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The Impact of Property Rights Structure on Productivity, Capital Allocation and Labor Income in Chinese State and Collective Enterprises

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Industrial Reform and Productivity in Chinese Enterprises
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ABSTRACT

This paper first develops a neoclassical dynamic model of Chinese enterprises, incorporating some important unconventional constraints. Then, it uses firm-level data from Chinese industrial survey in 1985 to test the model. Overall, the paper provides a theory of property rights structure for post-Mao Chinese industrial enterprises.

The evidence shows that the introduction of profit retention and managerial autonomy during the early years of the decade-long reforms succeeded in increasing industrial effort and raising total factor productivity in both the state and collective enterprises. In comparisons cross sectors, it is found that the collective enterprises have allocated more effort and capital to industrial production (instead of fringe benefits production) than the state enterprises. The evidence also suggests that the reduced monitoring on non-industrial activities by the government led to rapid expansion of fringe benefits production and had negative impact on productivity growth. The paper also finds convergence of productivity among industries, increase returns to scale at firm-level, and a widening of gaps in real personal income including both wage and in-kind fringe benefits among sectors and industries.

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I. Introduction

Since 1978, Chinese government has increased managerial autonomy in state-owned enterprises (Byrd & Tidrick, 1987; Zhang & Zhang, 1987;). It has also reduced restrictions on collectively owned enterprises (Lockett, 1988). These reforms toward less government control of industrial activities were carried out primarily by the introduction of the profit contract system. With this system, the enterprises negotiate a contract with their local supervisory agencies or the central government ministries regarding retained profits, funding, and quota of input materials and output. After paying 15% of the retained profits as energy and transportation taxes, the enterprises may use about half of the net retained profits for welfare projects and bonuses, and the other half for industrial investment. The enterprises may also buy and sell the input and output above the quotas freely in the markets. This practice allowed under the profit contract system is also called dual-allocation mechanism (one through planning or quota, the other through markets). While the profit contract system lessened the power of the central government ministries and local supervisory agencies, it also simplified their task to collecting contracted profits, reallocating profits for investments and subsidies, and assigning chief managers. The system has improved the ability of these agencies to monitor important dimensions of the state enterprises's activity and seems successful in reducing the rigidity and inefficiency of the planning system.¹

However, the limited partial reforms quickly gave root to other problems such as the expansion of fringe benefits. Although the government has monitored closely the growth of bonuses, it has been common for enterprises to use more than half of their retained profits to finance welfare projects such as enterprise-owned residential housing, hotels, and recreational facilities. On several occasions, the central government has ordered enterprises to stop these projects to no avail. Hence, the profit contract system creates a dilemma of managerial autonomy for the government. On the one hand, the government expects the managers to use their increased discretion to improve production efficiency. On the other hand, the government can no longer monitor the expansion of fringe benefits easily. The excessive use of fringe benefits and the dilemma of managerial autonomy have more to do with the separation of ownership and control than with planning. Hence, in this paper I use a

¹ Xiao (1990b) has detailed discussion about institutional feature of post-Mao Chinese industrial enterprises.

property rights approach to study these new problems arising from the partial reforms of a planned economy toward a market-oriented system.²

The theoretical part of this paper formalizes the new institutions of Chinese industrial enterprises. I extend the incentive structure in the well-studied share-cropping model to the dynamic situation of profit-sharing with fringe benefits provision in Chinese industrial enterprises. I also prove the inefficiency of the Chinese system and provide a Pareto Optimum solution for comparison. In the sharecropping models, the output-sharing may be used to deal efficiently with risk-sharing, labor market competition, and monitoring problems. However, all the theories giving efficiency to the sharecropping depend on the crucial assumption that the landlord is an utility-maximizing individual with private property rights to land.³ In the Chinese enterprises system, the assumption that the Chinese government can be as consistent and intelligent as the landlord in maximizing its share of profits is difficult to maintain. Hence, the inefficiency modelled in this paper is likely to reflect the real situation in Chinese enterprises. I demonstrate graphically the mis-allocation of resources in the profit contract system. More importantly, I derive, from the first order conditions of the dynamic model, the specific hypotheses to be tested with regression analysis.

The empirical part of this paper tests the theoretical hypotheses. Using cross-firm industrial data in 1980 and 1985, I examined productivity level and growth in the state and collective sectors and compared the relative efficiency between the two sectors by taking into account the fringe benefits as well as industrial production. Also, I test the capital allocation hypothesis which concern the effects of monitoring on productivity and the expansion of fringe benefits. The paper also examines differences in labor income between the state and collective firms.

Since the state and collective enterprises are two major systems of industrial organizations in China, the empirical findings in this paper about the relative efficiency between the two enterprise systems have important policy implication for future economic reforms in China. The development of the collective firms should be encouraged if they have significantly higher productivity than the state firms. In addition, the findings will suggest future reforms in Chinese industrial enterprises, because they identify the role of property rights structure in influencing enterprise performance.

² The literature of the modern theory of the firm started with Coase (1937) and was further developed by Alchian and Demsetz (1972), Jensen and Meckling (1976), Klein, Crawford, and Alchian (1978), Fama and Jensen (1983), Klein (1983), Demsetz and Lehn (1985), Williamson (1985), and Alchian and Woodward (1988) among others. Eggertsson (1990) has an updated review of the property rights approach. Barzel (1989) introduces a non-technical model of property rights. Grossman and Hart (1986) and Hart (1988) have tried to formalize the property rights approach.

³ The traditional view of sharecropping can be found in D. G. Johnson (1950) and S.N.S. Cheung (1969). More recent survey on the issue includes K. Otsuka and Y. Hayami (1988).

II. The Model

I assume that Chinese state and collective firms have one representative worker. In each period, the worker produces two types of output – industrial products and non-industrial services (or fringe benefits). The fringe benefits, H_t , are produced using non-industrial capital, S_t , and non-industrial effort, Z_t . They are used exclusively by the workers in the firm. The industrial products are produced using industrial capital, K_t and industrial effort, X_t . They are sold for profits, Y_t . The worker retains part of the profits, $(\bar{\beta}_t + \bar{\theta}_t)Y_t$, and the government collects the rest, $T_t = (1 - \bar{\beta}_t - \bar{\theta}_t)Y_t$. The worker may use part of the retained profits, $\bar{\beta}_t Y_t$, for bonuses. For simplicity, I assume that the worker's monetary income consists only of the bonuses, $C_t = \bar{\beta}_t Y_t$. The worker may invest the other part of the retained profits, $\bar{\theta}_t Y_t$, in next period's industrial capital, $K_{t+1} = K_t + \alpha_{t+1} Y_t$, and/or non-industrial capital, $S_{t+1} = S_t + [\bar{\theta}_t - \alpha_{t+1}] Y_t$. I assume that the government is able to set and enforce the two profit-contract terms $\bar{\beta}_t$ and $\bar{\theta}_t$. However, because of the difficulty in distinguishing industrial and non-industrial investment at the Chinese firms, I assume that the government is unable to enforce the industrial re-investment rate, α_{t+1} . Also, the government can not observe the worker's effort, X_t and Z_t , and fringe benefits, H_t . I assume that the industrial profits function has a stochastic variable Ω_t as an input. This assumption excludes the possibility of inferring X_t from K_t and Y_t , since at least one input Ω_t is always unknown ex ante. Contrary to the principal-agent model in the recent Western economic literature on incentive problems, I assume that the government does not choose optimally the specific contract terms, such as $\bar{\beta}_t$ and $\bar{\theta}_t$, to maximize its claims of industrial profits. I regard the contract terms between the government and worker as different from the contracts between individuals of private property society. In the market economy, a contract or a transaction, such as the one between principal and agent, more likely results from individuals's optimal strategic interactions. Hence, the game-theoretical principal-agent model is useful. However, it is doubtful whether the Chinese government has a consistent objective and a realistic ability to maximize its tax revenues through the complicated strategic processes modeled in the principal-agent theories. So, I assume that the government's policy parameters are evolved from a historical process. If there are any optimal behaviors from the government, they appear only slowly through learning and reforms. This approach also avoids modelling complicated strategic interactions between the government (the principal) and the worker (the agent). The government's policy parameters in this model are exogenously given in each period. This simplifies the model to an individual's constrained maximization problem. Given the government policies in each period, the worker maximizes his present and future expected utility subject to constraints of his income, in-kind fringe benefits and dis-

utility of effort. His discount rate for next period's utility is δ . His maximizing problem can be written as the following:

$$\begin{aligned} \max_{X_t, Z_t, K_t} \quad & \mathbf{E} \sum_{t=1}^{t=\infty} \delta^{t-1} u(C_t, H_t, X_t, Z_t); \\ \frac{\partial u}{\partial C_t} > 0, \quad & \frac{\partial u}{\partial H_t} > 0, \quad \frac{\partial u}{\partial X_t} < 0, \quad \frac{\partial u}{\partial Z_t} < 0, \\ \frac{\partial^2 u}{\partial C_t^2} \leq 0, \quad & \frac{\partial^2 u}{\partial H_t^2} \leq 0, \quad \frac{\partial^2 u}{\partial X_t^2} \leq 0, \quad \frac{\partial^2 u}{\partial Z_t^2} \leq 0. \end{aligned} \quad (1a)$$

subject to:

$$\begin{aligned} C_t &= \bar{\beta}_t Y_t; \\ 0 \leq \bar{\beta}_t &\leq 1, \quad 0 \leq \bar{\beta}_t + \bar{\theta}_t \leq 1. \end{aligned} \quad (1b)$$

$$\begin{aligned} Y_t &= f(K_t, X_t, \Omega_t); \\ \frac{\partial f}{\partial K_t} > 0, \quad \frac{\partial f}{\partial X_t} > 0, \quad \frac{\partial^2 f}{\partial K_t^2} \leq 0, \quad \frac{\partial^2 f}{\partial X_t^2} \leq 0, \quad \frac{\partial^2 f}{\partial K_t \partial X_t} \geq 0. \end{aligned} \quad (1c)$$

$$\begin{aligned} H_t &= g(S_t, Z_t); \\ \frac{\partial g}{\partial K_t} > 0, \quad \frac{\partial g}{\partial X_t} > 0, \quad \frac{\partial^2 g}{\partial K_t^2} \leq 0, \quad \frac{\partial^2 g}{\partial X_t^2} \leq 0, \quad \frac{\partial^2 g}{\partial K_t \partial X_t} \geq 0. \end{aligned} \quad (1d)$$

$$\begin{aligned} K_t &= K_{t-1} + \alpha_t Y_{t-1}; \\ 0 \leq \alpha_t \leq \bar{\theta}_{t-1}, \quad & 0 \leq \bar{\theta}_{t-1} \leq 1, \quad 0 \leq \bar{\beta}_{t-1} + \bar{\theta}_{t-1} \leq 1. \end{aligned} \quad (1e)$$

$$\begin{aligned}
S_t &= S_{t-1} + (\bar{\theta}_{t-1} - \alpha_t) Y_{t-1}; \\
0 \leq \alpha_t \leq \bar{\theta}_{t-1}, \quad 0 \leq \bar{\theta}_{t-1} \leq 1, \quad 0 \leq \bar{\beta}_{t-1} + \bar{\theta}_{t-1} \leq 1.
\end{aligned} \tag{1f}$$

For period t , define the state variables as K_{t-1} , S_{t-1} and Y_{t-1} the control variables as X_t , Z_t and α_t , the policy parameters as $\bar{\beta}_t$ and $\bar{\theta}_t$, and the stochastic variable as Ω_t . The Bellman's equation for (1a) to (1f) is then,

$$\begin{aligned}
\mathbf{E}v(K_{t-1}, S_{t-1}, Y_{t-1}, \bar{\beta}_t, \bar{\theta}_t, \Omega_t) = \\
\max_{X_t, Z_t, \alpha_t} \{ \mathbf{E}u(\bar{\beta}_t f[K_{t-1} + \alpha_t Y_{t-1}, X_t, \Omega_t], g[S_{t-1} + (\bar{\theta}_{t-1} - \alpha_t) Y_{t-1}, Z_t], X_t, Z_t) \\
+ \delta \mathbf{E}v(K_t, S_t, Y_t, \bar{\beta}_{t+1}, \bar{\theta}_{t+1}, \Omega_{t+1}) \}.
\end{aligned} \tag{2}$$

To concentrate on the incentive problems, let's assume a simple utility function for the worker:

$$\begin{aligned}
u(C_t, H_t, X_t, Z_t) &= C_t + H_t - d(X_t + Z_t); \\
\frac{\partial d}{\partial X_t} = \frac{\partial d}{\partial Z_t} &\geq 0, \quad \frac{\partial^2 d}{\partial X_t^2} = \frac{\partial^2 d}{\partial Z_t^2} \geq 0.
\end{aligned} \tag{3}$$

Utility function (3) assumes separable utility from income, fringe benefits and effort. The worker is assumed risk-neutral towards income and fringe benefits. The function also assumes perfect substitution between income and fringe benefits and between industrial and non-industrial effort. The total effort is limited by the assumption of increasing marginal dis-utility of effort. The first order conditions for the Chinese publicly owned firms can be written as the following:

$$\frac{\partial d(X_t + Z_t)}{\partial X_t} \Big|_t^c = \mathbb{E} \frac{\partial F}{\partial X_t} \Big|_t^c \left\{ \bar{\beta}_t + \delta \left[\alpha_{t+1} \bar{\beta}_{t+1} \frac{\partial F}{\partial K_t} \Big|_{t+1}^{c+1} + (\bar{\theta}_t - \alpha_{t+1}) \frac{\partial G}{\partial S_t} \Big|_{t+1}^{c+1} \right] \right\}. \quad (4a) \text{ for } X_t$$

$$\frac{\partial d(X_t + Z_t)}{\partial Z_t} \Big|_t^c = \frac{\partial G}{\partial Z_t} \Big|_t^c. \quad (4b) \text{ for } Z_t$$

$$\frac{\partial G}{\partial S_t} \Big|_t^c = \mathbb{E} \frac{\partial F}{\partial K_t} \Big|_t^c \left\{ \bar{\beta}_t + \delta \left[\alpha_{t+1} \bar{\beta}_{t+1} \frac{\partial F}{\partial K_t} \Big|_{t+1}^{c+1} + (\bar{\theta}_t - \alpha_{t+1}) \frac{\partial G}{\partial S_t} \Big|_{t+1}^{c+1} \right] \right\}. \quad (4c) \text{ for } \alpha_t$$

The first order conditions in (4a), (4b) and (4c) describe the worker's behavior under the profit-contract system in Chinese publicly owned firms. As can be seen, some of the worker's choice behavior changes not only with the current government policies, such as the current terms of profit-contract $\bar{\beta}_t$ and $\bar{\theta}_t$, but also with the expected future policies such as $\bar{\beta}_{t+1}$ and $\bar{\theta}_{t+1}$. Since the government policies influence the allocation of effort and capital in this model, it is important to know whether a policy will lead the economy toward a more efficient allocation or not. However, to derive efficiency implication, it is necessary to define the most efficient or Pareto Optimum allocation.

