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ABSTRACT

Reforms and Productivity Dynamics in Chinese State-Owned Enterprises*

Institutional change has taken place gradually since 1978 for State-Owned Enterprises (SOEs) in the Industrial Sector of China. In this paper we estimate the effect of deep reform (the right to hire and fire labour, buy and sell capital and operate on international markets) on the productivity dynamics of enterprises. Using a unique balanced panel of 681 SOEs for the period 1980 to 1994, we find consistent production function estimates using an algorithm put forward in Olley and Pakes (1996), which corrects for simultaneity bias. Furthermore, we allow selection to reform to be endogenous, and correct for this selection bias by formulating an entry rule to reform similar to the Olley and Pakes (1996) exit rule. We show that exposure to deep reform have lead to higher productivity realisations while remaining under state ownership.

JEL Classification: P20, P27, D20, D24

Keywords: selection to reform, simultaneity, production functions, productivity, Chinese Industrial State-Owned Enterprises

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1. INTRODUCTION

The focus of this paper is to estimate the parameters of a production function for Chinese State-Owned Enterprises (SOEs) in the Industrial sector of the economy during the period 1980 to 1994. We use such estimates to examine changes in the distribution of enterprise level productivity, paying particular attention to a set of deep enterprise level reforms. Deep reforms reflect the right to hire and fire labour, buy and sell capital assets and operate on international markets. We intend to show that such deep reforms have induced large improvements in productivity at the enterprise level, controlling for simultaneity and selection bias. Simultaneity bias can result from a tendency for high productivity enterprises to hire more labour and invest more into capital. Selection bias results from the fact that unobservable productivity can make enterprises more likely to reform.

Our analysis is carried out on unique data, derived from surveys undertaken by the Chinese Academy of Social Sciences (CASS) and academics from Oxford University and the University of Michigan. These surveys were undertaken in two waves covering the periods 1980-89 (769 enterprises) and 1990-1994 (681 enterprises) and give us a balanced panel of 681 Chinese SOEs during the years 1980 and 1994. The data covers four provinces, Jilin, Jiangsu, Shanxi and Sichuan (northeast, east, north and west) of China. The sample covers thirty-nine industries but is clustered into homogeneous goods industries such as the manufacturing of machinery, textiles, chemicals and building materials. The surveys contain the quantitative information necessary to estimate production functions. In addition, the surveys contain more qualitative questions on the year that each enterprise adopted a particular reform. This allows us to control for a selection to reform bias in our estimation procedure. Appendix I outlines the data used in our estimation procedure.

Groves et al. (1994), (1995) and Li, (1997) have used the data covering the period 1980-89 and Li and Wu (2002) for the period 1980 and 1994. These papers also use a production function approach to evaluate the reform process but there are three key issues not addressed by them that we take on in this paper. First, they correct for simultaneity bias in their production functions by using a "naive" within group estimator. This requires the enterprise component of productivity to be time invariant. Secondly, they do

not allow for selection bias coming from an endogenous reform process. The Central Government may have become more open to allowing enterprises to undertake reforms over time, but this does not imply that enterprises get selected on non-economic grounds or by random selection. We provide evidence (supported by the literature) that the decision to select into reform came from the grassroots which depended on enterprise level characteristics, some of which are observable to us, and others not (productivity type).

Finally, we consider a set of reforms overlooked by other studies. These deep reforms gave enterprises the right to hire and fire labour, buy and sell capital assets and operate on international markets and were taken-up by enterprises from the late 1980s and early 1990s.[1] Such reforms allowed enterprises to distance themselves from government in day-to-day operations while government remained the equity holder. There are two important observations concerning the take-up of deep reforms. The take-up was not industry or region specific. We observe those who did, and did not, select to reform across all industries and regions. Secondly, once enterprises embrace one deep reform there is a push to select further deep reforms. This indicates that the set of deep reforms were considered complementary in nature. Thus, while the reform process in China has been gradual, it is apparent that the complementary nature of reforms was appreciated for these critical, deep reforms. We witness initial reforms in the 1980s, which increased output autonomy, the payment of wage bonuses, and devolution of control from the centre to the regions (municipality), and the use of market prices on the margin. While these reforms improved incentives, the transmission of information, and the internal organisation of enterprise, researchers have not been able to link productivity to initial reforms, see Li and Wu (2002) and Groves et al. (1994). Indeed, Coady and Wang (2000) provide evidence that rent sharing was driving the allocation of bonuses in

[1] Li and Wu (2002) do consider the issue of increased competitive pressure coming from a second stage of reforms in the late 1980s and early 1990s, which are related to our set of reforms. They proxy competitive pressure at the enterprise level with the ratio of input to output prices and the ratio of private to state controlled investment. These are included as additional regression variables in the production function. The ratio of input to output prices (motivated as a price cost mark-up) is constructed from variables that are used as deflators for output and raw materials in the production function. Their proxies for competitive pressure seem endogenous.

Chinese SOEs with little efficiency gain. We set out to document productivity gains from a second stage of deeper reform.

Thus, our goal is to estimate consistent production function parameters dealing with two interrelated estimation biases. Simultaneity bias arises out of the fact that input demands are, in part, determined by the manager's knowledge of productivity levels. Selection bias stems from the notion that productivity affects the decision to select into deep reform. We adapt an estimation algorithm developed in Olley & Pakes (1996) to deal with both of these biases.

Why use Olley & Pakes (1996) to deal with simultaneity bias? Blundell, Bond and Windmeijer (2000) suggest a "system" GMM estimator to deal with simultaneity bias in production functions. The problem with this approach is that there is no behavioural model of the unobservable. They model the unobservable as a dynamic error component model and use linear and non-linear moment restrictions (from the structure of the error) to estimate the parameters of the production function with some precision. The benefit of the Olley & Pakes (1996) approach is that there is a structural model of the unobservable that suggests the optimal investment dynamics of enterprises, given the observable state variables, should allow one to control effectively for the omitted unobservable using non-parametric techniques. One key question is whether the investment dynamics present in Chinese State Owned Enterprises would tell us anything about enterprise level productivity. Clearly, we appeal to the first welfare theorem. Planners try to make decisions that mimic what prices do in a decentralised economy. During our sample period enterprises were at least signed up to a "contract responsibility system". The contract had profit and tax targets to be paid to the government and, in return, managers and workers would be paid agreed bonuses. Even though incentive problems were not solved, clearly planners would target investment at enterprises where profit and taxes were coming back to government. Such investment dynamics should be enough to back out the unobservable (productivity type). Clearly, the adopting of our deep reforms should induce investment dynamics to reflect productivity type. We will allow the non-parametric relationship between investment and the (observable and unobservable) state variables to be different across unreformed and reformed enterprises. In addition, ex-post,

we confirm that investment and productivity estimates at the enterprise level are positively correlated over-time in both sub-samples.

We also use Olley & Pakes (1996) to deal with our selection to reform bias. With respect to the Blundell, Bond and Windmeijer (2000) "system" GMM estimator, it is hard to see how the parametric IV approach deals with selection biases, particularly in the presence of endogenous dummy variables. We wish to allow selection to reform to be endogenous, and correct for this selection bias by formulating an entry rule to reform similar to the Olley and Pakes (1996) exit rule. Their 3-step semi-parametric approach can deal with simultaneity and selection biases in a simple way. The main contribution of this paper is to adapt their estimation procedure to allow for a selection to reform bias. Allowing for the endogenous nature of reform/internal organisation within companies is absent in most literatures (mainly due to a lack of data and estimation procedures).

Turning to our results, we first treat reform as an exogenous (rather than a choice) variable that is randomly allocated across enterprises. We control for a simultaneity bias in a two-step procedure using Olley & Pakes (1996). Our parameters move in the direction found in other studies when compared to OLS estimates. The labour coefficient decreases and our capital coefficient increases. Given that we find significant differences in our productivity estimates across reformed and unreformed firms we split the sample according to reform status and employ a three-step Olley & Pakes (1996) procedure. Thus, we allow the selection into the reformed or not reformed sub-samples to be endogenous to an enterprises productivity type, as well as production technology to differ across reform-type. Our results indicate that enterprises that embrace deep reform under Sate Ownership exhibit higher productivity compared to enterprises in the initial stages of reform, controlling for simultaneity and selection biases. Most western studies that have failed to find efficiency gains from privatisation argue that State Owned Companies tend to operate with competitive pressures in factor and product markets pre-privatisation and hence the contributions of privatisation are hard to isolate (see Walsh and Whelan, 2001, for an overview). This paper presents a natural experiment that supports this previously untested view. Exposure to competitive forces in factor and product markets does induce important efficiency gains at the enterprise level pre-privatisation.

