Control, Incentives and Competition:
The Impact of Reform on Chinese State-Owned Enterprises
Lixin Colin Xu
Abstract. Through the lens of the theory of the firm, I examine how a series of reforms affected performance of Chinese state-owned enterprises with a panel data of more than 500 firms. The study finds that performance improved with various reforms such as increasing competition, appointing new managers, using firm-level pay sensitivity, raising marginal profit retention rates, and allowing managers to determine wages and to make production decisions. Adopting performance contracts did not improve performance significantly. These results confirm the importance of competition, control rights, managerial and internal incentives, as emphasized by the theory of the firm.

Key words: control, incentives, competition, state-owned enterprises, reform, China.

JEL Code: D2, L1, L2, P2.

I. INTRODUCTION

Through the lens of the theory of the firm, a firm’s productivity is affected by its market structure and various ownership or control rights, such as cash flow rights, internal and managerial incentives, and production decision rights (Holterm and Tirole, 1989). The empirical literature on the relationship between ownership, control and productivity, however, has not caught up: the organization of production is usually represented by dummy variables of private (or state or collective) ownership (Boardman and Vining, 1989), and their effects on growth are usually not captured.²
Following the theory of the firm, this paper considers how changes in both market structure and ownership and control rights of state-owned enterprises (SOEs) affected the productivity, both in level and in growth rate. In particular, we consider the following reforms: (i) appointing new managers, (ii) delegating production autonomy to managers, (iii) reducing the output share under the government’s plan, (iv) allowing managers to determine employees wages, (v) using performance contracts (i.e., contracts signed between government and SOE managers), (vi) applying firm-level pay sensitivity, and (vii) reducing markup ratios. This fine delineation of various ownership and control rights, seldom found in related studies, is available for a panel of Chinese SOEs in the 1980s.

These ownership and control rights exhibited tremendous variations both cross-sectionally and in time series, variations derived from the decentralized nature of the Chinese economy. As a result, firms in different regions or industries, and those controlled by different levels of government, instituted the reforms at different times. This variation can be used to identify the effects of ownership and control.

This empirical analysis offers some support for the theory of the firm. The most important impetuses for productivity improvement came from competition (as measured by the reduction of markup ratios), new management, employee incentives, and increasing marginal profit retention rates. In contrast, the adoption of performance contracts, regarded as the most important by policy makers, is found least effective.

This research contributes to two strands of literature. The first is to the growing literature on productivity changes among Chinese SOEs. Many papers have estimated the extent of productivity change of SOEs since the early 1980s and found performance improvements (Chen et al. 1988, Dollar 1990, Woo et al. 1994, Jefferson, Rawski, and Zheng 1996). Furthermore,
Gordon and Li (1995) investigate the role of the enterprise governance system on TFP; Groves et al (1994) focus on the effects of production autonomy and incentives on labor productivity. Groves et al. (1995) find that the Chinese SOEs’ managerial labor market provided useful discipline on managers. Li (1997) attributes TFP to factor allocation between enterprises, increasing employee bonuses, and intensified competition. This paper takes into account a more comprehensive series of reforms. For instance, the existing literature has not, to our knowledge, examined the effects of firm-level wage elasticity, managerial wage discretion, and performance contracts; while the role of markup ratios, marginal profit retention rates and production autonomy has been examined, other important reforms have not been simultaneously controlled for.

Perhaps more importantly, this paper finds empirical support for many notions of the theory of the firm, such evidence being especially rare in the context of SOEs. Distinguishing ownership from control rights, the theory suggests that control rights matter (Grossman and Hart, 1986). This conjecture is borne out by the data used here: performance improved with the decentralization of wage setting rights and of production decision rights. A major catalyst for efficiency is competition in product markets; and we find that the reduction of markup ratios was a leading efficiency-enhancing reform. Another increasingly favored way to improve performance is competition in the managerial labor market (Rosen, 1992; Barberis et al., 1996; Groves et al., 1995; Lopez-de-Silanes, 1997). Again, we find the appointment of new managers raising productivity enormously. Alchian and Demsetz (1972) distinguish two ways to motivate employees: incentives based on outputs (“pay sensitivity”) or on inputs (“monitoring”). We find that performance improved with both firm-level wage elasticity (corresponding to incentives
based on output) and managerial wage discretion (corresponding to incentives based on both inputs and outputs).

II. THE DECENTRALIZED REFORMS

In the 1980s the Chinese government experimented with decentralizing SOEs. By the end of the decade, the legal structure of SOEs had changed dramatically, and SOEs had become much more, though not completely, market-oriented. When the decade began, both control and ownership belonged to the state. All profits were turned over to the state, and investment, wage, and collective welfare expenditures were determined by the state. The managers, thus, had neither production autonomy nor discretion in wage determination. Since reward and performance were not linked, employees and managers did not have incentives to work hard and improve skills. In the 1980s the government, while opening up the market, partially and gradually decentralized ownership and control rights. After fulfilling their mandatory output quota, SOEs were allowed to sell their products to the market. As for inputs, SOEs could obtain a certain amount at the subsidized prices of the state, and purchase the rest from the market (Perkins, 1994; Jefferson and Rawski, 1994). Between 1980 and 1989, the share of material inputs purchased through the market rose from 32% to 59%, and the share of output sold to the market went up from 49% to 60% (Perkins, 1994). The reforms that accompanied market participation are summarized in table 1 and illustrated more fully below.

