ISSN 1471-0498

DEPARTMENT OF ECONOMICS
DISCUSSION PAPER SERIES

HOW PRODUCTIVE IS CHINESE LABOUR?
THE CONTRIBUTIONS OF LABOUR MARKET REFORMS, COMPETITION AND GLOBALISATION

Linda Yueh

Number 418
December 2008

Manor Road Building, Oxford OX1 3UQ

How Productive is Chinese Labour?
The Contributions of Labour Market Reforms, Competition and Globalisation

Linda Yueh
University of Oxford
linda.yueh@economics.ox.ac.uk

December 2008

Abstract. Productivity advances drive long-run economic growth, and a crucial factor is labour productivity improvements. The productivity of labour in China was marginally relevant in the pre-1978 period, but the picture has changed dramatically in the reform period due to numerous labour market reforms as well as radical changes in ownership structure whereby the dominance of state-owned enterprises has given way to the rise of private sector firms and globalisation. Using a national firm-level panel data set from 2000 to 2005, this paper hypothesises that labour productivity has improved as a result of labour market reforms, increased competition, and greater opening to the global economy, and finds that all of these factors to be important.

JEL Codes: J24, O12, O53

Keywords: Labour productivity, China, economic reform

Acknowledgements: The support of a British Academy Larger Research Grant is gratefully acknowledged. Research assistance was kindly provided by Markus Eberhardt, Lefu Li, and Jing Xing. The helpful comments of the participants of The Microeconomic Drivers of Growth in China conference organised by the University of Oxford and the China Center for Economic Research at Peking University are appreciated, particularly those of Albert Guangzhou Hu.

1. Introduction

Productivity advances drive long-run economic growth, and a crucial factor is labour productivity. The productivity of labour in China was marginally relevant in the pre-1978 period when the labour market was administered, wages were centrally determined and detached from effort (Knight and Song, 2005). However, the picture has changed dramatically in the post-1978 reform period due to numerous labour market reforms as well as radical changes in ownership structure whereby the dominance of state-owned enterprises (SOEs) has given way to the rise of private sector firms and globalisation, all of which introduce competition into the previously planned economy.

Labour market reforms have included liberalising wages to better reward productive characteristics such as education, as well as increasing job mobility to permit better matching between worker and employer characteristics, leading to a more competitive labour market (Knight and Yueh, 2004). Ownership reform has also progressed significantly throughout the reform period (Dougherty *et al.,* 2007). From state-owned enterprises dominating GDP to accounting for less than half of China's output by 2005 (NBS, 2006), China's economy is therefore increasingly characterised by private sector competition (Jefferson *et al.,* 2006). Moreover, the "open door" policy culminated in membership of the World Trade Organisation (WTO) in

2001, which heralded a period of global integration and market opening, which again results in greater competitive pressures.

These changes are hypothesised to influence labour productivity in the following ways. The value of marginal product (VMP) of labour is equal to the wage in a competitive labour market, which is a far cry from the administered wage system of China where compensation depended on age and seniority, among other factors, all of which were unrelated to effort (Yueh 2004). Reform of the labour market better aligns VMP, which is the product of the marginal product of labour (MPL) and the price of the good (P), with the wage: VMP = MPL x P. Therefore, by liberalising wages to match effort, MPL should be raised as a result of rewarding effort exerted in producing output. Also, reforms to increase the flexibility of labour markets during the 1990s allowed workers to move to firms which better match their skills and thus improve productivity. This stands in stark contrast to the lifetime employment system that resulted in over-manning and surplus labour, which reduced productivity as labour, like other factor inputs, is subject to decreasing returns. Reforms geared toward a more competitive labour market would thus increase labour productivity.

As the VMP = MPL x P equation further suggests, wages are not only determined by effort, but a function of MPL together with the price of the good. When prices are administered, then demand for, and the quality of, a good do not matter as in a competitive market and thus would stifle labour

productivity if wages are kept down despite higher MPL by a state-run product market. The rise of the non-state sector in China foretells of increased competition in which markets would better respond to the forces of demand and supply. Competition may well drive down prices as well as increase them, but market forces rather than administrative ones would operate to appropriately reward firms.

