

# Township and Village Enterprises in China

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*Township and Village Enterprises (TVEs) have played a significant role in the growth of the Chinese economy since the economic reforms of 1978. This article analyses the productive efficiency of a cross-section of TVEs in the manufacturing sector. TVEs are found to be much more efficient than comparable state-owned enterprises (SOEs). They are also competitive in international markets. Their management which responds to market forces and their outward-orientation have contributed to their productive efficiency. The analysis concludes that efficient management, which successfully exploits the endowments and resources of the country rather than the nature of ownership of production entities, is crucial to the success of manufacturing firms.*

## I. INTRODUCTION

Township and Village Enterprises (TVEs) have played a significant role in the growth of the Chinese economy since the economic reforms of 1978. They accounted for 47 per cent of total industrial output in the year 2000<sup>1</sup> and their annual average real growth rate over the ten-year period 1988–99 was as high as 19 per cent.<sup>2</sup> This paper analyses the productive efficiency of TVEs and the sources of their efficiency. Various indicators of productive efficiency for a cross-section of TVEs in the manufacturing sector are estimated and compared with those for state-owned enterprises (SOEs), and for some of the major international competitors of TVEs.

Section II of the article provides a brief review of the characteristics of TVEs; section III estimates indicators of productive efficiency for TVEs; section IV examines the sources of efficiency; section V concludes.

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## II. CHARACTERISTICS OF TVES

TVEs are economic units which are either collectively owned by local residents in the rural areas of China or mainly owned and controlled by the peasants.<sup>3</sup> The broad concept of TVEs includes, in addition to the collectively-owned enterprises, other rural non-state enterprises such as the enterprises owned and run by individual peasants (Appendix 1).<sup>4</sup> The share of the privately-owned enterprises in total industrial output of TVEs as a whole has increased in the late 1990s from 33 per cent in 1995 to 54 per cent in 1999. The collectively-owned township and village enterprises, however, continue to attract attention because of their unique characteristics and their rapid growth in the past two decades. This study is confined to an analysis of the productive efficiency of the collectively-owned TVEs.

The industrial value-added of TVEs reached RMB 1881 billion (US\$227 billion) in 2000, accounting for 47 per cent of China's total industrial output. They employ a total of 127 million people, accounting for 18 per cent of the total labour force of the country and 25 per cent of the rural labour force. In the year 1999 their exports reached US\$94 billion, accounting for 48 per cent of the country's total exports. The average annual real growth rate of their exports over the ten-year period 1988–99 was as high as 28 per cent, exceeding that of China's total exports at around 13 per cent over the same period. The composition of their exports has shifted over the years from primary and unskilled labour-intensive products towards relatively skilled labour-intensive products.<sup>5</sup> TVEs have experienced faster productivity growth than SOEs based on a low starting point since the reforms in 1978 [Jefferson *et al.*, 1992; Woo *et al.* 1993; Weitzman and Xu, 1994; Zheng *et al.*, 1998], while SOEs revealed some catch up in efficiency in the late 1990s [Zhang *et al.*, 2001].

Collectively-owned TVEs exhibit a number of distinctive characteristics: they are publicly owned but market-orientated; they are small in size, enjoy a high degree of autonomy of operations; they are much more outward-orientated than SOEs; they are subject to hard budget constraints (Table 1). In general collectively owned TVEs are the property of local residents, but rights of ownership on their behalf is exercised by the town and village governments. The profits of TVEs are an important source of local government revenues. Although they are publicly owned, TVEs are subject to a hard budget constraint. They have very limited access to loans from the formal financial system such as the state-owned banks and the Rural Credit Cooperatives [Qian and Roland, 1996]. They may go bankrupt if they lose money.

The management of TVEs is executed by the township and village leaders who act as entrepreneurs, or by hired managers. Day-to-day management functions have been increasingly devolved to professional

TABLE 1  
INDUSTRY CHARACTERISTICS OF TVEs AND SOEs, 1995

	100 million yuan, yuan/worker									
	Exports/ Labour	Exports/ Output	Stock of Foreign Capital	Capital labour ratio	Output per firm	Number of employees	Net fixed assets per firm	Industries reported to be loss making (% of total)		
SOE	5132 (6310)	0.17 <sup>a</sup> (0.12)	0.79 (1.69)	27773 (17410)	36 (95)	338 (553)	22 (64)	68		
TVE	11591 (17293)	0.26 <sup>a</sup> (0.15)	2.84 (5.44)	20052 (11408)	7 (6)	84 (49)	2 (2)	2		
t-statistic	0.00	0.07	0.00	0.00	0.00	0.00	0.00			

	Wage rate	Workers with university level education (% of total)	Workers with secondary level education (% of total)	Managerial staff (% of total)	Engineers (% of total)	Non- production workers (% of total)	Non- production net fixed assets (% of total)	Payment on piece rates (% of total)
SOE	5209 (1680)	8 (4)	83 (5)	12 (6)	7 (4)	34 (8)	27 (9)	62 (40)
TVE	4199 (1048)	2 (1)	82 (6)	11 (2)	7 (2)	23 (5)	17 (18)	86 (10)
t-statistic	0.00	0.00	0.01	0.00	0.13	1	0.00	0.00

Notes: 1. The figures presented here are unweighted averages of all industries in TVE and SOE sectors respectively.

