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Can job turnover improve technical efficiency? : a study of state-owned enterprises in Shanghai

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CAN JOB TURNOVER IMPROVE TECHNICAL EFFICIENCY?
A STUDY OF STATE-OWNED ENTERPRISES IN SHANGHAI

ABSTRACT

This paper studies the relationship between job turnover and technical efficiency of state-owned enterprises (SOEs) in Shanghai's manufacturing sector during the period of 1989 - 1992. Data Envelopment Analysis (DEA) is used to compute measure of technical efficiency for each enterprise. Our findings indicate that, for non-expanding SOEs, the relationship between job turnover (i.e., downsizing) and technical efficiency is a U-shaped one such that efficiency declines at low levels of turnover, but after a certain level, it starts to increase. In addition, we show that small non-expanding SOEs (i.e., with employment size less than 100) start to increase their efficiency at a lower level of turnover than other medium and large SOEs. We also find that, for medium and large expanding SOEs, the turnover-efficiency relationship is a positive and linear one.

Key Words

job turnover; technical efficiency; firm size; state-owned enterprises; China.

INTRODUCTION

The major objective of enterprise reforms in China is to improve the efficiency of state-owned enterprises (SOEs) by allowing them to operate freely in the market. The poor performance of SOEs has been attributed to a number of factors, such as a lack of managerial autonomy, the absence of well-specific property rights, redundant labour, inappropriate incentives for managers and workers, and heavy social burdens (Grove, Hong, McMillan, and Naughton, 1994; Jefferson and Singh, 1999; Meng and Kidd, 1997; Yao, 1997). In particular, the lack of wage and employment flexibility in SOEs restricts the adjustment of their workforce to changing market conditions (Bensen and Zhu, 1999; Lee, 1999). To tackle the above problems, the Chinese government has launched several changes in the employment system during the past two decades, noticeably the introduction of 'labour contract system' and 'performance-based compensation scheme'. Additionally, the government has also relinquished its control over labour affairs, and hence SOEs have gained greater autonomy to recruit and discharge their workers (Zhu, 1995).

An important outcome of these reform measures is an increase in job turnover (Chow, Fung, and Ngo, 1999; Korzec, 1992), which is expected to bring about an improvement in technical and allocative efficiency of SOEs (Lee, 1999). However, the relationship between turnover and efficiency is not well understood in transitional China, given its distinctive institutional and economic setting. From a policy perspective, empirical evidence on the turnover-efficiency relationship may be useful in the design of effective employment policy that further boosts the performance of SOEs.

Given its practical implications, the relationship between job turnover and firm efficiency is not a new topic in management research. Studying firms in market economies, previous research has not reached a consensus on the turnover-efficiency relationship and inconsistent findings have been reported (Alexander, Bloom, and Nuchols, 1994). In view of the serious problem of overstaffing in SOEs, one may expect that an increase in job turnover especially downsizing in these firms would lead to a significant improvement in their efficiency. The existing literature, however, suggests that there are both costs and benefits associated with turnover and the net impact on efficiency would depend on the level and nature of turnover (Alexander, et al. 1994).

When a firm starts to reduce its manpower, it is likely to bring about several negative consequences. For example, turnover may adversely affect the basis of organizational control by undermining the normative foundation on which much control is exercised (Alexander et. al., 1994). This is particularly the case for SOEs, which have developed a strong collectivist tradition. With increased staff turnover, the long-established work culture and normative control have been disrupted. Under the wave of layoffs, it becomes more difficult to maintain the stability and harmony in the workplace, and the workers may lose confidence and trust in management (Verburg, 1996). In turn, this may result in a short-term decline in morale and productivity among workers in SOEs. Furthermore, workers in SOEs usually have a long tenure with the enterprise, which implies that the human asset specificity is high. As pointed out by Alexander et al. (1994), the enterprise is likely to suffer greater relocation costs as workers' long-term investment in firm-specific skills will be adversely affected when there is a high level of job turnover.

Another possible negative consequence is loss of talents. Although most of the workers involuntarily left the enterprises, it has been pointed out that, under the wave of large-scale downsizing, some workers in SOEs had voluntarily resigned, either moved to foreign-invested firms or started their own businesses (Warner, Goodall, and Ding, 1999). Most of them were either professional and managerial workers who were in short supply or productive workers with better job skills (Grove, Hong, McMillan, and Naughton, 1995). The departure of these workers from the SOEs is detrimental to the efficient running of the enterprises.

On the other hand, we expect a high level of turnover in SOEs is associated with the following beneficial outcomes. It is likely that more costly senior workers can be replaced by less expensive young workers. Under the threat of layoffs, the remaining workers may feel greater pressure to perform and their work discipline may improve. With fewer surplus workers, a more rational deployment of workers is likely to emerge and the responsibilities of individual workers become clearer than before (Gordon and Li, 1998). Finally, when the poor performers left the enterprises, the motives and morale of remaining workers may improve and their productivity may increase.

Given that there are both costs and benefits associated with job turnover, the relationship between turnover and efficiency may vary under different conditions. The purpose of this paper is to investigate such a relationship in state-owned industrial enterprises in Shanghai, a major industrial and commercial city in China. The data set for our empirical analysis consists of a panel of state-owned industrial enterprises in thirteen industries, covering the period between 1989 and 1992. Utilizing Data Envelopment Analysis (DEA), we compute the measure of technical efficiency for each state-owned enterprise in our sample. The Tobit model is then used to investigate the turnover-efficiency relationship. Specifically, we address the following questions in the present study: Is the relationship a positive, a negative, or a quadratic one? Is the relationship fixed or varied by firms of different sizes? Does the direction of turnover (i.e., expansion versus contraction) matter? Answers to these questions may advance our understanding on the implications of job turnover on state-owned enterprises during the process of economic reforms in China.