The remainder of the paper is structured as follows. Section two provides the reader with the background of enterprise reform in China. We set out how we tailor the behavioural model of Olley and Pakes (1996) to our particular problem in section three. Section four summarises the estimation procedure. Our results and conclusions are set out in sections five and six, respectively.

2. CHINESE STATE-OWNED ENTERPRISES

In this section we shall elaborate on the nature of the reform process in State-Owned Enterprises. We highlight two main characteristics of reform. First, reforms were not assigned randomly, but rather due to pressure from 'able' enterprises, which fully appreciated their ability to profit from implementing reforms. Furthermore, while overall reform process has been gradual, crucial deep reforms were clustered together.

There exists a wide consensus that the authorities, lacking an initial clear vision of the reform goal, and hence could also not have planned a reform path, gave in to grassroots (enterprise) pressure. It appears that the grassroots appreciation of the potential offered by the market, beginning with the agricultural sector, caused the reform process to advance. In this sense initial reforms cannot be seen as the initiation of a plan, which was to bring to reality some grand vision. Also, the quality of their impact in isolation is widely disputed. Over time a clearer vision of reforms was developed, and commitment to reform intensified. Thus, initial reform was preparatory which allowed a second stage of reforms to become a possibility. Interestingly, we provide evidence that a second stage of deeper reform were undertaken all together by an enterprise or were not implemented at all. The fact that they were taken up as a package indicates that the authorities/enterprises realised the complementary nature of such deep reforms. Thus, it appears that China, accidentally or otherwise, allowed the short-term inefficiency of gradual reform, while at the same time building the institutions/social capital that would provide the infrastructure to support crucial, deep reform. In this section we support the above view of the reform process in more detail.

Reform in China was initiated in 1978 due to the realisation that the economy had been near stagnating over the preceding decades, and a large portion of the population was living on less than a dollar a day. Reforms refer to institutional changes that move

the economy from planned to a market economy. The crucial difference is reflected in prices, which are set by the planner in the former, and set in the market in the latter case. Prices under planning are often set such that inputs are cheap and final goods are expensive, especially industrial goods. Thus, profits from the industrial sector are the main source of government revenue, rather than taxes as in market economies. Hence, the allocation of goods in the economy is not achieved by demand and supply creating a price that reflects the value/scarcity of a product. Rather, the planner must process a wealth of information and then use this information in order to gear the economy toward arriving at some set of desirable goals, defined by quotas. Information and incentive problems lead to stockpiling and loss of economic prowess. Over-time this system has had to reform. (Naughton, 1995).

Since the act of planning is so complex, partial reform within planning may not improve efficiency significantly, but may, in fact, lead to distortions, which adversely affect efficiency and the commitment to further reform, see Dewatripont & Roland (1995). However, a big bang approach, that removes all aspects of planning without the institutions of a market economy in place, could result in a period of disorganisation, which could in turn result in an initial massive fall in output as witnessed in the former Soviet Union; see (Repkine and Walsh, 1999) and (Konings and Walsh, 1999). In 1978 the Chinese tentatively sought for a way to avoid this problem, where the "*government's role often has been to permit change rather than to initiate it*" (McMillan, 1994). The planned economy was upheld, while units bought and sold goods in the market, at market prices, if they were in excess of quotas regulations. While initial reforms in industry were deemed unsuccessful, with some retrenchment by 1983, there was a strong push for reforms again after 1983 (Naughton, 1995). Thus, we witness the birth of the *Dual-Track* system, which allows both planned and market prices to coexist for goods produced to quotas and excess goods respectively.

"*Beginning in 1978 […], China reformed its industrial sector. Enterprises that had been largely controlled by the state were given some market or market-like incentives. […] State owned enterprises were allowed to keep some fraction of their profits, where before all profits had to be remitted to the state. Enterprises began to sell some of their outputs and buy some of their inputs in free markets, rather than selling and*

procuring everything at state-controlled prices" (Groves et al., 1994; see also Byrd 1991, Naughton 1995, Qian, 1999).

In 1978 SOE's accounted for 78 percent of industrial output, 19 percent of total employment (Kennedy & Marquis, 1988). The degree of state produced output sold at market prices rose steadily, and averaged 38 percent of state-owned enterprises' output by 1989, and, in particular cases, even amounted to all output. By the same time on average 56 percent of inputs to state production was procured at market prices. (McMillan, 1994)

By the end of the 1980s most SOEs in our sample had engaged in this type of reform, now having the right to determine output value, pay bonuses, retain excess profits, and sell and produce at market prices. Also, the level of control was devolved from the state or provincial level to the municipal level. We view these reforms as initial steps toward creating a market economy environment. The effect of these reforms by themselves is overviewed in Li and Wu (2002), who conclude that their effect was indeed limited. Groves et al. (1994) take a more benevolent view of initial reforms, but they fail to link the reform process to productivity. Indeed, while they provide strong evidence that firms make use of their right to pay bonuses out of retained profits, they fail to supply convincing evidence that bonuses, which, it should be stressed, were distributed evenly across worker-class, effected efficiency gains. We are of the persuasion that SOE workers were 'bonus-sharing', as outlined in Coady and Wang (2000). Also, the fact that the government passed a law in the late eighties dictating that bonuses could only increase at a rate commensurate with productivity gains is a strong signal that bonuses were *de facto* abused in rent-seeking behaviour.

Thus, the main function of initial reforms appears to be the creation of institutions necessary for the second stage of reforms to be successful. A standstill at the level of initial reform was counterproductive, as certain agents made use of the status quo in this halfway house by trading between the co-existing parts of the economy. This reportedly led to a rise in social tension in the late 1980s (See Laffont & Qian, 1999; Dewatripont & Roland, 1995; Fang, 1994).

It is at this point that the authorities began to appreciate the necessity to advance further reforms, but still they lacked a clear goal or path, which is summed up in the

slogan *"crossing the river by touching stones". "[U]ncertainty over its vision of the future and aversion to risk help explain China's initial groping reform strategy. …and success has sustained the continuity of a gradual evolutionary approach to reform*" (Jefferson & Singh, 1999). It was appreciated that the growth in the private sector could not be matched by the state-sector. One can say with respect to this phenomenon that, rather than destroying the old institutions and starting from scratch, China let its new economy grow around what already existed, i.e. was *"[g]rowing out of the Plan"* (Naughton, 1995).

Further reforms were initiated. Figure 1a shows how reforms evolved over time in our sample of enterprises. We see how these deep reforms begin in the late 1980s, but only permeate most of the sample by the early 1990s. Even though are data on reforms only goes to 1995, careful analysis of the data shows that an enterprise's endeavour in one of these areas tended to be followed by further reform in another critical area. Also, contrary to our prior beliefs there is no clear sequencing in the adoption of deep reform. Thus, these later reforms were not taken up gradually: enterprises selected to the full package, or did not undertake any of the second stage reforms. The evolution of the proportion of enterprises taking up a set of deep reforms is illustrated in Figure 1b.

Regarding the causality of reforms, which is an important part of our analysis, we find support for our view that it runs from enterprise performance to reform and vice-versa. "*Virtually all of the literature on the enterprise reform examines the impact of reform on performance. Causality also operated strongly in the other direction. Poor or declining performance, particularly among enterprises operated at lower levels of government, motivates new rounds of reform. Indeed, the industrial innovation ladder predicts that causality should run from enterprise to reform*" (Jefferson & Singh, 1999).

We have information on various types of reform undertaken by enterprises by year. Given the strong heterogeneity across enterprises, regions, industries and time, we do not support a view of top-down initiated reform. Naughton (1995) supports our view when he states that the ex-post consistency of the reform process came about only because reforms were introduced in a heterogeneous/experimental fashion, where failures were disguised in the mass or by retrenchment. The information gathered in these initial, localised experiments were then reapplied to most SOEs in the mid-1980s, thus reducing the

cost of implementation due to trial and error (McMillan and Naughton, 1992; Qian, 1999). It was not then a grand vision and divine leadership that has produced seemingly successful reform in Chinese SOEs as one might be led to believe, but rather from pressure at the grassroots level.