2. The standard deviations are shown in parentheses.

3. The t-statistic tests the null hypothesis of the equality between SOE and TVE sectors; data listed here are probabilities associated with Student's t-test.

a Weighted average.

Source: Calculated from 'The Third National Industrial Census of P.R.China', 1995.

managers. Managerial remuneration systems of TVEs have evolved over the years, changing from the fixed wage contract to profit sharing contracts and fixed payment schemes, which are essentially lease agreements.

The remuneration of workers as opposed to managers in most TVEs is tied to performance. Workers are mostly paid by piece rates. TVEs are able to acquire high quality engineers because their salaries and wage payments methods are tied to performance. TVEs also enjoy a high degree of freedom in their management of labour. They can recruit and lay off workers depending on demand conditions for their output. The average skill level of employees, however, is relatively low in the TVE sector. Most of the workers are from the countryside with very little training and skills.

Most TVEs have positioned their business in areas with severe shortages of output or where SOEs have been weak. They have taken advantage of China's endowments of cheap labour and specialised in the production of labour or resource-intensive products such as textiles, clothing, food processing, and toys. With the gradual opening up of the economy, TVEs have also attracted substantial volumes of export-orientated FDI (Table 2).

TABLE 2  
MAJOR EXPORTING INDUSTRIES OF TVES, 1995

Industry	Export-output ratio	Export Value million US\$	FDI-total capital ratio
Toy manufacturing	0.70	579	0.54
Computer manufacturing	0.65	193	0.54
Apparel manufacturing	0.54	3146	0.36
Sport articles manufacturing	0.54	100	0.39
Leather products manufacturing	0.52	1320	0.41
Watch & clock manufacturing	0.51	91	0.55
Other electric equipment	0.50	63	0.73
Feather products manufacturing	0.47	243	0.28
Hat manufacturing	0.46	29	0.33
Electronic appliances manufacturing	0.44	93	0.67
Knitted products manufacturing	0.41	833	0.33
Footwear manufacturing	0.39	170	0.32
Plastic shoes manufacturing	0.39	61	0.44
Office machines manufacturing	0.36	13	0.40
Electronic parts manufacturing	0.34	276	0.44
Textile manufacturing	0.22	4484	0.17

Source: Calculated from 'The Third National Industrial Census of P.R.China', 1995.

## III. PRODUCTIVE EFFICIENCY OF TVES

A. *Methods of Estimation*

There are three principal approaches to the measurement of productive efficiency: ratio analysis such as labour productivity and capital productivity, econometric approach such as the stochastic frontier model, and programming approach such as the data envelopment analysis. Total factor productivity (TFP) provides a comprehensive guide to efficiency than partial productivity. It takes into account the contribution of factors, other than raw labour and capital, such as managerial skills and technical know-how. A Solow-type TFP index based on the Cobb-Douglas production function with constant returns to scale is as follows [Good *et al.*, 1997]:

$$TFP = Y / (L^\alpha K^{1-\alpha})$$

where  $TFP$  = total factor productivity,  $Y$  = value-added,  $L$  = labour,  $K$  = capital. At cost-minimising levels of inputs,  $\alpha$  denotes the share of labour in total output and  $1 - \alpha$  denotes the share of capital in total output. However, estimation of TFP is subject to several well-known problems.

In the programming approach, for a sample of  $n$  firms, if  $X$  and  $Y$  are the observations on inputs and outputs, assuming variable returns to scale, the firm's efficiency score,  $\theta$ , is the solution to the linear programme problem:

$$\begin{aligned} & \text{Min}_{\theta, \lambda} \theta \\ \text{st. } & \theta x_i - X\lambda \geq 0 \\ & -y_i + Y\lambda \geq 0 \\ & \lambda_i \geq 0 \\ & \Sigma \lambda_i = 1 \quad i = 1, \dots, n. \end{aligned}$$

where  $\theta$  is a scalar and  $\lambda$  is a  $n \times 1$  vector of constants. The efficiency score ranges from 0 to 1. If  $\theta_k = 1$ , the  $k$ th decision making unit (DMU) is deemed to be technically efficient.

The strength of the programming approach lies not only in its lack of parameterisation, but also in that no assumptions are made about the form of the production function. Instead, a best-practice function is built empirically from observed inputs and outputs. The main shortcoming of this technique is that there is no provision for statistical noise or measurement error in the model [Greene, 1997; Norman and Stoker, 1991]. The econometric approach, however, has its main advantage in that measurement error can be minimised and hypotheses can be tested with statistical rigour, it is restricted by the main drawback that the production function is assumed to be known and to be homogeneous across firms or sectors.