The remainder of the paper comprises three main sections. Section 2 contains a discussion of the data set as well as the procedures and techniques for data analysis. Section 3 presents the empirical findings. The last section provides some concluding remarks and policy implications.

DATA AND METHODOLOGY

Data

The Shanghai Economic Commission supplied the data for our empirical analysis. Panel data for the period of 1989 to 1992 are available. The data set covers all manufacturing enterprises in Shanghai Municipality with an average annual gross value of output (measured at 1990 prices) exceeded one million Chinese yuan in the sample period. Altogether, there are 1,432 state-owned enterprises with different sizes distributed in thirteen industries. For each firm, data on net industrial output values (value- added, measured at current prices), gross industrial output values, original values of fixed assets, net values of fixed assets, and employment size are available.

[Insert Table 1]

Enterprises are classified by size as measured by the average number of workers employed during the sample period. As shown in Table 1, enterprises are divided into five classes: 6.77% of them have less than 100 workers; 17.18% of them have between 100 and 249 workers; 26.67% of them have 250-499 workers; 25.28% of them have 500-999 workers; and the remaining 24.1% have 1,000 workers or more. About half of them employ fewer than 500 workers, which are considered as "small firms" according to the United States Small Business Administration (USSBA).

Measuring Technical Efficiency

The standard method of estimating firm-level technical (in)efficiency is the stochastic production frontier method. However, estimating stochastic production frontier models usually suffers from the following three problems (see Schmidt and Sickles, 1984): (1) the technical (in)efficiency cannot be consistently estimated. (2) There is a problem of estimating and separating technical (in)efficiency from statistical noise. (3) It may be wrong to assume that (in)efficiency is independent of the regressors.

In this study, we adopt the Data Envelopment Analysis (DEA) method to measure technical efficiency of enterprises[2]. DEA is a non-parametric method in production frontier analysis introduced by Charnes, Cooper, and Rhodes (1978). Gong and Sickles (1992) compare DEA and stochastic frontier methods and find that the relative performance of DEA is better where the misspecification of the functional forms is serious and the degree of correlatedness of efficiency with regressors is high. One application of DEA method on Chinese data is done by Zheng, Liu and Bigsten (1998). They apply the method to measure the technical efficiency of enterprises in seven industries in China during 1986-1990. They show that technical efficiency among state, collective, and township enterprises are different; however, the impact of incentive schemes on technical efficiency is shown to be inconclusive.

We use the following DEA model, formulated by Banker, Charnes, and Cooper (1984), to estimate the efficiency of enterprises in each industry and each year under the assumption of variable returns to scale (VRS):

$$
\begin{aligned}
&\underset{U_Y, U_O, V_L, V_K, V_M}{Max} \quad E_{io} = U_Y \cdot Y_{io} - U_O \\
&subject\ \ to: \\
&U_Y Y_i - (V_L L_i + V_K K_i' + V_M M_i) U_O \le 0, \quad i = 1, \ldots, n_j \\
&V_L L_{io} + V_K K_{io}' + V_M M_{io} = 1, \\
&U_Y \ge 0, V_L \ge 0, V_K \ge 0, V_M \ge 0, \\
&and\ U_O\ is\ unconstrained\ in\ sign.
\end{aligned} \tag{1}
$$

where E_{io} is the efficiency of enterprise io , Y_i is the gross value of industrial output of enterprise i, L_i is the total number of workers, K'_i is the efficiency-price adjusted capital stock which is estimated by following Jefferson et al. (1992)[3], M_i is the value of materials, U_Y, V_L, V_K, and V_M are the weight assigned to output, labour, capital, and materials respectively, and n_j is the number of enterprises in industry j.

The above DEA model is interpreted as follows. The model is a linear version of an output-to-input ratio maximization problem. Efficiency (E_{io}) is defined as weighted output per weighted input, which is bounded (normalized) between 0 and 1. Efficiency being unity indicates the highest efficiency of an enterprise relative to others in the same industry, and zero indicates the lowest efficiency. The objective for each enterprise is to maximize its E_{io} by optimizing its input weights (V_L, V_K and V_M), output weight (U_Y), and U_O under the condition that other enterprises' efficiency must not exceed unity when the optimal weights of this enterprise are applied to them. The production process exhibits increasing, constant or decreasing returns to scale if the optimal choice of U_O is less than, equal to, or greater than zero (Banker, Charnes, and Cooper, 1984).

[Insert Table 2]

The basis of firm comparison is an industry in a single year. We use the *Warwick DEA Software* to compute the technical efficiency for each enterprise in each industry and for each year and calculate the firm's average efficiency over time. The average DEA efficiency scores under VRS of firms against different size classes in each industry are shown in Table 2. As revealed in the table, the smallest size class (0-99 workers) stands out as their average DEA efficiency is the highest on average, while the middle size class (250-499 workers) have the lowest DEA efficiency. The relationship of firm size and DEA efficiency seems to be a U- shaped one.

