parsimonious parametric specification for  $W_{nt}^X$ . First, I assume that the value marginal products of factors evaluated at marginal cost can be represented by the following linear specification:

$$MC_{nt} A_{nt} \frac{\partial F_n}{\partial X_{nt}} \frac{P_{89}^*}{P_t^*} = w_1^x D_{1t} + w_2^x D_{2t} + (\beta_1^x D_{1t} + \beta_2^x D_{2t})(x_{nt} - \bar{x}_t) \quad (6)$$

where  $D_{1t} = 1$  if  $1980 \leq t \leq 1984$  and 0 otherwise and  $D_{2t} = 1 - D_{1t}$ . The period dummies  $D_{1t}$  and  $D_{2t}$  are included to capture the effects of deepening reform on factor productivity.

The first component in (6),  $(w_1^x D_{1t} + w_2^x D_{2t})$ , measures the average value marginal product both before and after 1985. If the deepening of the reform had a positive impact on factor productivity, one would expect that  $w_2^x > w_1^x$ . The second component,  $(\beta_1^x D_{1t} + \beta_2^x D_{2t})(x_{nt} - \bar{x}_t)$ , relates the value marginal product to changes in factor allocation. It attempts to capture how factors were reallocated in response to economic liberalization.

If an enterprise had above-average factor productivity, say labor productivity, then there would be an efficiency gain if more labor was allocated to the enterprise relative to other enterprises. In other words, there is an improvement in the allocation of factors, if  $\beta_1^x > 0$  and  $\beta_2^x > 0$ . This parameterization therefore allows one to test whether the economic liberalization resulted in improved allocation of factors.

Second, I assume that the change in markup ratio over time is proportional to the change in output prices relative to input prices:

$$\frac{P_{nt}}{MC_{nt}} - \frac{P_{n,t-1}}{MC_{n,t-1}} = \theta C_{nt} \quad (7)$$

for  $t = 1981, \dots, 1989$ . Since in general  $C_{nt} = \pi_{nt} - \pi_{nt}^m < 0$ , a positive  $\theta$ , which is implied by the definition of markup ratio, means that the markup ratio declined over time and that competition in the emerging markets had disciplinary effects on the behavior of state enterprises. To derive a specification for the level of the markup ratio, I assume that the markup ratio in 1989 is different across industries, but identical across enterprises within the same industry. Specifically,

$$\frac{P_{n,89}}{MC_{n,89}} = \sum_{h=1}^H \mu_h I_{nh} \quad (8)$$

where  $\mu_h$  is industry  $h$ 's markup ratio,  $I_{nh}$  is an industry dummy variable which equals 1 when enterprise  $n$  is in industry  $h$  and 0 otherwise, and  $\sum_h I_{nh} = 1$ . Although in principle one could include a dummy variable for each two-digit industry in the sample, doing so would leave some industries with too few observations. In the estimation, I regroup the sample into four industry groups ( $H = 4$ ): light industries ( $h = 1$ ), chemical industries ( $h = 2$ ), material industries ( $h = 3$ ), and machine industries ( $h = 4$ ).<sup>6</sup> Combining (7) and (8) leads to a parametric specification of the markup

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<sup>6</sup>Light industries include food, beverages, tobacco, textiles, apparel, leather, wood products, furniture, paper, printing, arts and crafts, and recreational equipment. Chemical industries include chemicals, pharmaceuticals, synthetic fibers, rubber, and plastic. Material industries include all mining industries, logging, water utilities, electric utilities, petroleum products, coke, building materials, and all metal products. Machine industries include electric and non-electric machines, transportation equipment, electronics, and instruments.

ratio for each enterprise in each year:

$$\frac{P_{nt}}{MC_{nt}} = \sum_h^H \mu_h I_{nh} - \theta \sum_{s=t+1}^{89} C_{ns} \quad (9)$$

In order to derive a regression equation that can be estimated using the available data, I assume further that each dimension of the reform leads to the same percentage change in output in all affected enterprises, implying that  $\frac{A_{nt}}{Q_{n,t-1}} \frac{\partial F_n}{\partial R_{jnt}}$  does not vary with  $n$ . Specifically, given the available data, I assume

$$\sum_j \frac{A_{nt}}{Q_{n,t-1}} \frac{\partial F_n}{\partial R_{jnt}} \Delta R_{jnt} = (\gamma_1^b D_{1t} + \gamma_2^b D_{2t}) B_{nt} + (\gamma_1^c D_{1t} + \gamma_2^c D_{2t}) C_{nt} \quad (10)$$

where  $B_{nt}$  is the growth rate in bonuses per worker and  $C_{nt}$  is the rate of inflation in output prices relative to material input prices. By interacting  $B_{nt}$  and  $C_{nt}$  with the period dummy variables, I can test whether the marginal effects of bonuses and competition were different at different stages of the reform.

