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Successful Factor Market Competition Pre-Privatisation? China's eclectic.com

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Abstract

Can factor market competition, given pertinent incentives, bring about efficiency gains, or is privatisation necessary? We assess the impact of factor market competition on Chinese state-owned enterprises' productivity in a laboratory-like setting. The empirical evidence suggests that substantial efficiency gains are achievable pre-privatisation. Methodologically, we adapt an algorithm developed by (Olley and Pakes 1996) which deals with simultaneity and selection bias in production function estimation. This is required since the reform process that introduced factor market competition involved endogenous group selection. While macro-level timing was important, enterprise characteristics, chiefly capital intensity and productivity, played an important role in the sequencing of reforms. Further, reform-induced competitive pressures brought about significant efficiency gains prior to privatisation. Finally, not controlling for selection bias would have resulted in an overestimation of reform-related productivity gains by up to fifty percent.

KEYWORDS: Endogenous Group Selection, Simultaneity, Production Functions, Productivity Dynamics, Institutional Change, Chinese Industrial State-Owned Enterprises.

1 Introduction

Underlying China's extraordinary economic growth process in recent decades is an ideological and practical eclecticism that has allowed free-market capitalism to coexist with, and finally eclipse, the erstwhile dominant central plan. Similarly, the privately owned sector has outgrown the state sector, which is not only shrinking in relative importance, but since the mid-1990s has been undergoing a limited privatisation process. Still, the stability of the once dominant state-owned sector remains crucial, in terms of employment, economic activity, and debt levels, to the economy as a whole. The intention to move away from a planned system to a market based one was announced at the end of the 1970s. However, no clear statements about how to proceed with this were made. Still, whichever sector of the economy we focus on, it appears that reforms, and their sequencing, were chosen in a deliberately eclectic and opportunist fashion, in an attempt to maintain social stability while allowing for explosive economic growth.

This paper focuses on the effect of introducing factor market competition to Chinese state-owned enterprises pre-privatisation, essentially the penultimate chapter in this move from plan to market, from state- to private-enterprise dominated economy. From an economic point of view, the debate whether the benefits of competition can be reaped prior to privatisation is of ongoing interest. Here we have a laboratory-type set-up which allows us to evaluate the impact of competitive forces, introduced in a heterogeneous fashion, pre-privatisation. While we provide a detailed view of a complex reform process itself, our method for evaluating its effects is considerably more sophisticated than any employed in the analysis of institutional change so far. The methodology employed and the results offer a fundamental insight to the assessment of the reform process as a whole.

Thus, we provide both a methodological and an empirical contribution. Empirically, we describe a reform process that introduces competition to factor markets and evaluate its effect on SOE performance. This process involves the devolution of decision-making power over factor markets from a central authority to the managerial level, where the timing differs from

enterprise to enterprise. We show that this process followed a strategic path, in the sense that it was tentative and experimental to begin with, but then evolved into a more general push by the late 1980s. Along this path, enterprise characteristics, in particular capital intensity and productivity, were important determinants of the timing. Further, we generate and analyse dynamic, firm-level production function parameters and productivity estimates for Chinese SOEs between 1980 and 1994 in the industrial sector of the economy while controlling for simultaneity and selection bias. The sample is comprised of 680 SOEs that operate in forty two-digit sectors of the industrial sector of the economy. On the methodological front we adapt an algorithm originally outlined in (Olley and Pakes 1996) such that we can control for endogenous group selection when comparing estimates of production functions. The problem arises here because of the way capital intensity and productivity affect into the sequencing process.¹ Thus, this methodology deals with a complex reform process and sheds light on the driving forces behind it and the effects it produces. Further potential application of this methodology could be the testing of learning-by-doing versus inherent characteristics hypotheses in the trade literature, state versus private ownership problems, or domestic versus foreign outsourcing of intermediate inputs.²

As for the effect of reforms, enterprises that are reformed are more capital intensive and productive than the unreformed. The difference in our estimates becomes starker once we allow for differences in technology, the relationship between investment and productivity, or control for selection bias between those that have asset control and those that do not. Hence we conclude that the reform process is linked to productivity in a way that suggests the causality runs in both directions: Enterprises with control over

¹See (Olley and Pakes 1996) for an analogous argument relating to enterprise survival.

²See (De Loeker 2004), on exporting versus non-exporting status, (Amiti and Konings 2005) for status of imports in terms of final versus intermediate goods. Also, (Feenstra, Markusen, and Zeile 1992) and (Kasahara and Rodrigue 2004) consider the effect of imported versus indigenous input status on productivity, though TFP is estimated without controlling for endogenous selection to a status. In a second step TFP is linked to a particular status.

assets were better to begin with, and improved their performance once they reformed. Finally, these results hold pre-privatisation. This is important, as it shows that incomplete reforms in terms of changing the economic structure from plan to market can be effective on the margin so long as incentives are aligned.³

Since the core question under consideration here is whether devolution of control over enterprise assets from the centre to the managerial level had a positive impact on Chinese SOE performance, we proceed as follows: In Section 2 we discuss institutional features regarding China and its reform process, in order to understand the process we are modeling. Specifically, we know for each enterprise the year during which control over production factor was devolved from the centre to the managerial level.⁴ The data were assembled from four datasets, which were compiled by the Chinese Academy of Social Sciences in collaboration with the universities of Oxford and California, San Diego.⁵

Section 3 introduces the estimator of choice. Since we will evaluate performance in terms of productivity, we require an estimator that will generate production function parameter and dynamic productivity estimates that are consistent. Weighing up the pros and cons of various estimators, we arrived at the conclusion that an adapted version of an algorithm developed by (Olley and Pakes 1996) would be the preferred estimator for the problem at hand, since it crucially deals with simultaneity and selection bias. We discuss this facet in more detail below.

³N.B.: Essentially, grassroots and top-down selection are observationally equivalent since we cannot distinguish one from the other. The assumption is that, either, more productive firms are selected by the political centre for a particular reform based on their observable characteristics, i.e. technology. We consider productivity is more readily observed by the manager and so he may push for reform, as he can gauge the potential benefits and risks associated. This particular view is a matter of interpretation, but the fact that productivity and technology are driving forces in the reform process, and that reforms improve productivity remains.

⁴This control over factor markets is given by the manager's right to hire and fire workers, and the right to invest or sell-off enterprise assets.

⁵(Groves, Hong, McMillan, and Naughton 1994), (Groves, Hong, McMillan, and Naughton 1995) and (Li 1997) have used the same data covering the 1980-89 period, while (Li and Wu 2002) also extend the data to 1994.

As the discussion of our results in Section 4 suggests, reform pre-privatisation can be successful. Hence, we make a contribution to the ownership-versus-control debate, which attempts to tackle the question as to whether significant performance gains through competitive pressures are possible by operational reform only, or whether private ownership is essential for this. Most western studies that have failed to find efficiency gains from privatisation argue that SOEs tend to operate with competitive pressures in factor and product markets pre-privatisation, and hence the contributions of privatisation are hard to isolate.⁶ We note here, that apart from initial conditions, labour market can prove crucial since reforms in this area can shift bargaining power to the manager, thus containing SOE-employee demands.⁷ Given the correct incentives, managers can thus effectively employ their autonomy over factors to improve productivity pre-privatisation. A crucial feature of our set-up is that managerial autonomy over factor markets is introduced at different times to different enterprises, which all remain in state-ownership. Essentially, we thus have laboratory type set-up, where we can test for the effect of the introduction of factor market competition prior to privatisation, while controlling for the fact that reform might be brought about by productivity. Finally, we draw our conclusions in Section 5.