<u>Estimating the Relationship of Technical Efficiency and Job Turnover</u>

Due to the censored distribution of DEA efficiency scores, we use the following Tobit model to estimate the relationship of technical efficiency and job turnover:

$$\begin{aligned} EFF_i = {} & \beta_o + \sum_j \beta_j DI_j + \sum_l \beta_l D_l + \beta_T TURN_i + \sum_l \beta_{Tl}(D_l \times TURN_i) \\ & + \beta_{Te}(D_e \times TURN_i) + \beta_{TS} TURN_i^2 + \sum_l \beta_{TSl}(D_l \times TURN_i^2) \\ & + \beta_{TSe}(D_e \times TURN_i^2) + \varepsilon_i \end{aligned} \tag{2}$$

Where EFF_i is the average DEA efficiency score of firm i over the period 1989-1992 (i.e., $0 \leq EFF_i \leq 1$), DI_j are dummy variables for the 13 industries (j=1, 2, 3, …, 13), D_l are dummy variables for the five categories of firm sizes (l=100, 250, 500, 1000, 1000+ for average employment size <100, 100-249, 250-499, 500-999, ≥1000 respectively), $TURN$ is the measure of average job turnover of an enterprise during the period 1989-1992 and is computed as follows:

$$TURN = \frac{|EMP_{90} - EMP_{89}| + |EMP_{91} - EMP_{90}| + |EMP_{92} - EMP_{91}|}{3}, \tag{3}$$

EMP_t is the employment size of an enterprise in year t, D_e is dummy variable for enterprises with an increase in employment size within our sample period ($EMP_{92} - EMP_{89} > 0$) and ε is the random error term with a mean zero and a finite variance σ^2. To avoid perfect multi-collinearity, one category of industry (*DTI*) and size (*D1000*) dummies is omitted in the equation.

Before we consider the empirical results, we first look at the change in labour employment of enterprises in our sample.

[Insert Tables 3, 4 and 5]

Among the various industries, rubber industry has the highest turnover (i.e., 61.87), followed by textile, electronics and telecommunication equipment, and electrical equipment.

As expected, the average job turnover is increasing in the size class in absolute term. If we adjust the job turnover figures by the average employment size listed in Table 4, the job turnover relative to the average employment size of 0-99, 100-249, 250-499, 500-999 and 1000+ size classes are 8.5 %, 7 %, 5.4 %, 4.5 % and 3.7 % respectively. The figures are declining steadily with size which implies that larger enterprises have less average job turnover in relative term. Moreover, as shown in Table 5, 37.5 % of enterprises in our sample were expanding in their employment size during our sample period. The percentage of expanding enterprises are decreasing along with size: there are 48.45 % of small state-owned enterprises (i.e., with the size of less than 100) increased their employment size over time while only 33.33 % of large state-owned enterprise (1000+) did so.

EMPIRICAL RESULTS

In this section, we provide the empirical findings of this study. Table 6 reports the estimates of our full model by using Tobit analysis while all Wald statistics of various restrictions including the quadratic term effects are reported in Table 7.

[Insert Tables 6 and 7]

First of all, according to Table 6, all the estimates of intercept dummies are statistically significant. The benchmark enterprises are non-expanding SOEs with more than 1,000 workers (i.e., the largest size class). Among the various intercept dummies, the smallest size class has a significantly higher level of DEA efficiency compared with the largest size class. The remaining size classes, however, have a lower level of DEA efficiency compared with the benchmark enterprises.

In China, the size of SOEs is largely assigned by the government, rather than being determined by market forces (Li, 1998). In the past, following the Russian model of industrialization, the industrial policy had long been biased toward large enterprises so as to capture economies of scale. This policy of promoting large enterprises in national economic development was re-stated in the Fifteenth Congress of the Chinese Communist Party held in September 1997 (Smyth, 2000). In general, large SOEs have some advantages over the medium and small SOEs. For example, they tend to have a higher level of capital concentration, better information (Sun, Hone and Doucouliagos, 1999), and receive more government subsidies and special supports (Smyth, 2000). One thus may expect that they are more efficient than their smaller counterparts.

However, several studies reveal that the relationship between firm size and efficiency is inconclusive and plausibly contingent upon some industrial characteristics. Comparing the total factor productivity among SOEs of different sizes, Murakami, Liu, and Otsuka (1996) find that large SOEs are less efficient than small SOEs in the machine tool industry. On the other hand, using the DEA approach, Zheng, Liu, and Bigsten (1996) report that large enterprises are more efficient than the medium and small ones in seven light industries. Furthermore, Sun, Hone, and Doucouliagos (1999) show that firm size significantly explains technical efficiency for the timber and furniture industry in which a large number of small firms existed. Our findings, however, confirm the relatively high efficiency of small enterprises in manufacturing industries in Shanghai.

Moreover, our results indicate that, for the non-expanding enterprises, the relationship between job turnover and technical efficiency is a U-shaped one such that efficiency declines at the low level when the costs outweigh the benefits of turnover, but after a certain level of turnover, efficiency starts to increase when the benefits exceed the costs. In particular, we note that, at the lower level, an inverse relationship between job turnover and efficiency emerges in SOEs when the turnover level is below the level of excess workers in these enterprises. A World Bank survey of 142 Chinese enterprises in 1994 found that 60% of them had redundant workers exceeding 10% of their workforce. Another one-third of these firms reported labour redundancy exceeding 20% (World Bank, 1996). Estimates of surplus labour in Chinese SOEs range from 20% to 40% (Lardy, 1998). Given these figures, it is likely that the SOEs may need a high level of turnover to reap the benefits. In other words, they gain efficiency improvement only after a certain level and hence a U-shaped relationship between efficiency and job turnover emerges.