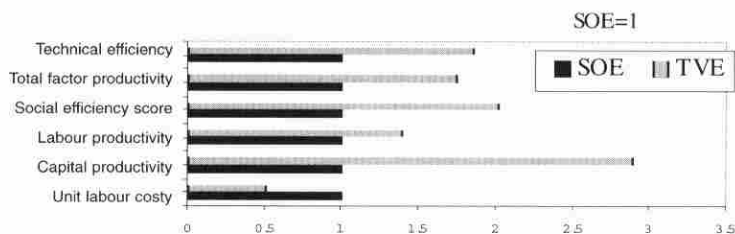
### B. Data and Results

The data used for estimation of various efficiency indicators are taken from 'The Third National Industrial Census of China' for 179 industries in both TVE and SOE sectors in the year 1995. The data envelopment analysis approach employs value-added in current prices as the measure of output, net fixed assets for each of the industries at the end of the year 1995 as the measure of capital, and total wage bill as the measure of labour inputs. The capital variable includes non-production capital such as housing and expenditures on health care, both of which can contribute to productive efficiency of workers [Zheng *et al.*, 1998; Jefferson, 1999]. We concentrate on output-oriented technical efficiency under variable returns to scale (VRS),<sup>6</sup> as growth of output has been the major objective of Chinese industries in recent years.

Estimates of the various indicators of productive efficiency for TVEs at the industry level are reported along with comparable estimates for SOEs (Figure 1). In the year 1995, the average technical efficiency score for TVEs was 85 per cent higher than that for comparable SOEs. Six industries are found to be technically efficient, including one SOE industry and five TVE industries. TVEs' total factor productivity (TFP) was 74 per cent higher than that for SOEs.<sup>7</sup> These estimates of TFP are consistent with those reported in previous studies [Zheng *et al.*, 1998; Jefferson, 1999]. All the other indicators including capital productivity, labour productivity and social efficiency index attest to the relative superior efficiency of TVEs. The statistical tests for paired samples show that the mean of the two sectors are significantly different from each other in the case of all the indicators.<sup>8</sup>

Sectoral analysis of the performance of TVEs also indicates that, in general, TVEs are more efficient than comparable SOEs (Table 3). In a sample of 18 sub-industry groups, TVEs exhibit superior efficiency in all

FIGURE 1  
COMPARATIVE PERFORMANCE OF TVEs and SOEs, 1995



Note: The figures here are the unweighted average of each indicator of TVE and SOE sectors respectively.

TABLE 3  
PERFORMANCE OF TVEs, SECTORAL ANALYSIS, 1995

SOE=1.00

Industry <sup>1</sup>	Technical efficiency	Total factor productivity	Value-added per fixed assets	Value-added per worker	Wage rate	Output/firm	Capital labour ratio
Machinery equipment	2	3.28	9.53	1.92	0.85	0.32	0.70
Leather	3.81	2.93	3.56	3.25	1.30	1.00	0.79
Transportation	2.39	2.70	6.22	1.62	0.64	0.15	0.63
Textile	2.47	1.93	2.25	2.16	0.97	0.43	0.93
Food	2.69	1.92	2.46	1.83	0.84	0.38	0.76
Plastic product	2.43	1.85	2.11	2.70	1.34	0.63	1.27
Mining	2.03	1.85	3.45	1.36	0.79	0.19	0.42
Electric machinery	2.25	1.80	2.12	2.09	0.89	0.53	1.04
Apparel	2.14	1.73	2.22	1.81	1.24	1.00	0.81
Chemical	2.42	1.73	2.31	1.43	0.71	0.19	0.62
Drug	1.64	1.69	2.10	1.70	0.71	0.48	0.89
Non-metal	2.41	1.63	2.23	1.86	1.02	0.36	0.94
Instruments and office machinery	2.16	1.59	1.81	1.90	0.80	0.50	0.82
Fibre & rubber	2.33	1.57	1.87	1.74	0.83	0.25	0.99
Metal	1.95	1.54	1.92	1.87	0.94	0.09	0.94
Electronic and telecom	1.54	1.38	1.47	1.67	0.97	0.54	0.90
Miscel light industry	1.63	1.35	1.84	1.04	0.85	0.17	0.64
Alcohol & tobacco	1	0.61	1.03	0.35	0.66	0.05	0.50

Note: <sup>1</sup>The industries listed here are the major industry groups each consisting of several sub-industries.

Source: Calculated from 'The Third National Industrial Census of P.R.China', 1995.

but the alcohol and tobacco industry groups which are rigidly controlled by the state. A hundred and sixty-three TVE industries out of a total of 179 exhibit superior total factor productivity and technical efficiency. Only 16 SOE industries exhibit superior efficiency relative to TVEs. These are the tobacco and alcohol industries, steel melting and processing, oil processing, cement, headgear and electronic and communication equipment industries. These industries are either under state monopoly, and/or exhibit high capital and technology intensity. Preliminary comparison of the efficiency of TVEs with that of their principal competitors in other emerging economies, suggests that TVEs may be competitive in international markets as well.<sup>9</sup>

#### IV. SOURCES OF PRODUCTIVE EFFICIENCY

What are the sources of productive efficiency of TVEs? Their exposure to international markets through trade and FDI could be a principal factor in

their observed superior productive efficiency [Grossman and Helpman, 1990; Egan and Mody, 1992; Balasubramnyam et al., 1996; Clerides, 1998]. It could, however, be argued that it is only the relatively efficient firms which enter the world markets. The causation is from efficiency to exports and not the other way round [Henriques and Sadorsky, 1996; Yamada, 1998; Bernard and Jensen 1999; Aw et al., 2000]. Whilst there is no firm statistical evidence to support either of these contentions, the fact remains that exposure of TVEs to international competition has been to their advantage. In addition, the sizeable volumes of FDI that TVEs have attracted may also serve as efficient conduits for the transmission of technology and managerial know-how.