Decentralization of cash flow rights by increasing profit retention rates. The average marginal retention rate rose from 11% in 1980 to 17% in 1984, ending up 25% in 1989. The variation across firms and over time was substantial. SOEs could use retained profit for investment, collective welfare (such as housing and firm-owned schools), or employee bonuses.
Table 1. Trends of the Reforms in the 1980s

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<tbody>
<tr>
<td>Marginal retention rate</td>
<td>.11</td>
<td>.12</td>
<td>.11</td>
<td>.14</td>
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<td>.17</td>
<td>.18</td>
<td>.22</td>
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<tr>
<td>Share of firms with production autonomy</td>
<td>.07</td>
<td>.08</td>
<td>.10</td>
<td>.15</td>
<td>.26</td>
<td>.35</td>
<td>.40</td>
<td>.54</td>
<td>.65</td>
<td>.68</td>
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<tr>
<td>Output share under the state plan</td>
<td>Not available</td>
<td>.65</td>
<td>.62</td>
<td>.61</td>
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<td>.56</td>
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<tr>
<td>Share of firms with wage discretion</td>
<td>.01</td>
<td>.01</td>
<td>.01</td>
<td>.02</td>
<td>.06</td>
<td>.10</td>
<td>.14</td>
<td>.21</td>
<td>.33</td>
<td>.36</td>
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<tr>
<td>Share of firms under performance contract</td>
<td>.00</td>
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<td>.00</td>
<td>.01</td>
<td>.02</td>
<td>.04</td>
<td>.07</td>
<td>.43</td>
<td>.83</td>
<td>.88</td>
</tr>
<tr>
<td>Firm-level pay sensitivity for firms under performance contracts</td>
<td>Too few observations</td>
<td>.51</td>
<td>.39</td>
<td>.41</td>
<td>.46</td>
<td>.43</td>
<td>.42</td>
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<tr>
<td>Share of firms with management turnover</td>
<td>.09</td>
<td>.01</td>
<td>.06</td>
<td>.10</td>
<td>.16</td>
<td>.14</td>
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Note. All numbers come from the author’s computation based on A Survey of State Enterprises: 1980-89.

However, in return, the manager faced a bonus cap, a high progressive tax rate, or might have to rely more on self-financing for investment, for which the government was previously fully responsible.

**Autonomy of production decisions.** When the decade started the government controlled most of SOEs’ production plans. Over the decade it gradually granted some SOEs more autonomy in production decisions, concentrating on six areas: value of output, physical quantity of output, choices of product, technology, production scheduling, and exports. The proportion of firms with production autonomy—i.e., firms with at least five of the six areas of autonomy—increased from 7% in 1980 to 26% in 1984, 54% in 1987, and 68% in 1989. Another aspect of production autonomy was the decrease of the output share under the state plan, which declined from 65% in 1984 to 56% in 1989 for the firms in our sample.

**More discretion for SOE managers to determine employee wages.** Traditionally an employee’s wage depended solely upon his or her age, education, location, tenure and gender; managers had little leverage to induce employee effort. Employment guarantee further
encouraged shirking. To give more leverage to SOE managers, the government granted some firms *managerial wage discretion*, controlling only the growth rate or aggregate amount of wages for the firm. The proportion of firms with this discretion increased mainly in the late 1980s: from 1% in 1980 to 6% in 1984, then to 21% in 1987, and to 36% in 1989.

*Contract Responsibility System (CRS) and linking wage increase with profit increase.*

Contract Responsibility System (or performance contracts, PCs hereafter) was probably intended (by policy makers) to be the most dramatic reform for SOEs. Under a PC, the manager had the legal right to operate the firm and was granted some discretion in decision making for an agreed period, usually 3--5 years. Typically, a PC specified the distribution of value added between the state and the firm, performance targets such as the minimum annual expenditure on capital maintenance, the number of new products to be developed, the output volume and price to the state, the CEO’s compensation, and the *ex ante* firm-level wage elasticity with respect to profit. Note that this aggregate pay sensitivity existed *only* when the firm was under a PC. Most firms adopted PCs only after 1986. While virtually no SOE had a PC in 1980, only 2% of them had adopted it in 1984, but then the number skyrocketed to 43% in 1987, and 88% in 1989. The average firm-level wage elasticity in 1989 was 0.44 for firms with a PC, 25 percent of which had an elasticity of 0.

*The increase of management turnover.* The share of firms with management turnover increased over the decade, especially in 1983-85 and 1987-1989. The increase, however, was by no means smooth: Starting at 6 to 9% from 1980 to 1982, it jumped to around 15% in 1984 and 1985, plummeted to 7% in 1986, rose to 15% in 1987, and dropped again to 9 to 10% in 1988 and 1989.
Competition. In the 1980s SOEs faced increasingly fierce competition from the rural township and village enterprises as well as among themselves. The share of industrial output from non-state-owned firms rose from 21 percent in 1980 to 47 percent in 1991 (Perkins 1994). The competition among SOEs also intensified. Li (1997), using the same data set, found that the average markup ratios for SOEs declined significantly over time.

III. HYPOTHESES OF THE EFFECTS OF DECENTRALIZATION

This section shows how the discussed SOE reforms should affect performance. The relationship between the government and the manager (and between a manager and his employees) can be viewed as that of the principal and the agent. The decentralized reforms should affect productivity because, in comparison with under the centralized status quo, they increase the payoff to effort and learning for managers and employees. Assume that a higher reward for effort (of either the manager or the employees) raises firm-level effort and thus the productivity level. Also assume that a more handsome reward for learning activity induces a larger increase in firm-level human capital thus a faster productivity growth. Now we examine each specific reform.

Marginal Profit Retention Rate. Raising the marginal rate also present the employees and managers a higher payoff for efforts. As a result, they work harder. Although the free-riding problem may limit the gains from this reform, peer monitoring should limit the extent of the dilution of incentives (Kandel and Lazear, 1992). Since the government re-adjusts the rate annually, however, the manager or employees may not capture higher future returns for learning. As a result, the productivity level increases but not necessarily its growth rate.

The Decentralization of Wage Controls. There are two types of wage controls: firm-level pay sensitivity (a stipulation in performance contracts), and managerial wage discretion. Both
should raise the payoffs to efforts and to skills of employees, though by different means. Firm-level pay sensitivity, as a group incentive scheme, cannot escape the curse of the free-riding problem; the curse, however, may be mitigated since peer monitoring will emerge because of the negative externality of one worker’s shirking upon fellow employees (the negative externality is especially strong because of the lifetime employment nature of SOE jobs) (Kandel and Lazear, 1992). Besides the free-riding problem, the use of pay sensitivity may reduce long-term investment—pay sensitivity is usually based on short-term profits, which can be raised by sacrificing long-term investment—and thus reduces the productivity growth of the firm. In contrast, the delegation of managerial wage discretion, an individual performance-based incentive scheme, allows the manager to base workers’ pay upon their productivity, therefore inducing them to work harder and improve skills. Note that relative to firm-level pay sensitivity, managerial wage discretion works better in spurring learning. Managerial wage discretion is thus expected to have a greater impact on growth than the wage elasticity variable.