Of particular interest is whether or not the turnover-efficiency relationship varies by firms of different sizes. Among the linear and quadratic terms of turnover and size variables, all medium and large non-expanding enterprises (i.e., more than 100) are not significantly different, which imply a similar U-shaped relationship between efficiency and job turnover. However, the smallest size class (i.e., less than 100) behaves differently as its interaction variables with linear and quadratic terms of turnover variables are statistically significant although the relationship is still a U-shaped one. According to Table 6, the absolute magnitude of the quadratic term of turnover for the non-expanding enterprises in the smallest size class (0.000001 + 0.001221 = 0.001222) is significantly larger than that of enterprises in other size classes (0.000001). Relative to their larger counterparts, these non-expanding and smallest enterprises start to gain efficiency at a much lower level of turnover. This result can be supported by a rough estimation (determined from the ratio of estimates, -b/2a, from quadratic equation ax^2+bx+c): the estimated turning point for the case of medium or large enterprises (more than 100) to trigger efficiency gain is roughly around 218 workers of turnover (or 25.9 percent of average employment of all medium or large enterprises in our sample) while the estimated turning point for the smallest enterprises is roughly around 13 workers of turnover (or 24.7 percent of average employment of the size class).

In Western literature, size of employment is often considered as one of the firm-level characteristics that affects staff turnover (Kalleberg and Mastekaasa, 1998). Firm size is generally thought to be negatively associated with turnover due to the following reasons. First of all, as compared with small firms, large firms generally offer higher pays and provide more fringe benefits to the workers. They are also more willing to invest in employees and offer more job-related training to retain staff. Moreover, long-term employment relations are more developed in large firms. The contracts between employer and employees are more formalized and explicit. Internal labour markets are thus commonly found in large firms. As there are more hierarchical levels in large firms, workers may perceive greater structural opportunities for advancement and this helps to lower their turnover rates (Kalleberg and Moody, 1994). These arguments regarding firm size and turnover, however, assume the operations of a free and competitive labour market, which is absent in China.

Since the large SOEs have been protected and subsidized by the government, they are likely to shelter a large number of redundant workers. With more slack resources and a softer budget, they tend to feel less financial pressure to streamline their operations and optimize the firm size. In addition, large firms are more likely to encounter greater organizational inertia despite the economic reform, as they tend to have a well-entrenched 'non-market' cultures and traditions, together with more cumbersome organizational structures (Ding, Goodall and Warner, 2000). Moreover, being more constrained by government regulations, large SOEs are more rigid in personnel policies and thus they become less flexible in adjusting their workforce. To trigger the efficiency gain, these firms may need a higher level of turnover. Consistent with such an expectation, we find that, for the large SOEs, the optimal level of turnover can only be attained when a large number of surplus workers have been removed.

On the contrary, small SOEs tend to be more responsive to market conditions and flexible in employment practices (Chow, et al., 1999). Subject to less administrative interference, they are more likely to use involuntary terminations or layoffs to adjust the workforce. Li (1998) pointed that small SOEs generally have tighter budget constraints, and thus they need to operate in an efficient manner. It follows that there will be fewer surplus workers in these firms. For that reason, small enterprises are found to reach the turning point at a lower level of turnover than their large counterparts.

We also investigated whether or not the relationship between job turnover and technical efficiency is different by directions of turnover (i.e., expansion versus contraction). For the SOEs under industrial reforms, job turnover often means a reduction (rather than a growth) in employment size. Poor performance induces them to optimise the size and eliminate the surplus labour. On the other hand, some better–performed SOEs may expand in order to gain economies of scale. If so, the increased job turnover due to a growth of these firms may generate a positive effect on efficiency, regardless of the level of turnover. According to Table 6, for those medium and large enterprises that are expanding, the estimate of corresponding dummy of the linear term of turnover is positive, while the estimate of the dummy of the quadratic term is negative. Adding up the turnover estimates against benchmark enterprises, we find that those expanding medium and large enterprises have a simple upward sloping, rather than having a U-shaped relationship between DEA efficiency and turnover. This indicates that expanding enterprises may be different from the non-expanding enterprises in that they enjoy technical efficiency gain as they continue to expand.

CONCLUSION AND DISCUSSION

Since the Fifteenth Congress of the Chinese Community Party held in 1997, speeding up the reform of the state-owned enterprises (SOEs) is the top policy priority for the Chinese government. It has been decided to downsize inefficient large SOEs and close down or auction away medium and small SOEs. This policy aims to restore the efficiency of SOEs as soon as possible so that they can survive in the increasingly competitive market. In addition, it can also reduce the financial burden of the central government in subsidizing these SOEs. Consequently, many SOEs workers have been laid off and this created the problem of high unemployment in urban areas. This is part of the reason that has led to the economic slowdown and the deflation of the Chinese economy over the past few years.

However, whether downsizing can improve the technical efficiency of SOEs is uncertain. Our paper attempts to provide some insights to answer this important question. According to our empirical study, there is a general U-shaped relationship between technical efficiency as measured by DEA and negative job turnover (i.e., downsizing) for SOEs in our sample. This implies that a small increase in job turnover is unlikely to bring about significant improvement in technical efficiency in these firms. To reap the benefits of technical efficiency gain, a critically large increase in job turnover (i.e., beyond the turning point of the U-shaped curve) is necessary. This result also explains why the technical efficiency gains of SOEs during the slow and gradual reforms undertaken in 1980s were rather limited.