Combining (3), (5), (6), (9), and (10) yields the following regression equation

$$\begin{aligned} \frac{\Delta Q_{nt}}{Q_{n,t-1}} = & \left( \sum_h^H \mu_h I_{nh} - \theta \sum_{s=t+1}^{89} C_{ns} \right) \sum_{x=l,k,m} \sum_{\tau=1}^2 D_{\tau t} [w_\tau^x + \beta_\tau^x (x_{nt} - \bar{x}_t)] x_{nt} \\ & + \sum_{\tau=1}^2 D_{\tau t} (\gamma_\tau^b B_{nt} + \gamma_\tau^c C_{nt}) + \xi_{nt} \end{aligned} \quad (11)$$

for  $n = 1, \dots, N$  and  $t = 1981, \dots, 1989$ . The error term  $\xi_{nt}$  is added to capture several sources of productivity variations not yet accounted for in the model and possible approximation errors.

The growth of total factor productivity (TFP), which measures the growth in output unexplained by increases in factor inputs valued at their average value marginal products, is simply

$$TFP_{nt} = \frac{\Delta Q_{nt}}{Q_{n,t-1}} - \left( \sum_h^H \mu_h I_{nh} - \theta \sum_{s=t+1}^{89} C_{ns} \right) \sum_{x=l,k,m} [w_1^x D_{1t} + w_2^x D_{2t}] x_{nt} \quad (12)$$

Compared to (11), the growth in TFP includes the growth of output attributable to reallocating resources from less productive enterprises to more

productive ones, which is

$$\text{AE}_{nt} = \left( \sum_h^H \mu_h I_{nh} - \theta \sum_{s=t+1}^{89} C_{ns} \right) \sum_{x=l,k,m} (\beta_1^x D_{1t} + \beta_2^x D_{2t})(x_{nt} - \bar{x}_t)x_{nt} \quad (13)$$

This index measures the change in allocative efficiency (AE) from inter-enterprise shifts in resources. The growth in TFP also includes the part of the growth attributable to the included reform variables. This part of TFP growth is measured by

$$\text{TFP-R}_{nt} = \sum_{\tau=1}^2 D_{\tau t} (\gamma_{\tau}^b B_{nt} + \gamma_{\tau}^c C_{nt}) \quad (14)$$

The remaining portion of the TFP growth is the error term  $\xi_{nt}$ .

### 4.3 The Error Term

The error term  $\xi_{nt}$  has a complex structure. It includes random technological shocks ( $\Delta A_{nt}/A_{n,t-1}$ ), unaccounted variations in marginal productivity of factors and marginal effects of bonuses and competition on output growth in (6) and (10), and possible approximation errors. It also includes variations in productivity arising from changes in labor redundancy and capital utilization that are caused by demand shocks or supply disruptions (*e.g.*, blackouts). In order to take advantage of the detailed nature of the panel data, I use the analysis of covariance approach to control for the specific effects by estimating coefficients from the “within” dimension of the data. Specifically, I assume that  $\xi_{nt}$  can be decomposed into three orthogonal parts,

$$\xi_{nt} = \lambda_t + \psi_n + \phi_{nt} \quad (15)$$

where  $\lambda_t$  and  $\psi_n$  account for the time- and enterprise-specific effects in  $\xi_{nt}$ , and  $\phi_{nt}$  with mean zero represents the idiosyncratic shock. In order to capture the implied covariance structure of the complex error term  $\xi_{nt}$ , I allow  $\text{Var}(\psi_n)$  to vary arbitrarily across enterprises and  $\phi_{nt}$  to have arbitrary serial correlation. In the estimation,  $\lambda_t$  and  $\psi_n$  are treated as fixed effects.

The time- and enterprise-specific shocks will likely be correlated with changes in factor inputs, regardless of whether the changes were made by enterprise managers autonomously or by the local government, since these shocks were likely to be observed by the decision-makers. They are also likely to be correlated with how policy changes were made, since the imple-

mentation of the reform was typically left to the local government. Using the within estimation technique with panel data eliminates these specific shocks from the regression equation by transforming the data through differencing. To obtain consistent estimates of the parameters one needs only to consider the endogeneity of the regressors with respect to the idiosyncratic shock  $\phi_{nt}$ . The economics here suggests that even the idiosyncratic shock  $\phi_{nt}$  is likely to be correlated with changes in factor inputs, changes in bonuses, and changes in enterprise markup, to the extent that enterprise managers observe  $\phi_{nt}$  and make autonomous decisions. To identify the model, one first needs to identify a set of instrumental variables.