Factor and product market reforms, therefore, play a notable role in increasing labour productivity. Labour productivity is also influenced by the reform of the market for the other factors of production, notably, capital. With over-investment common in SOEs that seek their funding from the state or state-owned banks and the continued presence of the state-owned sector, the capital to labour (K/L) ratio is inefficiently high in China. By reforming the industrial sector and reducing obsolete capital, labour becomes more productive as K/L falls. The relationship is evident in the alternative formulation of VMP, which is the marginal revenue product (MPR) of labour, a more precise measure in less than perfectly competitive markets where price does not necessarily equal marginal revenue: MPR = MPL x MR. The marginal revenue of a firm depends on its productive efficiency and the demand conditions that it faces for its goods. A firm would only hire more workers if the value of the additional output from the worker was warranted by the marginal cost to the firm of that output. MRP, as with VMP, in turns determines wages and therefore the rewards to the marginal product of

labour. A firm's capital stock, as well as its industry conditions, would shape its revenue and cost curves.

It follows that labour productivity is further determined by not only the factor inputs but also by the technology and efficiency of the use of its workers and capital. A firm with lagging technology would be less efficient than one with more advanced production capabilities, affecting its cost curves and therefore the productivity of its workers. For Chinese and firms from developing countries which lag behind the know-how of competitors from more advanced economies, it would have lower labour productivity than otherwise comparable firms (see e.g., Blomström and Sjöholm, 1999, for the finding that firms with foreign equity in Indonesia had higher labour productivity). Globalisation and the incursion of foreign firms directly into the domestic market as well as act as competition in the global economy would expose these differences, while at the same offering an opportunity for Chinese companies to become exposed to, learn from and even obtain the technological know-how of those firms. This mechanism of learning from technology embodied in foreign capital is well-known and forms the basis for the theory of "catching up" often discussed in economic growth models (see e.g., Solow, 1956).

Using a national firm-level panel data set from 2000 to 2005, this paper investigates the contribution of these factors to improving labour productivity in China. The paper hypothesises that labour productivity has improved due

to labour market reforms, increased competition, and greater opening to the global economy. The extent of labour productivity advances would inform China's growth prospects and gauge the effectiveness of the policies geared at increasing the market-driven elements of the Chinese economy and aiming for the same goal of sustained growth (see Kokko, 1996, who argues that labour productivity essentially reflects the technological ability of firms which would constitute the long-run driver of economic growth of a country).

Few papers have focused exclusively on the determinants of labour productivity in China, though a large number has examined the factors influencing firm total factor productivity (TFP), including those impacting on the productivity of labour (see e.g., Jefferson and Su, 2006). Kraay (2006) investigates the role of exports on labour productivity using a panel of firms from 1988-1992 and finds a positive and significant influence. Jefferson *et al.* (2000), using a National Bureau of Statistics (NBS) of China data set covering 1980-1996, similarly find large increases in labour productivity, particularly for the 1990s, and notably for SOEs during this period attributed to the large scale layoff policy (*xiagang*) over the latter period. Jefferson *et al.* (2006) explore the sources of China's growth, including aspects of labour productivity, using a NBS panel data set of large and medium sized enterprises (i.e., those with sales over five million RMB) from 1995-2004. They conclude that there is evidence of improved allocative efficiency from labour moving out of

agriculture and between industrial and ownership sectors which reflect productivity advances.

Another strand of the literature views labour productivity in comparative perspective. Over the period 1952 to 1997, Wu (2001) concludes that China's comparative labour productivity increased from about 3.0 in 1952 to 7.6 in 1997 (USA= 100), showing a significant gap with the U.S. even after three decades of reform. Jefferson *et al.* (2006) likewise focus on China's international productivity gap and estimate that China's labour productivity must increase by some six-fold before it achieves a GDP per capita that is one-quarter that of the U.S. Although they find evidence that industries in the coastal regions are already nearly one-quarter of that of the U.S. by the early 2000s, the rest of China lags behind.