Such efficiency gains in SOEs were much smaller than those in collective or township and village enterprises (Jefferson and Rawski, 1994). During that period, the central government had implemented various measures to improve the wage flexibility (such as introducing bonus and performance-based rewards) and to stimulate job mobility. However, these measures were mostly applied to contract workers and the majority of SOE workers who were permanent workers were not affected. The increase in job turnover was rather negligible and technical efficiency gains of SOEs were also smaller than expected.

It seems that the dosage of laying off workers applied by the central government to large SOEs must be large enough in order to yield any observable efficiency gain. In view of the above, one should not expect that the urban unemployment problem will be resolved soon as there may be more layoffs with the purpose of enhancing technical efficiency in large SOEs.

REFERENCES

Alexander, J.A., Bloom, J.R. and Nuchols, B.A. 1994. "Nursing Turnover and Hospital Efficiency: An Organization-Level Analysis". *Industrial Relations*, 33: 505-520.

Banker, R.D., Charnes, A. and Cooper, W.W. 1984. "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis". *Management Science*, 30: 1078-1092.

Charnes, A., Cooper, W.W., and Rhodes, E. 1978. "Measuring the efficiency of decision making units". *European Journal of Operational Research*, 2: 429-444.

Chow, C.K.W., Fung, M.KY. and Ngo, H.Y. 1999. "Job turnover in China: a case study of Shanghai's manufacturing enterprises". *Industrial Relations*, 38: 482-503.

Ding, D.Z., Goodall, K. and Warner, M. 2000. "The end of the 'iron rice-bowl': whither Chinese human resource management?". *International Journal of Human Resource Management*, 11: 217-236.

Gong, B.H. and Sickles, R.C. 1993. "Finite sample evidence on the performance of stochastic frontiers and data envelopment analysis using panel data". *Journal of Econometrics,* 51: 259-284.

Gordon , R.H. and Li, D.D. 1999. "The Effects of Wage Distortions on the Transition: Theory and Evidence from China". *European Economic Review*, 43:163-183.

Groves, T., Hong, Y., McMillan, J. and Naughton, B. 1994. "Autonomy and Incentives in Chinese State Enterprises". *Quarterly Journal of Economics*, 109: 189-209.

Groves, T., Hong, Y., McMillan, J. and Naughton, B. 1995. "China's Evolving Managerial Labour Market". *Journal of Political Economy*, 103: 873-92.

Jefferson, G.H., and Singh, I. 1999. *Enterprise Reform in China Ownership, Transition, and Performance*. N.Y: Oxford University Press.

Jefferson, G.H., and Rawski, T.G. 1994. "Enterprise Reform in Chinese Industry". *Journal of Economic Perspective*, 8: 47-70.

Jefferson, G.H., Rawski, T.G., and Zheng, Y. 1992. "Growth, Efficiency, and Convergence in Chinese State Enterprises". *Economic Development and Cultural Change*, 40: 239-66.

Kalleberg , A.L. and Mastekaasa, A. 1998. "Organizational Size, Layoffs, and Quits in Norway". *Social Forces*, 76: 1243-73.

Kalleberg, A.L., and Moody, J. 1994. "Human Resource Management and Organizational Performance". *American Behavioral Scientist*, 37: 948-962.

Korzec, M. 1992. *Labour and the Failure of Reform in China.* London: Macmillan.

Lardy, N.R. 1998. *China's Unfinished Economic Revolution*. Washington, D.C.: Brookings Institution.

Lee, Y. 1999. "Wages and Employment in China's SOEs, 1980-1994: Corporatization, Market Development, and Insider Forces". *Journal of Comparative Economics*, 27: 702-729.

Li, S. 1998. "Success in China's Industrial Market: An Institutional and Environmental Approach". *Journal of International Marketing*, 6: 56-80.

Meng, X. and Kidd, M.P. 1997. "Labour Market Reform and the Changing Structure of Wage Determination in China's State Sector During the 1980s". *Journal of Comparative Economics*, 25: 403-21.

Murakami, N., Liu, D., and Otsuka, K. 1996. "Market reform, division of labour, and increasing advantage of small scale enterprises: the case of the machine tool industry in China". *Journal of Comparative Economics*, 23: 256-277.

Schmidt, P. and Sickles, R.C. 1984. "Production frontier and panel data". *Journal of Business and Economics Statistics*, 2: 367-374.

Seiford, L.M., and Thrall, R.M. 1990. “Recent developments in DEA: the mathematical programming approach to frontier analysis”. *Journal of Econometrics*, 46: 7-38.

Smyth, R. 2000. “Should China be promoting large-scale enterprises and enterprise groups?” *World Development*, 28: 721-737.

Sun, H., Horne, P. and Doucouliagos, H. 1999. “Economic openness and technical efficiency - a case study of Chinese manufacturing industries”. *Economics of Transition*, 7: 615-636.

Verburg, R. 1996. “Developing HRM in Foreign-Chinese Joint Ventures”. *European Management Journal*, 14: 518-525.

Warner, M., Goodall, K. and Ding, D.Z. 1999. “The 'myth' of human resource management in Chinese enterprises”. *Asia Pacific Business Review*, 5: 223-237.

Yao, S. 1997. “Profit sharing, bonus payment, and productivity: a case study of Chinese state-owned enterprises”. *Journal of Comparative Economics*, 24: 281-296.

Zheng, J., Liu, X. and Bigsten, A. 1998. “Ownership structure and determinants of technical efficiency: an application of data envelopment analysis to Chinese enterprises (1986-1990)”. *Journal of Comparative Economics*, 26: 465-484.

Zhu, Y. 1995. “Major changes under way in China's industrial relations”. *International Labour Review*, 134: 37-49.