In this paper, I assume that in the Pareto Optimum solution, the worker maximizes his utility by choosing not only X_t , Z_t , and α_t , but also β_t and θ_t . In return to his enlarged choice set, he guarantees the government a fixed level of revenues from the firm's profits in each period. Hence, the Pareto Optimum model is obtained by adding two more choice variables β_t and θ_t and one more restriction to the profit-sharing system. The restriction can be written as the following:

$$(1 - \beta_t - \theta_t) Y_t = \bar{T}_t. \quad (5g)$$

This definition of Pareto Optimum eliminates the asymmetric information problems by transferring all the control rights or actions from the less informed government to the most informed worker. It should be pointed out that this Pareto Optimum is equivalent to an outright sale of the Chinese firms to the workers. The sale price is equal to the present value of the fixed revenue streams specified in the model. At the Pareto Optimum, every party is absolutely better off, if discounting any additional transaction costs involved in the change toward an efficient system. However, relatively, the government's share of future profits may decline, although the government's revenue will increase. The first order conditions for X_t , Z_t , and α_t in the Pareto Optimum model are:⁴

$$\begin{aligned} \frac{\partial d(X_t + Z_t)}{\partial X_t} \Big|_t &= \mathbf{E} \frac{\partial f}{\partial X_t} \Big|_t \left\{ \left(\beta_t + \delta \left[\alpha_{t+1} \beta_{t+1} \frac{\partial f}{\partial K_t} \Big|_{t+1} \right. \right. \right. \\ &\quad \left. \left. \left. + (\theta_t - \alpha_{t+1}) \frac{\partial g}{\partial S_t} \Big|_{t+1} \right) \right\} \quad (6a) \\ &\quad + \left\{ (1 - \beta_t - \theta_t) + (1 - \beta_{t+1} - \theta_{t+1}) \delta \alpha_{t+1} \frac{\partial f}{\partial K_t} \Big|_{t+1} \right\}. \quad \text{for } X_t \end{aligned}$$

$$\frac{\partial d(X_t + Z_t)}{\partial Z_t} \Big|_t = \frac{\partial g}{\partial Z_t} \Big|_t. \quad (6b) \quad \text{for } Z_t$$

As shown in (4b) and (6b), the first order conditions for non-industrial effort look exactly the same for the two systems. This means that the workers under both systems will use their effort to

⁴ In the following analysis, I will compare only the first order conditions for X_t , Z_t , and α_t in the two systems. Hence, I omitted here the first order conditions for β_t and θ_t in the Pareto Optimum case.

$$\begin{aligned} \frac{\partial g}{\partial S_t} \Big|_t &= \mathbb{E} \frac{\partial f}{\partial K_t} \Big|_t \left\{ \left(\beta_t + \delta \left[\alpha_{t+1} \beta_{t+1} \frac{\partial f}{\partial K_t} \Big|_{t+1} \right. \right. \right. \\ &\quad \left. \left. \left. + (\theta_t - \alpha_{t+1}) \frac{\partial g}{\partial S_t} \Big|_{t+1} \right) \right\} \\ &+ \left\{ (1 - \beta_t - \theta_t) + (1 - \beta_{t+1} - \theta_{t+1}) \delta \alpha_{t+1} \frac{\partial f}{\partial K_t} \Big|_{t+1} \right\}. \end{aligned} \tag{6c}$$

for α_t

increase fringe benefits until their marginal costs of total effort equals their marginal fringe benefits of non-industrial effort. Government policies do not directly affect the marginal conditions for non-industrial effort allocation in the Chinese publicly owned firms. However, since the industrial and non-industrial effort can substitute for each other, government policies will affect non-industrial effort allocation through its effect on industrial effort allocation. For example, if a new policy leads to a lower industrial effort, from (4b), the new marginal costs of total effort will be lower than the previous marginal benefits of non-industrial effort. As a result of optimal choice by the worker, the non-industrial effort will increase following the new government policies until the new marginal costs of total effort are equal to the new marginal fringe benefits of non-industrial effort.⁵ This adjustment of non-industrial effort, however, is always efficient, given any government policies.

A comparison of (4a) and (6a) reveals that the first order conditions for industrial effort of the two systems differ only in some extra terms for (6a) if:

$$\bar{\beta}_t = \beta_t \text{ and } \bar{\theta}_t = \theta_t. \tag{7}$$

The condition (7) requires that the terms of profit-sharing specified by the government in the profit-sharing system be equal to those implicitly chosen by the worker in the Pareto Optimum model. Although, in the Pareto Optimum case, the government collects a fixed sum of profits and does not use β_t or θ_t in the contract. The ex post equivalent value of β_t and θ_t can be computed from the lump-sum tax and the total profits. These ex post equivalent values of β_t and θ_t are assumed to be equal to

⁵ More rigorously, I should totally differentiate all the first order conditions using the envelope theorem and solve the resulting systems for a comparative static analysis. Here, I only analyze the first order condition for Z_t and assume other variables such as X_t and S_t are given either from solutions of other first order conditions or by ad hoc assumptions.

the ex ante value of $\bar{\beta}_t$ and $\bar{\theta}_t$ in the profit-contract system in the following analysis. The extra terms in (6a) are rewritten as the following:

$$\Delta_t = (1 - \beta_t - \theta_t) + (1 - \beta_{t+1} - \theta_{t+1}) \delta \alpha_{t+1} \left. \frac{\partial \pi}{\partial K_t} \right|^{t+1} \quad (8)$$

From (8), it is obvious that Δ_t are positive as long as the government's share of current and future profits is greater than zero, e.g. $(1 - \beta_t - \theta_t) > 0$ and $(1 - \beta_{t+1} - \theta_{t+1}) > 0$. Hence, the marginal condition for industrial effort in the profit-contract system (4a) will differ from the Pareto Optimum marginal condition (6a). This proves the inefficiency of the profit-contract system in allocation of industrial effort.

Applying the similar analysis to (4c) and (6c), it can be proved that the profit-contract system is inefficient in the allocation of capital.

The government policies or the profit-contract terms (β_t and θ_t) in the Chinese publicly owned firms are directly responsible for the distortion of the marginal condition for the allocation of industrial effort and capital. The distortion leads to a lower level of total effort use, a smaller share of industrial effort use, a lower industrial output, a lower level of total capital accumulation, a smaller share of industrial capital accumulation and a lower level of government revenue from the firm than in the Pareto-Optimum allocation. These results are derived and illustrated in figures 1 and 2 of the following section.

III. Graphical Presentation

To derive resource allocation in the two systems graphically, I assume no uncertainty. Also, I assume that condition (7) holds. To simplify the formula for schedules in the figure, I define an incentive parameter Γ_t as the following:⁶

⁶ Mathematically, Γ_t will change with the choice variables in the model. However, to simplify the graphical presentation, I assume that Γ_t is approximately constant and regard it as a parameter in the graphical analysis. More rigorous conditions and results are derived in next section.

$$\Gamma_t = \beta_t + \delta \left\{ \alpha_{t+1} \beta_{t+1} \frac{\partial f}{\partial K_t} \Big|^{t+1} + (\theta_t - \alpha_{t+1}) \frac{\partial g}{\partial S_t} \Big|^{t+1} \right\}. \quad (9)$$

A. *Effort allocation*

Figure 1 graphically solves the Pareto Optimum effort level from the first order conditions (6a) and (6b). In figure 1, the horizontal axis measures effort level. The vertical axis denotes marginal costs and returns to effort. Schedule MC represents the left sides of (6a) and (6b) which are the worker's marginal costs functions of effort:

$$MC = \frac{\partial d(X_t + Z_t)}{\partial X_t} \Big|^\tau = \frac{\partial d(X_t + Z_t)}{\partial Z_t} \Big|^\tau.$$

Schedule MP represents the right side of (6a) and is the worker's marginal return function of industrial effort in the profits production:

$$MP = (\Gamma_t + \Delta_t) \frac{\partial f(K_t, X_t)}{\partial X_t} \Big|^\tau.$$

Schedule MB represents the right side of (6b) and is the worker's marginal return function of non-industrial effort in the fringe benefits production:

$$MB = \frac{\partial g(S_t, Z_t)}{\partial Z_t} \Big|^\tau.$$

In figure 1, all points on the horizontal line A have the same level of marginal returns or costs. The intersection between the horizontal line A and the schedules MB, MP, and MC at points P, Q, and R represent equalization of the worker's marginal returns and costs. The Pareto Optimum effort level is solved by shifting the horizontal line A until $OP + OQ = OR$ in figure 1. OP, OQ, and

OR equal respectively Z_i , X_i and $Z_i + X_i$. $OP + OQ = OR$ is the equilibrium condition that the sum of non-industrial effort, Z_i and industrial effort, X_i are equal to the total effort, $X_i + Z_i$. The Pareto Optimum effort levels are marked as X and Z in figure 1 with t subscript omitted.

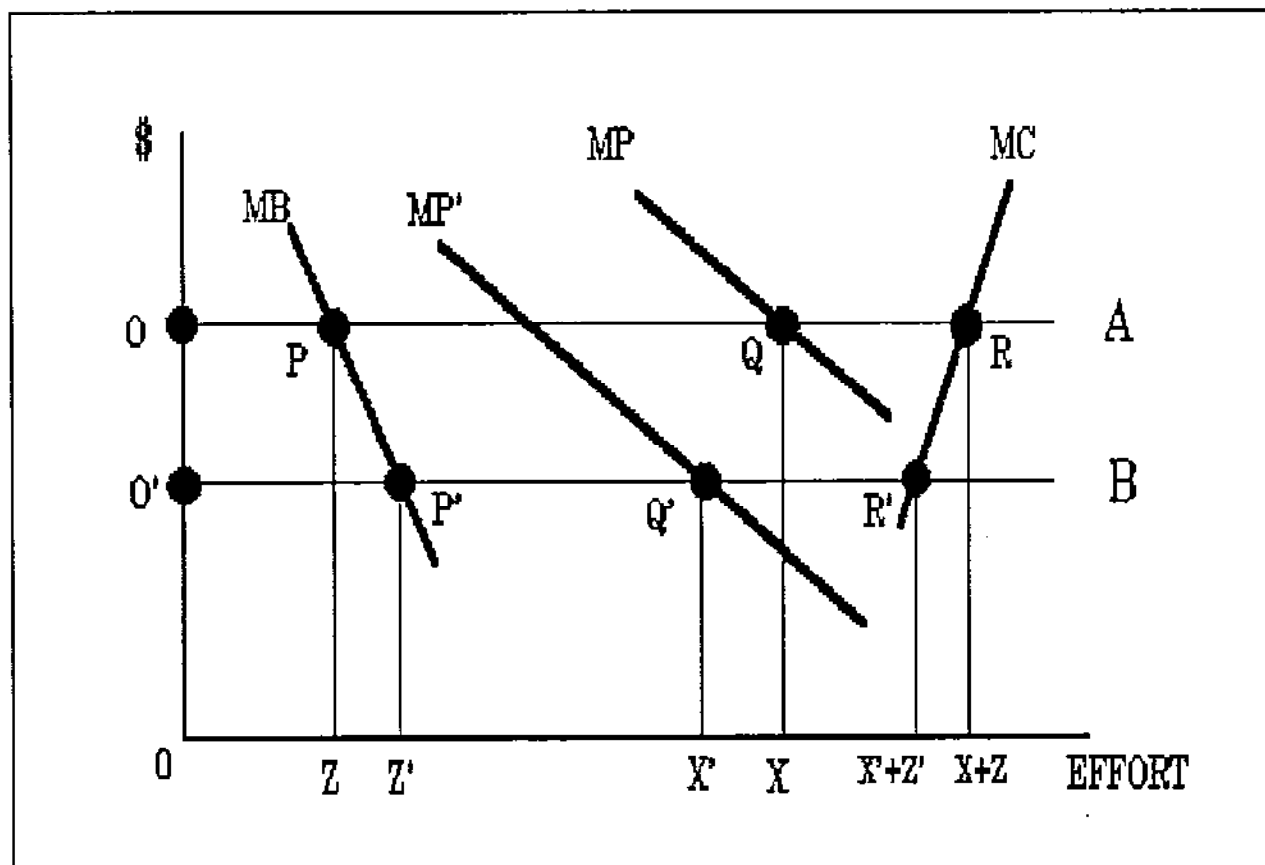


Figure 1 Equilibrium Condition for Effort Allocation:
Marginal Profits = Marginal Costs = Marginal (Fringe) Benefits

Figure 1 also solves the effort level under the profit-contract system, assuming that everything is the same as in the Pareto Optimum case except the institutional arrangement and the choice variables of the worker. In particular, the condition (7) is assumed to be true. From the last section, the first order conditions for the profit-sharing system (4a) to (4c) can also be obtained by dropping the term Δ_i from (6a) to (6c). As can be seen from (6a) to (6c), dropping Δ_i affects neither the worker's marginal costs function of effort nor his marginal return function of non-industrial effort in the fringe benefits production. Hence, the MC and MB schedules in figure 1 can be used to solve effort allocation under both systems. However, the worker's marginal return function of industrial

effort in the profits production decreases when Δ_i is dropped. Graphically, dropping Δ_i is equivalent to shifting schedule MP downward to a position at schedule MP'. MP' is defined as the following:

$$MP' = \Gamma_t \frac{\partial F(K_t, X_t)}{\partial X_t} \Big|_t.$$

Now, using schedule MC, MB, and MP' and shifting the horizontal line B until $O'P' + O'Q' = O'R'$, the effort levels under the profit-contract system are solved in figure 1 and marked as X' and Z'.