The conclusion across these studies emphasises on the importance of productivity in driving China's economic growth. Whether in comparative or internally comparative perspective across China's regions, assessing the factors which increase labour productivity will shed light on the reforms which have contributed to China's growth.

2. Data

The primary data set used in this paper is comprised of a national firm-level survey. The survey pertained to 2005 which was then matched by China's NBS to their annual enterprise survey to create a panel from 2000 to 2005. The

questionnaire was designed by an international research team, and carried out by NBS with support from the World Bank. The survey was conducted in the summer of 2006 on 1,268 firms in 12 cities (province in parenthesis): Beijing (municipality), Changchun (Jilin), Chifeng (Inner Mongolia), Dandong (Liaoning), Hangzhou (Zhejiang), Shijiazhuang (Hebei), Shiyan (Hubei), Shunde (Guangdong), Wujiang (Jiangsu), Xian (Shaanxi), Zibo (Shandong), Chongqing (municipality). The survey data was then matched to the enterprise panel and is a representative sub-sample of that large-scale data set. The National Bureau of Statistics takes considerable care with their annual enterprise survey such that the figures match data obtained independently by the Chinese tax authorities.

After matching the data to the NBS panel, observations with incomplete information were eliminated, so the data used is comprised of unbalanced panel data from 1,201 industrial firms for the years 2000-2005 for which 2005 provides survey information as well as the NBS data. The information was also checked against the provincial level data, which revealed that the sub-sample is broadly in line with the provincial averages. Comparison with the averages for other studies using the large NBS firm-level data set (Dougherty *et al.*, 2007) yielded similar results. Also in line with most enterprise firm studies, the survey only covered firms with an annual sales volume larger than 5 million Yuan following the NBS practice (see e.g., Jefferson and Su, 2006). The NBS data set only includes firms in industry, and

does not include construction and transportation companies. Thus, the majority of firms operate in the manufacturing sector, with a small number of firms in mining or utilities.

To avoid influential observations due to reporting error, the production data is cleaned using standard procedures of "windsorising": for the pooled data on firm-level value-added, capital stock and labour, the values at the 1st and 99th quantile of the distribution is first determined. Then, all observed values below the former cut-off are replaced with that of the 1st quantile and all observed values above the latter cut-off with that of the 99th quantile. Additional information available allows for identification of firms which are multi-plant groups. Data for multi-plant enterprises may lead to bias in the estimates, and are controlled for with a separate dummy variable in the estimations, as is the age of the firm. The year of entry into the data set is also controlled for with a dummy variable to control for any bias resulting from the date of appearance in the data set.

Other sources of data used in the paper include the 2002 CHIP (China Household Income Project) national household survey as well as data from the International Labor Organization (ILO) and China's national and provincial statistical yearbooks. These sources of data are used to provide additional measures of interesting variables rather than form the core of the estimations, which utilise the firm-level data set.

3. Measuring Labour Productivity

FIGURE 1 HERE

FIGURE 2 HERE

TABLE 1 HERE

Figures 1 and 2 show China's labour productivity in comparative perspective and over time relative to a starting point in 1980 when it began its market-oriented reforms. Figure 1 in particular shows the extraordinary gains in labour productivity in China since then. Gains in GDP per worker in manufacturing were steady and comparable to international increases until the early 1990s when China's "open door" policy took off. After which, whilst other major economies experienced a nearly tripling of productivity and India improved more modestly, China's productivity levels increased nearly seven-fold. The productivity leader nevertheless remains the USA, which is evident in Figure 2. China is around $1/8^{th}$ as productive as the leader, although its gains are much faster than the richer country. By 2005, as seen in Table 1, China's GDP per worker in the broader economy as well as in manufacturing was still modest relative to other comparable sized economies due to its low level of development, which contributes to its cost advantage. However, it has had faster labour productivity growth even against a similarly poor country such as India, which contributes to China's faster overall GDP growth.