The decentralization of production decisions. It should raise productivity for three reasons. First, when production decision rights shift from planning bureaus to managers, the quality of decision making changes. This is because managers know better about technology and market demand, and they have stronger incentives than bureaucrats: While bureaucrats’ economic well-being does not hinge on the performance of an enterprise, the manager has a direct stake in the firm’s outcomes. For instance, Groves et al. (1995) uses the same data set to find that managers’ pay was closely related to performance. Second, the decentralization of production decisions reduces the number of layers of the hierarchy. Since agents in each layer have incentives to distort information to benefit themselves, fewer layers of hierarchy cause less distortion of information, enabling them to concentrate more on providing performance incentives for
production workers (McAfee and McMillan, 1995; Groves et al. 1995). Third and finally, the seminal paper by Grossman and Hart (1986) also emphasizes the importance of control rights in resource allocation.

The appointment of new managers. At least two reasons explain why new managers perform better. First, for the new manager his predecessor’s firing should imply a more credible threat of losing his position if he does a poor job. Since losing a job entails a loss of income and reputation, the new manager should have incentives to work harder and invest more time in improving skills than do incumbent managers. He may also want to invest in skills especially because the government generally evaluates a manager based on multi-year observations, a time frame allowing skill improvement to be reflected in performance. Second, the 1980s witnessed better management selection mechanisms that promoted efficiency. While under the old regime the managers were more likely political appointees who were more efficient in handling politicians (Shleifer and Vishny, 1994), the reform regime leaned toward managers capable of running a firm profitably (Groves et al. 1995). Moreover, the CEO pay sensitivity became larger over time, and the design of CEO pay sensitivity appeared to be consistent with the agency theory (Mengistae and Xu, 1999). Indeed, a new body of empirical literature emphasizes the role of new managers in restructuring firms (Rosen, 1992; Barberis et al., 1996; Groves et al., 1995, Lopez-de-Silanes, 1997).

The adoption of performance contracts. Having discussed firm-level pay sensitivity—a component of PCs—here I shall only discuss how productivity is affected by the other contract specifications. PCs cannot improve productivity if they do not reduce the information advantage of managers, if they do not improve the firm’s incentives, and if they are not credible (World
There are impediments that hindered the effectiveness of PCs in China:

- A PC is typically assigned by the government without using competitive methods (except a small percentage of firms that used bidding); as a result, its information disadvantage relative to managers is not reduced. The manager’s information advantage, in turn, allows him to bargain for easy performance targets. Indeed, the literature of “ratchet effects” (Weitzman, 1980) suggests that SOEs under PCs may mimic inefficiency by not working hard so that they get easy performance targets for the next round.

- Worse yet, there are incentive problems: PCs offer firms neither a “carrot” (besides firm-level pay sensitivity) nor a “stick”, as there was no bankruptcy threat in the 1980s.

- In addition, there is the multi-tasking problem. The performance targets tend to be numerous with respect to profit, capital maintenance, labor, and product innovations. The presence of multiple tasks often dull the intensity of incentives (Holmstrom and Milgrom, 1991). Moreover, the wrong design of incentives often would have adverse effects. For instance, firm-level pay sensitivity rewards current profits, but may reduce investment incentives and ultimately hurt productivity.

- Besides these static impediments, PCs’ effectiveness is also hurt dynamically by the lack of long-term commitment both from the government and from the firm. A PC usually lasts only for three to five years, unlikely to be long enough to internalize the benefits of long-term investment. Moreover, PCs might be perceived to be a temporary experiment. Furthermore, since China lacked third-party enforcement, the government as a party to the contract did not have to abide by the contract terms.

As a consequence, the adoption of PCs on average may not improve productivity much.
The reduction of markup ratios. Competition in the product market is widely believed to be an important safeguard for the efficiency of firms (Holmstrom and Tirole, 1989; Stiglitz, 1994). Competition, by reducing information asymmetry enjoyed by SOEs, makes their performance easier to interpret (Holmstrom and Tirole, 1989). As long as managers and employees are adversely affected by poor performance (through performance incentives), competition can make them work hard to avoid such scenarios. However, the likely beneficial effects of competition may not materialize because, without bankruptcy for SOEs, they could avoid paying the ultimate price for bad performance. It thus remains an empirical question as to how performance is affected by increasing competition. Empirical examination will also shed light on the magnitude of performance improvement associated with increasing competition in the absence of bankruptcy, which may be a lower bound on such improvements.

IV. EMPIRICAL IMPLEMENTATION

In this section we first discuss the empirical strategy, then estimate the effects of the decentralized reforms in SOEs, and finally conduct a growth-accounting exercise to explore the relative importance of each reform in explaining productivity improvement over 1980 to 1989. All variables used are constructed from A Survey of State Enterprises: 1980-1989. (See the data appendix for details.) We estimate a Cobb-Douglas-type “institutionalized production function”\(^{9}\):

\[
\ln y_{it} = A_j + \tau_t + \alpha_i \ln k_{it} + \beta_i \ln L_i + \sum_{u} R_u (\theta_{i,u,t} + \theta_{i,u,t}) + \phi_i M_{it} + \phi_i + \epsilon_{it}.
\]

Here \(i\) refers to a firm; \(t\) denotes year; \(j\) indexes the industry. \(\phi_i\) is a firm-specific fixed effect. \(\epsilon_{it}\) is the contemporaneous error term. Among other things, \(\phi_i\) should capture firm-specific labor quality (given the de facto no firing constraint, labor quality tended to persist over time), and the
firm-specific implicit subsidy level. Remaining variables are defined as follows (see the data appendix for the construction of $y_{it}$, $k_{it}$ and $M_{it}$):

\[ y_{it} \] Value added per employee.$^{10}$

\[ A_{j} \] The industry-specific TFP level.

\[ \tau_{it} \] The coefficient for industry-time dummies, capturing industry-wide economic shocks (including subsidy level) and technological growth.

\[ k_{it} \] Capital stock (derived by perpetual inventory method) divided by the number of employees.

\[ L_{it} \] The numbers of employees, excluding those absent for more than half a year.

\[ R_{k} \] Reforms including (i) the marginal retention rate, (ii) production autonomy dummy, (iii) the output share under the state plan, (iv) managerial wage discretion, (v) the presence of new managers, (vi) the adoption of performance contracts, and (vii) firm-level wage elasticity. Note that $t_{k}$ is the number of years since this reform has been in effect. The reforms are allowed to affect both the productivity level (as captured by $\theta_{k}$) and its growth rate (by $\theta_{it}$). The rate effects are allowed only for reform dummies for which the interpretation is more natural.

\[ M_{it} \] The markup ratio (see Bresnahan 1989 for interpretation). It is included to disentangle the reforms effects from those due to changes in market structure.