With respect to SOEs, prior to 1992 they were not privatised. Over the coming years there was a marked increase in levels of privatisation. Small SOEs were privatised at the county level and layoffs emerged at the city-level. This form of holding on to large enterprises was promoted by the slogan "*grasping the large and letting go of the small*". Small- and medium-sized enterprises made up 95 percent of SOEs in 1993, and in many provinces about half of these were privatised by 1996. At this stage some ten million workers had been laid off from SOEs, and a further 11.5 million in 1997. This appears typical of China's initially slow pace of reform, which then accelerates. Large-scale layoffs were never a feature in modern China prior to this. In this paper we do not evaluate the benefit of privatisation after 1994. However, we do have the ability to estimate the impact of competitive pressure on productivity at the enterprise level under state ownership.

3. THE BEHAVIOURAL MODEL

As outlined above, our aim is to analyse changes in the distribution of productivity that is accompanied by enterprise-level institutional change, i.e. the initiation of deep reform. A necessary condition for this is the computation of consistent estimates of production function parameters. Our data indicate a great deal of heterogeneity in type and completeness of deep reform realised, even across industries and regions. We class the reforms that changed enterprise managers and workers incentives internally as *initial* or early reforms. Reforms that induced external competitive pressure (right to hire and fire labour, buy and sell capital assets and buy and sell into international markets) on the enterprise, that came later, we classify as *deep* reforms. We will allow productivity to be a major determinant of *selection* to deep reform.

Since the productivity variable is not measured directly in our data, the assertion that selection to deep reform and choice of factors of production should depend on productivity type leads to two complications when attempting to estimate a production

function. The first complication appears if productivity levels observed by managers determine input levels. Thus, we face the classic simultaneity problem analysed by Marshak and Andrews (1944). The second complication arises out of the fact that some enterprises select to reform while others do not. The evidence suggests selection to reform is related to productivity type. Hence we must deal with the fact that selection to deep reform implies a higher productivity type to begin with and may not be related to the reform per se. The problems associated with entry and exit of companies is widely discussed in western literatures. Here we have a balanced panel of enterprises, but unbalanced panels of reformed and unreformed enterprises, since not all firms engage in 'deep' reform, and those that do, select at different points in time. If the decision to induce reform is related to their productivity level, then our unbalanced panels of reformed or unreformed enterprises result in part due to an endogenous selection process based on unobserved productivity. This would create selection bias in the production function estimates of our unbalanced samples of unreformed and reformed enterprises.

Olley & Pakes (1996) provide us with a dynamic behavioural model that allows for productivity differences within firms across time, and also across firms. This allows us to examine the effects of simultaneity and selection problems. In order to address simultaneity, the model specifies the information available when input decisions are made. The model develops a 'selection' rule in order to tackle the selection problem. As in Ericson and Pakes (1995), it is assumed that current profits are a function of a firm's state variables, factor prices, and the state variables of all other firms active in the market. We assume the vector of firm specific state variables consists of a firm's age, a_{it}, its capital stock, k_{it}, and firm productivity, a measure denoted by ω_{it}. A market structure consists of a list of these triples for all active firms. Factor prices are assumed to be common across firms and to evolve according to an exogenous first-order Markov process.

We will assume that each period a firm faces three decisions. First, the manager/government will decide whether or not a firm should embrace deep reform. If it does the manager faces a cost of doing this while reaping potential rewards. Given that decision, the firm will then choose its labour and investment level. We assume that labour

and investment levels can be freely chosen, the latter of which, together with firm-level depreciation, δ_t , determine next period's capital stock.

The accumulation equations for capital and age are given by

(1) $$k_{t+1} = (1 - \delta_t)k_t + i_t \quad \text{and} \quad a_{t+1} = a_t + 1,$$

which hold with probability of one. Productivity, ω, is known to the firm and evolves according to an exogenous Markov process, as in Hopenhayn and Rogerson (1993). Its distribution at $t + 1$ conditional on all information known at t is determined by the family of distribution functions,

(2) $$F_\omega = \{F(\cdot\,|\omega), \omega \in \Omega\}$$

Firms are assumed to maximise the expected discounted value of future cash flows. In this fashion a firm's decision to reform, as well as its choice of investment, depends on its perception of the future market structure given available current information, which in turn affects the future market structure. Similar to Olley and Pakes (1996), we subsume the existence of a Markov perfect Nash equilibrium in investment strategies for our particular problem, which is similar to that defined and proved in Ericson and Pakes (1995).

In equilibrium, the profit and value functions depend on factor prices and the structure of the market. However, since we assume that these do not vary across competitors in any given period, we suppress them in our notation. Profit and value functions are thus indexed by time. In this way we take note of the fact that the relationship between a firm's state variables and profit functions depends on factor prices and market structure.

The Bellman equation for an incumbent firm can be written as

(3) $$V_t(\omega_t, a_t, k_t) = \max\{\Phi_t(\omega_t, a_t, k_t, r_t = 0), \sup \pi_t(\omega_t, a_t, k_t, r_t = 1) - c(r_t = 1, i_t) + \beta E[V_{t+1}(\omega_{t+1}, a_{t+1}, k_{t+1}, r_{t+1} = 1) \mid J_t]\},$$

where π_t (·) is the restricted profit function, which gives current profits as a function of the vector of state variables and reform status, c(i_t , r_t) is the cost of current investment, i_t, and reform r_t . β is the firm's discount factor, and J_t represents information available at time t. Φ_t, the value of not reforming, naturally depends on the firm's state variables. As noted in Olley and Pakes (1996), this lack of independence will have no effect on the sign of the biases so long as the difference between reformed and unreformed earnings is increasing in the state variables.

The max operator in (3) indicates that a firm compares the value of 'languishing' with the expected return from selecting to reform. If the current state variables of the firm indicate reform is not worthwhile, it chooses investment and labour to maximise profits. Otherwise it reforms and chooses investment and labour appropriately. The solution to this control problem generates a reform rule, and an investment demand function. Let r_t be zero for 'no reform' choices, then the 'entry to reform' rule and the investment demand equation can be written as

$$(4)\ r_t = 1 \quad \text{if } \omega_t \geq \underline{\omega}_t(a_t, k_t)$$
$$= 0 \quad \text{otherwise}$$

$$(5)\quad i_t = i_t(\omega_t , a_t , r_t, k_t)$$

Thus, a firm will choose to reform if its perceived productivity realisation is greater than the threshold productivity level, $\underline{\omega}_t$, which depends on a firm's age and capital stock at time t. The functions $\underline{\omega}_t (\cdot)$and $i_t (\cdot)$ are determined as part of the Markov perfect Nash equilibrium, and will depend on all the parameters determining equilibrium behaviour.

4. THE ESTIMATION PROCEDURE

Enterprises across different industries are assumed to produce homogeneous products with Cobb-Douglas technology. The log-linear production function to be estimated is given by

(6) $$y_{it} = \beta_0 + \beta_a a_{it} + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \eta_{it}$$

Thus, we model the log of enterprise *i*'s value added at time *t*, y_{it}, as a function of the log of that enterprise's state variables at *t*, namely age, a_{it}, capital, k_{it}, and the choice variable labour, l_{it}. The error structure is comprised of a stochastic component, η_{it}, with zero expected value, and a component that represents unobserved productivity differences, ω_{it}. Both ω_{it} and η_{it} are unobserved, but ω_{it} is a state variable, and thus affects firm's choice variables. On the other hand η_{it} has zero expected value given current information, and hence does not affect decisions.