It follows from figure 1 that under the profit-contract system, the total effort of X' + Z' is less than that in the Pareto Optimum case of X + Z. This results from a lower level of equilibrium marginal returns of effort under the profit-contract system. Also, under the profit-contract, the industrial effort X' decreases while the non-industrial effort Z' increases from the levels in the Pareto Optimum case of X and Z. These changes reflect the flow of effort from industrial production to fringe benefits production. The reason for this adjustment is that the private return of industrial production to the workers is lower than the social return under the profit-sharing system. In the Pareto Optimum system, private and social returns are equal. Also, from figure 1, the share of industrial effort in the profit-contract is smaller than that in the Pareto Optimum.⁷

B. *Capital allocation*

In figure 2, I solve graphically allocation of retained profits for both the Pareto Optimum and profit-sharing cases. The horizontal axis measures investment using retained profits. The vertical axis gives the marginal returns of investment. The total amount of retained profits for investment in the production of both profits and fringe benefits are limited by $OP = \theta_t Y_{t-1}$ as shown in figure 2. For any points between O and P, such as A, OA and PA represent respectively investment in industrial capital for profits production and investment in non-industrial capital for fringe benefits production.

In the Pareto Optimum case, Schedule MP in figure 2 represents the right side of (6c) or the worker's marginal return function of industrial capital in profits production:

⁷ The analysis here includes only the two first order conditions for effort. Hence, I implicitly assume that all other choice variables are given either from solutions of other first order conditions or from ad hoc assumptions.

$$MP = (\Gamma_t + \Delta_t) \frac{\partial F(K_{t-1} + OA, X_t)}{\partial K_t} \Big|_t;$$

$$OA = \alpha_t Y_{t-1}.$$

Schedule MB represents the left side of (6c) or the marginal return function of non-industrial capital in fringe benefits production:

$$MB = \frac{\partial g(S_{t-1} + PA, Z_t)}{\partial S_t} \Big|_t;$$

$$PA = (\theta_{t-1} - \alpha_t) Y_{t-1}.$$

As α_t (or $OA = \alpha_t Y_{t-1}$) increases, or equivalently, as point A moves away from O toward P in figure 2, the worker's marginal return from investing in industrial capital decreases while his marginal return from investing in fringe benefits capital increases. The optimal allocation of retained profits (or α_t) in the Pareto Optimum case is determined by the intersection of schedule MP and MB at point E.

To derive the α_t (or $OA = \alpha_t Y_{t-1}$) under the profit-contract using figure 2, I assume that everything is the same in the Pareto Optimum and profit-contract cases except the contract forms and choice variable α_t . As in figure 1, it is assumed that the condition (7) holds in figure 2. From last section, by dropping the Δ_t term, the first order condition (6c) for capital allocation of the Pareto Optimum case becomes that of the profit-contract case. Since the left side of (6c) does not contain Δ_t , the worker's marginal return function from investing in fringe benefits capital is the same under the two contracting systems. Hence, the MB schedule for the Pareto Optimum case can be used to solve capital allocation under the profit-contract case. However, the worker's marginal return from investing in industrial capital under the profit-contract system is smaller than under the Pareto Optimum case. Graphically, this requires a downward shift of schedule MP to a position at MP'. MP' is defined by the following equation:

The solution of α_t under the profit-contract system is given by the intersection of schedules MB and MP' at point E'. From figure 2, the

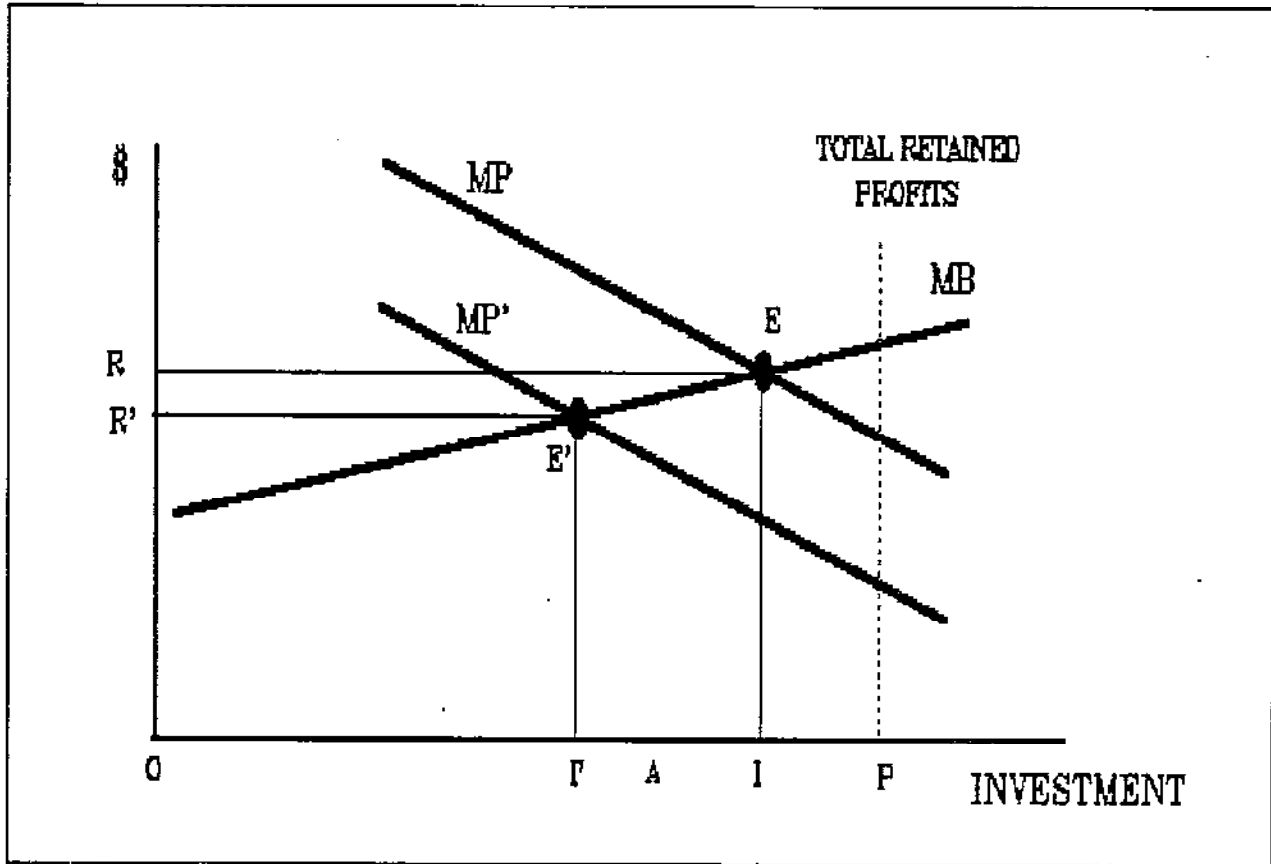


Figure 2 Equilibrium Condition for Investment Allocation:
Marginal Profits = Marginal (Fringe) Benefits

$$MP' = \Gamma_t \frac{\partial f(K_{t-1} + OA, X_t)}{\partial K_t} \Big|_t;$$

$$OA = \alpha_t Y_{t-1}$$

investment in industrial capital under the profit-contract system (OI') is less than that in the Pareto Optimum case (OI).

From the analysis in figure 1 and 2, it follows that under the profit-contract, total profits are lower since both industrial effort and capital are less than those in the Pareto Optimum case. Since the total capital accumulation rate is determined by the government policy parameters, such as β_t and θ_t , and the total profits, given the policy parameters, the accumulation rate will be lower if the profits is lower. Lower total profits also bring about less government revenue.

IV. Implications for Empirical Work

A. *Renting out small state enterprises to workers*

The above analysis is useful not only in identifying the mis-allocation of resources under the profit-contract system but also in suggesting hypotheses for empirical testing. The analysis points out directly that if the Chinese publicly owned enterprises are rented to the workers for a fixed rent in each period, they will be run more efficiently than in the profit-contract system. This implication may be tested empirically. Since 1978, there have been a large amount of state-owned small firms in service sector rented to individual workers. The efficiency of these firms should increase according to the model. I will not examine the empirical evidences on the performance of rented firms in this paper. However, there are plenty reports confirming this theoretical prediction.⁸

B. *Economic reform and efficiency improvement*

The model also suggests a relationship between the degree of inefficiency and the terms of profit-contract (or the level of β_t and θ_t). This relationship is summarized by (10). In (10), Δ_t could be regarded as an index of inefficiency predicted by the theoretical model since it measures the distortion of the profit-contract to the optimal conditions of resource allocation. According to (10), the larger the government's share of profits in the current or/and future periods, the higher the firm's inefficiency index.⁹ Also, the higher the marginal return of industrial capital in the future period, the higher the inefficiency index.

The maximum value of Δ_t is approximately:¹⁰

⁸ See Research Office of the State Council 1987.

⁹ The distortion in this model is very similar to those caused by taxation. $1-\beta_t-\theta_t$ is effectively a tax rate applied to profits (or valued added, using public finance terminology). In this case, the fringe benefits are not taxed while industrial profits are heavily taxed. This biased taxation on the value added leads to a distorted allocation of input factors.

However, it should be emphasized that although the incentive problem studied here looks like the taxation problem, this study does not deal directly with the taxation problem. Hence, I will interpret the profits and fringe benefits in both the profit-contract system and the Pareto Optimum case as after-standard-tax value.

¹⁰ In (20), I implicitly assume that α_{t+1} is constant. From section 4.4, α_t depends on β_t and θ_{t+1} , unless in a corner solution. Hence, the implicit assumption does not hold in most of the cases. However, this implicit assumption greatly simplifies exposition and is not likely to cause any significant difference to the results.

$$\Delta_c^{\max} = \max_{\beta_c, \theta_c, \beta_{c+1}, \theta_{c+1}} \Delta_c = (1 - \beta_c - \theta_c) + (1 - \beta_{c+1} - \theta_{c+1}) \delta \alpha_{c+1} \left. \frac{\partial f}{\partial K_c} \right|^{c+1};$$

$$s. t. \quad 0 \leq \beta_c, \theta_c, \beta_{c+1}, \theta_{c+1} \leq 1;$$

$$\Delta_c^{\max} = 1 + \delta \alpha_{c+1} \left. \frac{\partial f}{\partial K_c} \right|^{c+1}, \quad \text{when } \beta_c = \theta_c = \beta_{c+1} = \theta_{c+1} = 0.$$

The condition in (20) for maximum inefficiency might have been nearly satisfied during the Cultural Revolution period for the Chinese state-owned enterprises. At that time, incentive wages and bonuses were virtually non-existent ($\beta_i=0$) and there was little investment autonomy ($\theta_i=0$). According to the model, the economic reforms since 1978, which introduced the profit-contract system and increased β_i and θ_i from zeros to positive values, would have increased the efficiency of Chinese publicly owned enterprises. In empirical part of the paper, I will examine the productivity growth of Chinese state and collective enterprises during 1980 to 1987 to test this prediction about the effects of reforms.

C. *Efficiency gap between state and private enterprises*

The minimum value of Δ_i is¹¹:

$$\Delta_c^{\min} = \min_{\beta_c, \theta_c, \beta_{c+1}, \theta_{c+1}} \Delta_c = (1 - \beta_c - \theta_c) + (1 - \beta_{c+1} - \theta_{c+1}) \delta \alpha_{c+1} \left. \frac{\partial f}{\partial K_c} \right|^{c+1};$$

$$s. t. \quad 0 \leq \beta_c, \theta_c, \beta_{c+1}, \theta_{c+1} \leq 1; \quad (21)$$

$$\Delta_c^{\min} = 0, \quad \text{when } \beta_c + \theta_c = 1 \text{ and } \beta_{c+1} + \theta_{c+1} = 1.$$

The condition in (21) requires that the government allows the contracted workers to retain all the profits not only for the current period but also for the next period. To keep the inefficiency index zero for every period, this condition is equivalent to a private or collective ownership of the firm by the workers.

Hence, the model predicts that the publicly owned enterprises are less efficient than the privately or collectively owned enterprises. This may also be tested. However, since the private

¹¹ Assuming α_{c+1} approximately constant.

sector in China is not only small but also very primitive, a comparative study between the publicly owned firms and a handful of small private firms is limited by both the data availability and the poor representation of the Chinese economy by the private sector.