Value added and capital stocks are all measured in their market prices in 1989, which should be closer to a market evaluation of resources than using prices from the beginning of the
Measured this way, the changes in outcomes have to come from factors other than just changes in the prices of the outputs and the inputs.

**Empirical Issues**

To accommodate potential selectivity of the reform dummies, we experimented with allowing reform-specific-sample-specific productivity levels and growth rates to see if their inclusion altered the estimates of reform effects. For the fixed effects (FE) model, I include three sample-specific growth rates for the sample of firms which eventually had production autonomy, or had managerial wage discretion, or had PCs. The coefficients for the reform variables are quite similar and are thus not reported. In short, selection bias associated with the reform dummies does not appear to be important (after controlling for firm-specific fixed effects).

A closely-related concern is the correlation of reforms with the contemporaneous shocks--the same shocks may explain the change of managers as well as the adopted reform measures. To avoid the bias arising from this correlation, we shall employ the fixed-effect two-stage-least-square (FE2SLS) method. That is, beyond controlling for firm dummies, we shall find instruments that are orthogonal to contemporaneous shocks but are correlated with the reforms. The instruments we shall employ are the once-lagged reforms, log(K_{t-1}/L_{t-1}), log(L_{t-1}), and the once-lagged share of employees as engineers (presumably past technology structure might affect the incentives to adopt alternative reforms). Here K is capital stock and L is the number of employees. Since the equation is overidentified, we can explicitly test the validity of the instruments (i.e., whether the instruments are indeed statistically orthogonal to the contemporaneous shocks) by the overidentifying restrictions test (Davidson and MacKinnon, 1993, p. 236). The test shows that PC, production autonomy, wage elasticity, and managerial wage discretion × year cannot be rejected as exogenous, but log(K/L), marginal retention rate, the
presence of new managers × year, and the share of output under state plan are rejected as exogenous at the 10 percent levels. Moreover, when those variables that are rejected as exogenous are treated as endogenous in a 2SLS regression, with the above-mentioned instruments, the overidentifying restriction test cannot reject the null that these instruments are appropriate. The p-value of the test is 0.369. We thus should pay more attention to the FE2SLS results.

Finally, outliers may adversely affect the results. To check it, I will also report median regressions for both the OLS and the fixed effect specifications. The median regression aims to predict the behavior of the median (instead of the mean as in OLS and in the fixed effects specifications), and is therefore less sensitive to the influence of outliers (Narula and Wellington, 1982).

**Empirical Estimates**

In the empirical analysis, we delete any observation (1) missing the dependent variable or (2) missing the capital-labor ratio (a key explanatory variables for performance) or (3) any firm having an unbalanced panel. The final estimations are based on a balanced panel of 564 firms over a period of ten years. Table 2 presents the results based on the OLS, the median regression, the FE, the FE-median, and the FE2SLS regressions. Since specification tests between the OLS and the FE models favor the FE model, we shall focus on the FE-based regressions.

Increases in marginal retention rates improved productivity levels (columns 3 to 5). An increase of 10 percentage points in the marginal retention rate is associated with an boost in the productivity level of 2 percentage points by the FE or FE-median regressions; once its endogeneity is taken into account, its magnitude doubled. Thus a SOE facing temporary negative shocks was likely given higher marginal rate.
SOEs’ autonomy in production, reflected in both the production autonomy dummy and the output share under the state plan, also affected performance. The delegation of production autonomy had positive effects: an increase of roughly five percentage points (for all three FE-based models). A higher output share under the state plan was associated with lower productivity in all the FE-based specifications but higher productivity in the OLS and the median regressions. Thus, once firm heterogeneity was taken into account, a lower output share under the state plan was associated with better performance.

| Table 2. The estimates of reform effects (Dep. = ln(value added per employee) ) |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|                            | (1) OLS                     | (2) Median                  | (3) FE                      | (4) FE-Median               | (5) FE2SLSA                  |
| ln(K/L)                    | 0.383                       | 0.383                       | 0.147                       | 0.132                       | 0.111                       |
|                            | (16.68)**                   | (19.84)**                   | (5.39)**                    | (5.63)**                    | (2.75)**                    |
| ln(L)                      | 0.023                       | 0.025                       | 0.142                       | 0.140                       | 0.157                       |
|                            | (1.80)                      | (2.09)*                     | (2.65)**                    | (2.29)*                     |                              |
| Marginal rate              | -0.018                      | 0.079                       | 0.209                       | 0.203                       | 0.411                       |
|                            | (0.31)                      | (3.26)**                    | (3.33)**                    | (3.20)**                    |                              |
| Autonomy                   | 0.025                       | 0.047                       | 0.048                       | 0.049                       | 0.045                       |
|                            | (1.00)                      | (1.91)                      | (2.02)*                     | (1.75)                      |                              |
| The share of output under state plan | 0.171                       | 0.106                       | -0.087                      | -0.072                      | -0.270                      |
|                            | (4.20)**                    | (2.11)*                     | (2.00)*                     | (1.80)                      | (3.64)**                    |
| Managerial wage discretion × year | 0.033                       | 0.049                       | 0.018                       | 0.015                       | 0.018                       |
|                            | (3.03)**                    | (4.06)**                    | (1.49)                      | (1.55)                      | (1.49)                      |
| Wage elasticity            | 0.420                       | 0.321                       | 0.187                       | 0.149                       | 0.178                       |
|                            | (6.53)**                    | (3.68)**                    | (3.17)**                    | (2.76)**                    | (3.01)**                    |
| PC                         | -0.092                      | -0.071                      | -0.077                      | -0.070                      | -0.069                      |
|                            | (1.82)                      | (1.79)                      | (1.91)                      | (1.60)                      |                              |
| The presence of new managers × year | -0.017                      | -0.017                      | 0.043                       | 0.049                       | 0.037                       |
|                            | (2.43)*                     | -1.84                       | (4.70)**                    | (6.73)**                    | (3.84)**                    |
| Markup                     | -0.834                      | -0.878                      | -0.764                      | -0.746                      | -0.777                      |
| Observations               | 5640                        | 5640                        | 5076                        | 5076                        | 5076                        |
| R-squared                  | 0.41                        | 0.48                        | 0.48                        | 0.369                       |                              |
| p-value of the test of overidentifying restrictions |                              |                              |                              |                              |                              |

Note. *, ** indicates statistical significance at the 5 and 1 percent levels.