Several other factors besides their outward-orientation could be conjectured to have played a role in the observed superior productive efficiency of TVEs. We discuss some of these factors prior to subjecting them to a rigorous statistical test.

Management is one of the major factors which contributes to productive efficiency. Efficient management serves to minimise costs of production, reduce transaction costs within firms, improves product quality and efficient utilisation of resources. However, when managers are not responsible for the consequences of their actions, with wages predetermined, there are opportunities for free-riding, the degree of X-inefficiency increases [Leibenstein, 1978]. Performance related payments to managers, frequently observed in the TVEs, might be one method of reducing X-inefficiency. The incorporation of accountability through a hard-budget constraint, performance payment schemes for managers and piece rate payments for workers may contribute to the growth of X-efficiency in the TVE sector.

Increased autonomy over managerial decision-making and a stake in the firm's profits may also contribute to efficient operations. Usually the larger the fraction of the total profits the enterprise is allowed to retain, the stronger will be the motivation to improve productive efficiency on the part of managers. A high degree of autonomy over decision-making is accorded to managers in most TVEs.

The nature of ownership of firms could also impact on productive efficiency of firms. The property rights model suggests that public ownership attenuates property rights, reduces incentives to minimize costs and encourages free-riding. Agency theory, however, suggests that when ownership is separated from management, the objectives of managers and owners may diverge. Individuals in the firm will not minimise costs for a given level of output. Such principal-agent relationship is regarded as an important source of X-inefficiency [Leibenstein, 1978; Button and Weyman-Jones, 1992]. A number of empirical studies have investigated the comparative efficiency of different ownership structures, but no strong



evidence has been provided in favour of one system or the other [Byrnes *et al.*, 1986; Ferrier, 1993].

TVEs in China, however, fit none of the commonly observed patterns of ownership and management. TVEs are nominally owned by the local residents, but controlled, managed and supported by the local governments and they respond to market forces. Their ownership is similar to that of SOEs to the extent that they are all publicly owned. Such public ownership may provide some institutional advantages over private firms in solving the agency problem [Bowles and Dong, 1996]. Also, the assignment of property rights to the local government may be an efficient response to Chinese institutional constraints [Chang and Wang, 1994]. Weitzman and Xu [1994] though argue that the demographic stability of China's rural communities and the Confucian tradition have promoted the emergence of a co-operative culture, which renders well-defined private property rights unnecessary for the promotion of entrepreneurial activity and productivity.<sup>10</sup> Ownership at the local government level may not be entirely without the sort of problems posed by central government ownership [Sachs and Woo, 1997].

Although they are both publicly owned, the management style of TVEs is considerably different from that of SOEs. TVEs are subject to the discipline of the market. The incorporation of accountability and exposure of publicly-owned firms to market forces compels TVEs to minimise costs and maximise efficiency. Loss making enterprises are not bailed out by the state nor are they allowed to cream off all the profits they make. While loss-making firms go bankrupt, the successful ones share their profits with the local governments. The so-called agency problem is greatly reduced in the case of these contractual arrangements as managers' fortunes depend upon the efficiency with which they manage the enterprises. The unique combination of public ownership with market-orientated management of TVEs may have helped them overcome both the moral hazard and agency problems. The market environment in which the enterprises operate motivates entrepreneurship, allows managers to experiment and innovate, but it also holds them accountable for their actions. For these reasons TVEs may not only be more efficient than the SOEs, but they may also be as productive as those firms which are owned privately [Pitt and Putterman, 1992; Dong and Putterman, 1997].

The foregoing hypotheses and suggestions though are subject to one major qualification. It is that the nature of ownership per se may not be a significant determinant of productive efficiency. Much more important may be factors such as style of management, scale effects, proportion of resources devoted to non-production activities such as social services, degree of managerial autonomy and other enterprise specific factors. A carefully designed econometric study of the productive efficiency of

China's rural enterprises suggests as much [Jefferson, 1999]. The study finds that when these and other policy-orientated variables are controlled for, the productive performance of TVEs were not unambiguously higher than that of SOEs. The present study, however, relates to the performance of the two groups in the year 1995 and relies on a data set different from that used by Jefferson. In any case, the statistical results of the present study discussed below endorses the Jefferson proposition, but argues that the sort of factors which promote productive efficiency were more frequently to be found in the case of TVEs than the SOEs.

In sum, outward orientation, efficient management and the unique combination of public ownership with market-orientated management are factors which may have contributed to the productive efficiency of TVEs. The influence of these and other factors on the observed productive efficiency of TVEs is analysed below in the context of a statistical model.

### A. Model

We employ regression analysis to estimate the impact of the factors discussed earlier on the productive efficiency of TVEs. The equation to be estimated in logarithms is of the following form:

$$PE_i = \alpha + \beta_1 EX_i + \beta_2 MS_i + \beta_3 WS_i + \beta_4 FS_i + \beta_5 KI_i + \beta_6 DO_i + \mu \quad (1)$$

where  $i = 1, \dots, N$  indexes industry,  $PE$  = productive efficiency,  $EX$  = outward orientation,  $MS$  = a vector of management variables such as incentive schemes, degree of autonomy and types of managerial contract,  $WS$  = labour skills,  $FS$  = firm size,  $KI$  = capital intensity,  $DO$  = sector dummy, 1 for TVEs and 0 for SOEs. Two alternative measures of productive efficiency, labour productivity (VAL) and technical efficiency (TE), are regressed upon the independent variables listed above respectively.