#### 4.4 Instrumental Variables

The instrumental variables for consistent estimation of the model should cause important changes in the five potentially endogenous explanatory variables—normalized changes in factor inputs ( $m_{nt}$ ,  $l_{nt}$ ,  $k_{nt}$ ), changes in bonuses per worker ( $B_{nt}$ ) and changes in relative market prices ( $C_{nt}$ ). But they should be uncorrelated with  $\phi_{nt}$ . Although finding such instrumental variables is in general a tall order, the particular economic structure in China makes it possible. Below I discuss a set of five instruments.

Between 1980-89, the Chinese government continued to allocate a substantial amount of capital, labor and materials to state enterprises based on planning, while permitting them to engage in market trade after they fulfilled their planning obligations. With the economic reform, planned allocation of resources was gradually scaled down. Given that the government typically had quite a bit of room to adjust plan quotas both upward and downward, it is very unlikely that the plan quotas would have been affected by the idiosyncratic shock  $\phi_{nt}$ . Instead, the plan quotas were most likely to have been affected by the need to coordinate and enforce plans among enterprises so as to prevent disruptions to the traditionally rigid supply channels established under central planning. They were also likely to have been influenced by enterprise-specific effects  $\psi_n$ , macroeconomic fluctuations  $\lambda_t$ , as well as political concerns. Labor, for example, might have been allocated to an enterprise not because the enterprise needed to expand for economic reasons, but because the government feared the instability that rising unemployment could bring. In addition, the idiosyncratic shock  $\phi_{nt}$  could have been unobserved by the government as decision-making became more decentralized and less information was transmitted to the government in minute detail. It is therefore plausible that the quota allocations were uncorrelated with  $\phi_{nt}$ .

Plan inputs were part of the inputs that an enterprise used in production; changes in planned inputs are naturally correlated with  $l_{nt}$ ,  $k_{nt}$ , and  $m_{nt}$  in the regression. Since an increase in an enterprise's output quota reduced the enterprise's market demand and hence its market price under China's dual track system (Li (1996)), changes in output quota should have had negative influences on its market output prices and be negatively correlated with  $C_{nt}$  and  $B_{nt}$ . Changes in planned inputs and output quotas are therefore admissible instruments here. Let  $L_{nt}^s$ ,  $K_{nt}^s$ ,  $M_{nt}^s$ , and  $Q_{nt}^s$  denote, respectively, planned labor, capital, intermediate materials, and output quota for enterprise  $n$  in year  $t$ . The percentage changes in these quantities, denoted by  $\Delta L_{nt}^s/L_{n,t-1}^s$ ,  $\Delta M_{nt}^s/L_{n,t-1}^s$ ,  $\Delta K_{nt}^s/L_{n,t-1}^s$ , and  $\Delta Q_{nt}^s/Q_{n,t-1}^s$ , represent four instruments.

The fifth instrumental variable used here is the market price inflation in intermediate inputs,  $\pi_{nt}^m$ . It is plausible that price changes in the intermediate good markets were not caused in any important way by random fluctuations in a single enterprise's productivity. And it is expected that  $\pi_{nt}^m$  is negatively correlated with both  $C_{nt}$  and  $B_{nt}$ .

#### 4.5 Estimation Procedure

Because  $\sum_h I_{nh} = 1$ , the 1989 markup ratios for all four industry groups cannot be jointly identified. In the estimation, the 1989 markup ratio for the light industries is set to 1, that is,  $\mu_1 = 1$ . This is harmless since the other markup ratios and the marginal products of factors are identified up to a positive multiplier, which is the unobserved true value of  $\mu_1$ . In other words, the relative markup ratios and the relative marginal products of factors are identified. As a result, the total factor productivity is consistently estimated using (12).

The estimation is carried out in two steps. First, the enterprise-specific effects are eliminated by applying the following transformation to the data:  $y_{nt} - y_{n,89}$ . The resulting left-hand side variable is  $\Delta Q_{nt}/Q_{n,t-1} - \Delta Q_{n,89}/Q_{n,88}$ ,  $t = 81, \dots, 88$ . The usual "within" transformation,  $y_{nt} - \bar{y}_n$ , is not used here because it would result in regression equations that are very complicated in parameters, given that the model is non-linear in parameters and the parameters are time-variant.