Other controlled for variables include year dummies, industry-specific TFP levels (only for the OLS and median regressions), industry-year dummies, province-specific growth rates, missing indicators for firm-level wage elasticity, marginal profit retention rates, and the output share of mandatory plan. The constant term is supressed.
In this specification, endogenous variables include ln(K/L), (the presence of new CEO \times year), marginal rate, the share of output under state plan. The excluded instrumental variables include the once-lagged reform variables, the square of the once-lagged marginal rate, ln(K_{t-1}/L_{t-1}) and its square, ln(L_{t-1}) and its square, the once-lagged the share of engineers in total labor force. The overidentifying restrictions test reject the exogeneity of the above endogenous variables but not the rest of the reform variables. To hold the sample of the last three FE-based specification constant, and since the last column has to use some once-lagged variables as IVs, the first year of the sample are all excluded from the sample.

Employee incentives seemed to have raised productivity remarkably. Managerial wage discretion increased growth rate by 1.5 to 1.8 percentage points (columns 3 to 5). Firm-level wage elasticity also had a positive impact. An one-standard-deviation increase of wage elasticity (0.34, conditional on being a PC-participant) was associated with a productivity jump of slightly more than 5 percentage points (columns 3 to 5). The contrast of the FE-based estimates with the OLS-based estimates (column 1 and 2) is illuminating. The OLS estimates are roughly twice as large as the FE-based estimates, indicating that wage elasticity is positively correlated with unobserved firm-heterogeneity. This positive correlation is consonant with the contract-theoretical notion that managers with higher unobserved ability pick higher-powered incentives (Laffont and Tirole 1993). Consistent with our hypothesis, the growth effect of managerial wage discretion was larger than that of firm-level wage elasticity. (We have also tried allowing wage elasticity to affect growth rates, and found the growth effects insignificant. Thus the rate effect of wage elasticity is, as discussed in section III, smaller than that of managerial wage discretion. This is consistent with our earlier conjectures.)

Besides employee incentives, managerial incentives--or knowledge--also enhanced efficiency. All the FE-based models imply a positive and significant growth rate effect, ranging from 3.7 to 4.9 percentage points. Note that the OLS or median regressions present much smaller
or insignificant estimates of new management effects. This implies that the change of management was negatively correlated with firm heterogeneity, consonant with the findings of Groves et al. (1995).

The adoption of PCs, being hailed as the official reform mode for SOEs around 1987, did not live up to expectations. PC adoption itself, when not accompanied by firm-level wage elasticity (recall that only a subset of contract participants had positive wage elasticities), actually reduced productivity by roughly 7 to 8 percentage points.\textsuperscript{16}

Last but not least in importance, reducing markup ratios was associated with productivity improvements. Reducing the standardized markup ratio by one standard deviation (the markup ratio is standardized so that its mean is zero and its variance is 1) was associated with an increase in productivity level by more than 75 percentage points (columns 3 to 5). Note that the negative correlation between productivity and markup ratios is not due to differential price changes among firms with distinct markup ratios-- the value added of a firm is evaluated at its market price in 1989 for all years. This piece of evidence highlights the large payoff of competition, which would be even larger had bankruptcy been allowed.

\textit{Growth Accounting Results}

Table 3 uses a growth-accounting method (Solow, 1957)\textsuperscript{17} to decompose the productivity change of SOEs in the 1980s using the estimates from the FE and the FE2SLS. The logarithm of average labor productivity, measured at the market price index of value added in 1989, rose by 106 percentage points over the decade, or at an annual rate of 12.5.\textsuperscript{18}
Table 3. The Growth-Accounting Results of Chinese SOEs: 1980-89

<table>
<thead>
<tr>
<th>Contributions to change in ln(average value added) from (%)</th>
<th>FE</th>
<th>FE2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The allocation of labor</td>
<td>4.2%</td>
<td>4.5%</td>
</tr>
<tr>
<td>The allocation of capital</td>
<td>13.6%</td>
<td>10.3%</td>
</tr>
<tr>
<td>The Presence of New CEOs</td>
<td>12.8%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Marginal Profit Retention Rate</td>
<td>1.0%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Wage Control Rights</td>
<td>9.7%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Managerial wage discretion</td>
<td>2.1%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Firm-level wage elasticity</td>
<td>7.6%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Performance Contracts</td>
<td>-6.4%</td>
<td>-5.8%</td>
</tr>
<tr>
<td>Decentralization of production decision rights:</td>
<td>4.0%</td>
<td>4.6%</td>
</tr>
<tr>
<td>The output share under state plan</td>
<td>1.2%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Production autonomy</td>
<td>2.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Change in markup ratio</td>
<td>17.0%</td>
<td>17.3%</td>
</tr>
</tbody>
</table>

| Changes of Institutional Arrangements in total:           | 38.1%| 36.9% |

a. This figure is based on the sample used for estimation. Li (1995) reports GVO growth rate of 6.4 percent.  
b. The contribution of new management is also counted here.

The major sources of productivity growth were stronger incentives and the reduction of market power:
The increase of competition, proving to be the most important, raised productivity by roughly 17 percent (of the total changes) (by both specifications).

Closely following were the presence of new managers and the allocation of capital, each raising productivity by roughly 10 to 13 percent. The finding about the effectiveness of new management resonate well with Barberis et al. (1996) about the pivotal role of new management (in encouraging restructuring).

Similarly impressive contributors were the wage control rights, whose combined effects amounting to almost 10 percent: from the delegation of managerial wage discretion, 2.1 percent; and from the firm-level wage elasticity, roughly 7.5 percent.

The increase of marginal profit retention rates raised productivity by 1.0 to 2.2 percent of total. The relative small magnitude reflects not the ineffectiveness of this incentive but rather its little change.

Finally, decentralizing production decisions improved productivity by roughly 4 to 5 percent.