In the estimation of technical efficiency, the efficiency scores have an upper bound of 1.0 and a lower bound of 0.0, the ordinary least squares estimates would be inconsistent. Therefore, the regression model for technical efficiency is specified in form of the Tobit model as follows [Tobin, 1958; Zheng, 1998].

$$PE_i = \begin{cases} \alpha + \beta X_i + \mu & \text{if } \alpha + \beta X_i + \mu < 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

where  $X_i$  is a vector of independent variables as listed in equation (1).

### B. Data and Methodology

The main data set relates to a pooled sample of 358 industries, including 179 TVE industries and 179 comparable SOE industries for the year 1995.

It is derived from 'The Data of The Third National Industrial Census of P.R. China'. The second set of data relates to panel data for TVEs in 29 provinces of China over the time period 1987–98. These data are collected from the *China Township and Village Enterprises Yearbook* and the *China Agricultural Statistical Yearbook*. This data set covers most of the TVEs during their period of rapid growth. It not only enables us to investigate the dynamic effects of the determinants on efficiency, but also takes into account the regional dimension.

Outward orientation of enterprises is measured by the total value of exports of each of the industry categories in the sample. We have opted to use the total value of exports of the relevant enterprises rather than an export intensity variable measured by the ratio of exports of the enterprises to their total output. The former variable which is a scale variable may capture the impact of outward orientation in the form of knowledge spillovers from exports to the industry as a whole including exporters and non-exporters. The latter which is an export intensity variable may confine the impact of outward orientation to exporters and fail to capture industry wide effects.

Management intensity cannot be quantified with any one single measure. Differing types of management contracts in force may be one measure which may come close to measuring managerial efficiency. In the absence of information and data on types of management contracts, we employ two proxies – bonuses paid per employee and retained profits per employee. Admittedly neither of the two variables may measure managerial efficiency *per se*. They are but indirect measures of managerial efficiency, the former may provide pecuniary incentives for managers and the work force and the latter may signify the degree of financial autonomy managers enjoy. Admittedly, these variables may exert a positive influence on productive efficiency of enterprises irrespective of the nature of their ownership.

Measurement of labour skills is also beset with problems. One frequently used measure is the proportion of labour force with secondary school level of education. This variable though may not always correlate with productive efficiency, for several other factors such as learning by doing and nature and extent of managerial supervision of labour may influence productive efficiency besides schooling. For these reasons we measure labour skills by wage rates per worker on the assumption that wage rates may be positively related to the productivity of workers. Detailed description of the sources of data and methods of measurement are set out in Appendix 2.

The statistical test is in three steps. First, we estimate regression equations (1) and (2) with the pooled data set for SOEs and TVEs. The explanatory variables include outward orientation and management intensity. Labour skills, firm size, capital intensity and a sector dummy DO,

which equals to 1 for TVEs and 0 for SOEs, are used as control variables. Because of possible endogeneity between openness and productive efficiency, we first apply the Wu-Hausman specification test to test for endogeneity. Management intensity (MS), workforce skills (WS), capital intensity (KI), firm size (FS), market size (MARKS), comparative advantage<sup>11</sup> (CA), and policy dummy (DI) are used as predetermined variables. If endogeneity is detected between openness and productive efficiency, we utilise the 2-stage least square (2SLS) for labour productivity estimation and 2-stage Tobit model for technical efficiency estimation, otherwise we use the OLS and the standard Tobit model.

Secondly, we test for the effects of outward orientation, management and other factors on the productive efficiency of TVEs and SOEs separately, and investigate the major factors which determine the efficiency gap between the two groups. We test for the structural differences between the two productivity equations by applying the Wald test of restrictions imposed on parameters. The 'seemingly unrelated' equations are as follows:

$$PE_t = \alpha_t + \gamma_1 EX_t + \gamma_2 MS_t + \gamma_3 WS_t + \gamma_4 FS_t + \gamma_5 KI_t + \mu_t \quad (3)$$

$$PE_s = \alpha_s + \delta_1 EX_s + \delta_2 MS_s + \delta_3 WS_s + \delta_4 FS_s + \delta_5 KI_s + \mu_s \quad (4)$$

where t and s denote TVEs and SOEs, respectively.

We first compare the estimated coefficients for corresponding variables in the two equations pair-wisely, for example,  $\gamma_i$  and  $\delta_j$ ; then we employ a Wald test to test the null hypothesis  $\gamma_i = \delta_j$ . As there may be endogeneity between exports and productivity, a Hausman test is also applied. If there is endogeneity between exports and productivity, we apply the 3SLS to the equation system; otherwise, we utilise the SURE method.

Finally, we estimate equation (1), with the panel data set, to test for dynamic effects of outward-orientation and management on the productive efficiency of TVEs when, region specific characteristics are controlled for. In order to control for the possible reverse causality between variables such as openness, bonuses and retained profits on the one hand, and productivity on the other, we use lagged variables as instruments in the fixed effects model.