Turning to the microeconomic data used in this paper, Table 2 provides measures of the levels and growth rates of labour productivity. Per the

standard computation, value-added is the sum of profits, profit taxes, wages and additional labour compensation (insurance and welfare payments). The value-added measure was deflated by the Ex-Factory Price Index of Industrial Products, while the capital stock was deflated by the National Price Index for Investment in Fixed Assets (NBS 2006). Table 2 shows that average annual real value-added per worker was 50,259 RMB over 2000-2005 with an annual average growth rate of 4.77%. This is in line with other raw estimates of labour productivity growth during the reform period, which have been around 4-6% (see Jefferson and Rawski, 1994). The growth rate slows considerably between the first half of the period (2000-2003) of nearly 10% real per annum growth to around 1.5% for 2003 to 2005. The pattern is echoed in the average profit per worker, growth of which was around 6% for the period but slowed down from over 12% in the first half to just over 2% during the latter half. Measured in terms of sales per worker, the real annual average growth rate is an impressive 13.5% for the sample time frame, with per annum growth rate speeding up in the latter half of the period (14.7% from 2003-2005 from 11.8% in 2000-2002). Although imprecise as a measure of labour productivity, the sales measure indicates that real output per worker has grown rapidly over the period 2000-2005, while growth in profits and value-added had slowed. It suggests that margins are becoming tighter. Figure 3 shows the evolution of labour productivity levels over time over 2000-2005, while Figure 4 provides the annual growth rate over the same period which maps out the noted trends.

TABLE 2 HERE

FIGURE 3 HERE

FIGURE 4 HERE

China's industrial sector has also changed dramatically over the past few decades, particularly seen in the diverse ownership structures of enterprises in the 2000s. Since the *gaizhi* or restructuring policy of the late 1990s, the non-state sector has increased its presence in China's economy, accounting for ever larger shares of industrial output. The non-state sector comprises of privatised SOEs, private Chinese firms and foreign invested enterprises (FIEs), such as Chinese-foreign joint ventures (JVs) and wholly foreign-owned enterprises (WOFEs). FIEs can be further disaggregated into those from Greater China (Hong Kong, Macau and Taiwan) and other countries. Since the establishment of the two stock exchanges in Shanghai and Shenzhen in the early 1990s and the more recently permitted overseas listings, a number of firms have become publicly listed (*gufen)* companies. Tables 3-7 provide descriptive information, including measures relating to human capital, listing and export capacity of such firms. Given the diversity, ownership sector and listing are controlled for before any interpretations are made of the drivers of labour productivity.

TABLE 3 HERE

Table 3 provides firm-level information on value-added, employees, capital stock and the wage bill for the different types of enterprises. It shows that mean value-added per firm is highest for JVs from countries other than Greater China and lowest for private Chinese firms, although WOFEs from other countries have the highest median value whilst the lowest remains that of private Chinese firms. Mean number of employees is highest in SOEs and lowest for private firms, while the median gives a similar picture but for the tie for largest with Greater China WOFEs. Capital stock is highest for SOEs measured in means, but greatest for other WOFEs when measured in medians which is less prone to skewness in the data. Private Chinese firms continue to have the lowest value of the different ownership types in both mean and median. Finally, the firm mean wage bill is highest in SOEs and lowest in private firms. But, when measured in medians, the highest wage bill belongs to Greater China WOFEs and the lowest still for Chinese firms. The firm characteristics indicate that private Chinese firms tend to be the smallest in terms of labour and capital, as well as value-added, while the privatised SOEs are only slightly larger.

TABLE 4 HERE

Table 4 provides information on average firm characteristics per worker: value-added per worker, capital stock per worker or the capital/labour ratio, wage bill per worker, hourly wage and the average number of hours worked per week. Value-added per worker is highest in other JVs by both average measures, while the lowest is privatised SOEs, again measured in terms of mean and median. The raw descriptives indicate that FIEs all have higher labour productivity than Chinese firms with SOEs at about the same level as private Chinese firms on average. Capital per worker is also uniformly higher for FIEs than Chinese firms, while SOEs have more capital per worker than other Chinese firms. The largest capital to labour ratio is found in WOFEs from other countries. Wage bill per worker is also higher for FIEs, though the hourly wage for SOEs exceeds that of WOFEs from Greater China and is broadly in line with FIEs rather than domestic firms. Of the FIEs, WOFEs from Greater China pay the lowest hourly wage and have the second longest hours in a working week (46 hours). The most hours worked per week on average is in private Chinese firms, while SOEs and other JVs have the shortest working week (around 42 hours). The median values provide a similar picture with the longest hours worked in Chinese firm as compared with FIEs.