Table 1. *Size Distribution of Firms By Industries*

Industry	0 - 99	100 - 249	250 - 499	500 - 999	1000 +	Total
Food	51	52	42	8	10	163
Textile	3	15	45	90	115	268
Clothing	2	8	12	9	2	33
Leather & Furs	1	9	13	7	1	31
Medical & Pharmaceutical	6	8	14	8	8	44
Rubber	0	2	5	9	9	25
Plastics	3	14	11	7	2	37
Building materials & non-metal mineral products	3	12	21	18	19	73
Metal products	8	32	49	32	10	131
Machinery	15	67	119	109	110	420
Electrical equipment	2	14	19	34	29	98
Electronics &	1	7	9	11	22	50
Instruments, Meters & other measuring equipment	2	6	23	20	8	59
Total	97	246	382	362	345	1432

Note: Size is measured by the average employment of enterprises over the period of 1989 - 1992.

Table 2 *Average DEA Efficiency By Industry and Firm Size 1989 -1992*

Industry	0 - 99	100 - 249	250 - 499	500 - 999	1000 +	Total
Food	0.7267	0.5026	0.4258	0.5307	0.5715	0.5585
	(0.1385)	(0.1163)	(0.1165)	(0.1626)	(0.0853)	(0.1723)
Textile	0.7296	0.5491	0.4904	0.4764	0.5375	0.5119
	(0.1922)	(0.1474)	(0.1108)	(0.1143)	(0.1129)	(0.1209)
Clothing	0.8707	0.5515	0.5178	0.5990	0.5079	0.5689
	(0.1828)	(0.1315)	(0.0861)	(0.1120)	(0.0048)	(0.1332)
Leather & Furs	0.9038	0.5103	0.4803	0.4736	0.4989	0.5018
	(0.0000)	(0.0947)	(0.0687)	(0.0745)	(0.0000)	(0.1057)
Medical & Pharmaceutical	0.7057	0.5388	0.6414	0.6571	0.7127	0.6473
	(0.1850)	(0.1489)	(0.1448)	(0.0714)	(0.0998)	(0.1410)
Rubber	0.0000	0.5725	0.4297	0.5815	0.6405	0.5716
	(0.0000)	(0.0870)	(0.1511)	(0.1080)	(0.1037)	(0.1327)
Plastics	0.4839	0.3219	0.4269	0.5545	0.6286	0.4268
	(0.0522)	(0.0657)	(0.1139)	(0.1423)	(0.2456)	(0.1426)
Building materials &	0.7852	0.6125	0.4769	0.5623	0.6102	0.5676
non-metal mineral products	(0.1346)	(0.1390)	(0.1545)	(0.1938)	(0.1255)	(0.1676)
Metal products	0.7259	0.5187	0.4831	0.5468	0.6110	0.5319
	(0.1003)	(0.1216)	(0.1164)	(0.1087)	(0.1464)	(0.1310)
Machinery	0.8480	0.6173	0.5736	0.5787	0.6717	0.6174
	(0.0967)	(0.1123)	(0.1114)	(0.1018)	(0.1275)	(0.1277)
Electrical equipment	0.7937	0.5588	0.5987	0.5911	0.6568	0.6115
	(0.2111)	(0.0837)	(0.1419)	(0.1281)	(0.1392)	(0.1349)
Electronics &	0.8249	0.7555	0.7193	0.6904	0.6906	0.7075
Telecommunication equipment	(0.0000)	(0.1528)	(0.1533)	(0.1289)	(0.1351)	(0.1369)
Instruments, Meters &	0.4841	0.3794	0.3584	0.4331	0.5338	0.4139
other measuring equipment	(0.1177)	(0.1058)	(0.1181)	(0.1221)	(0.0996)	(0.1273)
Total	0.7407	0.5449	0.5138	0.5449	0.6141	0.5665
	(0.1493)	(0.1415)	(0.1399)	(0.1303)	(0.1363)	(0.1498)

Note: Standard deviations are in parentheses.

Table 3 *Average Job Turnovers By Industry and Firm Size 1989 - 1992*

Industry	0 - 99	100 - 249	250 - 499	500 - 999	1000 +	Total
Food	4.16	16.53	33.31	19.21	55.33	19.49
	(5.89)	(18.25)	(36.78)	(11.81)	(49.44)	(28.38)
Textile	3.78	16.20	13.39	31.59	96.82	55.35
	(3.37)	(21.44)	(13.54)	(37.89)	(121.67)	(90.54)
Clothing	1.50	6.46	40.97	36.59	122.33	33.95
	(0.24)	(7.06)	(35.76)	(39.87)	(98.99)	(43.79)
Leather & Furs	4.33	20.52	33.36	43.29	45.67	31.33
	(0.00)	(16.28)	(30.44)	(48.48)	(0.00)	(31.82)
Medical & Pharmaceutical	2.06	7.58	17.45	8.12	38.75	15.73
	(1.29)	(7.23)	(13.72)	(5.56)	(39.68)	(21.81)
Rubber	0.00	44.00	7.60	47.37	110.48	61.87
	(0.00)	(28.76)	(5.61)	(52.65)	(118.21)	(85.01)
Plastics	12.67	11.64	17.70	41.43	20.83	19.66
	(1.00)	(20.36)	(19.52)	(37.31)	(3.06)	(24.70)
Building materials &	2.00	17.14	20.73	33.15	87.23	39.74
non-metal mineral products	(1.33)	(23.36)	(22.42)	(28.11)	(109.85)	(65.44)
Metal products	8.83	8.32	17.45	43.94	60.47	24.45
	(8.68)	(9.34)	(17.98)	(61.27)	(42.18)	(38.12)
Machinery	3.91	10.98	17.02	30.47	67.78	32.37
	(3.84)	(15.27)	(29.32)	(50.34)	(137.25)	(79.58)
Electrical equipment	2.00	13.36	24.28	30.96	88.66	43.63
	(1.89)	(13.43)	(33.47)	(43.98)	(111.68)	(73.44)
Electronics &	2.00	20.10	13.78	22.76	95.03	52.15
Telecommunication equipment	(0.00)	(20.53)	(6.51)	(13.47)	(88.68)	(70.38)
Instruments, Meters &	5.67	4.61	10.16	16.70	106.83	24.77
other measuring equipment	(0.00)	(4.22)	(8.23)	(11.45)	(142.80)	(60.18)
Total	4.47	13.06	19.73	31.41	82.77	35.69
	(5.56)	(16.58)	(26.44)	(43.34)	(119.22)	(69.91)