One surprise, at least to the policy makers, is perhaps that the government did not accomplish much through performance contracts. The total effect of PCs, including that from the component of firm-level wage elasticity, was 1.2 to 1.6 of the total. However, PCs without any firm-level elasticity would have lowered performance. This finding, as discussed in an earlier section, may not constitute too much a surprise given the impediments mentioned earlier (see the section on analytical framework).

According to the FE and the FE2SLS estimates, over the decade the decentralized reforms accounted for 38.1 and 36.9 percent of the total productivity improvement. The inclusion of new management may overstate the effects of reforms; management turnover, after all, would have had occurred in the centralized mode as well. Management turnover in the centralized mode,
however, was not likely to enhance efficiency. Besides, this potential overstatement was perhaps offset by an understatement of the reform effects on other margins. The contribution of improvement in labor or capital allocation (15 to 18 percent) could have stemmed from the reforms as well.

V. CONCLUSION

The reforms greatly improved productivity. Especially effective were reducing markup ratios, appointing new managers, using firm-level pay sensitivity, and allowing managers to determine wages. Besides confirming the importance of competition, these findings also imply that managers out-perform bureaucrats in directing firms, and that shirking prevails in centralized firms, therefore, effective SOE reform should strengthen both managers’ and employees’ incentives. Adopting performance contracts, regarded as perhaps the most important reform by the Chinese government and many scholars, did not help much. The results are robust with respect to the form of the production function, the sample selection problem, and the endogeneity problem. These findings underscore the need to distinguish various ownership and control rights, and to examine both their static and dynamic effects.

With the usual caveat that any non-experimental finding is rarely wholly replicable in a different setting, some of the results should have general applicability outside of China. One such result is that increasing competition in product markets can greatly enhance efficiency, at least in economies where the market power of SOEs is large, such as in the countries of the Former Soviet Union and many developing countries. The confidence in the efficacy of competition is warranted since increasing competition greatly improved productivity even in China where there was no bankruptcy. Another applicable result is the importance of employee incentives and
managerial incentives, which has been corroborated by a rich empirical literature in other economies.¹⁹

There are also other caveats. First, the over-representation of large firms in our data makes it risky to draw inferences about productivity gains for all Chinese SOEs based on this research. Second, although the results about the relationship between productivity and market structure, ownership and control rights may have general applicability, initial conditions still matter. For example, while the change of management figured impressively here, its gains may drop in economies where managers have long been appointed for the sole purpose of running the firm profitably.

Appendix A. the Data Set

The data set we use is *A Survey of Chinese State Enterprises: 1980-1989*. It covers 769 SOEs in 21 cities of four provinces (Shanxi, Jilin, Jiangsu, and Sichuan). The 769 firms constitute a stratified random sample of all SOEs in manufacturing. There was substantial variation in the size of these SOEs: the median SOE had 930 employees, the SOE at the 10th size percentile had 304, and that at the 90th percentile had 3175.

The data set has two parts. Part one is a quantitative table filled out by the accountants of an enterprise. It includes 321 variables covering details about products, costs, wages and labor utilization, investment, financing, fixed assets, profit distribution, taxes, prices, and material inputs. Part two is a questionnaire answered by the manager of the enterprise. The manager answered questions about performance contracts signed with the government, the relationship between the enterprise and the government, production autonomy, the characteristics of the management, and so on.

Appendix B. Construction of Key Variables for the 1980-89 Data Set

In constructing these variables, we have followed other users of this data set, especially Li (1997), and Gordon and Li (1995). All quantities (value added, capital stock) are expressed in 1989 market values.
Capital Price Indexes and Capital Stock. The survey contains answers to questions about the inflation rate of the mixed price of equipment between the periods 1965-1975, 1975-1980, 1980-1984, and for each year between 1985 and 1988. Based on these answers we computed average inflation rates for equipment. For 1980-1984, we assumed equal yearly inflation rates. For 1989, since we did not observe equipment inflation, we used the output inflation rate in the machine industry as a proxy.

Since the survey did not provide information on prices of buildings or plant, for that inflation measure we followed Li (1997) by using the percentage increase in aggregate construction costs compiled by the State Statistical Bureau.

We computed the composite price index for capital goods by averaging the equipment price index and the buildings and plant price index, the weights being the investment expenditures on equipment and plant.

We based our measure of capital stock on capital assets “for productive use”, which includes plant and equipment for industrial production. (In contrast, capital assets “for non-productive use” are mainly buildings and expenditures on dormitories, cafeterias, employee housing, and other social welfare functions.) We did not use the net value of capital stock as the base to compute capital stock because it “tends to exaggerate the increase in enterprise capital stock during the sample period in which the inflation rate was high, because the accounting rate of depreciation was artificially low and the depreciation was based on historical costs.” (Gordon and Li, 1995)

Realized investment at year $t$ is imputed by subtracting the nominal value of productive capital assets at the end of year $t-1$ from that at the end of year $t$. The reported investment, usually different from our imputed figures, is not used because it measures the value of capital expenditure (rather than capital formation) in a given year. Assuming that investment occurs smoothly over the course of a year, we can compute the capital stock in 1980 ($K_{80}$), the initial year, as

$$K_{80} = 0.5(K^*_{79} + K^*_{80})P^K_{80} / P^K_{80}$$

where $K^*_t$ is the productive capital asset in year $t$, and $P^K_t$ is the cumulative price index for the composite capital goods. The capital stock for the following years is then constructed by the following formula:

$$K_t = K_{t-1} + 0.5I^*_t P^K_{t-1} P^K_{t-1} + 0.5I^*_t P^K_{t-1} P^K_{t-1}, t = 81, \ldots, 89$$

where $I^*$ is the imputed realized investment.
**Price Index for Value Added.** The price index for value added is based on the price indexes of output and material inputs. Let $P_v^t$ be the price index of value added in year $t$, and $P_Q^t$ be that of output, and $P_M^t$ be that of intermediate inputs. Let $Q_t$ denote output units, and $M_t$ input units. By definition, the Laspeyres price index of value added is computed as follows:

$$\frac{P_{Vt}}{P_{Vt-1}} = \frac{P_{Qt}Q_{t-1} - P_{Mt}M_{t-1}}{P_{Qt}Q_{t-1} - P_{Mt}M_{t-1}}$$

Tyler expansion along $(P_{Qt}, P_{Mt-1})$ gives the following formula for the percentage price increase of value added based on those of output and of intermediate inputs:

$$\ln \left( \frac{P_{Vt}}{P_{Vt-1}} \right) = \frac{Q_{t-1}}{V_{t-1}} (P_Q^t - P_Q^{t-1}) - \frac{M_{t-1}}{V_{t-1}} (P_M^t - P_M^{t-1})$$

(Below we discuss the construction of the output price index ($P_Q^t$) and intermediate input price index ($P_M^t$). In the empirical implementation, we value the value added for each year at the 1989 price of value added.)