Simultaneity means OLS estimates should provide biased estimates for inputs if ω_{it} is serially correlated, and the bias should be higher for more readily adjusted inputs. On the other hand, selection to the reform process has a negative bias on the capital coefficient. To see this, assume for the moment there are no variable inputs. The expectation of output at *t* conditional on current inputs, selection to reform, and information available at *t-1* includes the term, $E_{it}[\omega_{it} | a_{it}, k_{it}, \omega_{it-1}, r_{it} = 1]$. But, the necessary and sufficient condition for $r_{it} = 1$ is that productivity is above some threshold level, $\omega_{it} \geq \underline{\omega}_{it}(a_{it}, k_{it})$. Also, we assumed the profit function is increasing in *k*, which implies the value function is also increasing in *k*. Thus the threshold productivity level, $\underline{\omega}_{it}(\cdot)$, will be decreasing in *k*. Firms with a higher capital stock have higher profits, *ceteris paribus*, and hence can select to reform with lower realisations of ω. The entry to the reform process implies that $E_{it}[\omega_{it} | a_{it}, k_{it}, \omega_{it-1}, r_{it} = 1]$ is decreasing in *k*, producing a negative bias in the estimate of the capital coefficient.

The remainder of this section is an exposé of Olley and Pakes (1996) estimation algorithm, recast for our particular problem. The choice variables, labour and investment, are assumed to be the only variables that are affected by current productivity. Age and capital are fixed factors, and are only affected by the distribution of current productivity conditioned on the information available in the previous period, and past realisations of productivity. Specifically, the optimisation of (3) yielded the investment equation (5). If current investment is strictly increasing in current productivity levels, we can invert the investment equation $i_{it} = i_{it}(\omega_{it}, a_{it}, k_{it})$ for $i_1 > 0$ and write,

(7) $$\omega_{it} = h_{it}(i_{it}, a_{it}, k_{it}).$$

This makes the unobservable productivity variable a function of observable variables, which allows us to control for ω_{it} in our estimation. The two assumptions here are a positive relationship between investment and productivity, and also the assumption that productivity is the only unobserved firm specific state variable. Substituting (7) into (6) gives;

(8) $$y_{it} = \beta_l l_{it} + \varphi_{it}(i_{it}, k_{it}, a_{it}) + \eta_{it}$$

where,

(9) $$\varphi_{it}(i_{it}, k_{it}, a_{it}) = \beta_0 + \beta_a a_{it} + \beta_k k_{it} + h_{it}(i_{it}, k_{it}, a_{it}).$$

The partially linear equation (8) is a semi-parametric regression model, which defines the coefficient on labour while the parameters on the state variables are left unspecified. Thus, we are unable to distinguish the effect of capital and age on the investment decision from that on output. In order to identify β_k and β_a we will need estimates of the probability of selection to reform in addition to the estimates on β_l and $\varphi_{it}(\cdot)$.

We look for the probability that a firm (we drop the *i* subscript) is reformed next period given the, currently known, threshold productivity next period and all information available at present.

(10) $$\begin{aligned} Pr\{X_{t+1} = 1 \mid \underline{\omega}_{t+1}(a_{t+1}, k_{t+1}), J_t\} & \\ &= Pr\{\omega_{t+1} \geq \underline{\omega}_{t+1}(a_{t+1}, k_{t+1}) \mid \underline{\omega}_{t+1}(a_{t+1}, k_{t+1}), \omega_t\} \\ &= \rho_t(\underline{\omega}_{t+1}(a_{t+1}, k_{t+1}), \omega_t) \\ &= \rho_t(i_t, a_t, k_t) \\ &\equiv P_t \end{aligned}$$

Thus, the probability an enterprise will reform can be reduced to i_t, a_t, and k_t because productivity can be calculated from these by (5), and threshold productivity is a

function of age and capital, which result from the realisation in the previous period of i_t, a_t, k_t. The expectation of output at $t+1$ cleaned of the part attributable to labour at $t+1$ and conditional on selection to reform

(11) $$E[y_{t+1} - \beta_l l_{t+1} \mid a_{t+1}, k_{t+1}, r_{t+1} = 1] = \beta_0 + \beta_a a_{t+1} + \beta_k k_{t+1} + E[\omega_{t+1} \mid \omega_t, r_{t+1} = 1] \equiv \beta_a a_{t+1} + \beta_k k_{t+1} + g(\underline{\omega}_{t+1}, \omega_t)$$

where,

$$g(\underline{\omega}_{t+1}, \omega_t) = \beta_0 + \int_{\underline{\omega}t+1} \omega_{t+1} [F(d\omega_{t+1}|\omega_t) / \int_{\underline{\omega}t+1} F(d\omega_{t+1}|\omega_t)].$$

In order to measure the impact of the unobservable we need a measure of both productivity and the threshold level, i.e. the productivity value that sees a company as just indifferent between reforming and maintaining the status quo.

The selection equation (10) can be inverted provided $F(d\omega_{t+1}|\omega_t) > 0$ about ω_{t+1}, at every ω_t, which allows us to express $\underline{\omega}_{t+1}$ as a function of P_t and ω_t, which naturally extends to $g(.)$. By conditioning on selection we can condition on the value of one of the indices needed. Then, for given β_a and β_k we can condition on the second index by conditioning on the semi-parametric equation in (8).

Substituting P_t and φ_t into g(.), and letting ξ_{t+1} be the innovation in ω_{t+1} we have

(12) $$y_{it+1} - \beta_l l_{it+1} = \beta_a a_{t+1} + \beta_k k_{t+1} + g(P_t, \varphi_t - \beta_a a_t - \beta_k k_t) + \xi_{t+1} + \eta_{t+1}$$

where,

$$\xi_{t+1} = \omega_{t+1} - E[\omega_{t+1} \mid \omega_t, r_t = 1]$$

and from (9), (10), and (11),

$$g(\underline{\omega}_{t+1}, \omega_t) = g[\rho_t^{-1}(P_t, \varphi_t - \beta_a a_t - \beta_k k_t), \varphi_t - \beta_a a_t - \beta_k k_t] \equiv g(P_t, \varphi_t - \beta_a a_t - \beta_k k_t)$$

Since labour can adjust to shock productivity realisations this variable is not independent of ξ_{t+1}, which explains the need for the first stage estimation. The equations to be estimated are (8), (10), and (12). We get our estimate for labour and φ_t by running ordinary least squares with current value added as the dependent variable on the independent variables current labour and φ_t , which is a Nth-order polynomial with a full

set of interactions of the current variables age, capital, and investment. The probability of reform, P_t, is modelled in (10), which states that this can be found by formulating a probability on the joint-outcome that productivity will exceed the threshold level, defined by the firm's state variables, and last period's productivity realisation, estimated by using φt. This is essentially a probit regression of the reform-realisation on last period's investment, age, and capital realisations.

The estimates for age and capital in (12) are obtained by minimising the squared errors in a non-linear search routine

(13) $$y_{it+1} - \beta_l l_{it+1} = \beta_a a_{it+1} + \beta_k k_{it+1} + \sum_{j=0}^{4-m} \sum_{m}^{4} \beta_{mj} h_{it}^{m} P_{it}^{j} + e_{it}$$

Where, P_{it} was estimated in (10) and $h_{it}(i_{it}, k_{it}, a_{it}) = \varphi_{it} - \beta_0 - \beta_a a_{it} - \beta_k k_{it.}$ We include time dummies in our regressions. The above should be re-written to allow for thirteen intercept shifts for each year.

5. RESULTS

In this section we will present our results. An important issue will be to determine whether reform is a state (exogenous) or an enterprise level choice variable. We shall begin by treating the reform status of an enterprise as exogenous (randomly assigned), i.e. as a state variable. In this context we will contrast the OLS and GLS within estimators with the Olley-Pakes estimator, which corrects for possible simultaneity bias. We find that the Olley-Pakes 2-step productivity estimate is significantly larger for the set of reformed versus the unreformed enterprises. This suggests that the reform status of an enterprise is endogenous to its productivity type. Hence, we progress by computing a predicted probability of being reformed in a probit model, and, using the Olley-Pakes 3-step framework, find productivity estimates, which are corrected for simultaneity and our selection to reform bias. By splitting the sample according to reform status we implicitly we allow technology to vary across our sub-samples. We find consistently higher productivity estimates for our sample of deep reformers. The standard errors of the Olley-Pakes coefficients are bootstrapped and clustered by 2-digit industries codes.