Second, each regression equation in each year from 1981 to 1988 is treated as a regression equation in a group of eight "seemingly-unrelated" equations. In order to make use of the information from the cross-equation correlation among regression residuals ( $\phi_{nt} - \phi_{n,89}$ ) and cross-equation parameter restrictions, non-linear three stage least squares (NL-3SLS) is used to estimate

the equations using the instrumental variables discussed earlier (Gallant and Jorgenson (1979)). This procedure generates consistent parameter estimates if the instrumental variables are uncorrelated with  $\phi_{nt} - \phi_{n,89}$  in all equations.

Due to many missing observations and some obvious miscodes in the survey, the available data on the changes in prices, output, inputs, and reform variables, and on the added instruments, form a balanced panel data set consisting of 272 enterprises from 30 two-digit industries between 1981 and 1989. The regression is applied to the available data. The results are discussed below.

## 5 Results

### 5.1 Estimation Results

Table 2 reports the non-linear three stage least squares (NL-3SLS) estimates of (11). For comparison, the table also includes the estimates from the conventional seemingly unrelated nonlinear regression (NL-SUR). Comparing these estimates, a Hausman specification test strongly rejected the hypothesis that the regressors are exogenous.<sup>7</sup>

The parameters of the model are in general quite precisely estimated. Almost all of the estimates are significant at the 1% level. This is striking in light of the fact that the sample enterprises are quite heterogeneous.

#### *Markup Ratio*

Estimates of the markup ratios show wide variation in market power in China's industrial sector in 1989. The markup ratios of the three heavy industry groups in 1989 are markedly smaller than that of the light industries. The material industries ( $h = 3$ ) have the smallest markup—only slightly more than one-third of the markup in the light industries. The chemical ( $h = 2$ ) and machine ( $h = 4$ ) industries have somewhat larger markup ratios in 1989. They are respectively 48 percent and 41 percent of the markup ratio in the light industries. If the material industries' markup ratio were 1 in 1989, then the markup ratio would be 2.89 in the light industries, 1.19 in the chemical industries, and 1.39 in the machine industries. This finding is certainly consistent with the casual observation that light industrial goods, such as watches and television sets, tended to have higher relative prices in

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<sup>7</sup>The Hausman test statistic ( $\chi^2$ ) is 2200.9 with 19 rather than 20 degrees of freedom because the 20 parameters in the model are identified up to a positive multiplier.

Table 2: Regressions of Productivity Changes (N=272)

Coefficients	NL-3SLS		NL-SUR	
	Estimates	t-ratios	Estimates	t-ratios
$\gamma_1^b$	.089**	(3.384)	.067**	(4.680)
$\gamma_2^b$	.060**	(3.167)	.044**	(4.216)
$\gamma_1^c$	-.732**	(-7.811)	-.744**	(-10.475)
$\gamma_2^c$	-.456**	(-8.203)	-.532**	(-13.657)
$w_1^l$	8.749*	(2.176)	4.603	(1.897)
$w_2^l$	13.468**	(3.090)	7.909**	(3.505)
$w_1^k$	.025	(.205)	-.034	(-.548)
$w_2^k$	.411**	(3.922)	.249**	(4.023)
$w_1^m$	.999**	(8.534)	.856**	(13.147)
$w_2^m$	1.002**	(9.300)	.995**	(16.826)
$\beta_1^l$	1.893	(1.341)	1.572*	(2.573)
$\beta_2^l$	9.597**	(5.388)	3.321**	(3.822)
$\beta_1^k$	.006	(.133)	.003	(.173)
$\beta_2^k$	-.025	(-.680)	-.006	(-.271)
$\beta_1^m$	.553**	(6.131)	.493**	(10.534)
$\beta_2^m$	.355**	(3.905)	.297**	(7.141)
$\theta$	.158**	(4.174)	.127**	(5.296)
$\mu_2$	.482**	(7.755)	.615**	(11.720)
$\mu_3$	.346**	(7.869)	.449**	(13.232)
$\mu_4$	.411**	(6.770)	.468**	(11.188)

1. Estimation equation:

$$\frac{\Delta Q_{nt}}{Q_{n,t-1}} = \left( \sum_h \mu_h I_{nh} - \theta \sum_{s=t+1}^{89} C_{ns} \right) \sum_{x=l,k,m} \sum_{\tau=1}^2 D_{\tau t} [w_\tau^x + \beta_\tau^x (x_{nt} - \bar{x}_t)] x_{nt} + \sum_{\tau=1}^2 D_{\tau t} (\gamma_\tau^b B_{nt} + \gamma_\tau^c C_{nt}) + \lambda_t + \psi_n + \phi_{nt}$$