2 Reform of Chinese State-Owned Enterprises

Along the road from planned to market driven economy the Chinese Government introduced a plethora of economy-wide as well as sector- or region-specific reforms, which allowed market economy institutions to take root and incentives to spur economic activity. In our analysis we focus on a particular set of factor market reforms that were undertaken in Chinese SOEs from the mid-eighties onward. Essentially, this is the penultimate step in a reform process that began between 1978 and 1983 and culminated in the large-scale privatisation that took place from the mid-nineties onward. In particular, we focus on the introduction of managerial autonomy over deci-

⁶See (Walsh and Whelan 2001) for an overview.

⁷See (McGoldrick 2005).

sions regarding investment and control over assets and, to a lesser extent, hiring and firing of workers.⁸

This section addresses two important issues. First, this subset of reforms should be set in context of a larger process, paying particular attention to the underlying driving forces. Second, the SOE reform process is by its very nature subject to endogeneity, i.e. driven by enterprise characteristics. We briefly discuss the main reform strategies that appeared around this time in the literature, *Big-Bang* vs. *Gradualism*, referring the avid reader to the literature for a more complete picture. Against this backdrop, we sketch the economic development and important reforms of the Chinese economy in broad-brush strokes since the beginning of reforms. Our focus, however, is the reform path of Chinese SOEs, which sees these entities follow different paths on their way from planned economy toward privatisation. Thus, we refer to previous important work regarding the reform of Chinese SOEs, and factor markets in particular. The second point we want to make is that, due to the philosophy underlying the general process, idiosyncracies appear naturally. Chiefly, the path itself is likely to be different for each reforming unit, often depending on other factors, such as firm characteristics, notably linked to factors of production and productivity. This feature of the reform process can lead to problems with endogeneity when attempting to assess the effect of a reform. Hence this second point underpins our methodology, which attempts to deal with endogeneity of exactly that type.

While the former Soviet Union largely followed the policies of the *Washington Consensus*, put forward by institutions such as the World Bank and the International Monetary Fund, China only paid limited attention to it. For example the Chinese respected macroeconomic stability but resisted demands for wide-scale privatisation and liberalisation. Instead, they took an approach to reform that has been termed *Gradualism*.⁹ Thus, a very dif-

⁸Enterprises that are capital market reformed enterprise have autonomy over decisions regarding the buying and selling of enterprise assets, short- and long-run investment decisions, and buying and selling on international markets.

⁹It has been purported that the *Big-Bang* approach has the benefit of incurring a once-off negative shock to economic activity which is more than compensated for by the relatively swift rebound in activity. This sees the idle resources employed in a more

ferent philosophy underlies the reform strategy under a *Gradualist* regime when compared to one that implements blanket policies indiscriminately. Namely, rather than following some rigid, pre-planned path, one can take an experimental approach, regionally as well as regarding the sector or unit. Thus, one gains experience regarding the effects of different reforms in different settings, while not affecting the economy as a whole. This policy doctrine of looking for the easiest reform strategy by slowly *feeling* one's way forward has been termed *crossing the river by groping stones*. Further, the *sequencing* of reforms is an important factor. In a *Gradualist* framework, one can initiate the least costly reforms first, essentially building constituencies in favour of further reform, while, in theory, compensating those that lose out. It should be noted that a potential major problem with *Gradualism* is the possibility of getting stuck in a *half-way house*, a state in which the initial gainers prefer to stay in the current situation rather than press on. The inefficiency inherent in such a situation of incompatible yet co-existing systems is self-evident and may even allow for certain agents to gain from arbitrage across both systems, for example in the case where goods are traded at market and planned prices.¹⁰

A particular facet of sequencing could then be summarised by the notion of necessary, e.g. prices, vs. sufficient reforms, e.g. managerial autonomy. Many reforms that went before the reform of factor markets, and eventually privatisation, may be thought of as preparatory, such as price liberalisation, devolution of operational control and ownership from the centre to the municipality, or the granting to managers of autonomy over output decisions.

productive fashion than they would have been if the institutions using them had been bank-rolled or kept in existence even if they were no longer logically compatible with the new order. This *Schumpeterian* view has been challenged by the observation that the initial drop in activity is likely to have cataclysmic effects if it is too large and prolonged for the system to absorb, thus resulting in wide-spread unemployment of resources rather than simply inefficiency. Thus, 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). Furthermore, *social capital* such as organisational, institutional and procedural knowledge may be terminally lost under such circumstances, see (Stiglitz 2000).

¹⁰See (Dewatripont and Roland 1995) for a discussion on this.

Similarly, marginal reform, such as the introduction of flexible wages in the form of 'performance' related bonuses or limited fixed-term employment contracts, is preparatory.¹¹ As for factor market liberalisation, we note the following features. First, there is a wide-spread push for factor market liberalisation in the late eighties and early nineties, suggesting a top-down policy. Second, prior to this big push, there is a tentative experimental phase. It is worth noting that there appears to be deliberate selection underlying these processes. Labour market autonomy is more likely to be achieved in enterprises that have larger labour forces and smaller capital stock. On the other hand, managers of enterprises that have a smaller capital stock, while more capital intensive, and larger value added are more likely to achieve capital market autonomy. It is this feature that could bring about selection bias when examining the effects of reform. While much debate has focused on bottom-up vs. top-down hypothesis about how reforms are brought about, it appears causality moves in both direction. We deal with this particular problem in our estimation procedure.¹² As outlined in Section III our estimation procedure deals with these issues in a unique way.

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".¹³ The planned economy was upheld, while firms bought and sold goods in the market, at market prices, if they were in excess of quo-

¹¹Certain reforms, such as the selling of above-plan quota produce and profit retention were quickly taken up by all sectors in the economy. Indeed, the liberalisation of prices was brought about in this fashion. In other cases, some sectors were quicker to liberalise than others. Sequencing and necessary vs. sufficient reforms: If one believes in the benefits of sequencing reforms, one may hold the view that reforms undertaken early on are largely preparatory in nature, providing the necessary institutions and infrastructure for more costly and risky reforms to take proper effect. The benefits of introducing these reforms at the margin are likely to be in the form of education as well as institutional development and flexibility, while preserving the old structures for the time being. However, it seems plausible that a manager without the autonomy to hire and fire, i.e. without the stick of threatening to replace a worker, is likely not to be able to strictly link bonus payments to performance, i.e. efficiently employ the carrot. This would see rent-sharing as observationally equivalent with efficiency wages. Thus, the introduction managerial hiring and firing should see a fall in wages, as pointed out in (McGoldrick 2005).

¹²See the Probit regressions of company characteristics on reform status reported in Table 7 in particular.

¹³See (McMillan and Naughton 1994).

tas regulations. While initial reforms in industry were deemed unsuccessful, with some retrenchment by 1983, there was a strong push for reforms again after 1983.¹⁴ 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”.¹⁵

In 1978 SOE’s accounted for 78 percent of industrial output and 19 percent of total employment.¹⁶ 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.¹⁷ By the latter half of the 1980s nearly all SOEs in our sample had completed this type of reform, thus having obtained the right to determine output value, pay bonuses, retain excess profits, and produce and sell 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, Hong, McMillan, and Naughton 1994) take a more benevolent view of initial reforms, but their results fail to establish a strong link from the reform process to productivity enhancement.

Thus, the main function of initial reforms appears to have been the

¹⁴See (Naughton 1995).

¹⁵(Groves, Hong, McMillan, and Naughton 1994). See also (Byrd 1991), (Naughton 1995) and, (Qian 2000)

¹⁶(Kennedy and Marquis 1998)

¹⁷(McMillan and Naughton 1994)

creation of the institutions necessary for a further stage of reforms to be successful. A standstill at this point would be counterproductive, as some agents had incentives to make use of the status quo of 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.¹⁸ 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 *emph*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 and 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*”.¹⁹

Further reforms were initiated. Figure 1 and Figure 2 as well as Table 1 show how the take-up of reforms involving the devolution of control over enterprise factors from the centre to the enterprise level evolved over time in our sample. We plot the percentage take-up over time of what we term capital and labour autonomy reforms.²⁰ While the reform process began in the late 1970s, it is only from the mid-1980s onwards that we see autonomy over enterprise factors of production being introduced. However, the vast majority of the sample is engaged in these latter-stage reforms by the early 1990s. Regarding the causality of reforms, there is evidence in the literature for two-way causality.