In Table 1 we document our descriptive statistics. Enterprises in the state of deep reform are bigger in terms of employment and capital. They produce more value added

and invest more in capital. Turning to our estimates of the parameters of the production function in Table 2 we note that the OLS and GLS estimates for the co-efficient on labour are consistently higher than the Olley-Pakes first-stage estimates. Also, the OLS and GLS estimates for the co-efficient on capital are significantly lower than the Olley-Pakes second stage estimates. We note that the coefficients on age and reform have a positive but lower impact on value-added in Olley-Pakes second stage estimates. In addition, we do a standard parametric test to show that the additional regression variables that form the fifth order polynomial in h_{it} are jointly significant. In Table 3 and 4 we report aggregate productivity measures for each year aggregating over reformed and unreformed enterprises using our 2-step Olley-Pakes consistent estimates, where productivity is measured as $TFP_{it} = exp(y_{it} - \beta_l l_{it} - \beta_a a_{it} - \beta_k k_{it})$. Productivity in Table 4 is a weighted average of enterprise productivity, weighted by real value added. We clearly see that the reformed enterprises have larger productivity estimates, particularly in larger reformed enterprises.

This begs the question whether productivity may actually be endogenous to reform status. Thus, we progress by correcting for the likelihood of being selected to reform as a result of being a higher productivity type. We achieve this by first computing a predicted probability of being reformed in a probit model, where reform status is regressed on a polynomial of *i*, *a*, and *k*, and time dummies. Time dummies capture the gradual change in the environment of the enterprise, namely the increasing willingness of the centre to relinquish control over time. We then split the sample according to reform status. After estimating the labour coefficient for both sub-samples we progress by estimating coefficients for age and capital, equation (13), allowing non-parametrically for our theory of simultaneity and selection bias to back out, or control for, productivity.

In Table 5 we find that the coefficient for labour is significantly higher for the unreformed sub-sample. There is a stark difference in the capital coefficients for the two unbalanced panels. Reformers thus appear to get a greater rate of return from capital vis-à-vis the non-reformed sample. Interestingly, the age estimate for the reformed sample is higher for the unreformed vis-à-vis the reformed enterprises. Finally, we do a standard parametric test to show that the additional regression variables that form the third order polynomial in h_{it} and P_{it} are jointly significant.

In Table 6 we address whether investment dynamics present in Chinese State Owned Enterprises are, at least ex-post estimation, correlated with enterprise level productivity. We see that investment and productivity estimates at the enterprise level are positively correlated over-time in both sub-samples.

Table 7 and Table 8 again report unweighted and weighted average aggregate TFP estimates. It seems clear that productivity for the reformers, even after controlling for selection bias, is on average higher for the reformed enterprises vis-à-vis the unreformed enterprises, in terms of the adoption of deep reform. Thus, it appears that, while productivity influences the decision to undertake deep reform, productivity is also higher for the reformed enterprises. Finally, in Figures 2 and 3 we compare the estimates of productivity across reformed and non-reformed enterprises, respectively, by graphing the log distributions computed from using a simple OLS model, 2-step and 3-step Olley and Pakes procedure. The imposed distribution allows us to easily compare productivity distributions across graphs. While the 3-step Olley and Pakes procedure produces lower productivity estimates, on average, across reformers and non-reformers, the difference between the reformed and non-reformed population is much more pronounced. We believe that this highlights the importance of correcting for selection bias when one is evaluating the impact of reform on productivity dynamics. The adapted 3-step Olley and Pakes procedure allows us to do this with relative ease.

6. CONCLUSION

Using a unique balanced panel of 681 State-Owned Enterprises in the Industrial sector of China during the period 1980 to 1994 we estimate the effect of a set of deep reforms, the right to hire and fire labour, buy and sell capital and operate on international markets, on the productivity dynamics of enterprises. We find consistent production function estimates using an adapted algorithm put forward by Olley and Pakes (1996), which allows one to control for simultaneity and (our innovation) selection to reform biases with relative ease. We show that exposure to deep reform, competitive pressures, has induced higher productivity realisations under state ownership pre-privatisation.

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APPENDIX I: THE DATA

Data

In what follows we will describe our data. We will proceed by first describing general features of the raw data and how we have used them to generate the actual dataset we use in our analysis. The data are compiled from SOE surveys conducted by the Institute of Economics, Chinese Academy of Social Science (CASS), in consultation with a dozen economists from Michigan and Oxford Universities, as well as from the University of California, San Diego. These surveys are unique in detail and quality.

In total we have four individual sets of data, which can be subdivided into two different types of data. The first type is contained in two sets and contains quantitative information on individual enterprises, which is supplied annually by each enterprise's accountant. These data have been recorded over two time periods. The first dataset ranges from 1980 to 1989, and the second ranges from 1990 to 1994. The earlier dataset contains 769 enterprises, while the latter dataset contains a subset of the enterprises represented in the first, namely 681 enterprises.

The second type of data is qualitative in nature, since it deals with the institutional environment of the firm, and also comprises two sets. The data represent the answers of each enterprise's manager to a questionnaire in 1990 and 1995. Thus, the institutional questionnaires append the final year of the quantitative questionnaires, and hence they each contain information on exactly those enterprises that were present in the respective antecedent quantitative datasets.

Since some the questions posed have not remained identical, it is important that we give a detailed account of how we constructed the variables in our dataset from these. We proceed by describing the features of the quantitative questionnaires first, followed by a description of the institutional ones.

The 1980-1989 quantitative questionnaire contains 321 questions which are subdivided into twelve categories, labelled *Output*, *Production Expenses*, *Wages*, *Labour and Personnel*, *Operations*, *Investment*, *Capital Accounts*, *Profit Accounts*, *Profit Retention and Enterprise Funds*, *Supplementary Materials*, *Costs of Main Products*, and *Other*.

The 1990-1994 accounts questionnaire contains 166 questions, which are subdivided into eight categories, *Output*, *Input*, *Wages*, *Financial Condition*, *Assets*, *Liability and Equity*, *Investment*, and *Utilisation of Capacity*.

The two institutional questionnaires are very similar. The 1990 one contains seventy questions in five categories, the 1995 one has eighty-four questions subdivided into six sections. Both have sections entitled *Enterprise Characteristics*, *Contract and Management Appointment*, *Relations Between Enterprise and Its Supervisors*, *Internal Incentive Stem*, and *Management Characteristics*. The 1995 questionnaire has an extra section with the title *Property Rights and asset Structure*, although many of the questions were already present in the 1990 questionnaire. Of these two we only need to make use of the 1995 questionnaire.

The remainder of this appendix deals with the quantitative questionnaires, and with how we created the variables from these, which now form our data series from 1980 through 1994. We will subdivide this section into various categories, depending on the type of variable we are dealing with.

Table A1: Firm Characteristics

Variable \ Dataset	Symbol	1980-1989	1990-1994
Enterprise Identifier	*ID*	Unique Identifier for each firm {1 - 769}	
Location	*loc*	Three digit number, first indicates province and last the district	
Industry	*ind*	Number from 0 – 40, indicating the industry the firm belongs to	
Operation Year	*Op_y*	Year from which an enterprise commenced operation	

Table A1 describes some of the unchanging firm characteristics. Each of the 681 firms has its own unique identifier in form of a firm identification number, ranging from 1 to 769. An enterprise's location is given by a three digit number, where the first number identifies the province a company resides in, and the last identifies the district in that province; the middle digit is a separator and is always zero. The industry affiliation of an enterprise is indicated by its industry code, which is a number between one and forty. The year of operation is given by a two-digit number, which indicates the year in the twentieth century that a firm commenced its operation.

Table A2 is concerned with the creation of our Real Value Added Variable, which has been constructed from variables in the raw data and some deflators. We have enterprise's value of output in present prices as well as in the prices of the base year for each dataset, namely 1980 and 1990. In order to get a consistent series spanning 1980-1994 we decided to make use of the 1980-1989 real value of output series, and then applied a deflator, with 1980 as base year, to the present value of output 1990-1994 series. The deflator supplied was by Changqi Wu. In addition, we have information on the value of raw materials consumed. By making use of the prices of the primary inputs and the quantities they were used in, we have constructed a firm-level material input deflator. Thus, we can create a variable that gives us the value of raw materials consumed at 1980 prices. When we subtract this real raw materials variable from real output value, we gain a variable that measures the value added for each enterprise in each year.