### C. Cross-Section Results

Table 4 reports the two-stage least squares (2SLS) estimation results for the pooled data set using labour productivity as the dependent variable.<sup>12</sup> The coefficients of outward-orientation (EX) and management intensity (MS) are positive and statistically significant, suggesting a positive contribution of outward orientation and management to productive efficiency. Workforce skills, firm size and capital intensity variables also bear the expected

TABLE 4  
ESTIMATION RESULTS OF DETERMINANTS OF PRODUCTIVE  
EFFICIENCY FOR POOLED DATA

Independent Variable	Efficiency measures			
	Labour productivity		Technical efficiency	
	OLS	2SLS	TOBIT	2S-TOBIT
CONS	3.578*** (0.000)	3.829*** (0.000)	-2.066*** (0.000)	-1.876*** (0.000)
DO	1.356*** (0.000)	1.560*** (0.000)	1.411*** (0.000)	1.563*** (0.000)
LEX	0.029*** (0.001)	0.076*** (0.000)	0.013 (0.112)	0.047*** (0.000)
LSM	0.157*** (0.000)	0.173*** (0.000)	0.128*** (0.000)	0.139*** (0.000)
LWS	0.123*** (0.000)	0.178*** (0.000)	0.121*** (0.000)	0.160*** (0.000)
LFS	0.074*** (0.000)	0.114*** (0.000)	0.035** (0.019)	0.064*** (0.000)
LKI	0.366*** (0.000)	0.290*** (0.000)	-0.170*** (0.000)	-0.225 (0.000)
Number of observations	358	358	358	358
Adjusted R <sup>2</sup>	0.546	0.505		
Log likelihood			-137.054	-129.54

Note: \*\*\*Significant at the one per cent level; \*\* Significant at the five per cent level; p-values are shown in parentheses.

significant positive coefficients. Results for the equation based on technical efficiency as the dependent variable are similar to that for labour productivity.

Table 5 presents the results for the three-stage least squares (3SLS) estimation of labour productivity of TVEs and SOEs.<sup>13</sup> Outward orientation (EX) exerts a significant positive effect on the productivity of TVEs, while it is insignificant in the case of the SOE sector. The Wald statistic at 8.828 suggests that the estimated coefficient of outward orientation variable in the TVE equation is significantly different from that in the SOE equation at the one per cent significance level (Table 6), indicating the contribution of outward orientation to the productive efficiency of TVEs.

Management intensity (MS) is positively correlated with productive efficiency in the TVE sector and the coefficient of management intensity (MS) variable is statistically significant. A one per cent increase in bonuses per employee is seen to increase labour productivity of TVEs by 0.18 per cent. These variables are, however, insignificant in the SOE equation. The Wald test indicates that the difference between the two coefficients is statistically significant. These results suggest that, in the TVE sector,

TABLE 5  
ESTIMATES OF LABOUR PRODUCTIVITY OF TVE AND SOE SECTORS

Independent Variable	3SLS		SURE	
	TVE	SOE	TVE	SOE
Intercept	6.337*** (0.000)	-1.381 (0.122)	6.221*** (0.000)	-1.393 (0.118)
LEX	0.041*** (0.003)	-0.012 (0.317)	0.026*** (0.006)	-0.002 (0.869)
LMS	0.180*** (0.000)	-0.007 (0.851)	0.180*** (0.000)	-0.002 (0.963)
LWS	0.102*** (0.001)	0.599*** (0.000)	0.082*** (0.002)	0.602*** (0.000)
LFS	0.046** (0.012)	0.074*** (0.000)	0.033** (0.042)	0.075*** (0.000)
LKI	0.212*** (0.000)	0.609*** (0.000)	0.232*** (0.000)	0.603*** (0.000)
N	179	179	179	179

Note: \*, \*\*, \*\*\* Significant at the ten, five and one per cent levels, respectively; p-values are shown in parentheses.

TABLE 6  
WALD TESTS OF EQUALITY OF ESTIMATED COEFFICIENTS  
BETWEEN TVE AND SOE EQUATIONS

Variables	Null Hypothesis	Wald Statistic	Reject Null (1%)
Intercept	$\alpha_1 = \beta_1$	64.440***	Yes
LEX	$\gamma_1 = \delta_1$	8.828***	Yes
LMS	$\gamma_2 = \delta_2$	13.638***	Yes
LWS	$\gamma_3 = \delta_3$	22.730***	Yes
LFS	$\gamma_4 = \delta_4$	1.111	No
LKI	$\gamma_5 = \delta_5$	34.659***	Yes

Note: \*\*\* Significant at the one per cent level. Dependent variable: log of labour productivity.

incentive schemes may have played a significant role in the promotion of X-efficiency.

Workforce skills (WS) variable exerts a positive impact on productivity in both the TVE and the SOE sectors. The magnitude of the coefficient of the workforce skills variable in the SOE equation, however, at 0.599, is considerably higher than that in the TVE equation. The Wald statistic indicates that this difference is statistically significant. It is likely that production workers in the SOE sector are better trained than those in the TVE sector. The coefficients of capital intensity (KI) variable tell the same story. This suggests that capital intensity in the SOE sector plays an important role in determining its productivity, mostly because of the recent vintages of technology embodied in capital goods in use in the sector.