”Virtually all of the literature on the enterprise reform examines the

¹⁸See (Laffont and Qian 1999), (Dewatripont and Roland 1995) and (Fang 1994).

¹⁹(Naughton 1995)

²⁰A labour market reformed enterprises has managerial autonomy over hiring and firing of employees, while an enterprise that is capital market reformed has managerial autonomy over decisions regarding either the right to buy and sell enterprise assets, make short- or long-term investment, or to buy and sell on international markets.

impact of reform on performance. Causality also operated strongly in the other direction. [...] Indeed, the industrial innovation ladder predicts that causality should run from enterprise to reform". (Jefferson and Singh 1999)

The dataset provides information on various types of reform undertaken by enterprises by year. While the period around 1990 is signified by several years of a strong push toward reform, there is some heterogeneity regarding the timing, with some enterprises taking up reform measures much earlier, and some never having reformed during our sample period. As for the take-up of asset control reform across industries and regions, we note that it has been a very homogenous process. By 1989 no more than 30% of enterprises had gained managerial control over assets in any of the industries or provinces, with the notable exception of one province which had 33%, and generally this figure was significantly lower. However, by 1992 at least 60% of all enterprises, irrespective of category, had gained said autonomy, but, again, considerably more for the bulk of industries. Thus, the reform, at large, did not target particular industries or locations, but was a broad measure, which, as our methodology reveals, was undertaken by observable and unobservable company characteristics.

As can be seen from Table 1, the reform process as a whole was very tentative until 1987. It appears that in the initial period from 1987 on those with labour, asset, or both reforms grew explosively in numbers. However, the labour reform only group slowly fell from a high of 64 enterprises in 1989 to a mere 20 in 1993. It also seems apparent that those that received labour market reforms alone were less likely to gain asset market reform, than vice-versa. On the other hand, those that gained asset market reform status were likely to gain control over hiring and firing. Eventually, more than two-thirds of the sample had managerial autonomy in both markets, with nearly a quarter having undergone asset market reform. Only less than ten percent remained unreformed, and a small minority of twenty had only achieved labour market reform. These statistics suggest that the reform process was intended to involve as many enterprises as possible, and it was to be as complete as possible. Still, the implementation was eclectic in the sense that the timing was chosen on a firm-to-firm basis, with a different

package (i.e. labour only, asset only, or both) envisioned for each enterprise. We will provide evidence that this selection process was determined by unobservable and observable enterprise characteristics in what follows.

The summary statistics in Table 2 indicate that enterprises in the capital market reformed group are generally larger. However, one can see from Table 3 that this is only due to the fact that enterprises grew significantly in all reported categories, other than labour, over time. Since the bulk of reformed enterprises are in the latter part of the period, what actually emerges from Tables 3 is that there is a general tendency for smaller enterprises to be selected to the group of capital reformers until 1993, by when eighty percent of firms are capital market reformed. Similar findings hold for the labour market reformers.

(Naughton 1995) supports a bottom-up view when he states that the ex-post apparent consistency of the reform process came about only because reforms were introduced in an 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.²¹ The empirical evidence presented here regarding the reform process suggests that reforms were initially introduced tentatively, in a low-risk, experimental fashion. Contrary to expectations, as more SOEs were involved, the selection criteria underlying this process appear not to have been dominated by industry or regional considerations. Rather, observable and unobservable firm characteristics appear decisive in this regard. Table 7 provides estimates of coefficients of a probit model that explains reforms status, the dependent variable, with various enterprise attributes. In the case of capital market reform, in regression (9), productivity²² is a significant positive factor in determining the likelihood of reform, while it has no effect on the probability of labour market reform, see regression (10). On the other hand, regarding the likelihood of labour market reform, the size of the

²¹See (McMillan and Naughton 1992) and (Qian 2000)

²²The productivity estimate used in this regression is generated in regression (6) in Table 4.

capital stock has a negative impact on the likelihood of managers' gaining autonomy over assets. The size of the labour force has a positive effect on the probability of labour market reform, while there is no discernable impact on the likelihood of capital market reform. Finally, the time-trend and managerial output autonomy are positive and significant factors in the probability of both reforms. This last observation is consistent with a hypothesis that reforms involved both central planning, there exists a clear time-line and sequencing is important. The fact that a smaller capital stock is associated with a lower likelihood of reform is consistent with an experimental nature of reforms. Namely, the potential loss if things go badly is lower than for enterprises with a large capital stock. Importantly, the deployment of each reform appears to be asymmetric otherwise, since productivity is a driving force for capital market reform, while the size of the labour force for labour market reform. Thus, grassroots pressures appear important for capital market reforms. On the other hand, introducing managerial autonomy over hiring and firing in firms with large labour forces indicates that this is employed as a disciplining device.

Furthermore, as we shall see in the next section, enterprises that engaged in capital market competition display higher capital intensity and productivity levels and better investment behaviour, especially once we correct for selection bias, which indicates that the devolution of control over assets was successful. Regression (10) in Table 7 indicates labour market reform is also less likely for enterprises with large capital stock and more likely for those with larger levels of employment. Also, as we will see in the following section, firms that engage in labour market reform without gaining control over assets have significantly lower productivity levels, and have larger employments levels. For those that engage in both reforms, the labour reform is neutral in effect. We believe grassroots pressure to be relevant to selection to reform status because such micro-considerations, such as productivity are relevant. If capital market reform is costly, then one will only choose it if one believes the potential gains outweigh the risks, which is more likely for productive enterprises. (McGoldrick 2005) shows that enterprises that introduce hiring-and-firing manage to reduce flexible wages significantly. This,

in conjunction with the labour intensity of the labour market reformers, suggests the reform actually altered the bargaining relationship in favour of the manager.²³ Thus, competitive pressures as much as Central Party schemes appear crucial to the process.

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. This analysis does not evaluate the benefit of privatisation after 1994. However, it does attempt to estimate the impact of competitive pressure coming from factor market liberalisation on productivity at the enterprise level under state ownership. (Li 2003), using data from 1998, models the selection of enterprises to private ownership and finds the same decentralised nature of the reform process. The enterprises that faced the most competitive pressure and hardest budget constraints were the first to select to privatization.

An important question regarding the set of reforms we look at in this paper and the methodology we apply in order to evaluate them is whether managers would have an interest in making use of any additional freedom gained from the reform process. Apart from being able to retain profits, as mentioned above, a personal incentive was also provided. Namely, during the sample period enterprises were signed up to the "contract responsibility system". The contract had profit and tax targets to be paid to the gov-

²³In a related paper that looks at the effects of hiring and firing by themselves (McGoldrick 2005) shows that hiring and firing did not bring about improvements in TFP. Rather, it appears to have changed the bargaining power of management vis--vis workers in a way that improved labour's productivity while being associated with a clear-cut reduction of bonuses, which were often abused, for any level of productivity.

ernment and, failing this, managers would forgo a bond posted prior to the contract. In return, managers and workers would be paid agreed bonuses. They also had the right to divert retained profits to a welfare and investment fund.