D. Efficiency gap between state and collective enterprises

On the other hand, the Chinese collectively owned enterprises are not exactly owned and managed by the workers in the collective. The local governments have shared profits from the collective enterprises. In some aspects, the collective enterprises are very similar to the state-owned enterprises. Hence, they should not have an inefficiency index of zero.

During the reform period from 1978 to 1989, the inefficiency index for the Chinese state and collectively owned enterprises should all fall between Δ_i^{\min} and Δ_i^{\max} . However, within this interval, this two groups of firms have different values of Δ_i . In Xiao (1990b), I discussed in detail the institutional differences between the state and collective enterprises. One of the important results there shows that the collective enterprises have higher value of wage share of value added than the state enterprises. The wage share of value added can be regarded as a proxy of β_i in the model. Hence, the collective enterprises have higher β_i than the state enterprises.

Although, it is difficult to find data to compute θ_i for the state and collective enterprises, there is little doubt that the collective enterprises also have higher θ_i than the state enterprises. The collective enterprises do not receive any major funding from the central government and have expanded their production mainly through self-investment. Also, the central government do not take any significant profits from the collective enterprises except normal taxation. Although, the local governments have shared profits from the collective enterprises and invested in these enterprises, the extent of their intervention to the collective enterprises is much less than that to the state enterprises by the central government. Hence, θ_i should be higher in the collective enterprises than in the state enterprises.

The collective enterprises have not only higher β_i and θ_i but also higher expected β_{i+1} and θ_{i+1} since future ownership and/or management reforms may increase or decrease the state enterprises' β_{i+1} and θ_{i+1} , but are less likely to decrease the collective enterprises's β_{i+1} and θ_{i+1} . The collective ownership is theoretically and practically better defined, and face less uncertainty than the state ownership.

Hence, according to the theoretical analysis, the collective enterprises will be more efficient in the use of both effort and capital than the state enterprises because of their lower inefficiency index

Δ_4 . These efficiency differences will be reflected mainly in the effort and capital allocation of the two enterprise systems. In the following sub-sections, I will use the first order conditions derived from the model to derive explicit hypotheses to be tested in linear regressions about the effort and capital allocation.

E. Testing effort allocation hypothesis

Assume the state and collective enterprises have the same capital, labor, Cobb-Douglas production function, and marginal costs function of effort but they face different contract terms.

The industrial production function can be written as the following:

$$Y_t = f(K_t, L_t X_t) = A (K_t)^\mu (L_t X_t)^\nu; \quad (10)$$

$$A > 0, 0 < \mu < 1, 0 < \nu < 1.$$

In the production function, K_t , L_t , and X_t are capital, number of workers, and effort per worker in period t .

The technical marginal return of effort is:

$$\frac{\partial F}{\partial X_t} = \nu A K_t^\mu L_t^\nu X_t^{\nu-1}.$$

Assume a simple function of effort costs as the following:

$$d(X_t + Z_t) = (X_t + Z_t)^\epsilon; \quad \epsilon \geq 2. \quad (11)$$

The marginal costs function of effort is then:

Denote the variables and parameters of the state and collective enterprises by superscript s and c . Then, from the assumptions in the this sub-section, the first order condition (4a), and equation (7) and (9), the relative levels of industrial effort in the two enterprise systems can be written as the

$$\frac{\partial d(X_t + Z_t)}{\partial X_t} = e(X_t + Z_t)^{e-1} = \phi_t X_t^{e-1};$$

$$\phi_t = e \left(1 + \frac{Z_t}{X_t}\right)^{e-1}, \quad e \geq 2.$$

following:

$$\left(\frac{X_t^c}{X_t^s}\right) = \left\{ \left(\frac{\phi_t^s}{\phi_t^c}\right) \left(\frac{\Gamma_t^c}{\Gamma_t^s}\right) \right\}^{\frac{1}{e-v}};$$

$$\phi_t^i = e \left(1 + \frac{X_t^i}{Z_t^i}\right)^{e-1}, \quad i = s, c; \quad (12)$$

$$\Gamma_t^i = \beta_t^i + \delta \left\{ \alpha_{t+1}^i \beta_{t+1}^i \frac{\partial f^i}{\partial K_t} \right\}^{t+1} + (\theta_t^i - \alpha_{t+1}^i) \frac{\partial g^i}{\partial S_t} \Big|^{t+1}, \quad i = s, c.$$

To simplify exposition, let's make four more assumptions:

$$\frac{X_t^s}{Z_t^s} = \frac{X_t^c}{Z_t^c}. \quad (13a)$$

$$\frac{\partial f^s}{\partial K_t} \Big|^{t+1} = \frac{\partial f^c}{\partial K_t} \Big|^{t+1} = R_K. \quad (13b)$$

$$\frac{\partial g^s}{\partial S_t} \Big|^{t+1} = \frac{\partial g^c}{\partial S_t} \Big|^{t+1} = R_S. \quad (13c)$$

$$\frac{\alpha_t^c}{\theta_t^c} = \frac{\alpha_t^s}{\theta_t^s} = w, \quad 0 \leq w \leq 1. \quad (13d)$$

From early discussion of this section, β_t^c , θ_t^c , and β_{t+1}^c are respectively greater than β_t^s , θ_t^s , and β_{t+1}^s . It follows from (13b) to (13d) that $\Gamma_t^c > \Gamma_t^s$. From (13a), $\phi_t^c = \phi_t^s$. Then, from (12), the effort level in the collective enterprises is greater than that in the state enterprises since $\epsilon \geq 2$, $\nu < 1$ and $\epsilon - \nu > 0$:

$$\frac{X_t^c}{X_t^s} = \left\{ \frac{\Gamma_t^c}{\Gamma_t^s} \right\}^{\frac{1}{\epsilon - \nu}} = \left\{ \frac{\beta_t^c + \delta \theta_t^c \{ \beta_{t+1}^c w R_K + (1-w) R_S \}}{\beta_t^s + \delta \theta_t^s \{ \beta_{t+1}^s w R_K + (1-w) R_S \}} \right\}^{\frac{1}{\epsilon - \nu}} > 1. \quad (14)$$

Equation (14) can be tested by estimating the Total Factor Productivity of the state and collective enterprises. The TFP is often computed as the following:

$$TFP_t = \frac{Y_t}{(K_t)^{\hat{\mu}} (L_t)^{\hat{\nu}}}. \quad (15)$$

In (15) and the empirical work, Y_t is output; $\hat{\mu}$ and $\hat{\nu}$ are weights used to compute a composite input of capital and labor. More specifically, $\hat{\mu}$ and $\hat{\nu}$ are estimates of output elasticities of capital and labor. Let's assume that the output Y_t is theoretically produced according to the production function in (10). Also, assume that the estimated elasticities ($\hat{\mu}$ and $\hat{\nu}$) are equal to the theoretical elasticities in the production function (μ and ν).

Then, substituting the production function (10) into TFP equation (15), the following equation gives the relationship between the estimated TFP index and the theoretical variables and parameters in the model:

$$TFP_t = \frac{A (K_t)^\mu (L_t X_t)^\nu}{(K_t)^\mu (L_t)^\nu} = A X_t^\nu. \quad (16)$$

It follows from (16) that the empirically estimated TFP, according to (15) will positively correlate with the labor effort X_t . Since the theory predicts higher level of labor effort in the collective enterprises than in the state enterprises, the estimated TFP of the collective sector will be higher than that of the state sector if the economic force modelled here is strong.¹²

Although, the TFP measured according to (15) reflects the conventional measure of the productive efficiency, it may not reflect the overall efficiency of factor uses. The difference arises when part of the factors are used to produce fringe benefits and the output of fringe benefits is not included in Y_t of (15). One way to include the fringe benefits capital and output in the measure of efficiency is to estimate the following Total Factor Efficiency index:

$$TFE_t = \frac{Y_t + H_t}{(K_t)^\mu (S_t)^\gamma (L_t)^\nu} \quad (17)$$

In the empirical work, $\hat{\mu}$, $\hat{\gamma}$, and $\hat{\nu}$, are assumed to be the estimated output elasticities in the regression of $(Y_t + H_t)$ on industrial capital, fringe benefits capital and labor. Equation (17) is equivalent to a weighted average of TFP indexes for industrial and non-industrial production. Assuming the estimated elasticities are equal to their theoretical values, the relationship between the estimated TFE index and the theoretical variables such as industrial and non-industrial effort can be written as the following:

¹² It is implicitly assumed that input and output are measured correctly. It is also possible that any estimated TFP gaps may be caused by other factors not measured or analyzed in the model.

$$\begin{aligned}
TFE_t &= \frac{A(K_t)^\mu (L_t X_t)^\nu + B(S_t)^\gamma (L_t Z_t)^\nu}{(K_t)^\beta (S_t)^\eta (L_t)^\nu} \\
&= \frac{A}{S_t^\gamma} X_t^\nu + \frac{B}{K_t^\beta} Z_t^\nu \\
&= \frac{1}{\nu K_t^\beta S_t^\gamma L_t^\nu} \left\{ \frac{\partial f}{\partial X_t} X_t + \left(\Gamma_t \frac{\partial f}{\partial X_t} \right) Z_t \right\} \\
&= \frac{1}{\nu K_t^\beta S_t^\gamma L_t^\nu} \frac{\partial f}{\partial X_t} (X_t + \Gamma_t Z_t).
\end{aligned} \tag{18}$$

In the last two lines of (18), the first order conditions for X_t and Z_t are used to relate the weights to the incentive parameter Γ_t . The model in sections II and III predicts that the total effort of X_t and Z_t and the incentive parameter Γ_t in the collective firms are higher than in the state firms, but the non-industrial effort is higher in the state firms than in the collective firms. Hence, the model can not predict the relative level of TFE for the state and collective firms if $\Gamma_t > 1$. However, if $\Gamma_t \leq 1$ for the state firms, which is a plausible assumption, the estimated TFE for the collective firms should be higher than that for the state firms according to (18), since:

$$\begin{aligned}
(X_t^C + \Gamma_t^C Z_t^C) - (X_t^S + \Gamma_t^S Z_t^S) &> (X_t^C + \Gamma_t^S Z_t^C) - (X_t^S + \Gamma_t^S Z_t^S) \\
&= \Gamma_t^S \{ (X_t^C + Z_t^C) - (X_t^S + Z_t^S) \} + (1 - \Gamma_t^S) (X_t^C - X_t^S) > 0.
\end{aligned}$$

F. *Testing capital allocation hypothesis*

In the model, it is assumed that it is difficult to regulate the use of retained profits because of information costs. So, the model allows the workers to decide freely the investment of retained profits in industrial and non-industrial production. This managerial autonomy implies a specific pattern for the industrial and non-industrial capital structure. In this sub-section, I will derive the pattern of capital allocation from the first order conditions in section II.

Equation (10) gives the industrial production function. Assume the fringe benefits production function is the following:

The technical marginal returns from industrial and non-industrial capital are the following:

$$H_t = g(S_t, L_t Z_t) = B(S_t)^\gamma (L_t Z_t)^\eta; \quad (19)$$

$$B > 0, \quad 0 < \gamma < 1, \quad 0 < \eta < 1.$$

$$\frac{\partial f}{\partial K_t} = \mu A(K_t)^{\mu-1} (L_t X_t)^\nu.$$

$$\frac{\partial g}{\partial S_t} = \gamma B(S_t)^{\gamma-1} (L_t Z_t)^\eta.$$

Substituting the above two marginal functions into the first order condition (4c), it follows:

$$\gamma B(S_t)^{\gamma-1} (L_t Z_t)^\eta = \Gamma_t \mu A(K_t)^{\mu-1} (L_t X_t)^\nu;$$

or:

$$\log\left(\frac{S_t}{L_t}\right) = \left(\frac{1-\mu}{1-\gamma}\right) \log\left(\frac{K_t}{L_t}\right) \quad (20)$$

$$+ \left(\frac{1}{1-\gamma}\right) \{-\log(\Gamma_t) - \nu \log(X_t) + \eta \log(Z_t) - \log(\mu A) + \log(\gamma B) + (\gamma + \eta - \mu - \nu) \log(L_t)\}.$$

Since the collective enterprises have higher incentive parameter Γ_t , higher industrial effort X_t , and lower non-industrial effort Z_t than the state enterprises, equation (20) predicts that given the industrial capital stock and the production functions, the collective enterprises will have less non-industrial capital stock than the state enterprises.

Data for $\log(S_t/L_t)$ and $\log(K_t/L_t)$ are available. Hence, equation (20), which is directly derived from the first order condition (4c), suggest a regression of $\log(S_t/L_t)$ on $\log(K_t/L_t)$ to test the capital allocation hypothesis. Specifically, the theory predicts that the coefficient of the dummy variable for the collective sector should be significantly negative in the regression of $\log(S_t/L_t)$ on $\log(K_t/L_t)$ using the pooled sample of the state and collective enterprises.

G. *Effects of monitoring on capital allocation*

In the previous analysis, I have assumed no monitoring on the investment decisions by the government. Under that assumption, the positive correlation between $\log(S_t/L_t)$ and $\log(K_t/L_t)$ will be very significant. However, the Chinese government has closely monitored the state enterprises for many years. In this sub-section, I discuss the effects of monitoring on capital allocation. I will examine two questions about monitoring: first, how monitoring influence the level of non-industrial capital; second, how monitoring affect the correlation of industrial and non-industrial capital.

If there is completely effective monitoring on the production of fringe benefits, a correlation between $\log(S_t/L_t)$ and $\log(K_t/L_t)$ is not plausible. Why should the government intentionally favor the employees of capital-intensive firms when they have already received higher wages while have lower productivity than the workers in labor-intensive firms? Why should the government voluntarily support the distribution of fringe benefits according to the capital-labor ratios? With zero information costs, fringe benefits capital per labor should not correlate with industrial capital per labor.