The coefficients of the firm size (FS) variable in both equations are significantly positive, and the Wald statistic shows the difference between them is statistically insignificant. This suggests that, irrespective of the ownership structure the firm adopts, productivity and size are related. The test on the determinants of technical efficiency in the two sectors also lends evidence supporting the positive contribution of outward-orientation and management to the superior productive efficiency of TVEs (Table 7).

TABLE 7  
ESTIMATES OF TECHNICAL EFFICIENCY IN TVE AND SOE SECTORS

Independent Variables	2S-TOBIT		TOBIT	
	TVE	SOE	TVE	SOE
C	0.501 (0.157)	-2.257** (0.020)	0.236 (0.504)	-2.258** (0.020)
LEX	0.028** (0.040)	0.005 (0.693)	0.010 (0.304)	-0.001 (0.940)
LSM	0.166*** (0.000)	0.117*** (0.005)	0.167*** (0.000)	0.115*** (0.006)
LWS	0.113*** (0.000)	0.145 (0.182)	0.087*** (0.001)	0.143 (0.188)
LFS	0.014 (0.447)	0.004 (0.869)	-0.001 (0.937)	0.003 (0.886)
LKI	-0.309*** (0.000)	-0.166*** (0.007)	-0.283*** (0.000)	-0.163*** (0.008)
N	179	179	179	179

Note: \* Significant at the ten per cent level; \*\* Significant at the five per cent level; \*\*\* Significant at the one per cent level; p-values are shown in parentheses.

#### D. Panel Data Results

Results using the panel data set are presented in Table 8. Here again, outward orientation (EX) exhibits a significant positive impact on the productive efficiency of TVEs. A one per cent increase in openness increases productive efficiency by about 0.10 per cent. Bonuses per employee (MS1) and retained profits per employee (MS2) are positively associated with productivity and are statistically significant. A one per cent increase in bonuses per employee increases labour productivity by 0.41 per cent, and a one per cent increase in retained profits per employee increases labour productivity by 0.11 per cent. These results suggest that incentives and autonomy promote productive efficiency in the TVE sector. Capital intensity and time trend variables, which capture exogenous technical progress, bear the expected sign.

TABLE 8  
DETERMINANTS OF PRODUCTIVE EFFICIENCY: PANEL DATA RESULTS

Independent variables	(1)	(2)
<i>C</i>	0.547* (0.077)	1.716*** (0.000)
<i>LEX</i>	0.157** (0.001)	0.136*** (0.000)
<i>LMS1</i>	0.108*** (0.010)	
<i>LMS2</i>		0.340*** (0.000)
<i>LKL</i>	0.134 (0.252)	0.320*** (0.000)
<i>T</i>	0.099*** (0.000)	0.022** (0.013)
<i>DC</i>	0.103 (0.394)	0.042 (0.203)
<i>N</i>	87	145
Adjusted R <sup>2</sup>	0.898	0.973

Note: Regression equation  $LPE_{it} = \kappa + \theta LEX_{it} + \xi LMS_{it} + \eta DC_{it} + \nu T + \varepsilon_{it}$ , where *PE* = labour productivity, *EX* = real exports per employee, *MS* = management intensity measured by real bonuses per employee (*MS1*), and real retained profits per employee (*MS2*) alternatively, *T* = the time trend, and *DC* = coastal region dummy variable which equals 1 for coastal regions and 0 for non-coastal regions. Instrumental variables are: *EX* and *PE* lagged by one year. Regression (1) and (2) cover the time period of 1995–1998 and 1987–1992 respectively.

\*\*\* Significant at the one per cent level. \*\* Significant at the five per cent level.  
\* Significant at the ten per cent level. p-values are in parentheses.

## V. CONCLUSIONS

The conclusions of the article can be briefly summarised. TVEs have made a significant contribution to growth and exports of China. Most of the indicators of productive efficiency suggest that TVEs are much more efficient than comparable SOEs. Their management which responds to market forces, the relatively high degree of managerial autonomy they enjoy and their outward-orientation all appear to have contributed to their productive efficiency.

China's TVEs appear to have successfully combined public ownership of industry with management which responds to market-based incentives. Their performance suggests that efficient management, which successfully exploits the endowments and resources of the country and exposure to market forces rather than the nature of ownership of production entities, is crucial to the success of manufacturing firms.