3 The Behavioural Model and Estimation Procedure

In this section we outline and motivate our choice of estimator. As indicated in the introduction, an attempt at answering the specific problem must meet certain requirements. Since we are looking to evaluate the effectiveness of the devolution of control over factors of production to the managerial level in Chinese SOEs pre-privatisation, we need to be able to evaluate how performance was affected by reform. In order to achieve this, we require a performance measure that we expect to respond to the reform, productivity. Production function estimation has well known caveats, in particular problems relating the simultaneity and selection bias. As the timing of reform take-up varies by enterprise we require productivity estimates at the enterprise level. Further, these estimates must be dynamic. This is essential so that we can make an attempt at identifying whether reforms had an effect on productivity. Also, since it is likely capital stock and productivity are linked to capital market reform, and the results in the next section strongly suggest this, we face a selection problem. In what follows we motivate our choice of the OP estimator for analysing the problem at hand. There exist a number of estimators that fulfil many of requirements outlined above. Naturally, a choice for any of them over the remainder can easily be criticised, as each is likely to be imperfect when attempting to model the situation. First, we highlight the weaknesses of some alternative estimators for the current problem, notably OLS, GLS within group, and *system* GMM. We then introduce the OP estimator and show how we adapt it to the problem at hand.

To begin with, we briefly discuss some alternative estimators. The natural starting point of regression analysis is OLS, with its well-documented limitations. While OLS allows for dynamic estimates of firm-level productivity, these estimates are thought to be subject to simultaneity bias.²⁴ Likewise, as regards selection bias, OLS provides no way of distinguishing the causality for differences in productivity. We may be able to estimate differences across groups, but we cannot identify the reason for these differences. An attempt at capturing a common effect due to reform is achieved by introducing a dummy variable for reform.

Alternatively, a GLS within group estimator, as set out by (Mundlak 1963), attempts to deal with simultaneity. However, this approach does not allow for firm-specific differences to vary over time.²⁵ This would be particularly detrimental if a structural break existed. We provide GLS within estimator estimates in the following section. Also, for production functions this estimator notoriously understates the capital coefficient. This is thought to be due to the relatively static nature of capital stock in large firms when compared to their labour stock, while the difference between enterprise capital stocks can be quite large.²⁶

Finally, we considered a *system* GMM estimator, such as (Blundell, Bond, and Windmeijer 2000). Simultaneity bias is addressed by modelling the unobservable as a dynamic error component model with the use of non-linear moment restrictions for identification. The extension of this approach to address the problem of an *endogenous* reform dummy is not straightforward. Hence, while this approach provides a solution to the simultaneity issue, it is difficult to see how it can readily be adapted to the issue of selection bias, which is our reason for rejecting it.

The advantage of the OP estimator is that it explicitly attempts to deal with simultaneity and selection bias related to production function estimation using a behavioural model of the unobservable that is applicable in the present scenario. The central assumption of (Olley and Pakes 1996) is that

²⁴See (Marschak and Andrews 1944).

²⁵See (Grilliches and Mairesse 1995).

²⁶See (Grilliches and Mairesse 1995).

managerial behaviour can be modelled such that their decisions regarding investment consistently provide information regarding productivity. Essentially, managers take their state variables, productivity and capital, and their environment, competitors and prices, as a given and then make decisions regarding their choice variables, investment and labour, that are consistent with maximisation of firm value. The relationship among investment and productivity is assumed to be positive and monotonic, i.e. managers invest more if they perceive a higher productivity draw, *ceteris paribus*. Importantly, the structural model of the unobservable does not dictate the specific functional form, i.e. the OP estimator is non-parametric in capital and investment. Thus, productivity can be backed-out of the production function by inverting the investment equation, which is a function of the state variables, so long as investment is positive. In their paper, investment dynamics are said to follow a Markov process.

In the case of simultaneity, it is assumed that the only variable unobserved by the econometrician, but *feeding through* to the manager's choice of inputs, is productivity.²⁷ As for selection bias, certain assumptions about the distribution of firm productivity, conditional on state variables, are made. Specifically, it is assumed that, given the remaining state variables, notably capital, there exists a threshold level of productivity, realisations below which induce the firm to exit from the market. (Olley and Pakes 1996) assume that the threshold level of productivity is decreasing in capital, while profitability is increasing in capital for any level of productivity. Hence, more capital intensive enterprises can expect to make higher levels of profit in the future for any given level of productivity. This should lead to a negative bias on the capital coefficient for companies that remain active.

In order to apply the OP estimator to our treatment of the problem two central assumptions mirroring (Olley and Pakes 1996) are required: First, there exists a *weakly* positive relationship between investment and produc-

²⁷See (Griliches and Mairesse 1995) for a summary of the problem and relevant criticism of (Olley and Pakes 1996). In particular the assumption that productivity is the only unobservable affecting investment decisions.

tivity.²⁸ We assume this holds whether control over enterprise assets has been devolved to the managerial level or remains centralised, usually at the level of the municipality.²⁹ Second, we assume that a firm will undertake asset market reform once its productivity exceeds some threshold level and that this threshold level is *increasing* in the capital stock. This feature would induce selection bias in a way that corresponds to the (Olley and Pakes 1996) *entry* rule. The idea is to control for survivor bias in a way that assumes firms enter into the reformed pool only if a certain threshold level of productivity is achieved, given the remaining state variables. By doing this we can correct the reformed group for the assumed underlying bias in the estimates of production function parameters, and hence productivity. In the discussion of our results in the next section, evidence supporting this selection related bias is discussed. We provide the results of two forms of the OP estimator, a two- and a three-step version. In the two-step version we simply correct for simultaneity, thus ignoring selection issues, i.e. we treat reform as an exogenous process. In the three-step approach we then tackle selection as an endogenous process.

The methodology aside, some serious questions remain regarding our empirical analysis. Is such a behavioural model appropriate for the current problem of reform regarding asset control in Chinese SOEs? Two objections must be dealt with. First, did investment follow productivity in China, pre- and post-liberalisation? Second, did a consistent process exist in Chinese SOEs that saw higher productivity enterprises more likely to be reformed? Our response to these objections is as follows. Even though (Olley and Pakes 1996) motivate their structural model of the unobservable with a theoretical contribution by (Ericson and Pakes 1995), which assumes the existence of Markov perfect Nash equilibrium in investment over time, the econometric technique is operational when investment sequences and adop-

²⁸In principle, this is sufficient for the OP-estimator to be consistent. We develop this argument below.

²⁹N.B.: Not having devolved control over assets to the manager does not imply no investment takes place. It simply implies the observation of productivity and the investment decisions are made at a greater distance, where distance may be taken to refer to an information chain, for example.

tion of reform are weakly rational, driven in some part by observable and unobservable state variables. In other words, the technique does not require investment dynamics and adoption of reform in Chinese SOEs to be optimal, but they have to be weakly related to economic factors such as enterprise level productivity. We argue that this is the case and provide strong evidence in the previous and the following sections of the paper that enterprises are selected to reform based on observable as well as unobservable characteristics. In this context we also refer to the *contract responsibility system*, outlined in the previous section, which was operational in the vast bulk of the enterprises we analyse. Even though incentive problems were not solved, managers had an interest in achieving performance goals, such as profitability and output growth. Also, planners would target investment at enterprises where profit and taxes were channeled back to Government.

Thus, investment dynamics and adoption of reform should be driven in some part by the unobservable productivity type. Essentially, we assume that undertaking reform is costly, and the cost is decreasing in productivity.³⁰ Hence, we can use (Olley and Pakes 1996) selection rules and enterprise-level investment dynamics to control for the omitted unobservable, i.e. productivity, using semi-parametric techniques in our estimation of production functions. By this reasoning, we should be able to back out a productivity index from the residual in the production function for each enterprise.

As outlined above, two types of reform are mentioned, namely the devolution of control to the managerial level of control over enterprise assets and hiring and firing of enterprise workers. To begin with, we use dummy variables to capture each. They take a value of unity if the reform has taken place, and zero otherwise. However, our main focus is on the asset control reform, which we refer to with ar_{it} . The labour market reform is denoted as lr_{it} and its interaction with labour is denoted llr_{it} , which allows for intercept shifts and variation in the output elasticity of labour due to labour market

³⁰Alternatively, future expected gains are increasing in productivity, while reform induces risk and higher expected returns. Thus, high-productivity firms are better able to cope with reform.

reform.