2. Instruments:  $\Delta L_{nt}^s/L_{n,t-1}^s$ ,  $\Delta M_{nt}^s/L_{n,t-1}^s$ ,  $\Delta K_{nt}^s/L_{n,t-1}^s$  (state allocation of factors);  $\pi_{nt}^m$  (inflation in intermediate input prices);  $\Delta Q_{nt}^s/Q_{n,t-1}^s$  (changes in in output quota); and  $I_{nh}$  (industry dummies),  $D_{1t}$  and  $D_{2t}$  (period dummies).

3. The markup ratio of the light industries is  $\mu_1 = 1$  by default.

4. \* denotes significance at the 5% level. \*\* denotes significance at the 1% level.

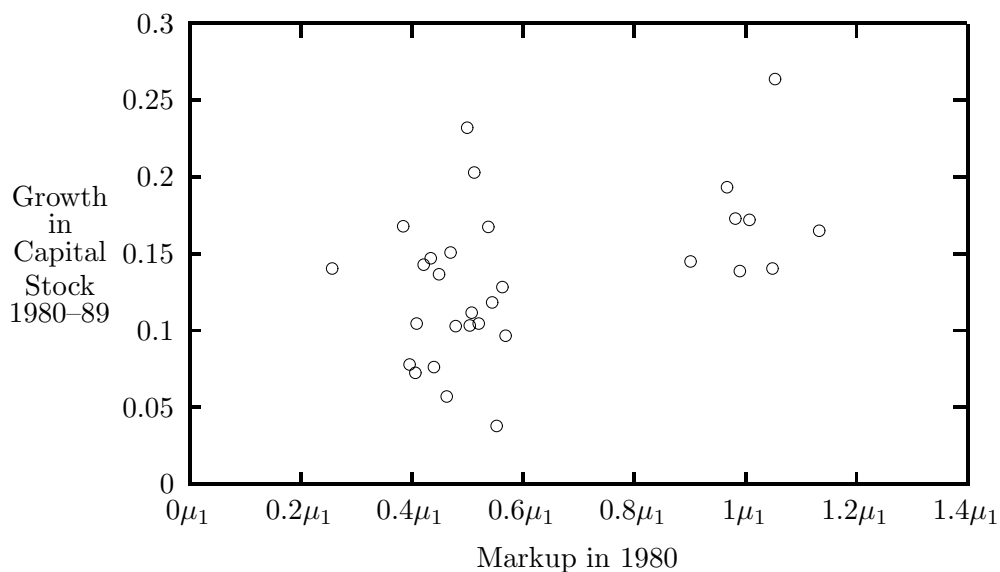


Figure 1: A positive correlation exists between the 1980 markup ratio and the aggregate growth in productive capital assets between 1980–89 at the two-digit industry level. Data on the growth of aggregate productive capital assets are from the State Statistical Bureau (1992).

China even in 1989 than in the world market, while capital and intermediate goods tended to have lower relative prices. Not surprisingly, this finding suggests that the economic liberalization in China in the 1980s was far from complete.

The markup ratios at the enterprise level in each year between 1980–88 can be constructed using (9). The key to this construction is  $\theta$ , which is estimated at 0.158. A positive  $\theta$  implies that the markup ratio declined between 1980–89, for in general the inflation rate of input prices exceeded the inflation rate of output prices (see the Data Appendix). Indeed, the markup ratio fell by 15 percent between 1980–89.

What could have caused state industries' markup ratios to fall? If China's economic liberalization were effective, it would have caused significant entry and expansion in industries that had higher profit margins. To test this hypothesis informally, I investigate whether the markup in 1980 as measured here is positively correlated with the aggregate investment growth between 1980–89 at the two-digit industry level. Figure 1 plots the aggregate

Table 3: Wald Tests of Improving Allocative Efficiency

Null Hypothesis	Alternative Hypothesis	Wald Statistics	Reject Null (1%)
$\beta_1^l = 0 \ \& \ \beta_2^l = 0$	$\beta_1^l > 0 \ \text{or} \ \beta_2^l > 0$	30.32 ( $\chi^2(2)$ )	Yes
$\beta_1^m = 0 \ \& \ \beta_2^m = 0$	$\beta_1^m > 0 \ \text{or} \ \beta_2^m > 0$	40.27 ( $\chi^2(2)$ )	Yes
$\beta_1^k = 0 \ \& \ \beta_2^k = 0$	$\beta_1^k > 0 \ \text{or} \ \beta_2^k > 0$	0.48 ( $\chi^2(2)$ )	No

annual growth rates in capital assets between 1980–89 (vertical axis) against the sample averages of the markup ratio in 1980 at the two-digit industry level. The plot reveals a positive correlation, indicating that more lucrative industries indeed attracted more investment than less lucrative industries.