However, with incomplete monitoring, there may or may not be correlation between S_t/L_t and K_t/L_t . A completely effective monitoring means that the government can decide exactly how many profits will be invested in the fringe benefits production. By incomplete monitoring, I mean that the government does not control the exact amount of fringe benefits investment, but it influences the non-industrial investment indirectly. One effect of the indirect monitoring is to shrink the marginal return from the fringe benefits production. The workers will decrease investment in fringe benefits capital as they see the shrinking marginal returns from fringe benefits production following close monitoring by the government. I define the shrinking multiplier as the following:

$$m = \pi \left(\frac{K_t}{L_t} \right)^{-\omega}; \quad \pi \geq 0, \omega \geq 0, 0 \leq m \leq 1. \quad (21)$$

Multiplying the left side of the first order condition (4c) by (21), the effects of monitoring on the allocation of capital are incorporated into the model. In (21), if ω is zero, the same monitoring measure is applied to both capital-intensive and labor-intensive firms. If ω is greater than zero, then, the capital-intensive firms are monitored more closely than the labor-intensive firms. To facilitate the study of monitoring effects empirically, equation (20) is extended to include the shrinking multiplier in the following equation:

$$\left\{ \pi \left(\frac{K_t}{L_t} \right)^{-\omega} \right\} \cdot (\gamma B (S_t)^{\gamma-1} (L_t Z_t)^\eta) = (\Gamma_t \mu A (K_t)^{\mu-1} (L_t Z_t)^\eta);$$

or:

$$\log \left(\frac{S_t}{L_t} \right) = \left(\frac{1-\mu-\omega}{1-\gamma} \right) \log \left(\frac{K_t}{L_t} \right) \quad (22)$$

$$+ \left(\frac{1}{1-\gamma} \right) \{ -\log(\Gamma_t) - \nu \log(X_t) + \eta \log(Z_t) + \log(\pi) \\ - \log(\mu A) + \log(\gamma B) + (\gamma + \eta - \mu - \nu) \log(L_t) \}.$$

According to (22), if the monitoring is not designed to pay more attentions to capital-intensive firms (e.g. if $\omega=0$), the correlation between $\log(S_t/L_t)$ and $\log(K_t/L_t)$ may still be high even if the monitoring is intensive. However, the effects of monitoring will be reflected in the coefficients of dummy variables grouping firms under different monitoring intensity (see the term $\log(\pi)$ in (36)). However, if the monitoring is more intensive for firms with higher capital-labor ratios, the correlation between $\log(S_t/L_t)$ and $\log(K_t/L_t)$ will not be significant and may even be negative since $(1-\mu-\omega)$ may be zero or negative.

V. Data

The firm data in this study are taken from the Chinese 1985 industrial census. Before the People's Republic of China was born in 1949, a national wide industrial census had never been attempted in China. In 1950, the first national wide industrial survey was carried out. However, it only surveyed very basic information from about 3,000 publicly owned or private-and-public-joint-venture firms. The Chinese industrial sector at that time was very small because of China's poor industrial development and the destruction of the Japanese-invasion (1937-1945) and Chinese civil war (1945-1949). The 1985 national-wide industrial census was initiated in 1983. At that time, the Chinese industrial sector had become the largest one in the national economy in terms of net output value. The net industrial output value had increased from a 19.5% share of national income in 1952 to 40.5% in 1984,¹³ and the economic reforms since 1978 had already have positive effects on industrial growth. The Chinese government did the 1985 industrial census in order to acquire the first extensive and systematic data base on the industrial sector. The reform-minded government

¹³ See SSB 1985 page 2.

needed such information to evaluate the effects of reform since 1978 and to design new policies in the future. After two years of preparation, the 1985 industrial census collected detailed information from about 360,000 enterprises. Among the 360,000 enterprises, there are 8285 large and medium-sized enterprises which produced 54.55% of the total net industrial output value of the nation. The results of the industrial census have been published by industry, province, city, and county in several volumes. However, the firm-level data are only published internally in two volumes for 1764 large and medium-sized enterprises.

This study will use the 1764-firm sample of large and medium-sized enterprises. This 1764-firm sample selects 32 from about 47 industries classified by the Chinese two-digit industrial classification standard. For each industry, firms producing similar and standard products are included in the 1764-firm sample. Hence, the 1764-firm sample includes less industries than the total of 8285 large and medium-sized firms have covered. However, the products in each industry of the 1764-firm sample are more comparable than those of the 8285-firm sample. In this paper, I will concentrate on the comparison of Chinese state and collective enterprises. Hence, I only use the data for 14 industries which have at least one collective enterprise (or an enterprise joint-ventured by a collective and a state enterprise) for each industry.

Table 1 lists the number of firms in the sample by industry. As can be seen, there are much more state firms in the sample (903) than collective firms (55). The imbalance is a direct result of the firm size restriction of this sample. All firms in this sample are large or medium-sized. The classification of firm size is primarily based on production capacity, e.g. output measured by physical quantity. If output quantity is difficult to measure, such as multiple and diverse products, gross value of fixed capital is used to determine firm size. The classification of large, medium-sized, and small firms for each industry has national standard regulated by the State. It should be emphasized that the sample used in this paper is not selected by any output value or value added. Also, unlike the Western concept of firm size, the medium-sized firms in China have several hundred employees, which might be classified as large firms in the West. Since only a handful collective firms have reached the large and medium-sized category, the following analysis may not represent the whole collective sector very well. However, the imbalanced sample can be used to study the state and collective firms of roughly comparable scale. The sample structure in this paper complements that in Xiao (1990a) where the cross-city sample includes the state and collective firms of all sizes but has a large gap in the average firm sizes between the two sectors.

The firm-level data have variables for net output value, industrial and non-industrial capital, number of employees, etc. in 1985. Some important variables are also reported for 1980 data. The

Table III Number of Firms in the Sample by Industry

Industry	State Firms	Collective Firms
Total	903	55
Electronic Products	51	3
Food Products	54	1
Textiles	151	2
Wearing Apparel	10	3
Coking	13	1
Industrial Chemicals	168	2
Chemical Fibre	31	1
Rubber Products	29	2
Plastic Products	16	6
Cement and Glass	71	3
Machinery I	105	2
Machinery II	85	10
Transport Equipment	79	1
Electrical Machine	40	18

Source: PRC 1985 Industrial Census.

variables used in the following regression analysis are described in table 2 and their summary statistics are shown in table 3. In the summary statistics and the following regression analysis, observations with zero or negative values for net output, net capital, and sales revenues are deleted from the sample. Table 3 shows that the geometrical average of labor productivity ($\log[\text{Net Output Value/Labor}]$) in the state firms was about 28% higher than that in the collective firms in 1980, but was 46% lower in 1985. This dramatic change of relative labor productivity between the two sectors can be attributed partly to the convergence of capital-labor ratios in the state and collective firms (see $\log[\text{Industrial Capital/Labor}]$ in table 3). Although the equipment makes up a much smaller portion of the capital stock in the collective firms than in the state firms, the collective firms have added more new equipment than the state firms since 1980 (see Equipment/Capital in table 3).

According to table 3, the state firms have increased output price more significantly than the collective firms (see $\log[\text{Price}]$). The state firms also use more electricity (see Electricity/Gross

Table IV Description for Variables in the Firm Sample

Variable	Unit	Description
Net Output Value	1000 yuan	annual net value of industrial output in current price;
Industrial Capital	1000 yuan	net value of fixed industrial capital in current price = net value of total fixed capital * {gross value of fixed industrial capital/gross value of total fixed capital};
Fringe Benefits Capital	1000 yuan	net value of fixed non-industrial capital in current price = net value of non-industrial fixed capital * {gross value of non-industrial fixed industrial capital/gross value of total fixed capital};
Labor	person	average number of employees over the year;
Wage	1000 yuan	total wage bill in the year;
Price		gross output in current price/gross output in 1980 constant price; The constant price is a fixed administrative price used solely for comparisons. The price used for actual sales is current price (even for 1980).
Equipment	1000 yuan	value of equipment counted as fixed industrial capital in current price;
New Equipment	1000 yuan	value of equipment brought since 1980 in current price;
Electricity	1000 KWH	electricity used in industrial production;
Gross Output	1000 yuan	gross value of industrial output in current price;
Technician	person	Engineers and technicians;
Manager	person	Managers and administrators;
Export	1000 yuan	value of export in current price;
Sales	1000 yuan	revenue from sales of industrial products in current price;
Good Firm Dummy		equal to one if the value of taxes and profits from 1949-85 is greater than five times of the value of investment from 1949-85; equal to zero otherwise;
Bad Firm Dummy		equal to one if the value of taxes and profits from 1949-85 is less than the value of investment from 1949-85; equal to zero otherwise;

Source: PRC 1985 Industrial Census.

Output Value). They also have more fringe benefits capital (see $\log[\text{Fringe Benefits Capital}/\text{Labor}]$). However, for this sample, the average wages in the collective firms are lower in 1980 and higher in 1985 than those in the state firms.¹⁴ In this sample, the size of technical and managerial personals in the two sectors are comparable (see $\text{Technician}/\text{Labor}$ and $\text{Manager}/\text{Labor}$). The average export

¹⁴ In the aggregate statistics, the average wage is much higher in the state enterprises than in the collective enterprises (see Xiao 1990b). The wage differences in the aggregate statistics may reflect gaps in labor skills since many small collective enterprises employ women and high school dropouts. The collective enterprises in this sample are significantly larger than the normal collective firms and may have roughly comparable quality of the labor to that in the state enterprises. Also, firm size may have positive influence on wages.

Table V Means for Variables in the Firm Sample

Variable	State Sample		Collective Sample	
	1980	1985	1980*	1985
Sample Size	903	903	55	55
log(Net Output Value/Labor)	1.416	1.746	1.139	2.207
log(Capital/Labor)	1.704	1.993	1.165	1.935
log(Fringe Benefits Capital/Labor)	-0.116	0.387	-1.318	-0.0008
log(Labor)	7.675	7.847	6.912	7.258
log(Wage/Labor)	-0.153	0.195	-0.271	0.280
log(Price)	0.0048	0.0507	-0.0155	-0.0790
Equipment/Capital	0.651	0.656	0.156	0.161
New Equipment /Equipment	N/A	0.373	N/A	0.701
Electricity/Gross Output	N/A	0.565	N/A	0.090
Technician/Labor	N/A	0.055	N/A	0.045
Manager/Labor	N/A	0.103	N/A	0.117
Export/Sales	N/A	0.067	N/A	0.050
Good Firm Dummy	0.256	0.256	0.036	0.036
Bad Firm Dummy	0.256	0.251	0.818	0.818

Source: PRC 1985 Industrial Census.

value in this sample is about 5% of the total sales for both the state and collective firms.

According to the ratio of taxes and profits to investment from 1949 to 1985, about 25% of the state firms in this sample failed to produce enough profits to cover their past investment (see description of Good and Bad Firm Dummies in table 2).¹⁵

In the following sections, the panel data of state and collective firms in 1980 and 1985 are used to test hypotheses about productivity, capital allocation, and labor income.

¹⁵ For many collective enterprises, the accumulated tax and profits since 1949 to 1985 are reported as zero in the data set. Hence, they are classified as Bad firms in following regressions.

VI. Productivity

One of the hypothesis derived from the model involves relative levels of productivity for different enterprise systems. Xiao (1990a) has used cross-city data to examine the productivity in the state and collective enterprises. The evidence there shows that the total factor productivity in the collective sector is higher than that in the state sector. The productivity gap is consistent with the theoretical model in this paper. However, the empirical results from cross-city data, which aggregate firm data in all industries, may be sensitive to the industry composition of the state and collective sectors. The collective sector has concentrated on light industries while the state sector has focused on heavy industries. Hence, the estimated productivity gap between the two sectors may reflect differences in industry composition as well as in effort levels relating to incentive structures. Xiao (1990a) also examined the effects of economic reforms on the state and collective sectors. The results there show that the reforms during 1985-1987 period had little impact on the growth of total factor productivity in the state sector but facilitated greatly the total factor productivity growth in the collective sector. However, some of the most important reform measures such as enterprise autonomy and profit-retention came during 1980-1985 period. Hence, it is likely that the reforms had more influence on the rate of productivity growth in the state sector during this early period.¹⁶

In Xiao (1990a), I discussed in detail the estimation of production function and the measure of total factor productivity. In this paper, I will concentrate on presenting the results from the basic regression analysis. I will first discuss the estimated sector-and-year-specific production functions in table 4 and 5. The results of these basic regressions are informative about the productive features of the state and collective firms. However, they are not suitable to measure productivity gaps between the two sectors.

After discussing these sector-specific features, I then examine a panel sample regression in table 6. This regression measures both productivity gaps and growth and is the most concise summary of the empirical evidence about productivity.

However, the fringe benefits production is ignored in the panel sample regression of table 6. The omitting will not affect the measure of the conventional industrial productivity. But, the industrial productivity in the Chinese enterprise system is not equivalent to a measure of efficiency. The state firms may divert effort and capital from industrial to non-industrial production. Hence, the profits will decrease but the fringe benefits will increase. To measure efficiency, it is necessary to

¹⁶ Xiao (1990b) has reviewed the literature on productivity growth of Chinese industrial enterprises.

consider fringe benefits services as well as profits as output. I will introduce fringe benefits into the production function estimation in table 9 and 10.