In all our estimations we assume enterprises produce under a common Cobb-Douglas technology.³¹ Though we present results for OLS and GLS fixed effects estimators in the following section, we omit their discussion here, and proceed by introducing the 2- and 3-Step OP-estimator. The log-linear production function to be estimated is given by:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_{lr} l r_{it} + \beta_{llr} llr_{it} + \beta_k k_{it} + \beta_{ar} ar_{it} + \omega_{it} + \eta_{it} \quad (1)$$

Thus, the log of enterprise i 's value added at time t , y_{it} , is modelled as a function of the log of that enterprise's state variables, capital, k_{it} , and unobserved productivity, ω_{it} , and its choice variable labour, l_{it} . We control for reforms by introducing dummy variables for asset reform, ar_{it} , and labour reform, lr_{it} . Further, by introducing an interaction term of labour with the labour reform dummy, llr_{it} , we allow for a different elasticity of labour once an enterprise is labour reformed. As we shall see, we allow technology in general to vary depending on whether it is asset market reformed. Thus, the error structure is comprised of a stochastic component, η_{it} , and the ω_{it} . Both ω_{it} and η_{it} are unobserved by the econometrician, but ω_{it} , as a state variable, affects the 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 would provide biased estimates for inputs if ω_{it} is serially correlated and also correlated with inputs and the bias should be graver for more readily adjusted inputs. On the other hand, we assume selection to the asset reform process produces a negative bias on the capital coefficient for that group. Enterprises with a lower capital stock are less of a risk to be *let go*, ceteris paribus, and hence can select to reform when compared with firms that have a larger capital stock and similar realisations of ω_{it} . If we assume that threshold productivity for entry to the reform process is decreasing in k , this should produce a negative

³¹Given the results outlined below it is clear that the difference in production technology across asset market reformed groups is as important as are the differences in technology across different sectors.

bias in the estimate of the capital coefficient. Real investment, together with enterprise-level depreciation, δ_t , determines next period's capital stock. The accumulation equation for capital is given by $k_{t+1} = (1 - \delta_t)k_t + i_t$.

Two-Step Procedure: We assume that investment sequences, i_{it} , are mainly determined by state variables such as the observable stock of physical assets, k_{it} , the unobservable productivity type of the company, ω_{it} . In particular, we assume investment chases performance to some degree. However, other than identifying its arguments, we do not impose the exact functional form the investment function takes, $i_t = h_t(\omega_t, k_t)$, and, importantly, we assume this function can be inverted and differentiated, $\omega_t = \phi_t(i_t, k_t)$. Thus, we can rewrite (1) as the following regression equation:

$$y_{it} = c + \beta_l l_{it} + \beta_{lr} l r_{it} + \beta_{llr} ll r_{it} + \beta_{ar} ar_{it} + \phi_t(i_{it}, k_{it}) + \eta_{it} \quad (2)$$

where $\phi_t(\cdot) = \beta k_{it} + h_t(\cdot)$, which is approximated by a fifth-order polynomial in i_{it} and k_{it} , with a full set of interactions. This provides “clean” estimates for all labour related parameters, $\beta_l, \beta_{lr}, \beta_{llr}$. We can now subtract that part of value added that is due to labour from overall value added. Thus, we define that part of value added that is not derived from labour as $\psi_{it} = y_{it} - \beta_l l_{it} - \beta_{lr} l r_{it} - \beta_{llr} ll r_{it}$.

So we have reduced the problem at hand to the estimation of β_k and β_{ar} . This is achieved by employing a non-linear least square estimator:

$$\psi_{it+1} = c + \beta_k k_{it+1} + \beta_{ar} ar_{it+1} + \sum_{j=0}^5 \beta_j \hat{h}_t^j + e_{it} \quad (3)$$

Notice that at this point (Olley and Pakes 1996) invoke a Markov process in the investment equation for identification, which allows the productivity realisation of last period to drive the investment decision given the other state variable, the capital stock.³² This is provided by the fourth term on the R.H.S. of (3), which we proxy for with a fifth-order polynomial with a

³²However, for econometric identification all that is required is weak rationality.

full set of interactions in estimates of h_t , $\hat{h}_t = \hat{\phi}_t - \beta_k k_t - \beta_{ar} ar_t$.³³ The reader will notice that at this stage the asset market reform is treated as an exogenous state variable. We include time and industry dummies in our regressions and the above may be re-written to allow for intercept shifts for each year and industries.

Three-Step Procedure: The estimation of the return to labour in the production function above can be extended to control for selection bias, the probability, ρ_{it} , of being in a reformed state, $ar_{it} = 1$, is modelled given the firm's productivity and a set of other characteristics, χ_{it} :

$$Pr\{ar_{it} = 1 | \omega_{it}, \bar{\omega}(k_{it}), \chi_{it}\} = \rho_{it}(i_{it}, k_{it}, \chi_{it}) \quad (4)$$

To generate unbiased estimates of β_l , a partially linear equation in a semi-parametric regression model allowing for both selection and simultaneity bias, one can proxy for $\phi_t(\cdot)$ with a third order polynomial in i_{it} , k_{it} and ρ_{it} . This can be run on sub-samples of enterprises in reformed and unreformed states to allow all for the possibility that the elasticity with respect to labour may change when the enterprise has autonomy over factors, $ar_{it} = 1$, and in addition the parameters of the third order polynomial in i_{it} and k_{it} and can be different. In step 3, to distinguish the effect of capital on the investment and selection decision from that on output, we estimate β_k using a non-linear least square estimator:

$$\psi_{it+1} = c + \beta_k k_{it+1} + \sum_{j=0}^{3-m} \sum_{m=0}^3 \beta_{mj} \hat{h}_t^j \hat{\rho}_{it}^m + e_{it} \quad (5)$$

We proxy the fourth term on the R.H.S. of the equation with a third-order polynomial in estimates of h_t and ρ_{it} (reform probability), where the estimate of $h_t(\omega_{it}, k_{it}) = \phi_t(i_{it}, k_{it}) - \beta_0 - \beta_k k_{it} - \beta_{ar} ar_{it}$.³⁴ As above, we

³³Our OP two-step procedure estimates of the parameters of the production function are stable from a polynomial of order three on.

³⁴The careful reader will note that the polynomial was of order five in the two-step procedure. We face a trade-off here: The number of terms required increases exponentially

point out that (Olley and Pakes 1996) assume that ω_{it} follows a Markov process, which allows one to use a one-period lag in the non-linear structure for ω_{it} . We argue that weak rationality suffices for empirical identification. Again, this can be estimated in sub-samples of asset market reformed and unreformed enterprises, which allows for different β 's in reformed and unreformed samples. We also include time and industry dummies in our regressions and the above may be re-written to allow for intercept shifts for each year and sub-industries.

4 Results

In this section we summarise the empirical results. The main results are the estimates of production function parameters, see Table 4, and firm-level productivity, see Table 5. We use various estimators, OLS, GLS within group, and OP 2-Step, which controls for simultaneity, and OP 3-Step, which also controls for selection bias. Given the evidence below, the OP 3-Step estimator appears to be the most pertinent one to use in this context. Further, we run these estimators using the entire sample, but we also split the sample according to whether asset control was devolved to the managerial level or not.³⁵ All the while we control for effects related to labour market reforms. For robustness, we provide evidence that investment is indeed correlated with our productivity estimates, see Table 6.³⁶ Further, we note that the probability of asset market reform does depend positively on productivity, time and previous reform steps, while it depends negatively on capital, see Table 7.

The main results can be summarised in three statements. First, there appears to be a two-way causality between asset market reform and productivity: Enterprises that have higher productivity are more likely to engage in

in the order of the polynomial. Since the production function parameter estimates in the OP two-step estimator are stable from a polynomial of order three on, an asymptotic argument should do much to quell any discomfort arising from this simplification.