#### *Marginal Products*

The value marginal product of labor increased by over 54 percent from  $8.749/\mu_1$  (measured in 1,000 constant 1989 yuan) in 1980–84 to  $13.468/\mu_1$  in 1985–89, where  $\mu_1$  denotes the true value of the markup ratio in light industries. The mean marginal product of capital increased even more dramatically from a statistically insignificant  $0.025/\mu_1$  to  $0.411/\mu_1$ . The mean marginal product of materials stayed at  $1/\mu_1$  in both time periods. A Wald test rejected the joint hypothesis that there is no change in the marginal products of all three factors from 1980–84 to 1980–89 at the 5 percent significance level. When tested individually, however, only  $w_1^k = w_2^k$  was rejected.

The increase in the mean marginal products of factors reflects only part of the improvement brought about by the reform. There was also a gain from improved allocation of factors. The estimated  $\beta$ 's for materials and labor are positive and statistically significant in both periods. The estimated  $\beta$ 's for capital in both periods are small in magnitude and are statistically insignificant. These results indicate that the reform resulted in more efficient allocation of labor and materials, but not capital. When tested formally (see Table 3), the null hypothesis that there was no change in efficiency of labor allocation, or  $\beta_1^l = \beta_2^l = 0$ , was rejected. A Wald test also rejected the null hypothesis  $\beta_1^m = \beta_2^m = 0$ . The test for capital, however, failed to reject the null hypothesis that there was no change in the efficiency of capital allocation.

The finding that there was a marked improvement in the allocation of materials is not surprising. Much of the improvement in materials allocation

was perhaps attributable to the dual track system that created a market for materials on the margin. What is surprising is the finding that there was a significant improvement in the allocation of labor in both periods, even when there was no functioning labor market in the state sector during the 1980s. Pinpointing what might have led to improved labor allocation is not so easy. There are, however, two possible explanations. The first, and perhaps the most important, is the consolidation of enterprise property rights. This change gave local governments the incentive to maximize the value of the enterprises they controlled. Given that the allocation of labor was primarily done by local governments, this should have motivated local governments to reallocate labor away from less productive enterprises to more productive ones within their jurisdiction. Second, the reform allowed some labor mobility. Although layoffs were virtually forbidden, enterprises were allowed to set up collectives where they could place their redundant workers. Employees were also given more flexibility to quit their jobs, whether they wanted to move to other state enterprises or to start their own businesses.

The finding that there was no visible improvement or deterioration in the allocation of capital at the enterprise level is not surprising. One could always point out that there was no capital market that directed funds to their most productive uses. In principle, however, the consolidation of enterprise property rights should have improved capital allocation among enterprises owned by the same government. But if so, this gain was apparently offset by a deterioration in the inter-governmental allocation of funds.

#### *Impact of Incentives and Competition on Productivity*

The growth of bonuses per worker had a significantly positive impact on the growth of total factor productivity. An increase in bonuses per worker by one percentage point raised TFP growth rate by .089 percentage point between 1980–84 and .060 percentage point between 1985–89. The difference in the impact of bonuses on productivity between the two periods was statistically insignificant. This finding confirms and extends the finding by Groves *et al* (1994a) that incentives improved labor productivity.

The increase in competition, or more precisely, the decrease in the relative price of output to material inputs between 1980–89 also contributed to productivity. Between 1980–84, a one percentage point reduction in the inflation rate of output prices relative to that of material input prices elicited a .732 percentage point increase in productivity. Between 1985–89, the elasticity of productivity with respect to competition was 0.456. This finding thus provides empirical support for the theoretical conjecture that competition promotes productivity. The drop in the elasticity of productivity with

Table 4: Annual Percentage Changes in Enterprise Performance

Year	TFP Growth	TFP Growth Attributable to Reform (TFP-R)	TFP Growth Attributable to Reallocation (AE)
1980-1	-2.18	2.20	2.43
1981-2	6.18	1.36	2.64
1982-3	6.26	-0.58	1.75
1983-4	10.75	7.16	1.47
1984-5	2.15	-1.56	1.90
1985-6	4.08	3.71	1.66
1986-7	8.36	7.31	1.83
1987-8	7.35	4.63	1.41
1988-9	-.12	-3.14	.98
1980-9	4.68	2.29	1.79

respect to market power between the two periods is statistically significant: A Wald test rejects the null  $\gamma_1^c = \gamma_2^c$  at 1 percent significance level. This suggests that changes in enterprise productivity in response to changes in market power exhibit diminishing returns. As market power winds down, an additional decline in market power brought less gain in productivity.