Note: Standard deviations are in parentheses.

Table 4 *Average Employment By Industry and Firm Size 1989 - 1992*

Industry	0 - 99	100 - 249	250 - 499	500 - 999	1000 +	Total
Food	38.49	175.60	342.83	652.41	1775.30	297.33
	(25.36)	(38.98)	(75.11)	(177.94)	(791.64)	(453.59)
Textile	59.00	205.15	372.31	710.28	2446.98	1363.19
	(34.22)	(42.88)	(72.19)	(141.54)	(1788.81)	(1511.09)
Clothing	50.62	197.03	391.88	701.36	1090.87	450.73
	(15.38)	(32.16)	(73.93)	(178.12)	(73.36)	(284.40)
Leather & Furs	74.75	170.47	365.81	640.25	2168.00	419.81
	(0.00)	(38.14)	(84.24)	(136.39)	(0.00)	(379.53)
Medical & Pharmaceutical	69.17	153.72	379.50	686.56	1796.06	609.52
	(14.31)	(46.97)	(75.78)	(111.39)	(434.91)	(628.16)
Rubber	0.00	140.75	377.20	672.47	1817.44	983.07
	(0.00)	(2.12)	(81.82)	(170.98)	(793.19)	(808.34)
Plastics	84.58	183.66	378.02	733.68	1711.25	420.04
	(18.88)	(42.73)	(72.50)	(142.82)	(472.70)	(393.88)
Building materials &	64.58	183.98	376.73	716.46	2024.47	844.85
non-metal mineral products	(18.81)	(39.62)	(79.53)	(157.09)	(1616.49)	(1092.93)
Metal products	67.47	190.77	361.70	699.44	1644.80	482.43
	(23.14)	(40.67)	(69.76)	(135.98)	(823.75)	(454.05)
Machinery	67.85	192.96	371.23	684.81	2353.05	932.38
	(26.92)	(39.89)	(68.57)	(137.85)	(1840.65)	(1279.57)
Electrical equipment	49.37	182.16	359.32	691.91	2096.15	957.03
	(32.00)	(39.57)	(63.70)	(138.41)	(1596.04)	(1152.82)
Electronics &	85.00	187.82	366.83	804.91	1748.15	1040.29
Telecommunication equipment	(0.00)	(47.87)	(72.79)	(151.08)	(495.31)	(744.37)
Instruments, Meters &	87.50	185.71	334.72	718.79	1796.69	639.61
other measuring equipment	(8.84)	(50.77)	(65.44)	(119.66)	(698.96)	(566.58)
Total	52.52	185.45	365.46	699.71	2217.46	844.02
	(28.30)	(41.05)	(71.57)	(141.42)	(1622.84)	(1130.51)

Note: Standard deviations are in parentheses.

Table 5 *Number of Expanding Firms By Industries*

Industry	0 - 99	100 - 249	250 - 499	500 - 999	1000 +	Total	% of all size
Food	28	28	18	3	3	80	49.08
Textile	1	9	5	12	23	50	18.66
Clothing	1	3	8	7	1	20	60.61
Leather & Furs	0	7	9	2	1	19	61.29
Medical & Pharmaceutical	0	2	12	3	4	21	47.73
Rubber	0	1	2	4	6	13	52.00
Plastics	1	3	6	4	0	14	37.84
Building materials & non-metal mineral products	2	3	5	5	11	26	35.62
Metal products	6	7	21	12	6	52	39.69
Machinery	4	30	48	40	38	160	38.10
Electrical equipment	1	8	9	20	11	49	50.00
Electronics & Telecommunication equipment	1	1	1	2	7	12	24.00
Instruments, Meters & other measuring equipment	2	1	7	7	4	21	35.59
Total	47	103	151	121	115	537	
% of all industries	48.45	41.87	39.53	33.43	33.33	37.50	

Note: Size is measured by the average employment of enterprises over the period of 1989 - 1992.