Table IV Regression Explaining Productivity (A1)

Conventional Case: Ignoring Fringe Benefits Production Sample: Cross-Sectional Data of State Firms		
Dependent Variable: log(Net Output Value/Labor)	1980	1985
Sample Size	903	903
R-Square	0.619	0.550
Adjusted R-Square	0.609	0.538
Independent Variable	Estimate (t)	Estimate (t)
Intercept	-0.672 (-2.5)	0.450 (1.7)
Basic Variable:		
log(Industrial Capital/Labor)	0.326 (10.3)	0.452 (14.7)
log(Labor)	0.050 (1.7)	0.064 (2.5)
Controlling Variables:		
log(Price)	0.232 (1.3)	0.386 (3.9)
Equipment/Capital	1.041 (6.1)	0.651 (4.4)
New Equipment/Equipment	N/A	0.403 (4.5)
Electricity/Gross Output	-0.134 (-4.2)	-0.132 (-5.0)
Technician/Labor	4.153 (4.1)	0.679 (0.8)
Manager/Labor	0.533 (1.0)	0.586 (1.4)
Productivity Gap:		
Export/Sales	0.177 (1.1)	0.009 (0.1)
Good Firm Dummy	0.743 (13.5)	0.553 (12.2)
Bad Firm Dummy	-0.875 (-16.9)	-0.543 (-12.6)

Source: PRC 1985 Industrial Census;

Note: Coefficients for industry dummies omitted.

Table V Regression Explaining Productivity (A2)

Conventional Case: Ignoring Fringe Benefits Production Sample: Cross-Sectional Data of Collective Firms		
Dependent Variable: log(Net Output Value/Labor)	1980	1985
Sample Size	903	903
R-Square	0.557	0.545
Adjusted R-Square	0.431	0.400
Independent Variable	Estimate (t)	Estimate (t)
Intercept	3.970 (2.1)	0.056 (0.03)
Basic Variable:		
log(Industrial Capital/Labor)	0.048 (0.2)	0.544 (3.6)
log(Labor)	-0.099 (-0.5)	0.087 (0.5)
Controlling Variables:		
log(Price)	0.086 (0.1)	-0.145 (-0.5)
Equipment/Capital	-1.326 (-1.9)	0.056 (0.1)
New Equipment/Equipment	N/A	-0.007 (-0.02)
Electricity/Gross Output	-3.005 (-2.1)	-1.507 (-1.5)
Technician/Labor	-12.419 (-2.8)	1.949 (0.6)
Manager/Labor	-0.935 (-0.2)	3.223 (1.0)
Productivity Gap:		
Export/Sales	-1.060 (-1.2)	-0.810 (-1.4)
Good Firm Dummy	1.018 (1.8)	0.511 (1.3)
Bad Firm Dummy	-0.688 (-1.3)	0.120 (0.3)

Source: PRC 1985 Industrial Census;

Note: Coefficients for industry dummies omitted.

A. *Productive features of state and collective firms*

Table 4 gives estimates of the Cobb-Douglas production function for the state firms in 1980 and 1985. According to the estimates, the output elasticity of capital is significantly positive and increases from .326 in 1980 to .452 in 1985. The elasticity of scale is also significant and increases

from 1.050 in 1980 to 1.064 in 1985. Since the small firms are left out, scale economies for firms of all size may even be greater. These elasticity changes are consistent with an improvement in production efficiency. Also, the intercepts increase from -0.672 in 1980 to 0.450 in 1985 with significant t-statistics for both years. The improvement is further demonstrated by the convergence of the total factor productivity gap between the Good Firms and the Bad Firms from 162% to 110%. The relative TFP for Bad firms changes from 87.5% to 54.3% below the average firms, while the relative TFP for good firms changes from 74.3% to 55.3% above the average. The variable $\log(\text{Price})$ in the cross-sectional regression measures relative price increases and has significantly positive coefficients in both 1980 and 1985. It seems that the state firms have benefitted from a relaxed price control regime after reforms.

The similar pattern of enhanced productivity is observed for the collective firms as well. In table 5, the output elasticity of capital for the collective firms is small (.048) and insignificant in 1980. However, in 1985, it is significant and increases to .544 -- even higher than the elasticity of capital in the state firms of the same year (which is .452). The intercept in 1980 is much higher than that in 1985 because the coefficient for $\log(K/L)$ in 1980 is too low. The productivity gaps between the Good Firms and Bad Firms in the collective sample drop from 171% in 1980 to 39% in 1985. In 1985 regression, the Bad Firms have 12% higher TFP than the average firms, although in 1980, they have 68.8% lower TFP than the average. Hence, the productivity increase seems more dramatic among the collective firms. However, the returns to scale in the collective sample is not significant for both 1980 and 1985 regressions.

The regressions in table 4 and 5 also reveal the effects of other control variables on productivity. Although the control variables have quite different coefficients for the state and collective samples, they are included in the following pooled panel sample regression of table 6 the same way as the basic variables. The rationale is to estimate an average set of coefficients or elasticities. Then, the productivity gaps and growth can be compared using the same set of elasticities.

Table VI Regression Explaining Productivity (B)

Conventional Case: Ignoring Fringe Benefits Production Sample: Panel data Pooling State and Collective Firms		
Sample Size = 1970; R-Square = .531; Adjusted R-Square = .524; Dependent Variable: log(Net Output Value/Labor);		
Independent Variable	Parameter Estimate	t Statistic
Intercept	0.349	(1.8)
Basic Variable:		
log(Industrial Capital/Labor)	0.394	(17.6)
log(Labor)	0.047	(2.3)
Controlling Variables:		
log(Price)	0.271	(3.2)
Equipment/Capital	0.290	(2.9)
Electricity/Gross Output	-0.167	(-7.8)
Technician/Labor	1.726	(2.6)
Manager/Labor	0.551	(1.5)
Productivity Gap:		
Collective Firm Dummy	0.742	(7.6)
Export/Sales	0.533	(3.5)
Good Firm Dummy	0.838	(16.2)
Bad Firm Dummy	-0.895	(-18.5)
Productivity Growth:		
Year1985	0.194	(4.9)
Year1985*(Collective Firm Dummy)	0.248	(2.1)
Year1985*(Export/Sales)	-0.837	(-4.3)
Year1985*(Good Firm Dummy)	-0.385	(-5.5)
Year1985*(Bad Firm Dummy)	0.416	(6.6)

Source: PRC 1985 Industrial Census;
Note: Coefficients for industry dummies omitted.

B. Growth, gaps and convergence of productivity

Table 6 reports the pooled regression using panel sample. As expected, the output and scale elasticities, which are respectively .394 and 1.047, are about the averages of the elasticities estimated in the above sector-and-year-specific production functions (see table 4 and 5). As shown in table 6, the total factor productivity in the state firms grew 19.4% from 1980 to 1985. Hence, following the

institutional change during 1980-85, the state firms have had, on average, almost a 4% annual growth of total factor productivity during 1980 to 1985. This finding is consistent with the prediction of chapter 4 about the effects of introducing profit-sharing on productivity enhancement.

The improvement of productivity is further confirmed by the growth pattern of the Good and Bad firms. The TFP gap between the Good and Bad Firms in 1980 was 173%. However, the gap decreased to 93% by 1985 because the TFP of Bad Firms have grown 41.6% while the TFP of Good Firms have declined 38.5% during this period.

During 1980 to 1985, the TFP in the collective firms have grown 44.2% which is equivalent to an annual rate of 8.8%. Hence, the productivity in collective firms grew twice as fast as that in the state firms.

The TFP of collective firms was 74.2% higher than that of state firms in 1980. Moreover, the TFP gap increased to 99% in 1985. Hence, throughout the period from 1980 to 1985, the collective firms were much more productive than the state firms. This evidence is consistent with the predictions of the theory about industrial effort allocation in this paper.

Unlike the TFP estimates from cross-city data reported in Xiao (1990a), the estimates of TFP gap in this paper are obtained after controlling for variation across industry. The coefficients for industry dummies are omitted in table 6. However, the industry TFP indexes computed from these industry dummies are listed in table 7. As shown in table 7, the TFP index for the industry of rubber products is about 44% higher than the sample average while the industry of machinery I is about 40% lower. Indeed, if the state and collective sectors have quite different industry composition, the estimated TFP gap between the state and collective sectors from the cross-city data may capture the cross-industry productivity differences as well as the productivity differences caused by effort level or incentive structures. As a result, the TFP gap may be biased in the cross-city regressions of Xiao (1990a). Using firm-level data and industry dummies, the estimated TFP gap between the state and collective firms in table 6 should not be biased by differences in industrial composition. Hence, the TFP gaps estimated here will reflect more closely the effects of property rights structures on productivity.

According to the regressions, there is little doubt that the collective firms produced more net industrial output than the state firms per unit of labor and capital. However, the productivity gap, even of such a large magnitude, does not confirm the most important prediction of the model that the collective firms are more efficient than the state firms in the use of effort and capital. The next subsection explains the difference between productivity and efficiency by considering fringe benefits as well as industrial production, and explores the testing of the efficiency hypothesis.

Table VII Industry TFP Index 1980-1985

Industry	Industry TFP Index
Average	100.0
Electronic Products	116.5
Food Products	98.3
Textiles	100.4
Wearing Apparel	104.6
Coking	88.6
Industrial Chemicals	97.8
Chemical Fibre	124.3
Rubber Products	144.1
Plastic Products	126.3
Cement and Glass	96.0
Machinery I	60.6
Machinery II	92.6
Transport Equipment	72.9
Electrical Machine	76.7

Source: PRC 1985 Industrial Census

Note: The indexes are computed from the industry dummies of the panel sample regression in table 6.6.

Before incorporating the fringe benefits into production function estimation, I briefly compare the results from the above panel sample regression in table 6 with those from cross-sectional pooled regressions without considering the fringe benefits variable. Panel sample regressions usually suffer correlation between years. In this work, the 5-year span from 1980 to 1985 is quite long and the correlation is reduced by significant institutional change. But, for comparison, the cross-sectional regressions are reported in table 8. According to table 8, the pattern of productivity from cross-sectional regressions is consistent with that from panel sample regression. The estimated TFP gaps between the state and collective firms are 76.5% in 1980 and 75.9% in 1985. The TFP gap between the Good Firms and Bad firms have decreased from 158% in 1980 to 105% in 1985.

The estimated output elasticities of capital from table 8 are .321 for 1980 and .460 for 1985. Comparing the elasticities in the two years it is clear that the production function structure is quite different between 1980 and 1985. In the following analysis concerning fringe benefits, I compare

Table VIII Regression Explaining Productivity (C1)

Conventional Case: Ignoring Fringe Benefits Production Sample: Cross-Sectional Data pooling State and collective Firms		
Dependent Variable: log(Net Output Value/Labor)	1980	1985
Sample Size	957	957
R-Square	0.583	0.532
Adjusted R-Square	0.572	0.520
Independent Variable	Estimate (t)	Estimate (t)
Intercept	-0.327 (-1.2)	0.557 (2.1)
Basic Variable:		
log(Industrial Capital/Labor)	0.321 (9.9)	0.460 (15.0)
log(Labor)	0.069 (2.3)	0.068 (2.6)
Controlling Variables:		
log(Price)	0.203 (1.2)	0.274 (2.9)
Equipment/Capital	0.344 (2.3)	0.196 (1.6)
New Equipment/Equipment	N/A	0.478 (5.5)
Electricity/Gross Output	-0.147 (-4.4)	-0.132 (-4.9)
Technician/Labor	3.099 (3.0)	0.483 (0.6)
Manager/Labor	0.530 (1.0)	0.617 (1.4)
Productivity Gap:		
Collective Firm Dummy	0.765 (6.5)	0.759 (7.7)
Export/Sales	0.224 (1.3)	-0.008 (-0.1)
Good Firm Dummy	0.745 (13.1)	0.553 (12.1)
Bad Firm Dummy	-0.836 (-15.7)	-0.493 (-11.3)

Source: PRC 1985 Industrial Census;
Note: Coefficients for industry dummies omitted.

efficiency across sectors and do not need the estimation of productivity growth. Hence, I will use cross-sectional regressions (instead of panel sample regressions) to avoid the problem of structural change in the production function over time.

C. *Fringe benefits and efficiency*

The conventional measure of productivity assumes that output of each firm can be aggregated by value. In measuring productivity of Chinese firms, the in-kind fringe benefits is usually not counted as output and the non-industrial capital, which is used to produce fringe benefits services, is also excluded from the inputs. If all the inputs for the production of industrial profits are measured correctly, the conventional measure of productivity will reflect efficiency. However, in the Chinese enterprises, the labor effort and capital are difficult to measure because of their dual-production. The labor effort may be used to produce fringe benefits while its costs go to the account of industrial production. Also, the industrial capital may not be used to produce industrial products. Instead, it may be used as fringe benefits capital. As a result, the more the state firms produce fringe benefits, the lower their productivity measured by the conventional method.

The diversion of effort and capital from industrial to non-industrial production can be tested by adding the term $\log(\text{Fringe Benefits Capital/Labor})$ into the independent variables of production function regressions. If there is diversion of effort and capital, other things given, more fringe benefits capital will lead to less industrial output so that the coefficient for $\log(\text{Fringe Benefits Capital/Labor})$ will be significantly negative. If the coefficient for $\log(\text{Fringe Benefits Capital/Labor})$ is significantly positive, then the diversion, if there are any, may not be important. A positive coefficient will also imply that the use of fringe benefits increases industrial effort and industrial output.

Table 9 shows the regression results incorporating the fringe benefits capital as an independent variable. In both 1980 and 1985 cross-sectional regressions, the coefficients for $\log(\text{Fringe Benefits Capital/Labor})$ are significantly negative. From this evidence, it can be concluded that there is diversion of effort and/or capital from industrial to fringe benefits production.

The productivity gaps between the state and collective firms in table 9, which are measured by controlling fringe benefits, are slightly smaller than those in table 8 ignoring fringe benefits. The gaps in table 9, which are 67.1% for 1980 and 73.1% for 1985, are more plausible measures of relative industrial productivity differences between the state and collective firms than those in table 8.