Table A2: Real Value Added

Variable \ Dataset	Symbol	1980-1989	1990-1994
Nominal Output	*Yn*	Current Price Value of Output in 10,000 Yuan	Total Value of Gross Output of Enterprise (present Value) in 10,000 Yuan
Base Year Output	*Yr*	Actual Value of Output (1980 Fixed Prices) in 10000 Yuan	Total Value of Gross Output of Enterprise (based on 1990 value) in 10,000 Yuan
Output Deflator	*ydef*	Nominal Divided by Real	Output Deflator in 1980 Prices (Li & Wu, 2002)
Output	*yr = Yn/ydef*	Actual Value of Output (1980 Fixed Prices) in 10,000 Yuan	Nominal Output divided by 1980 prices Deflator in 10,000 Yuan
Materials	*mn*	Total Raw Material Consumption in 10,000 Yuan	Total Raw Material Consumption 10,000 Yuan
Material Deflator	*mdef*	Firm level raw material price index as calculated by Changqi, replaced by industry level deflator if missing. 1980 Base Year.	
Real Materials	*m= mn/mdef*	Materials Divided by the 1980 Prices Material Deflator	
Real Value Added	***y = yr - m***	Real Output minus Real Materials	

Table A3, the labour variable simply measures the number of employees the enterprise employed at year-end.

Table A3: Labour

Dataset / Variable	Symbol	1980-1989	1990-1994
Labour	***L***	Workers at Year End	Total Number of Employees

Table A4 contains information on how we created our Real Capital Stock and Real Investment variables. The 1980 level of the real capital stock is given by the net capital asset position of each enterprise. For every following year we create a new Real Capital Stock value, which is given by the previous year's real capital stock, adjusted for firm level depreciation, to which we add Real Investment, which is investment in 1980 prices. Each of these constituent variables will be discussed in turn. Investment is deflated by a machinery output price index, with 1980 as base year, which yields Real Investment. Investment itself is given, where available, by productive fixed investment for the years 1980-1989. Where it is not available, which includes the years following 1989, we use the year on year change in productive capital. Productive Capital, in turn, is given by the cumulative value, that is adding up receipts of purchases, of industrial production related fixed assets for all years. We get firm level depreciation rates by dividing depreciation by the capital stock. For the years 1980 to1989 depreciation is defined as the year on year change in cumulative depreciation. For the years 1990 to 1994 we use depreciation of fixed assets for the year. The Capital Stock is the cumulative value of fixed assets.

Table A4: Investment and Capital Stock Variables

Dataset / Variable	Symbol	1980-1989	1990-1994
Net Capital	*netk*	Net Value of Fixed Capital, end of 1980	N/a
Capital	*kn*	Fixed assets, at Purchase Price, year end	Original Price of Fixed Assets
Productive Capital	*kprodn*	Industrial Production Fixed Capital Part of Capital	Original Price of Industrial Production Fixed Capital Part of Capital
Depreciation	*deprn*	Net change in cumulative nominal depreciation, year on year in 10,000 Yuan	Depreciation of fixed assets of the year in 10,000 Yuan
Machinery Price Index	*mpi*	Machinery Output price Index	
Real Capital	$kr = kn/mpi$	Capital divided by 1980 based machinery output price index	
Real Depreciation	$depr = deprn/mpi$	Depreciation divided by 1980 based machinery output price index	
Depreciation Rate	$\delta = depr/kr$	Depreciation divided by Capital	
Investment	*in*	Productive Fixed Investment	
Real Investment	$\boldsymbol{i = in/mpi}$	Investment deflated by 1980 based machinery output price index	

Real Capital Stock	***k***	1980	1981-1994
		$k_{80} = netk_{80}$	$k_{t+1} = k_t(1-\delta_t)+ i_t$

Table A5: Reform Variables

Variable \ Dataset	Symbol	1995 Questionaire
Output Autonomy	Output	Year from which had autonomy over output, its value, and daily regular decisions
Hiring and Firing Autonomy	Hire and Fire	Year from which had autonomy over employing and dismissing workers
Import and Export Autonomy	Export	Year from which had autonomy over exporting products and importing materials
Short-run Investment Autonomy	Investment_min2	Year from which had autonomy over investment with a recovery period within two years
Long-run Investment Autonomy	Investment_max2	Year from which had autonomy over investment with a recovery period above two years
Autonomy over Buying and Selling Assets	Buy and Sell Assets	Year from which had autonomy over the purchase and sale of assets

Table A5 displays the various reform variables we have for each company. They simply report the year from when on the enterprise manager gained the autonomy over specific decision processes.

Figure 1a: Proportion of Enterprises Engaged in Reforms

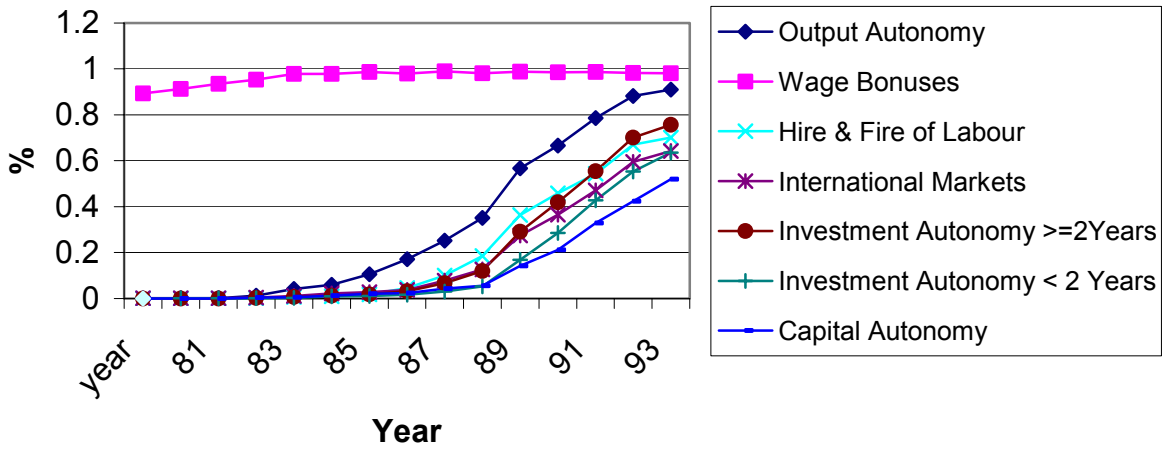


Figure 1b: Proportion of Enterprises Engaged in Deep Reform

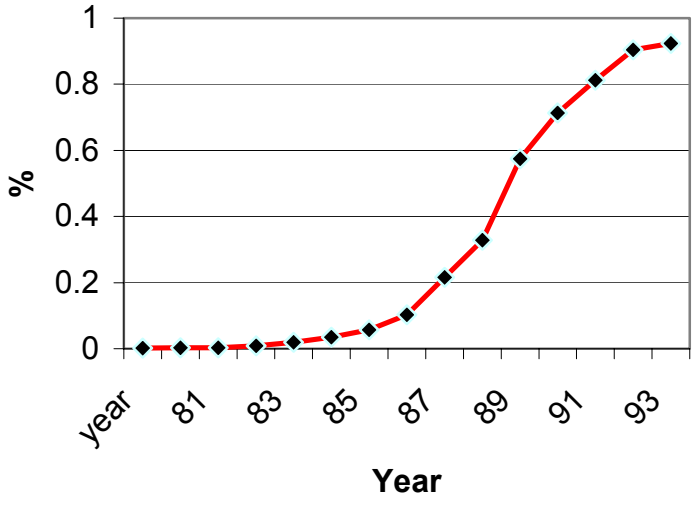


Table 1: Descriptive Statistics for the Whole Sample and Split Sample

	Whole Sample		Non-Reformed		Reformed	
Real Value Added	Obs	9814	Obs	6658	Obs	3156
	Mean	2077.62	Mean	1723.631	Mean	2824.395
	Std. Dev.	6967.67	Std. Dev.	5607.655	Std. Dev.	9155.763
Employees	Obs	10055	Obs	6859	Obs	3196
	Mean	1793.95	Mean	1766.152	Mean	1853.605
	Std. Dev.	3346.93	Std. Dev.	3460.653	Std. Dev.	3088.451
Real Value of Capital	Obs	10094	Obs	6891	Obs	3203
	Mean	2376.19	Mean	2092.949	Mean	2985.59
	Std. Dev.	8561.92	Std. Dev.	7698.843	Std. Dev.	10148.11
Age	Obs	10215	Obs	7012	Obs	3203
	Mean	27.0294	Mean	24.76997	Mean	31.97596
	Std. Dev.	13.5560	Std. Dev.	13.04616	Std. Dev.	13.33683
Reform Dummy	Obs	10215				
	Mean	.313558				
	Std. Dev.	.463961				
Real Productive Investment	Obs	9322	Obs	6656	Obs	2666
	Mean	397.995	Mean	363.4397	Mean	484.268
	Std. Dev.	2911.12	Std. Dev.	2763.446	Std. Dev.	3249.617