³⁵Strictly speaking we only present split-sample results for the OP estimators.

³⁶This is merely a crude measure, as our productivity instrument is actually a non-linear function i and k .

asset market reform, yet this reform process in itself increases productivity. The results indicate about half of the estimated superior performance in the asset market reformed sample is due to the selection issue, the remainder may be attributed to institutional change, i.e. the reform process. This can be seen from the fact that the productivity estimate increase induced by splitting the samples is tempered by 50% once one controls for selection bias. Second, the production technology of enterprises that have achieved managerial control over enterprise assets is more capital intensive compared to those that have not. This difference in estimates of production function technology further increases once selection is taken into account. In general, however, the OP estimates of production function parameters move in the expected direction when compared to the OLS estimates, i.e. there is a drop in the labour coefficient and a rise in the capital coefficient. Finally, the effect of either reform, but in particular the capital market reform, largely appears to be captured by the OP 3-Step estimator applied to the split sample.

The production function parameter estimates are given in Table 4 in columns numbered (1)–(8). The results of the OLS regression utilising the full sample are summarised in column (1). At a first glance they reveal labour intensive technology and also seem to imply the most significant reform is labour market related, which is associated with enterprises with low value added. Once this reform is implemented, however, labour productivity appears to increase. The asset market reform seems to be associated with larger value added firms, but is much smaller in degree when compared to labour market reform. Specifically, the labour coefficient of 0.59 is relatively large and the capital coefficient of 0.35 relatively small. At the same time, the coefficient on the dummy variable related to asset market reform is positive, 0.11, while that for labour market reform is negative, -0.66. The coefficient on a variable resulting from an interaction of labour with the labour market reform dummy variable is positive, 0.08. All of the reported coefficients are significant at the 99% level.

The GLS within effects estimates are somewhat troublesome, as the labour coefficient rises to 0.89 while the capital coefficient is only 0.19. This,

however, is not unexpected, as the fact that a firm's capital stock is typically relatively stagnant over time when compared to its labour, i.e. there is little within variation. Furthermore, since there is heterogeneity in capital stock between firms, much of the capital effect is likely to be picked-up by the firm-specific intercept, i.e. the fixed effect.³⁷ Also, the time-varying reform dummy variables become insignificant or change their sign, which is difficult to interpret. Thus, the GLS within group estimator does not appear to be ideal in these conditions.

The results of the OP 2-Step estimator are listed in columns (3)–(5) and those of the OP 3-Step estimator are listed in columns (6)–(8). In columns (3) & (6) we present results for the entire sample, while (4) & (7) represent those for the non asset market reformed sub-sample and (5) & (8) those for the asset market reformed sub-sample. The main points to take away from these regressions are the following. Taking the OLS regressions and the expected biases thereof, the Olley and Pakes generated estimates tend to move in the *right* direction, and this *correct* movement is accentuated for the reformed sub-sample.³⁸ In particular, we have an increase in the capital coefficient and a reduction in the labour coefficient, irrespective of reform status. Furthermore, while the sign of the reform related variables mirror those of OLS, there are some changes regarding size and significance. Consistent with our reasoning for employing this methodology, the selection procedure appears to take up most of the reform effects, especially those related to asset market reform. Also, once the samples are split, the labour market reform only retains significance for the non-asset market reformed sub-sample.

While the labour coefficient in the OP 2-Step remains close to the OLS estimates for the whole sample and the non-asset market reformers, it falls significantly, to 0.46, for the reformed sub-sample, see column (5). This remains so in the OP 3-Step estimator case, see columns (6)–(8). As for the capital coefficient, compared to OLS it rises by at least 20% for the OP

³⁷See (Olley and Pakes 1996) & (Grilliches and Mairesse 1995)

³⁸*Right & Correct* in the sense that, compared to OLS, the coefficients move in the expected direction given the perceived biases of the estimates. See (Olley and Pakes 1996).

estimators across the board. It is up to 30% higher for the asset market reformed sub-sample in the OP 2-Step, and 50% higher once selection effects are included in the 3-Step procedure. These changes in the capital coefficients are precisely what we would expect to see. Thus, the labour intensity of the non-reformers is somewhat tempered compared to OLS estimates, while the asset market reformed enterprises must now be labeled capital intensive. Regarding the impact of the reforms: Compared to OLS, the estimated impact of asset reform rises significantly in the OP 2-Step when the whole sample is included. Once the 3-Step procedure corrects for selection, however, the coefficient is below that estimated by OLS and barely significant, see column (6). For the 2-Step procedure, see columns (3)–(5), labour market reform matches the OLS estimates, though the impact is larger for the non-asset market reformed sub-sample. Though the labour market reform related variable coefficients remain significant in the OP 3-Step for the whole sample and the non-asset market reformed sub-sample, their coefficients have shrunk drastically, see columns (6) & (7). For the asset reformed sub-sample labour market reforms are not significant, see column (8).

The average productivity estimates from the OP estimator regressions from columns(3)–(8) of Table 4 are listed in Table 5 by year and asset reform sub-sample. The results suggest that asset market reformed enterprises are more productive. Half of this estimated difference, however, stems from selection, while merely the remainder may actually be attributed to improved performance. On inspection, it is immediately clear that average productivity of the asset reformed enterprises is larger than that of the non-reformers. Furthermore, this difference is most drastic when the samples are split but selection problems are not taken into account. The three-step procedure, however, tempers this effect. The productivity estimates of the unreformed enterprises remain relatively static as we change specifications. One may note that splitting the samples but not accounting for selection implies the reformed sub-sample have an average estimated productivity three times as large as the non-reformers. Once selection is taken into account by using the three-step procedure the productivity estimates of the reformers appears to be only twice as large when compared to the non-reformers. Finally, the ap-

parent lack of productivity improvement over time can be partly due to the fact that more productive enterprises *select* into the asset reformed group, thus dragging the average of both groups down.

There are two further points to make that may allay some specific doubts about the pertinence of this methodology to the matter at hand. Firstly, is investment at all suitable as an instrument for productivity in Chinese SOEs? And, secondly, does the propensity to undergo asset market reform depend significantly on productivity realisations for a given capital stock, i.e. do we have a selection problem at all? Table 6 shows that there does exist a positive (linear) correlation of about 0.1 among investment and productivity estimates, and that the correlation is consistently larger for the asset reformed group. This fact lends some support to our argument that investment is weakly related to productivity, though this does not include non-linearity and the other state variable, i.e. capital. Regressions (9) & (10) show the results of probit regressions with asset market and labour market reform dummies as dependent variables, respectively. The fact that in regression (9) capital and productivity, on top of a time trend and industry and location dummies, are significant implies that it is likely a selection problem exists. On the other hand, regression (10) shows that the labour market reform depends negatively on capital, positively on labour, and is independent of productivity, which implies a different selection process is likely to be involved here. The time-trend has a similar impact compared to asset market reform, which indicates that, though selection depended on enterprise characteristics, there as a general move for asset market and labour market reform.

Summing up our results we note the following. During the late 1980s and early 1990s asset market reform was most likely to be introduced in SOEs that exhibited higher productivity and this institutional change actually resulted in improved performance. Also, the asset market reformed enterprises exhibit higher levels of capital intensity in their production technology when compared to the non-reformed enterprises. The OP 3-Step estimator appears to be well employed in this scenario for several reasons. Irrespective of asset market reform status, investment seems to be related to

productivity, i.e. it appears to be a good proxy for productivity, while there also appears to be a selection issue. In particular, the smaller the capital stock the lower appears to be the productivity level required to select to the reformed group. This exactly mirrors the selection problem discussed in (Olley and Pakes 1996). Actually, (Olley and Pakes 1996) discuss survival bias, but a key innovation of this paper is to apply these insights to sample selection problems. Finally, Chinese SOEs' productivity and capital intensity increased over this time-period.