The Output Price Index. The survey reports the mixed (plan and market) price index for the firm’s main product. While most firms reported cumulative price indexes, some reported year-to-year price inflation. We checked carefully and corrected those obvious coding errors. When in doubt, we treated them as missing. Consequently, we have around 500 firms reporting a reasonable mixed price index. For the rest of firms, we computed the average year-to-year mixed price inflation rates for their industry-year sample, then assigned that value as the imputed mixed price inflation rate. Then, we converted them to a cumulative mixed price index.

We then estimated the market output price index. The survey has information about the sales under the state plan and to the market, and their respective prices. Based on this information, we constructed the market price index for output. Again, firms with missing values for the market price index were assigned their industry-year averages.

These price indexes were then used to compute the gross value of output (GVO). The survey reports GVO in current mixed prices. We first obtained GVO in current market prices by multiplying the reported GVO by the ratio of market output prices to mixed output prices in year $t$. That number was then translated into GVO in 1989 market prices by multiplying it by the ratio of the market price index in 1989 to the market price index in year $t$.

Price index of Intermediate Inputs. The data set has detailed information about the plan and the market prices of the two primary materials but it does not provide information about energy and other intermediate inputs. We therefore computed price indexes for intermediate inputs based on the assumption that the inflation rate for
intermediate inputs was the same as that of materials. This is reasonable since materials accounted for the vast majority of intermediate inputs. A significant portion of the reported material price variables was missing; roughly 40 percent of the answers were useful.

We first computed the mixed price of each material input using the physical shares of the plan and the market inputs. Then we computed the year-to-year Laspeyres index of mixed material prices. Year-to-year Laspeyres indexes of market prices were computed similarly. Again, the missing values were imputed using the industry-year averages.

The quantity of intermediate inputs was then computed using these price indexes. We first obtained the quantity of intermediate inputs valued at the current market price by multiplying the reported intermediate inputs--in current mixed prices--by the ratio of the current market price to the mixed price of intermediate inputs. This number in year \(t\) was then translated into intermediate inputs in 1989 market prices by multiplying it by the ratio of the cumulative market price index of intermediate inputs in 1989 and that in year \(t\).

**The Markup Ratio.** We follow Li (1997) in constructing the mark up ratio. Specifically,

\[
M_{it} = \sum_{j=1}^{4} D_{ij} \mu_j - \delta \sum_{i=1}^{10} C_{ii}.
\]

The first term on the right hand side is the industry-specific markup ratio, assumed to be the markup ratio for all the firms in four industries (Light, Material, Chemical, and Machine). It is assumed that the markup ratios were identical in 1989 within an industry, but differed across the four. The second term was calculated by assuming that the change in markup ratio was proportional to the change in output prices relative to input prices (\(C_{ii} = \pi_{ii} - \pi_{ii}^m\), \(\pi_{ii}\) being enterprise-specific inflation in market prices of output, and \(\pi_{ii}^m\), the enterprise-specific inflation in input prices). Thus, the markup ratio, though assumed to be a industry-specific constant in 1989, is allowed to vary across firms and over time between 1980 and 1988. Li (1997) estimated it to be 0.158. In addition, \(\mu_1\) is normalized to be 1, \(\mu_j\) for material, machine, and chemical industries are estimated to be 0.41, 0.35, and 0.48. These estimates are used to compute \(M_{it}\). It is important to note that the \(\mu_j\)'s are identified only up to the proportion with respect to \(\mu_1\); thus, if the markup ratio is 1 for the industry with the smallest markup ratio, the markup ratios for the rest of the industries are \((1/0.35) \times \mu_j\), respectively.
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08.

Woo, Wing Thye, Wen Hai, Yibiao Jin, and Gang Fan, “How Successful Has Chinese Enterprise Reform Been? 

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An exception is Ehrlich et al. (1994). They analyze the dynamic effects of private versus state ownership, find that state ownership is associated with lower growth rates, and explain that it is because private ownership facilitates the accumulation of firm-specific human capital.

Caves (1989), in surveying international differences in industrial organization, concluded with this sentence, “But systematic research on SOEs’ net effect on market performance is lacking.”

See Johnson (1990), Perkins (1994), and Jefferson and Rawski (1994) for Chinese industrial reforms.

Autonomy for all six types of production decisions were delegated around the same time, with the exception of production scheduling, which came earlier, and exports autonomy, which came later.

A state enterprise’s output fell into three categories: a mandatory output dictated under government plan, suggested output stipulated under the government directive plan, and “own” output which was left to the manager’s discretion.

All information about CRS is from CRS in Practice (the Research Group for The Chinese Firm System Reform).

This assumption can easily be justified by a production function where value added is increasing in firm-level skills and effort that are not captured by capital and labor (Jensen and Meckling, 1979; Ehrlich et al., 1994). We also tried a translog production function which included quadratic terms for capital and labor (i.e., (lnk)^2, (lnL)^2, and lnk * lnL). The results regarding reform effects remain similar to those from the Cobb-Douglas production function.
I chose to use value added rather than gross value of output. The whole intention of SOE reforms in China was to improve value added and profits rather than output value. While output value may be boosted simply by increasing inventory without selling any additional products in the market, value added can only be boosted by selling more products. Some may argue that output value is a better measure due to the dual-tract system in China. However, because we have measured value added in 1989 market prices, this criticism does not apply here (see the data appendix).

The justification of Li (1997) also applies here: “Since the extent of participation in the emerging product markets varied across enterprises, different enterprises often had different mixed prices for an identical product. By using market prices, this paper eliminates the possible errors in measuring real output and real inputs caused by the variations in mixed prices due to the differential participation in the dual-track system both over time and across enterprises.”