## 5.2 Changes in Enterprise Performance

Table 4 summarizes the weighted average annual growth rates of TFP, TFP growth attributable to incentives and competition (TFP-R), and TFP growth attributable to improvements in factor allocation (AE). The weight used was each enterprise's real output measured at marginal cost. The growth in TFP between 1980-9 was 4.68 percent per year on average, accounting for over 73 percent of output growth. The remaining 27 percent of output growth was presumably attributable to increases in factor inputs. Improvements in factor allocation (AE) contributed 1.79 percentage points to TFP growth, accounting for 28 percent of output growth and 38 percent of TFP growth. Improved incentives and intensified competition in product markets, TFP-R, contributed 2.29 percentage points to TFP growth, accounting for 49 percent of TFP growth and 36 percent of output growth. The study, therefore, finds robust growth in productivity in China's state

enterprises between 1980–89, and more importantly, that the growth can be attributed to the reform.

The growth of TFP, however, was far from steady. In Figure 2, I plot the movements of TFP, TFP-R and AE over time. For comparison, I also include the aggregate GNP growth rates in the figure (State Statistics Bureau (1991)). The enterprise TFP growth was cyclical and was positively correlated with the fluctuations in GNP growth. Sources of TFP fluctuations include the technological shocks ( $\Delta A_{nt}/A_{n,t-1}$ ), policy shocks (*e.g.*, TFP-R), and changes in resource allocation (*e.g.*, AE). The growth in TFP attributable to improvements in incentives and to market competition, or TFP-R, appeared to be procyclical. The improvements in allocative efficiency, AE, on the other hand, were much more steady and followed a declining trend, implying that the gain from marginal liberalization might exhibit diminishing returns. The measured TFP fluctuations are also likely to be influenced by demand shocks or supply disruptions that cause the variations in capacity utilization. In particular, aggregate demand shocks, which tend to cause counter cyclical variations in capacity utilization, can elicit procyclical fluctuations in TFP observed here. In any event, since state enterprises produced more than half of China’s industrial output in the 1980’s, their TFP fluctuations were an important component of the macroeconomic fluctuations.

## 6 Conclusion

This paper investigates the impact of economic reform on the performance of Chinese state enterprises using a panel data set of 272 state enterprises. The empirical method applied here measures marginal products of factors, changes in TFP, and improvements in factor allocation by comparing actual changes in output to actual changes in inputs. The evidence shows that there was substantial productivity growth during the reform. More importantly, the evidence shows that much of the productivity growth can be attributed to the reform.

The evidence here suggests that enterprise restructuring that concentrates on improving the allocation of property rights and incentives can yield large benefits even without formal privatization. It also suggests that liberalizing the economy at the margin while maintaining planning initially can improve resource allocation when entry barriers to the previously state monopolized industries are lowered simultaneously to foster competition.