However, to measure efficiency in contrast to industrial productivity, it is necessary to include fringe benefits output as well as fringe benefits capital input into the production function. But, there are no data collected for the fringe benefits services. The fringe benefits in Chinese enterprises are difficult to measure because of the unique structure of property rights. In Chinese enterprises, the fringe benefits services are generally not commodities for trade and their provision is only implicitly

Table IX Regression Explaining Productivity (C2)

Experimental Case: Incorporating Fringe Benefits Capital Sample: Cross-Sectional Data pooling State and collective Firms		
Dependent Variable: log(Net Output Value/Labor)	1980	1985
Sample Size	957	957
R-Square	0.587	0.535
Adjusted R-Square	0.576	0.522
Independent Variable	Estimate & t	Estimate & t
Intercept	-0.448 (-1.6)	0.496 (1.8)
Basic Variable:		
log(Industrial Capital/Labor)	0.369 (10.3)	0.484 (15.0)
log(Fringe Benefit Capital/Labor)	-0.075 (-3.1)	-0.056 (-2.3)
log(Labor)	0.074 (2.5)	0.070 (2.7)
Controlling Variables:		
log(Price)	0.205 (1.2)	0.263 (2.8)
Equipment/Capital	0.302 (2.0)	0.188 (1.5)
New Equipment/Equipment	N/A	0.454 (5.2)
Electricity/Gross Output	-0.154 (-4.6)	-0.137 (-5.1)
Technician/Labor	3.011 (3.0)	0.558 (0.7)
Manager/Labor	0.648 (1.2)	0.754 (1.7)
Productivity Gap:		
Collective Firm Dummy	0.671 (5.5)	0.731 (7.4)
Export/Sales	0.178 (1.1)	-0.041 (-0.3)
Good Firm Dummy	0.726 (12.8)	0.537 (11.7)
Bad Firm Dummy	-0.806 (-14.9)	-0.474 (-10.7)

Source: PRC 1985 Industrial Census;

Note: Coefficients for industry dummies omitted.

assumed. In table 10, I assume that the fringe benefits services are equal to the fringe benefits capital for each firm and the imputed value of fringe benefits services is added to the profits to yield a composite output. This assumption will overstate the level of fringe benefits services if the

Table X Regression Explaining Productivity (C3)

Experimental Case: Incorporating Fringe Benefits Capital and Services Sample: Cross-Sectional Data pooling State and collective Firms		
Dependent Variable: $\log((\text{Net Output Value} + \text{Fringe Benefits Service})/\text{Labor})$	1980	1985
Sample Size	957	957
R-Square	0.568	0.566
Adjusted R-Square	0.557	0.554
Independent Variable	Estimate & t	Estimate & t
Intercept	0.456 (2.1)	1.013 (5.0)
Basic Variable:		
$\log(\text{Industrial Capital}/\text{Labor})$	0.348 (12.6)	0.409 (16.4)
$\log(\text{Fringe Benefit Capital}/\text{Labor})$	0.122 (6.5)	0.163 (8.8)
$\log(\text{Labor})$	0.034 (1.5)	0.039 (1.9)
Controlling Variables:		
$\log(\text{Price})$	0.210 (1.6)	0.161 (2.2)
Equipment/Capital	0.064 (0.5)	0.183 (1.9)
New Equipment/Equipment	N/A	0.352 (5.2)
Electricity/Gross Output	-0.113 (-4.5)	-0.099 (-4.8)
Technician/Labor	2.217 (2.9)	1.015 (1.6)
Manager/Labor	0.502 (1.2)	0.483 (1.4)
Productivity Gap:		
Collective Firm Dummy	0.310 (3.3)	0.537 (7.1)
Export/Sales	0.170 (1.3)	-0.040 (-0.4)
Good Firm Dummy	0.695 (16.0)	0.468 (13.2)
Bad Firm Dummy	-0.401 (-9.7)	-0.278 (-8.2)

Source: PRC 1985 Industry Census;
Note: Coefficients for industry dummies omitted.

production functions for industrial profits and fringe benefits are the same. As can be seen from table 3, one dollar of industrial capital produces less than one dollar industrial output in both state and collective firms. Since, the state firms have more fringe benefits capital, the regression in table 10

using the above assumption may underestimate the efficiency gap. The estimated efficiency gaps in table 10 are 31.0% in 1980 and 53.7% in 1985. Compared with the productivity gaps of 67.1% in 1980 and 73.1% in 1985 from table 9, the efficiency gaps are significantly smaller than the productivity gaps. However, the quite conservative estimates of efficiency gaps are large enough to give strong support for the efficiency hypothesis.

Table 10 also shows that after considering fringe benefits production, the initial efficiency gap between the Good and Bad firms in 1980 are only 110% and by 1985 it has decreased to 75%.

D. Convergence of productivity at industry level

In the above regressions pooling the state and collective sample, I have used industry dummies to control for industry-specific variation in productivity. In table 11, the industry dummies from the regressions of table 8 and 10 are used to compute indexes of total factor productivity across industries. Table 11 also gives the coefficients of variation of the industry TFP indexes in each year. These coefficients of variation decline significantly from 1980 to 1985 and demonstrate the convergence of productivity across industries. Also, the dispersion of productivity across industries is reduced significantly when fringe benefits production is considered.

In the process of productivity convergence, the ranking of productivity across industries has also changed significantly. According to table 11, quite a few industries with lower productivity in 1980, such as electronic products, machinery I, transport equipment, and electrical machines, have acquired higher than average productivity in 1985. This pattern of productivity change is summarized by the coefficients of variation for the change of industry TFP indexes. The evidence reveals that Chinese industry has experienced a significant structural change during 1980 to 1985 in terms of industry productivity.

E. Effects of export on productivity

The profound change in the structure of property rights in Chinese industry sector during 1980 to 1985 has also been accompanied by an open-door policy. Many Chinese firms have started to export their products. The regressions in table 6, 8 and 10 can be used to examine the effects of export on productivity. In the sample, the variable Exports/Sales is only available for 1985. I assume the value of Exports/Sales in 1980 is equal to 1985 in both the panel sample and cross-sectional regressions. With this assumption, the variable Exports/Sales can be regarded similar as the categorical variables such as the Collective Firm Dummy and the Good and Bad Firm Dummies.

**Table XI Convergence of Total Factor Productivity
at Industry Level**

Industry	# of Firms	Industry TFP Index Based on Coefficients of Industry Dummies from Regression Ignoring Fringe Benefits in table 8			Industry TFP Index Based on Coefficients of Industry Dummies from Regression Considering Fringe Benefits in table 10		
		TFP Index in 1980	TFP Index in 1985	TFP Index Change 80-85	TFP Index in 1980	TFP Index in 1980	TFP Index Change 80-85
Average		100.0	100.0	0.00	100.0	100.0	0.00
Electronic Products	54	67.4	166.3	98.90	74.2	149.1	74.90
Food Products	55	127.8	70.5	-57.30	115.3	74.5	-40.80
Textiles	153	122.9	75.1	-47.80	123.0	80.2	-42.80
Wearing Apparel	13	108.8	88.2	-20.60	110.4	96.7	-13.70
Coking	14	72.1	119.3	47.20	73.5	110.9	37.40
Industrial Chemicals	170	103.9	89.5	-14.40	101.9	89.4	-12.50
Chemical Fibre	23	139.8	98.9	-40.90	131.3	99.7	-31.60
Rubber Products	31	141.5	145.9	4.40	135.3	134.9	-0.40
Plastic Products	22	151.1	102.4	-48.70	143.9	103.0	-40.90
Cement and Glass	74	99.8	91.3	-8.50	95.8	92.7	-3.10
Machinery I	107	52.7	73.6	20.90	65.3	79.0	13.70
Machinery II	95	93.4	87.8	-5.60	95.3	96.3	1.00
Transport Equipment	80	58.3	93.7	35.40	68.6	96.7	28.10
Electrical Machine	58	60.5	97.4	36.90	66.2	96.9	30.70
Coefficients of Variation		32.4 %	26.2 %	42.6 %	26.4 %	19.7 %	33.2 %

Source: PRC 1985 Industrial Census.

There are two conclusions emerging from the regressions. First, it is found that the exporting firms have initially (in 1980) significant advantages in productivity. Second, the productivity in the exporting firms have declined significantly over the period from 1980 to 1985. Incidentally, the pattern of productivity in the Good Firms resembles that of the exporting firms.

Although firms may have to be more productive to export, it is difficult to explain the productivity decline of exporting firms according to conventional trade theories. Although a detailed

examination of Chinese exporting firms based on trade theories is beyond the scope of this chapter, I will give an explanation of the poor performance in the exporting firm from the property rights perspective.

Since the Chinese government has monopolized the exporting industry, it selected the best firms to produce export goods. These firms were usually monitored very closely by the government before the reform. However, as managerial autonomy increased during 1980 to 1985, these exporting firms with higher productivity also had advantages in increasing fringe benefits production. As a result, the industrial productivity of these firms declined, but their fringe benefits production increased. The overall efficiency fell as well. The next section gives evidence supporting this explanation.

VII. Capital Allocation

A. *Incomplete monitoring and the diversion of capital from industrial to fringe benefits production*

In previous sections, I derived the hypothesis about capital allocation in Chinese firms from a dynamic utility-maximizing model. There are two major predictions about capital allocation to be tested. First, the model shows that if the monitoring of fringe benefits investment by the government is not completely effective, the change of fringe benefits capital will be correlated with the change of industrial capital. The condition of incomplete monitoring can be replaced by managerial autonomy and will yield the same prediction of positive correlation between changes in industrial and non-industrial capital.

In table 12, using a panel sample regression, the fringe benefits capital per labor is shown to be significantly positively correlated with industrial capital per labor. According to table 12, a one percent increase in industrial capital will on average lead to a half percent increase in fringe benefits capital during 1980 to 1985. In the cross-sectional regressions of table 13, the similar patterns concerning changes in industrial and non-industrial capital are shown in both 1980 and 1985. The coefficient for $\log(\text{Industrial Capital/Labor})$ in 1980 (.627) is even higher than that in 1985 (.461). The difference suggests that capital would be diverted from industrial production to fringe benefits production more rapidly in 1980 than in 1985.¹⁷ From the above evidence, it can be concluded that

¹⁷ The theoretical coefficient for $\log(\text{Fringe Benefits Capital/Labor})$ is $(1-\mu)/(1-\gamma)$, where μ and γ are output elasticities of capital respectively for industrial and non-industrial productions. Since μ has increased significantly

Table XII Regression Explaining Capital Allocation (A)

Sample: Panel data Pooling State and Collective Firms		
Sample Size = 1970;		
R-Square = .469; Adjusted R-Square = .462;		
Dependent Variable: log(Fringe Benefits Capital/Labor);		
Independent Variable	Parameter Estimate	t Statistic
Intercept	-2.074	(-9.2)
Basic Variable:		
log(Industrial Capital/Labor)	0.542	(18.9)
log(Labor)	0.042	(1.6)
Controlling Variables:		
Senior Worker/Labor	1.121	(5.5)
Technician/Labor	-0.686	(-0.7)
Manager/Labor	1.785	(3.9)
Residual Fringe Benefits Capital Gap:		
Collective Firm Dummy	-1.071	(-9.4)
Exports/Sales	-0.745	(-3.9)
Good Firm Dummy	-0.292	(-4.4)
Bad Firm Dummy	0.444	(7.4)
Fringe Benefits Capital Growth:		
Year1985	0.300	(6.0)
Year1985*(Collective Firm Dummy)	0.541	(3.6)
Year1985*(Export/Sales)	0.309	(1.2)
Year1985*(Good Firm Dummy)	0.051	(0.6)
Year1985*(Bad Firm Dummy)	-0.102	(-1.3)

Source: PRC 1985 Industrial Census;

Note: Coefficients for industry dummies omitted.

on average, the monitoring of fringe benefits by the government was ineffective in both 1980 and 1985.

B. Profit retention rate and the residual level of fringe benefits capital

The second major hypothesis derived from the model predicts that across the firms, given industrial capital, the level of fringe benefits capital will depend on the terms of the profit-sharing

from 1980 to 1985, if assuming γ is constant, $(1-\mu)/(1-\gamma)$ will decrease.

Table XIII Regression Explaining Capital Allocation (B)

Sample: Cross-Sectional Data pooling State and collective Firms		
Dependent Variable: log(Fringe Benefits Capital/Labor)	1980	1985
Sample Size	957	957
R-Square	0.468	0.364
Adjusted R-Square	0.456	0.350
Independent Variable	Estimate (t)	Estimate (t)
Intercept	-1.656 (-8.2)	-1.468 (-8.6)
Basic Variable:		
log(Industrial Capital/Labor)	0.627 (14.8)	0.461 (11.1)
Controlling Variables:		
Senior Worker/Labor	1.118 (3.6)	0.957 (3.7)
Technician/Labor	-1.578 (-1.2)	0.879 (0.7)
Manager/Labor	1.011 (1.5)	1.920 (3.5)
Residual Fringe Benefits Capital Gap:		
Collective Firm Dummy	-0.953 (-7.4)	-0.478 (-4.6)
Exports/Sales	-0.604 (-2.7)	-0.591 (-3.3)
Good Firm Dummy	-0.255 (-3.4)	-0.266 (-4.4)
Bad Firm Dummy	0.413 (6.2)	0.341 (6.2)

Source: PRC 1985 Industrial Census;
Note: Coefficients for industry dummies omitted.

contract and the degree of monitoring. The higher the profit-retention or the closer the monitoring, the less the fringe benefits capital. In the formal model, I assume infinite costs of monitoring. Hence, the predictions derived from the model depend on the profit-retention rate and other controlling variables, but do not explicitly relate to monitoring. However, the effect of monitoring is to restrict fringe benefits production in the firm through control by the central government. The same effects can be achieved through a higher rate of profit-retention without monitoring. So, for the purpose of examining fringe benefits capital, a certain amount of monitoring can be regarded as an increase in the actual rate of profit-retention.