5 Conclusion

In this paper we provide empirical and methodological contribution. Empirically, we describe and evaluate the effect of a particular set of reforms, namely the effect of introducing factor market competition, prior to privatisation. We do this using a unique balanced panel of 680 State-Owned Enterprises in the industrial sector of China during 1980 to 1994. Methodologically, we provide an adaptation of an algorithm outlined by (Olley and Pakes 1996) with which we estimate productivity dynamics allowing for simultaneity and selection bias. Selection bias is an issue as observable and unobservable enterprise characteristics, chiefly capital intensity, size, and productivity, co-determine the likelihood of being reformed at a particular point in time.

We draw the following conclusions from our analysis. Factor market reforms were introduced in a tentative and experimental fashion. By the late eighties and early nineties a broad push was made to include over eighty percent of enterprises. Throughout the bulk of this period smaller, more productive enterprises were more likely to be selected for capital market reform, while those with large labour force and low productivity appear to have been selected for labour market reform only. As for the effect of reforms, we note that enterprises selected into the group that has managerial control over enterprise assets have higher productivity levels and are more capital intensive to begin with. Further, the difference in our estimates becomes starker once we allow for differences in technology, the relationship

between investment and productivity, or control for selection bias between those that have asset control and those that do not. Also, the relationship between investment and our productivity estimate productivity is stronger for this group. Interestingly, and insightfully, while we only actively attempt to deal with the problem of selection bias for the group that has control over enterprise assets, the measure we take captures to a very large extent the effect of labour market reforms. Hence we conclude that the reform process is linked to productivity in a way that suggests the causality runs in both directions: Enterprises with control over assets were better to begin with, and improved their performance once they reformed. Once this effect is accounted for, we measure no further impact attributable to labour market reform. On the other hand, for those that did not gain autonomy over enterprise assets, the ones that gained the right to hire and fire employees improved their labour productivity. However, these enterprises exhibit lower levels of value added. Enterprises without managerial control over assets remained with lower total factor productivity throughout the sample period, even when correcting for selection bias. Finally, these results hold pre-privatisation. This is important, as it shows that incomplete reforms in terms of changing the economic structure from plan to market can be effective on the margin so long as incentives are aligned.

Tables

Table 1: Number of Enterprises by Reform Category & Year

Year	No Reform	Labour	Asset	Labour and Asset
81	679	0	2	0
82	679	0	2	0
83	675	0	5	1
84	668	0	8	5
85	657	0	17	7
86	642	4	27	8
87	611	18	39	13
88	534	41	79	27
89	457	64	98	62
90	290	50	143	198
91	195	50	174	262
92	128	32	183	338
93	65	20	159	437

Note: This table lists by year the number of enterprises that have undertaken no factor market reform, only labour market, only capital market, or both types of reform.

Table 2: Summary Statistics for the Whole Sample, and Sub-Samples

		Whole Sample	Asset Unreformed	Asset Reformed
Value Added	Mean	2221.6	1913.6	2991.8
	Standard Deviation	7364.6	5925.1	10063.2
	Observations	8424	6017	2407
Labour	Mean	1850.1	1827.1	1907.6
	Standard Deviation	3480.4	3555.3	3285.8
	Observations	9014	6437	2577
Capital	Mean	2419.1	2167.3	3054.9
	Standard Deviation	8741.2	7664.7	10976.2
	Observations	8340	5974	2366
Investment	Mean	398.9	375.1	476.2
	Standard Deviation	2980.6	2824.1	3439.8
	Observations	8344	6379	1965
Asset Reform	Mean	0.28	0.0	1.0
	Standard Deviation	0.45	0.0	0.0
	Observations	9144	6562	2582

Note: This table presents the summary statistics for key variables. They are reported for the whole sample, and sub-samples of capital market reformed and unreformed SOEs.

Table 3: Number of Observations and Means of Key Variables by year , Listed by Asset Reform Category

Year	Observations		Capital Stock		Value Added		Employees		Investment	
	No Reform	Reform	No Reform	Reform	No Reform	Reform	No Reform	Reform	No Reform	Reform
80	552	1	1163.7	275.6	904.75	192.3	1561.54	692	192.89	52.6
81	611	1	1350.2	319.36	975.49	285.33	1602.24	-	171.61	14.4
82	619	2	1473.65	316.51	1069.04	618.68	1693.35	845.5	205.24	18.75
83	618	6	1599.4	916.11	1548.4	978.11	1732.01	890.67	181.87	197.96
84	614	12	1723.22	1031.28	1422.42	1463.34	1724.27	1403.17	375.29	170.54
85	608	24	1921.92	1190.95	1720.38	2551.53	1755.76	1569.58	366.94	402.73
86	591	35	2107.64	1497.91	1922.49	2573.84	1822.45	1677.97	472.96	166.63
87	584	50	2367.46	1435.07	2207.35	1951.32	1894.8	1659.96	549.25	165.26
88	529	100	2739.26	2031.43	2850.36	2426.7	1942.51	1662.8	547.98	288.94
89	486	151	3116.88	2135.67	2785.97	2501.19	1985.78	1813.12	566.27	262.49
90	285	313	3981.7	2314.51	3433.22	2578.56	2192.21	1776.49	368.15	255.29
91	210	363	4860.87	2443.95	3505.1	2514.47	2370.14	1858.15	455.88	297.89
92	121	413	4018.58	3257.41	3303.79	3038.32	2230.5	2039.8	942.42	773.08
93	70	495	3953.57	3788.49	3374.55	3514.57	2442.74	1960.86	532.51	672.83
94	64	616	3847.7	3910.99	2924.76	3404.55	2284.72	1957.91	-	-

Note: This table lists by year the number of observations and mean values for key variables. They are reported for the whole sample, and sub-samples of capital market reformed and unreformed SOEs.

Table 4: Estimates of Production Function Parameters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS (All)	GLS (All)	2-Step OP (All)	2-Step OP (No Reform)	2-Step OP (Reform)	3-Step OP (All)	3-Step OP (No Reform)	3-Step OP (Reform)
Labour	0.58*** (0.02)	0.89*** (0.04)	0.56*** (0.02)	0.59*** (0.02)	0.46*** (0.05)	0.57*** (0.02)	0.59*** (0.02)	0.46*** (0.05)
Hiring-and-Firing	-0.66*** (0.24)	0.13 (0.16)	-0.72*** (0.24)	-1.00*** (0.44)	-0.75* (0.41)	-0.10*** (0.04)	-0.24*** (0.08)	-0.05 (0.05)
Interacted Hiring and Firing	0.08*** (0.03)	-0.04 (0.02)	0.09*** (0.03)	0.12** (0.06)	0.11** (0.06)	+0 (0.0)	+0** (0.0)	+0 (0.0)
Capital	0.35*** (0.02)	0.20*** (0.02)	0.43*** (0.03)	0.44*** (0.03)	0.46*** (0.05)	0.44*** (0.02)	0.44*** (0.02)	0.51*** (0.03)
Asset Reform	0.11*** (0.03)	-0.06*** (0.02)	0.17*** (0.05)	- (0.0)	- (0.0)	0.08* (0.02)	- (0.0)	- (0.0)
Time Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
k^{th} Order	-	-	$k=5$	$k=5$	$k=5$	$k=3$	$k=3$	$k=3$
Polynomial								
Observations	6,411	6,411	6,411	4,757	1,180	6,411	4,757	1,180
R-sq	0.56	0.44	0.93	0.91	0.96	0.92	0.91	0.96

Note: This table lists the coefficients of the production function estimates for various specifications. Their standard errors are reported in brackets. Significance levels are flagged by conventional star ratings: *** is 99%, ** is 98%, and * is 95% level significance. The number of observations used in OLS and GLS has been culled to the extent necessary to perform the OP-Estimator