Table 6 *Tobit Analysis of Relationship between DEA efficiency and job turnovers*

Variable	Linear Model	Quadratic Model
Intercept	0.542176**	0.553022**
	(0.013778)	(0.014957)
DI02	0.539905**	0.556152**
	(0.010489)	(0.012310)
DI03	0.613457**	0.626140**
	(0.023093)	(0.023709)
DI04	0.552496**	0.567836**
	(0.023712)	(0.024284)
DI05	0.667432**	0.678041**
	(0.020014)	(0.020581)
DI06	0.598602**	0.612789**
	(0.025408)	(0.026040)
DI07	0.466891**	0.487637**
	(0.021990)	(0.022647)
DI08	0.599680**	0.614478**
	(0.016126)	(0.017230)
DI09	0.575750**	0.590159**
	(0.013772)	(0.014926)
DI10	0.653413**	0.667246**
	(0.009490)	(0.011012)
DI11	0.644109**	0.658194**
	(0.014315)	(0.015489)
DI12	0.732495**	0.749650**
	(0.018556)	(0.019763)
DI13	0.460871**	0.476792**
	(0.017973)	(0.018877)
D0100	0.192027**	0.241458**
	(0.019192)	(0.024514)
D0250	-0.055516**	-0.067060**
	(0.013257)	(0.016426)
D0500	-0.077298**	-0.087173**
	(0.011427)	(0.013558)
D1000	-0.058812**	-0.070222**
	(0.011395)	(0.013488)
TURN	0.000043	-0.000436*
	(0.000091)	(0.000208)

D0100*TURN	-0.004856*	-0.031989**
	(0.002275)	(0.006544)
D0250*TURN	0.000611	0.000575
	(0.000476)	(0.001254)
D0500*TURN	-0.000295	-0.000351
	(0.000246)	(0.000506)
D1000*TURN	0.000110	0.000291
	(0.000159)	(0.000322)
DEXP*TURN	0.000152	0.000491**
	(0.000093)	(0.000181)
$TURN^2$		0.000001*
		(0.000001)
$D0100*TURN^2$		0.001221**
		(0.000276)
$D0250*TURN^2$		0.000004
		(0.000016)
$D0500*TURN^2$		0.000002
		(0.000003)
$D1000*TURN^2$		0.000000
		(0.000001)
$DEXP* TURN^2$		-0.000001*
		(0.000000)
SIGMA	0.121573**	0.120492**
	(0.002283)	(0.002263)
Log Likelihood	966.173	979.680
No.of Observations	1432	1432

Notes:
1. Figures in parentheses are standard errors
2. "*" and "**" indicate that the estimates are statistically significant at 5% and 1% level respectively.
3. DI02: Textile; DI03: Clothing; DI04: Leather & Furs; DI05: Medical & Pharmaceutical; DI06: Rubber; DI07: Plastics; DI08: Building materials & non-metal mineral products; DI09: Metal products; DI10: Machinery; DI11: Electrical equipment; DI12: Electronics & Telecommunication equipment; DI13: Instruments, Meters & other measuring equipment.

Table 7 *Test Statistics of Various Hypotheses*

Restriction	Ho: Coefficients of the following variables equal zero	Wald Statistic
Testing Main Effects:		
No Main Effect from Industry	DI02, DI03, DI04, DI05, DI06, DI07, DI08, DI09, DI10, DI11, DI12, DI13	4199.39**
No Main Effect from Firm Size	D0100,D0250,D0500,D1000	218.86**
No Main Effect from Turnover (Linear Term)	TURN	4.41*
No Main Effect from Turnover^2 (Quadratic Term)	TURN^2	6.41*
No Main Effect from Turnover and Turnover^2	TURN, TURN^2	6.53*
Testing Interaction Effects:		
No Interaction Effect from Firm Size and Turnover	D0100xTURN,D0250xTURN,D0500xTURN, D1000xTURN	25.65**
No Interaction Effect from Firm Size and Turnover^2	D0100xTURN^2,D0250xTURN^2,D0500xTURN^2, D1000xTURN^2	20.00**
No Interaction Effect from Firm Size and Turnover and Turnover^2	D0100xTURN,D0250xTURN,D0500xTURN, D1000xTURN,D0100xTURN^2,D0250xTURN^2, D0500xTURN^2,D1000xTURN^2	267.95**
Testing Overall Effects:		
No Effect from Industry	DI02, DI03, DI04, DI05, DI06, DI07, DI08, DI09, DI10, DI11, DI12, DI13	4199.39**
No Effect from Firm Size	D0100xTURN,D0250xTURN,D0500xTURN, D1000xTURN,D0100xTURN^2,D0250xTURN^2, D0500xTURN^2,D1000xTURN^2	375.34**
No Effect from Firm Expansion	DEXPxTURN,DEXPxTURN^2	7.40*
No Effect from Turnover (Linear Term)	TURN, D0100xTURN,D0250xTURN,D0500xTURN, D1000xTURN,DEXPxTURN	32.97**
No Effect from Turnover^2 (Quadratic Term)	TURN^2,D0100xTURN^2,D0250xTURN^2, D0500xTURN^2,D1000xTURN^2,DEXPxTURN^2	26.66**
No Effect from Turnover and Turnover^2	TURN,D0100xTURN,D0250xTURN,D0500xTURN, D1000xTURN,DEXPxTURN,TURN^2,D0100xTURN^2, D0250xTURN^2,D0500xTURN^2,D1000xTURN^2, DEXPxTURN^2	48.47**

Note: '*' and '**' are statistically significant at 5%and 1% level respectively.

NOTES

1. We would like to thank Ken Wan for his research assistance and the Hong Kong Institute of Business Studies, Lingnan University for its research support.
2. Seiford and Thrall (1990) provide a basic discussion on DEA.
3. Given the high inflation rates in the 1980s, deflating net fixed assets simply by using the capital price deflator may not be good enough. We follow the approach suggested by Jefferson, Rawski, and Zheng (1992) to adjust for the measurement errors of reported values of capital stock. Beside the adjustment for inflation, their approach can also capture the vintage effect of investment.