In table 12, the panel sample regression shows that the levels of fringe benefits capital in the collective firms are lower than those in the state firms by 107% in 1980 and by 53% in 1985,

controlling for the industrial capital-labor ratios. Using cross-sectional regressions, table 13 presents similar results. Since the collective firms have higher profit-retention than the state firms, these findings support the predictions from the model.

C. Disequilibrium in fringe benefits production and the growth of fringe benefits capital during 1980-85

Table 12 also shows that controlling for industrial capital-labor ratios, the fringe benefits capital has grown 30% in the state firms and 84% in the collective firms during 1980 to 1985. Since profit-retention increases over the years, the rapid growth seems to contradict the model's prediction that higher profit-retention will be associated with lower fringe benefits capital, given industrial capital. To resolve this puzzle, it is necessary to understand the government's monitoring behavior during this period. From 1980 to 1985, the government has gradually relaxed its control on the construction of residential housing by Chinese firms. The reduced monitoring by the government encourages the firms to expand the fringe benefits especially when the marginal return from fringe benefits production is much higher than from industrial production. In explaining the puzzle, it should be noted that the production of fringe benefits in Chinese firms had been repressed for more than a decade before the economic reform started in 1978. As a result, the marginal return from housing construction was very high in 1980. In terms of the model in this paper, the Chinese workers were declined the right to invest in the fringe benefits production before 1978. So, the marginal return from fringe benefits production grew so high that even if the Chinese workers had invested all capital under their control to build housing, their private marginal returns from industrial and non-industrial production would not be equal. The disequilibrium means that the terms of the profit-sharing contract is less relevant to their decisions about housing investment. Only when the workers start to balance the benefits of industrial and non-industrial investment, will the profit-retention rate begin to restrain the expansion of fringe benefits. Hence, the puzzle disappears if the model is followed closely. The increase of fringe benefits capital during the years from 1980 to 1985 was a disequilibrium process.

D. Fringe benefits expansion and productivity decline

In table 12, it is also found that those firms with a lower level of fringe benefits capital in 1980, such as the collective, exporting and Good Firms, have higher growth rates of fringe benefits

capital. The Bad firms have negative growth rate of fringe benefits capital, although they have higher level of fringe benefits capital in 1980.

If the level of fringe benefits capital in 1980 (controlling for industrial capital) can be regarded as an index of monitoring by the government, which seems a plausible assumption, then, the results in the last section suggest that close monitoring can improve productivity. In the end of the last section, I discussed the productivity decline of exporting firms. I suggested that the exporting firms have been among the best firms which were closely monitored by the government. However, as the government relaxed its control, the exporting firms started to divert resources to non-industrial production. Hence, they lost productivity. Now, the crucial evidence supporting this explanation is found in table 12. According to table 12, the exporting firms indeed have lower fringe benefits capital in 1980, which signals close monitoring by the government in 1980. They also have significantly higher growth of fringe benefits capital during 1980 to 1985 than the average state firms. Similar explanation can also be constructed for the productivity patterns of Good and Bad firms.

E. Convergence of fringe benefits?

In the last section, convergence of total factor productivity is found among firms and among industries. In this section, I examine the convergence of residual fringe benefits capital. In table 12 and 13, I assume that the fringe benefits capital per labor can be predicted partly by the basic variable of industrial capital-labor ratio and other controlling variables. Similar to the measurement of TFP, the coefficients of dummy variables in the regression of $\log(\text{Fringe Benefits Capital/Labor})$ are measuring the residual fringe benefits capital after subtracting the part explained by the basic and controlling variables. The convergence of residual fringe benefits capital is discovered among firms according to the gaps and growth of fringe benefits capital in table 12 and 13. However, the convergence is rather weak except between the state and collective firms.

In table 16, the dispersion of residual fringe benefits capital across industries is measured as 16.9% for 1980 and 23.8% for 1985. Hence, at the industry level, after controlling for industrial capital and other variables, the residual fringe benefits capital is not converging during 1980 to 1985. Also, as table 16 shows, the ranking of residual fringe benefits capital across industries has changed significantly. Moreover, in the cross-sectional regressions of table 13, the R-square in 1985 (.364) is less than that in 1980 (.468). The difference suggests that the fringe benefits is less predictable in 1985 than in 1980. These evidences shows that the reforms during 1980 to 1985 has greatly affected

the distribution of the fringe benefits. However, it is difficult to conclude whether the distribution has become more or less equal. In the next section, I will examine the wage income of the sample firms.

Table XIV Regression Explaining Wages (A)

Sample: Panel data Pooling State and Collective Firms		
Sample Size = 1970; R-Square = .650; Adjusted R-Square = .646; Dependent Variable: log(Wage/Labor);		
Independent Variable	Parameter Estimate	t Statistic
Intercept	-0.597	(-15.1)
Basic Variable:		
log(Industrial Capital/Labor)	0.041	(8.2)
log(Labor)	0.039	(8.5)
Controlling Variables:		
Senior Worker/Labor	0.189	(5.3)
Technician/Labor	0.446	(2.9)
Manager/Labor	-.294	(-3.6)
Residual Wage Gap:		
Collective Firm Dummy	-.014	(-0.7)
Exports/Sales	0.140	(4.1)
Good Firm Dummy	0.087	(7.4)
Bad Firm Dummy	-0.046	(-4.3)
Wage Growth:		
Year1985	0.302	(34.1)
Year1985*(Collective Firm Dummy)	0.156	(5.9)
Year1985*(Export/Sales)	-0.113	(-2.5)
Year1985*(Good Firm Dummy)	-0.025	(-1.6)
Year1985*(Bad Firm Dummy)	0.021	(1.5)

Source: PRC 1985 Industrial Census;
Note: Coefficients for industry dummies omitted.

VIII. Labor Income

In this section, I assume that the average wages can be explained by the same independent variables which explain the fringe benefits capital. Hence, the structure of regressions in table 14 and 15 is comparable to those in tables 12 and 13. It is found that the industrial capital is significantly

Table XV Regression Explaining Wage (B)

Sample: Cross-Sectional Data pooling State and collective Firms		
Dependent Variable: log(Wage/Labor)	1980	1985
Sample Size	957	957
R-Square	0.274	0.251
Adjusted R-Square	0.257	0.234
Independent Variable	Estimate (t)	Estimate (t)
Intercept	-0.309 (-10.8)	-0.026 (-0.7)
Basic Variable:		
log(Industrial Capital/Labor)	0.028 (4.7)	0.067 (7.3)
Controlling Variables:		
Senior Worker/Labor	0.305 (6.9)	0.230 (4.0)
Technician/Labor	0.139 (0.7)	0.905 (3.6)
Manager/Labor	-0.461 (-4.9)	-0.572 (-4.7)
Residual Wage Gap:		
Collective Firm Dummy	-0.032 (-1.7)	0.148 (6.5)
Export/Sales	0.076 (2.4)	0.057 (1.4)
Good Firm Dummy	0.082 (7.8)	0.080 (6.0)
Bad Firm Dummy	-0.043 (-4.6)	-0.014 (-3.8)

Source: PRC 1985 Industrial Census;

Note: Coefficients for industry dummies omitted.

related to wages as well as to fringe benefits capital. However, the size of the effects are different. According to tables 12 and 14, the wage elasticity of industrial capital is .041 while the fringe benefits capital elasticity of industrial capital is .542.

Also, from tables 12 and 14, the senior workers receive higher wages and more fringe benefits than the workers. The technicians have higher wages but no more fringe benefits than the workers. The managers have much lower wages but more fringe benefits.

Tables 12 and 14 shows that the wages growth in the state firms have matched the growth of fringe benefits capital at an annual rate of about 6%. In the previous sections of this chapter, it is found that the annual TFP growth for the state firms is about 4% (see table 6). Hence, for the state firms, the growth of labor income including wages and fringe benefits is 2% higher than the TFP

Table XVI Indexes of Residual Fringe Benefits Capital and Wage across industries

Industry	# of Firms	Index of Residual Fringe Benefits Capital across industries Based on Coefficients of Industry Dummies from Regression in table 13			Index of Residual Wage across Industries Based on Coefficients of Industry Dummies from Regression in table 15		
		Index in 1980	Index in 1985	Index Change 80-85	Index in 1980	Index in 1980	Index Change 80-85
Average		100.0	100.0	0.00	100.0	100.0	0.00
Electronic Products	54	97.5	67.0	98.90	97.2	98.4	74.90
Food Products	55	106.6	94.5	-57.30	104.5	97.0	-40.80
Textiles	153	113.1	121.1	-47.80	99.0	95.3	-42.80
Wearing Apparel	13	99.0	162.6	-20.60	96.8	98.3	-13.70
Coking	14	57.8	85.9	47.20	96.6	101.9	37.40
Industrial Chemicals	170	104.1	96.1	-14.40	99.1	95.3	-12.50
Chemical Fibre	32	99.7	89.2	-40.90	99.9	96.3	-31.60
Rubber Products	31	117.4	124.6	4.40	98.8	103.8	-0.40
Plastic Products	22	74.9	70.9	-48.70	102.1	98.8	-40.90
Cement and Glass	74	110.6	111.2	-8.50	106.5	102.7	-3.10
Machinery I	107	112.6	91.6	20.90	101.0	105.0	13.70
Machinery II	95	105.1	105.0	-5.60	98.8	95.5	1.00
Transport Equipment	80	119.8	101.2	35.40	100.2	105.1	28.10
Electrical Machine	58	81.6	79.2	36.90	99.4	106.6	30.70
Coefficients of Variation		16.9 %	23.8 %	22.4 %	2.7 %	3.9 %	4.5 %

Source: PRC 1985 Industrial Census.

growth.

According to tables 14 and 15, the gap of the residual wages between the state and collective firms is insignificant in 1980. However, during 1980 to 1985, the annual growth rates for wages, fringe benefits capital, and TFP in the collective firms are respectively 9.2%, 16.8% and 8.8%. As a result, by 1985, the residual wages are about 15% higher in the collective firms than that in the state firms (see table 15). Hence, between the state and collective firms, the residual wages are diverging. However, the gaps in residual wages between the exporting, Good or Bad firms and the average state

firms are weakly converging. At the industry level, as shown by table 16, there is no trend toward convergence of residual wages. From tables 11 and 16, it is also clear that variation in wages is much smaller than that in fringe benefits capital or in TFP. Hence, omitting fringe benefits is a big mistake for any analysis of productivity and income distribution in Chinese firms.

IX. Conclusion

Through theoretical modelling and econometric testing, this paper examines the structure of property rights in Chinese state and collective enterprises and its impact on productivity, capital allocation and labor income during 1980 through 1985. Since 1978, the Chinese government has gradually reduced the scope of central planning and increased enterprise autonomy. In particular, the government has allowed enterprises to retain a portion of profits for bonuses, welfare projects such as housing, and industrial investment. In this paper, a dynamic utility-maximizing model of Chinese workers is used to formalize the new institutional constraints. The model assumes that Chinese firms use labor effort and capital to produce not only profits but also fringe benefits. Under the new profit-sharing system, the workers receive the full marginal return from fringe benefits production but only a fraction of the marginal return from industrial production. Since it is costly for the government to monitor effort, regulate fringe benefits and distinguish industrial and non-industrial investment, the new institutions create incentives for Chinese workers to divert effort and capital away from industrial to fringe benefits production. As a result of the workers' rational behavior, the social marginal returns from the production of industrial profits and fringe benefits will not be equal. A workers' shirking behavior increases his own welfare but distorts the allocation of effort and capital. In equilibrium, the degree of the distortion depends directly on the terms of present and future rates of profit retention.

The distortion caused by the profit-sharing and fringe benefits production is similar to tax distortion. The fringe benefits production in China is not taxed. As a result, they may be over-produced. Inefficiency results. Although, all taxes create distortion, the effect of distortion is particularly serious when there is a gap in the tax rates between two production activities which use substitutable factors. In the Chinese firms, the diversion of capital from industrial to fringe benefits production may be more imminent since the industrial capital is owned by none.

Since the actual rates of profit retention varied during the reform periods and differed between the state and collective enterprises, the measured distortion should accordingly be different. The

empirical part of the paper investigates Chinese firm-level panel data to measure the distortion. The findings are highly consistent with the theoretical predictions.

The evidence shows that the introduction of profit retention and managerial autonomy during the early years of the decade-long reforms has succeeded in increasing industrial effort and raising total factor productivity in both the state and collective enterprises. In comparisons cross sectors, it is found that the collective enterprises have allocated more effort and capital to industrial production (instead of fringe benefits production) than the state enterprises. The evidence also suggests that the reduced monitoring on non-industrial activities by the government led to rapid expansion of fringe benefits production and had negative impact on productivity growth. The paper also finds convergence of productivity among industries, increase returns to scale at firm-level, and a widening of gaps in real personal income including both wage and in-kind fringe benefits among sectors and industries.

The empirical results in this paper are subject to caveat of production function specification, measurement errors in labor and capital, and sample selection bias. In particular, the comparisons between the large and medium sized state and collective firms in this sample may not be generalized to the whole population of Chinese industrial enterprises. However, the high growth rates of productivity through 1980 and 1985 and the large gaps in productivity between state and collective enterprises at least qualitatively confirmed the predictions of the theoretical model. In the future, I will experiment with some econometric techniques to refine the preliminary results presented in this paper.

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