Table 2: Alternative Estimates of Production Function Parameters Assuming Random Selection into an Exogenous State of Reform

Estimation Procedure	OLS[a]	GLS[b]	Two-Step Olley-Pakes[c]
Labor	.53 (.02)	.67 (.04)	0.51 (.08)
Constant	-.67 (.08)	-.22 (.24)	.39 (.23)
Capital	.40 (.01)	.20 (.02)	.48 (.03)
Age	.20 (.02)	.16 (.04)	.08 (.03)
Reform Dummy	.14 (.03)	.01 (.02)	.09 (.03)
Fifth Order Polynomial Expansion in h			Yes $\chi 2$ (5) = 4,680
Time Dummies	Yes	Yes	Yes
Observations	9,462	9,462	7,806
R-sq	0.56	0.60	0.94

Dependent Variable in *a* and *b,* the log of value added. Dependent Variable in *c,* the log of value added – b_1*log(labour). Standard Errors in brackets. Olley-Pakes 2-step stand errors bootstrapped with a 1000 replications, clustered by industry.

Table 3: Average TFP from the 2-Step Procedure

	Unreformed	*Reformed*
Year	Mean TFP	Mean TFP
81	.74	1.38
82	.74	1.40
83	.91	1.08
84	.90	0.91
85	.97	1.54
86	.99	1.57
87	1.03	1.34
88	1.22	1.30
89	1.18	1.25
90	1.13	1.34
91	.99	1.27
92	.92	1.33
93	1.13	1.36
94	.92	1.25

Table 4: Output Weighted Mean TFP from the 2-Step Procedure

	Unreformed	*Reformed*
Year	TFP*($y_i/\Sigma y$)	TFP*($y_i/\Sigma y$)
81	.84	1.38
82	.82	1.40
83	1.05	1.13
84	1.00	.95
85	1.06	1.74
86	1.08	1.83
87	1.12	1.51
88	1.35	1.41
89	1.30	1.37
90	1.24	1.49
91	1.08	1.44
92	1.02	1.49
93	1.31	1.54
94	1.04	1.41

Table 5: OP-Algorithm Estimates for Endogenous Reform Selection

Variable \ Sample	Reformed Sample	Non-Reformed Sample
Labor	.46 (.12)	.54 (.08)
Constant	-1.11 (.46)	-2.4 (.60)
Capital	.46 (.05)	.23 (.04)
Age	.45 (.08)	.98 (.19)
Third Order Polynomial Expansion in P & h	Yes $\chi 2$ (15) = 1,783	Yes $\chi 2$ (15) = 3,415
Time Dummies	Yes	Yes
Observations	1,851	5,421
R-sq	0.95	0.93

Dependent Variable is the log of value added – b_1*log(labour). Olley-Pakes 3-step standard errors in brackets, bootstrapped with a 1000 replications clustered by industry.

Table 6: Correlations of Enterprise Level TFP with Choice and State Variables

Reformed Sample

	TFP	Labor	age	k	I
TFP	1.0000				
Labor	0.0359	1.0000			
age	-0.1543	0.1715	1.0000		
k	0.0439	0.8031	0.1411	1.0000	
I	0.1269	0.4975	0.1143	0.6013	1.0000

Unreformed Sample

	TFP	Labor	age	k	I
TFP	1.0000				
Labor	0.0958	1.0000			
age	-0.3967	0.2052	1.0000		
k	0.1898	0.8242	0.1140	1.0000	
I	0.2394	0.5907	0.0932	0.6543	1.0000

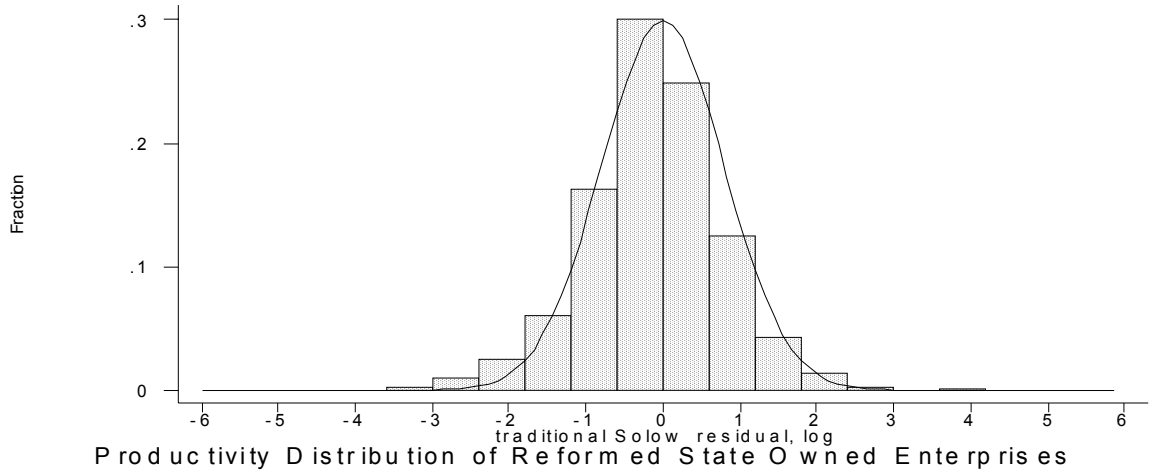
Table 7: Average TFP, by year, from the 3-Step Procedure

	Unreformed	*Reformed*
Year	Mean TFP	Mean TFP
81	.23	-
82	.24	.59
83	.27	.65
84	.31	.54
85	.33	.84
86	.32	1.66
87	.32	1.02
88	.38	.75
89	.40	.67
90	.36	.70
91	.30	.70
92	.27	.75
93	.29	.75
94	.28	.65

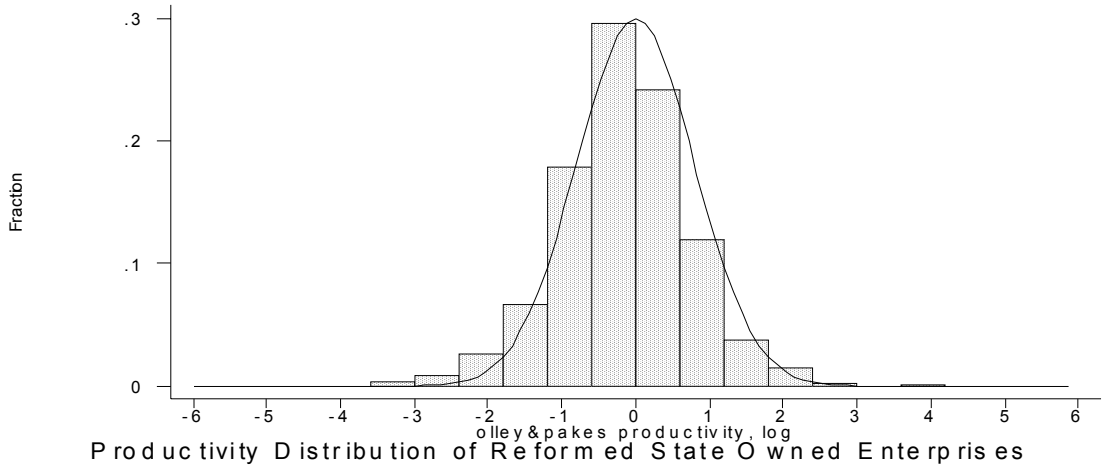
Table 8: Output Weighted Mean TFP, by year, from the 3-Step Procedure