Table 5: Mean OP Productivity Estimates

Year	OP 2-Step All		OP 2-Step Split		OP 3-Step All		OP 3-Step Split	
	Unreformed	Reformed	Unreformed	Reformed	Unreformed	Reformed	Unreformed	Reformed
81	0.92	—	0.70	—	0.82	—	0.71	—
82	0.95	1.16	0.73	—	0.84	1.03	0.74	—
83	1.21	1.29	0.91	2.97	1.07	1.15	0.93	2.18
84	1.11	1.44	0.84	1.33	0.98	1.27	0.86	0.96
85	1.27	2.16	0.96	4.33	1.12	1.90	0.97	3.03
86	1.30	1.99	0.98	3.96	1.15	1.75	1.00	2.75
87	1.37	1.46	1.03	2.69	1.20	1.28	1.05	1.86
88	1.60	1.81	1.20	2.85	1.40	1.58	1.22	1.98
89	1.48	1.74	1.11	3.12	1.30	1.53	1.13	2.16
90	1.49	1.94	1.12	3.19	1.31	1.71	1.14	2.22
91	1.23	1.76	0.92	2.97	1.08	1.55	0.94	2.06
92	1.18	1.85	0.88	3.09	1.03	1.62	0.82	2.13
93	1.35	1.85	1.00	2.96	1.18	1.63	1.02	2.04

Note: This table contrasts mean of the log of productivity estimates for capital market reformed enterprises with non-capital reformed using OP 2- and 3-step specifications. We compute these for the whole sample and for split sample cases and list these by year.

Table 6: Correlation Coefficients Among Investment and Two- and Three-Step Olley-Pakes Productivity Estimates

$\text{Corr}(I_{it}, \omega_{it})$	Sample	No Asset Reform	Asset Reform
OP 2-Step	All	0.09	0.11
OP 2-Step	Split	0.06	0.14
OP 3-Step	All	0.07	0.10
OP 3-Step	Split	0.06	0.11

Note: This table reports the correlation coefficients between investment and productivity estimates. The productivity estimates are generated using different samples, the full sample, and asset control reformed and unreformed subsamples, and different estimation methods, notably OP 2- and 3-step.

Table 7: Probit Regressions with (9) Capital Reform and (10) Labour Reform as Dependent Variables

	(9)	(10)
	Capital	Labour
Capital	-0.10*** (0.04)	-0.17*** (0.04)
Labour	0.10 (0.06)	0.13** (0.06)
Productivity	0.13*** (0.04)	0.02 (0.04)
Trend	0.33*** (0.01)	0.27*** (0.01)
Output Autonomy	1.19*** (0.06)	1.57*** (0.07)
Industry and Location Dummies	Yes	Yes
Third Order Polynomial	No	No
Observations	6411	6391
Pseudo R-Square	0.55	0.53
Log Likelihood	-1631.79	-1435.94
Likelihood Ratio (<i>Chi-square d.f.</i>)	4057.12 (51)	3227.5 (50)

Note: This table lists the coefficients of probit regressions. Reform status is regressed on various company characteristics. The estimates' standard errors are reported in brackets. Significance levels are flagged by conventional star ratings: *** is 99%, ** is 98%, and * is 95% level significance.

Graphs

Figure 1: Fraction of SOEs that are Capital Market Reformed, by Year

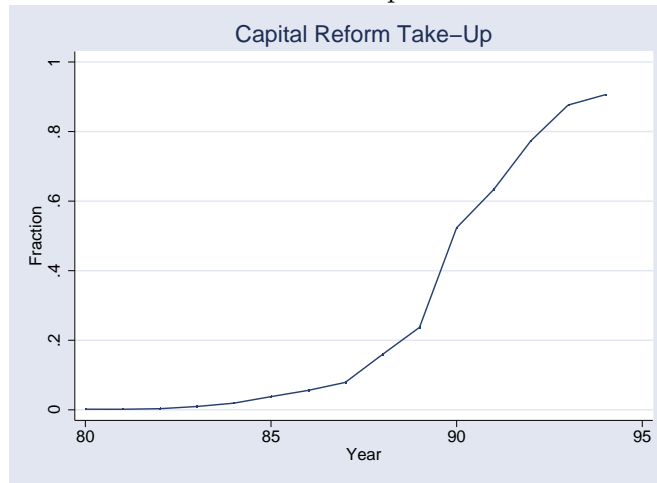


Figure 2: Fraction of SOEs that are Labour Market Reformed, by Year

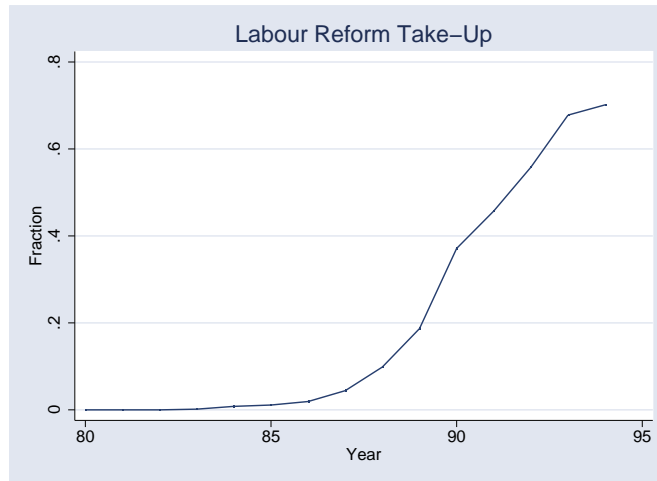


Figure 3: Distribution of the Logarithm of OP 3-Step Productivity Estimates of Reformed Enterprises (Normal Distribution Superimposed)

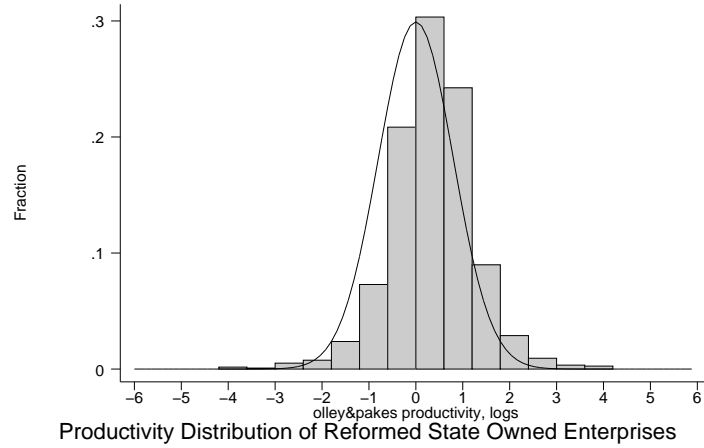
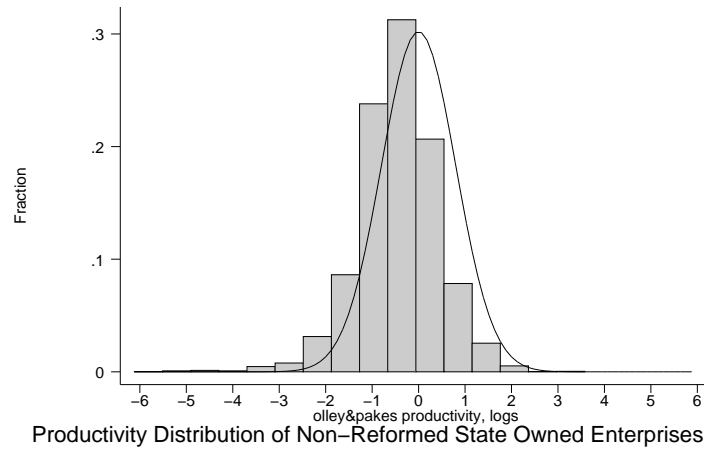


Figure 4: Distribution of the Logarithm of OP 3-Step Productivity Estimates of Unreformed Enterprises (Normal Distribution Superimposed)



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