That is, I created a sample dummy that is one if reform \( j \) was observed at the end of the sample period, then included it and its interaction with time in the regressions. This use of sample dummies is commonly referred to as the control function method; see Heckman and Hotz (1989) for an illustrative application.

Another concern is reverse causality—changes in productivity might have affected reform status rather than the other way around. This problem is particularly relevant to the dummy reform variables. To check this possibility, dummy variables \( DR_{j-1} \) are created for all reform dummies, whose values are ones when the particular reform is going to occur the next year. If reverse causality is important, some factors related to productivity would presumably predict that reform well, and as a result, these dummies should be significant and the reform effects should be significantly altered. The findings indicate the opposite: none of the leading reform indicators are statistically significant, and the reform effects remain largely unchanged. Thus, reverse causality should not be taken too seriously here.

Roughly nine percent of observations dropped because of (3). They involve large measurement errors because (i) the deflator for the output and capital stock were imputed based on industry-year cells, and (ii) markup ratio, an important feature in this paper, could not be reliably estimated. The estimation of markup ratio requires the data about each year’s price information on outputs and inputs (see the data appendix).
Still, several reform variables have many missing observations, and each variable has different firm-years missing. To avoid selection bias and to make full use of the information, the value of missing observations of a generic reform variable \( x_{it} \) was imputed as the average value of their observed industry-year cell (See Greene 1990, pp. 288-289, for methods to deal with missing observations). It did not appear to make sense to delete observations with *any* variable having a missing value; if all missing observations are dropped, the majority of the sample would disappear. Too much valuable information about other reforms would be unnecessarily lost. For instance, while firm-level wage elasticity is only occasionally missing and production autonomy and managerial wage discretion are never missing (after applying the three criteria in the text), the marginal profit retention rate is missing for the majority of the sample. Moreover, while some of the missing observations are random, others probably are not. Respondents to the questionnaire filled in answers as blank when the true number was zero or a reform regime did not apply to the firm. Consequently, the deletion of all observations with any missing right hand side variables may result in inconsistency due to selection bias. Consequently, I created a dummy variable \( m_{x_{it}} \) whose value is 1 if \( x_{it} \) is missing for firm \( i \) and year \( t \). Then, the coefficient of \( m_{x_{it}} \) measures the differences in average productivity between firm-years with missing \( x_{it} \) and those without. The main variables with missing observations are the marginal profit retention rates and the output share under state plan. The percentages of missing observations are 59.6 for the marginal profit retention rate, 33.7 for the output share under the state plan, and 2.5 for firm-level wage elasticity.

15 The random effect model is also rejected by Hausman’s test.

16 In a cross country case study of firms in industries with strong market power, Shirley and Xu (1998) also found performance contracts to be ineffective in raising TFP and rate of return to assets. They found evidence that the ineffectiveness could be partly attributed to managerial bargaining power, lack of incentives, and government reneging. In a follow-up study of Shirley and Xu (1998) and this paper, Shirley and Xu (1999) finds that, while on average PCs did not improve productivity, well-designed PCs improved performance. A well-designed PCs were those that had profit targets, posed managerial bond, designed incentives for employees, with longer contractual length, and operated in competitive environment.

17 Growth accounting is conducted as follows. Let \( y_{it} = \alpha' X_{it} + \beta' Z_{it} + \delta m_{x_{it}} + u_{it} \), where \( X_{it} \) is a vector of variables that do not have missing observations in the sample, \( Z_{it} \) a vector whose elements have missing
observations, and \( m_{Zit} \) a vector of dummy variables whose value is 1 if the corresponding elements of \( Z \) are missing. Then over the period of \( \{0, \ldots, T\} \) the change in \( X \) contributes to a change in \( Y \) by \( \alpha'(X_T - X_0) \) and \( Z_{ok} \) to change in \( Y \) by \( \beta_k(Z_{ITk} - Z_{0It}) + \delta_k(m_{ZITk} - m_{Z0It}) \), where \( \delta_k \) is the coefficient of \( m_{Zit} \).

18. This is higher than most other estimates, mainly because I use a larger sample and productivity is measured as average value added (rather than the commonly-used output). Since the share of intermediate inputs had declined substantially over the decade, outcomes based on value added should grow at a faster pace than those based on output. Here I shall illustrate why. Let \( Q \) be the output at year \( t \), and \( M \) the intermediate input, and \( V \) the value added, then \( V = Q - M \). Take a Taylor-series expansion for \( \ln(V_t) = \ln(Q_t - M_t) \), we get

\[
\ln(V_t) = \ln(Q_t) - M_t/Q_t
\]

then

\[
\ln(V_{80}) - \ln(V_{89}) = [\ln(Q_{80}) - \ln(Q_{89})] + (M_{80}/Q_{80} - M_{89}/Q_{89}).
\]

If \( (M_{80}/Q_{80} - M_{89}/Q_{89}) > 0 \), the growth of value added would necessarily be faster than that of output. Indeed, the data indicate that \( (M_{80}/Q_{80} - M_{89}/Q_{89}) \) is roughly 0.25.

19. For the importance of managerial incentives, see Rosen (1992), Groves et al. (1995), Barberis et al. (1996), and Lopez-de-Silanes (1997). For the importance of employee incentives, see a survey by Prendergast (1996).

20. \( K_{t,79} \), unobserved in the data set, is extrapolated as in Li (1994):

\[
\frac{(\text{beginning- of- year total capital})_{80}}{(\text{end- of- year productive capital})_{80}} = \frac{(\text{end- of- year total capital})_{80}}{(\text{end- of- year total capital})_{80}}
\]

21. To see this, note that (see Li 1995) when \( P_t/MC_t \) and its lagged value are close to 1,

\[
\frac{P_t}{MC_t} = \ln\left(\frac{P_{t-1}}{MC_{t-1}}\right) + 1,
\]

which implies

\[
\frac{P_t}{MC_t} - \ln\left(\frac{P_{t-1}}{MC_{t-1}}\right) = \ln\left(\frac{P_t}{MC_t}\right) - \ln\left(\frac{P_{t-1}}{MC_{t-1}}\right) = \Delta P_t/MC_t - \Delta MC_t/P_{t-1}
\]

The first term of the last equation is output inflation rate, and the second term is proxied by the inflation rate for intermediate inputs.