## NOTES

1. Estimated from *China Statistical Yearbook, China Township and Village-Owned Enterprises Statistical Yearbook*, 2000.
2. Estimated from *China Township and Village-Owned Enterprises Statistical Yearbook*, various issues.
3. Law on Township and Village Enterprises, P.R. China, 1996.
4. China's industrial enterprises are subdivided into eight groups based on the nature of ownership: the state-owned enterprises (SOEs), collectively-owned enterprises, privately-owned enterprises, individually-owned enterprises, jointly-owned enterprises, share-holding enterprises, foreign-owned enterprises and other types of enterprises. The major component of TVEs is the collectively-owned enterprises (Appendix 1).
5. Estimated from *China Statistical Yearbook, China Township and Village-Owned Enterprises Statistical Yearbook* and *China Foreign Economic Statistical Yearbook*, 1999.
6. According to Zheng *et al.* [1997] and Avkiran [2001], results under variable returns to scale is usually preferred when the estimation under constant returns to scale and variable returns to scale differ. Thus in this study we report mainly estimation results under variable returns to scale (VRS).
7. Following Bernard and Jensen [1999], assuming the production function across industries is homogeneous, we estimate the coefficients of a Cobb-Douglas type production function of value added on capital and labour for TVEs to obtain the share for labour ( $\alpha$ ). The estimated share of labour in TVE sector for the year 1995 is 0.39.
8. The statistical test for paired samples tests the null hypothesis that the means of SOE and TVE samples are equal. The probabilities associated with t-test are all 0.00 for every indicator.
9. Preliminary estimates indicate that unit labour costs of China's TVEs in principal export industries, such as textile, apparel, leather product and footwear industry, are also lower than that in comparable industries in Indonesia, Philippines, Thailand and India, her major competitors in world markets. This is either because China's wage rates are relatively low or because her labour productivity is higher. However data for wage rates, labour and output across national boundaries may not be strictly comparable and this issue is a topic for further research).
10. Weitzman and Xu [1994]. For an excellent discussion on productivity and ownership structure, see Nolan [1995]; Sachs and Woo [1997]; Dong and Putterman [1997]; Zheng, Liu and Bigsten [1998].
11. Comparative advantage is measured by revealed comparative advantage index developed by Balassa [1965] as follows,

$$RCA = (X_{ij} / X_{wj}) / (\sum_j X_{ij} / \sum_j X_{wj})$$

where  $i$  is the country,  $j$  is the commodity and  $w$  is the world. Detailed information of the measurement of predetermined variables and sources of the data is given in Appendix 2.

12. The t-statistic of -3.70 for exports-residual in the labour productivity (VAL) equation and -3.55 in the technical efficiency (TE) equation suggest that there is significant endogeneity between exports and productive efficiency in the sample. Therefore we utilise the 2-Stage Least Squares (2SLS) for labour productivity (VAL) equation and 2-Stage Tobit model for technical efficiency (TE) equation. The White heteroscedasticity statistics (cross term) suggest the existence of heteroscedasticity. Thus, we adopt White's heteroscedasticity-consistent estimates for the standard errors and t-ratios.
13. When the 3SLS estimates are compared with those for the seemingly unrelated regression, Hausman specification test statistics ( $\chi^2$ ) which are as high as 918 strongly suggest the endogeneity between exports and productive efficiency.

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APPENDIX 1  
OWNERSHIP STRUCTURE OF CHINESE ENTERPRISES, 1995

Sector	Gross industrial output	
	Value 100million yuan	Percentage of total %
Total	80519	100
State-owned enterprises	25890	32
Collective-owned enterprises	28541	35
Private-owned enterprises	2334	03
Individual-owned enterprises	9632	12
Joint-owned enterprises	652	01
Share-holding enterprises	2727	03
Foreign invested enterprises	10660	13
Others	78	00
of which		
Township and village-owned enterprises	36257	45
of which		
Township-owned enterprises	11682	15
Village-owned enterprises	11906	15
Rural joint/co-operative enterprises	1631	02
Rural private-owned enterprises	2295	03
Rural individual-owned enterprises	8742	11

Source: The third national industrial census of China, 1995.

APPENDIX 2  
DATA SOURCES AND VARIABLE MEASUREMENT

This study employs two data sets. One is a cross-industrial data set combined data derived from 'The Third National Industrial Census of P.R.China' 1995, various issues of *International Yearbook of Industrial Statistics*, UNIDO and *International Trade Statistical Yearbook*, UN. The other is a panel of data for TVEs across 29 provinces over the time period 1987-98 collected from the *China Township and Village Enterprises Yearbook* and the *China Agricultural Statistical Yearbook*. Tibet, Congqing and Hainan are omitted because of incomplete data. The measurement of variables use in the study in given below.

- PE* = productive efficiency. In this study we regress two measures of efficiency respectively: the labour productivity (VAL) measured by value-added per employee and technical efficiency (TE) which obtained by data envelopment analysis (DEA).
- EX* = outward-orientation, measured by export value of the industry;
- MS* = management intensity, measured by bonuses per employee. In the case of the panel data set, it is measured by bonuses per employee and retained profits per employee alternatively. Bonuses of TVEs in the cross-industry data set equals to *profits payable* times the ratio of bonuses to profits payable estimated from the *Statistical Yearbook of Township and Village Enterprises*, 1995.
- WS* = workforce skills, measured by wage rates per production worker;
- FS* = firm size, measured by average output per firm in industry *i* to total output of industry *i*;
- KI* = capital intensity, measured by capital-labour ratio;
- DO* = sector dummy, 1 for TVEs and 0 for SOEs;
- MARKS* = market size, measured by total output of the industry;
- CA* = comparative advantage, measured by estimated revealed comparative advantage index developed by Balassa [1965]; the data are collected from United Nation's *International Trade Statistical Yearbook* at the three-digit level.
- PI* = policy dummy, which equals to 1 for the industries which are favoured by government export-promoting policy and 0 for others.