These findings are, of course, not without qualifications. It is possible

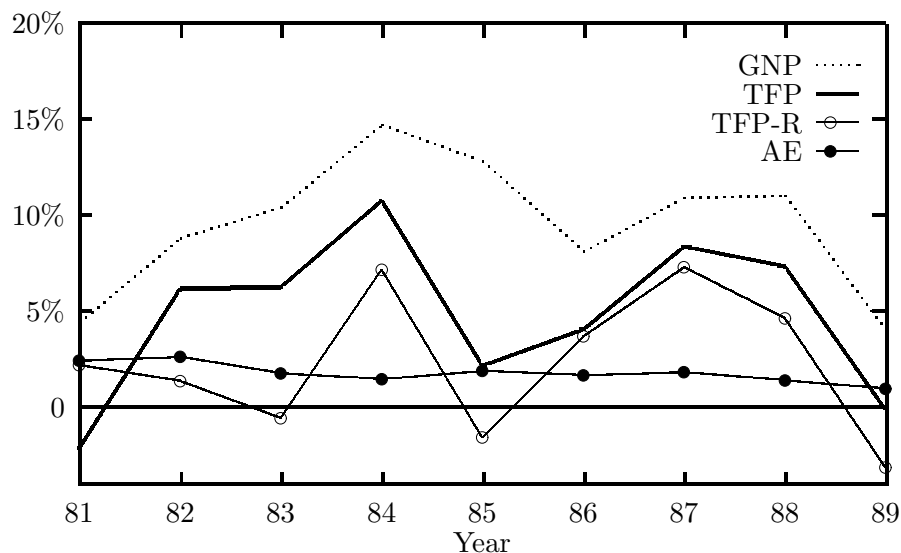


Figure 2: Growth in enterprise TFP, TFP-R, AE, and in aggregate GNP.

that better managed enterprises might have been chosen to participate in the survey, either because they were more “visible” or because there were political motivations to showcase the reform. If this is the case, the estimated productivity growth and the estimated impact of the reform will be *higher* than their true values. On the other hand, enterprises might have distrusted the anonymity and confidentiality pledged by CASS. Fearing that their responses may be used by the government to raise their tax rates, they might have chosen to understate their output growth and overstate cost increases. If this is the case, the estimated productivity and the estimated impact of the reform will be lower than their true value. Given the available data, however, the significance of the possible biases cannot be ascertained.

## A Data Appendix

This appendix gives a brief definition of variables and a brief discussion of the sample statistics of selected variables not discussed in the text. The reader is referred to Li (1994) for detailed documentation and discussion.

Table 5: Inflation Rates by Year (Percent)

Year	Output		Material Inputs		Capital
	Market Price Inflation	$\left(\frac{\text{Market } P}{\text{Plan } P} - 1\right)$ 100%	Market Price Inflation	$\left(\frac{\text{Market } P}{\text{Plan } P} - 1\right)$ 100%	Mixed Price Inflation
1980-1	0.6	3.3	1.3	22.3	6.6
1981-2	2.4	5.4	1.0	15.9	0.9
1982-3	2.2	4.4	2.0	30.8	7.1
1983-4	3.2	5.8	7.1	24.0	17.2
1984-5	7.3	15.5	5.2	29.8	12.1
1985-6	9.3	25.5	19.0	41.4	14.2
1986-7	4.6	17.1	11.9	63.4	22.8
1987-8	22.0	15.9	39.6	84.4	19.5
1988-9	21.2	39.3	18.7	117.1	15.8

### A.1 Price Changes

Table 5 reports the average inflation rates of market prices, the average markup of market prices over plan prices for output and material inputs. Aggregate inflation rates of mixed prices of capital goods, the only price data available for capital goods, are listed in the last column.

Inflation between 1981-83 was quite moderate due to price control that was still firmly in place. When price control was relaxed in the mid-1980s, inflation accelerated. The rapid increases in prices immediately following price liberalization was perhaps the result of converting monetary overhang into real purchasing power. The main purpose of price liberalization, however, is to undo distortions imposed by decades of central planning. This appears to be what happened in China between 1985-89: the inflation rates of material prices, which were traditionally kept low relative to those of processed goods, were substantially higher than the inflation rates of output between 1985-89.

### A.2 Output and Inputs

Real output is constructed for each enterprise in each year based on the market price prevailing in 1989 on the ground that the 1989 market prices

should more closely reflect the relative scarcity of resources than mixed prices or market prices in earlier years due to economic liberalization. Material input is defined as the sum of raw materials, auxiliary materials, fuel and power consumed in each year, measured also in the 1989 market prices. Data on material purchases are not available.

Labor is measured as the total number of employees excluding service workers and excluding employees who were absent for over half of the year. Due to data limitation, this measure does not adjust for underemployment (*i.e.*, labor redundancy or labor hoarding) which were common among state enterprises. The treatment of service workers in measuring labor merits discussion. Typically a Chinese state enterprise provides a variety of services to its employees and their immediate families. Those services include food preparation, day-care, medical care, housing, public entertainment, and in some cases, even elementary and/or secondary education. However the value of these services is not included in the firm's output. In order to be consistent with the measure of output, I exclude resources that are used in providing these services.

Similarly, capital,  $K_{nt}$ , includes only capital stock in place that is used in production. It excludes unfinished capital expenditure and capital stock used to provide services to enterprise employees. Since information on the market prices of capital goods is not available, the aggregate index of mixed prices listed in Table 5 is used to construct real capital stocks measured in 1989 prices. Due to data limitation, this measure does not adjust for underutilization of capital, which was also common among state enterprises.

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