	Unreformed	*Reformed*
Year	$TFP^*(y_i/\Sigma y)$	$TFP^*(y_i/\Sigma y)$
81	.27	-
82	.26	.59
83	.31	.69
84	.35	.57
85	.37	.97
86	.36	2.02
87	.36	1.21
88	.44	.82
89	.46	.72
90	.41	.78
91	.34	.80
92	.31	.86
93	.34	.87
94	.33	.74

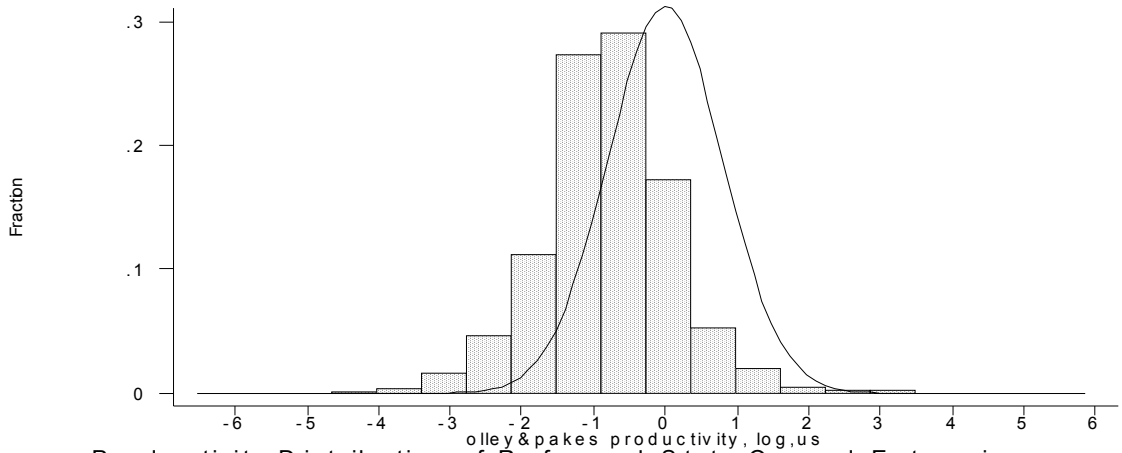
Figure 2: Reformed State Owned Enterprises
Productivity Distributions from OLS, 2-Step & 3-Step procedures, respectively



Productivity Distribution of Reformed State Owned Enterprises

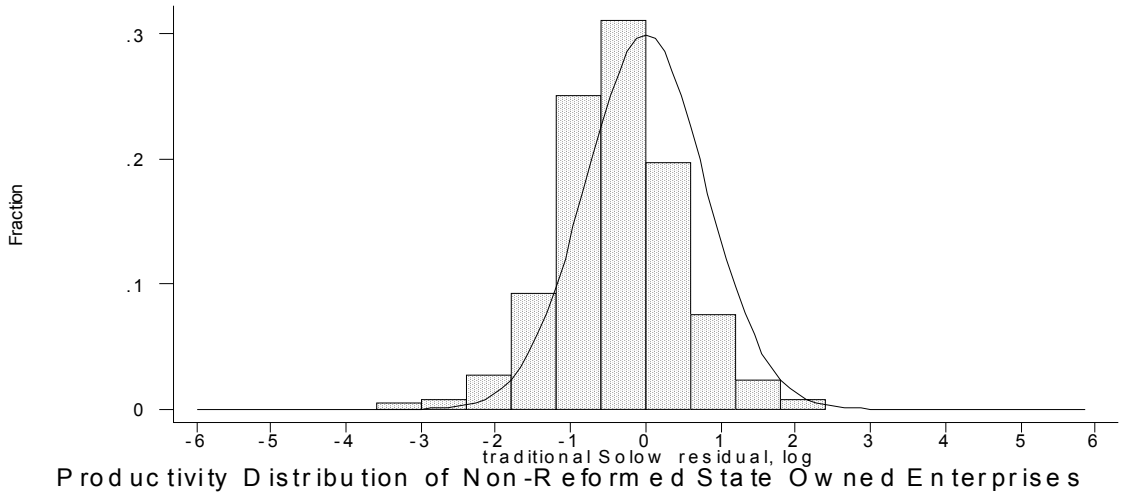


Productivity Distribution of Reformed State Owned Enterprises

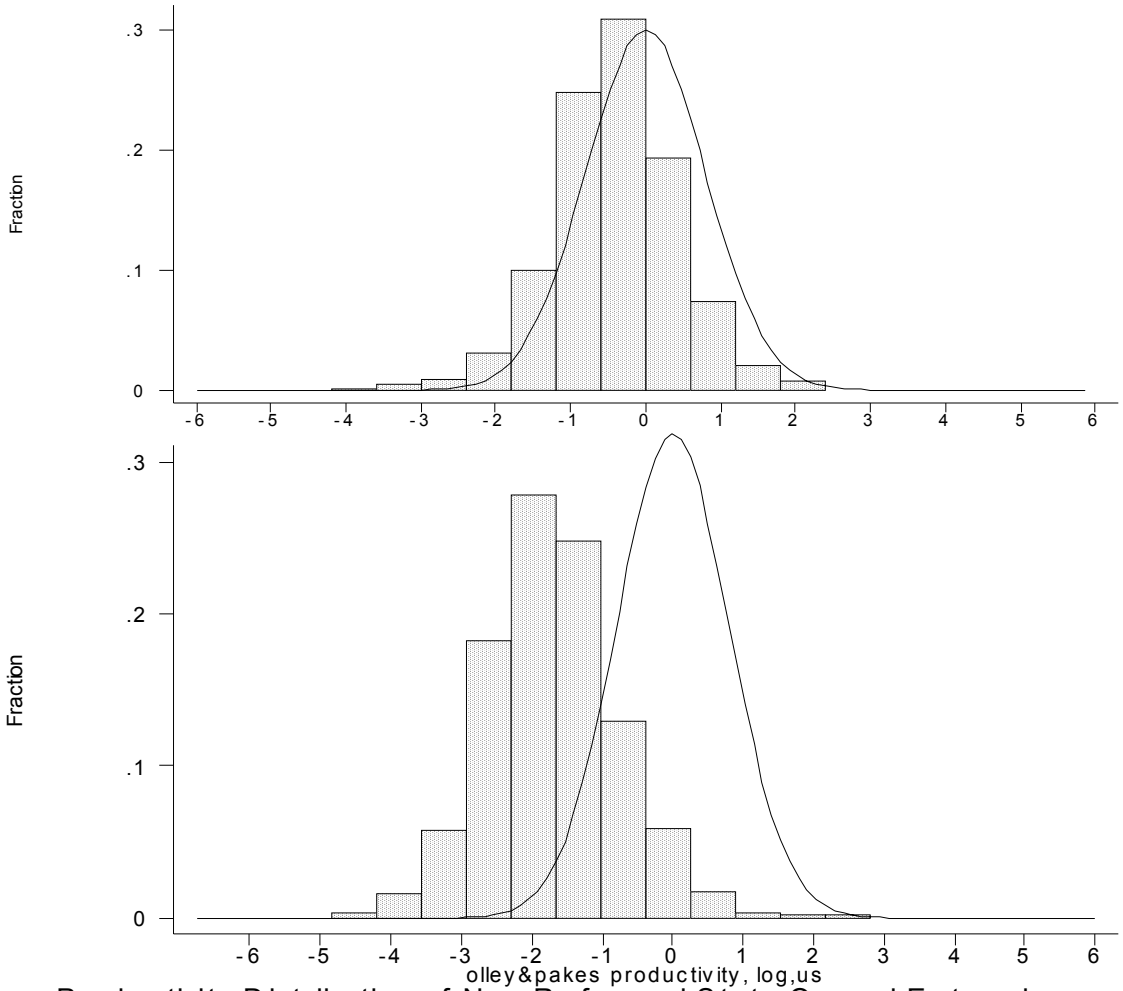


Productivity Distribution of Reformed State Owned Enterprises

Figure 3: Non-Reformed State Owned Enterprises
Productivity Distributions from OLS, 2-Step & 3-Step procedures, respectively.



Productivity Distribution of Non-Reformed State Owned Enterprises



Productivity Distribution of Non-Reformed State Owned Enterprises