TABLE 5 HERE

Table 5 provides some measures of human capital of the labour force (the share of workers with secondary and higher education and the share of managers with higher education), including for the different ownership types. Across all firms, some 62% of workers have secondary education, with more educated workers found in Greater China WOFEs and the least educated in other WOFEs. In terms of higher education, the proportion falls considerably to some 20% across all firms, and the lowest found in privatised SOEs and highest in Greater China JVs. FIEs have, on average, more educated workers than private Chinese firms. The picture is more varied when considering the share of managers with higher education. Across all firms, around 40% of managers have higher education. The lowest proportion is found in JVs from other countries while the highest proportion is in WOFEs also from other countries. SOEs have higher shares than other Chinese firms, though all Chinese firms have more educated managers than FIEs except for WOFEs from other countries.

TABLE 6 HERE

Table 6 shows the percentage of firms which are listed on domestic or international stock exchanges. The average is just under 5% of all firms, with SOEs having the highest proportion at over 12%. The lowest share of listings is found in private Chinese firms, privatised SOEs and Greater China WOFEs.

Among FIEs, more WOFEs from other countries are listed than other ownership types.

TABLE 7 HERE

Table 7 provides information on the proportion of output that is exported to global markets. Most firms either do not export or export less than 1% of their output. Across firms, the average export share is 11.5% with other WOFEs exporting more than other types of FIEs and SOEs exporting a greater proportion of their output than other domestic firms. Greater China WOFEs have the smallest share of exports in their total output, while private Chinese firms also export just a fraction more of their output. Both types of firms appear to be producing for the domestic Chinese market, while other WOFEs, SOEs, and both types of JVs export a greater share of their products.

4. Empirical approach

In a standard production function, y_{it} is determined by the following equation:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \varepsilon_{it}, \qquad (1)$$

where y_{it} represents the log form of output such as value-added (y) for firm i at time t produced by inputs of capital (k_{it} is the log of capital) and labour (l_{it} is the log of labour) and an error term (ε_{it}) which could represent technology, managerial ability, etc. The error term has the usual form of:

$$\varepsilon_{it} = \eta_i + \nu_{it} + \mu_t, \qquad (2)$$

where η_i is the time invariant fixed effect, μ_t are time dummies, and v_{it} is an AR(1) error term:

$$\nu_{it} = \rho \nu_{it-1} + \varepsilon_{it}. \qquad (3)$$

If there are unobservable firm-specific effects (such as managerial quality) which are correlated with both the dependent and the explanatory variables in the OLS estimation, then a fixed-effects estimator can be used to sweep out unobserved firm-specific differences. Also, the inputs can be endogenous with respect to $\varepsilon_{it,}$ which will cause biased results in OLS. To control for the time-invariant factors, first differences of equation (1) can be taken so that the η_i terms are eliminated. However, in first differences, there will not be any instruments for the factor inputs because lags of y_{it} and the factor inputs are correlated with past ε_{it} shocks and the autoregressive error term. Instead, the model can be transformed into a dynamic model with serially uncorrelated shocks that can be estimated using levels and differenced equations using a difference GMM estimator (Hansen, 1982; Arellano and Bond, 1991). But, the capital terms are likely to be highly autocorrelated, so using just the difference equations will be problematic due to the potential bias from weak instruments in finite samples. Thus, Blundell and Bond (2000) propose using the extra moment conditions (see also Blundell and Bond, 1998). This means that lagged differences are used as instruments for the levels equations, in addition to the lagged levels as instruments for the differenced

equations in the system GMM. The overall validity of the moment conditions is tested through the Sargan test with the null hypothesis that the instruments are valid or exogenous. Where the number of over-identifying restrictions is large, the Sargan test may have low power to reject the null hypothesis. Therefore, the Difference-in-Hansen tests for the validity of the additional lagged differences instruments in the levels equation are also both used as diagnostics in the system GMM procedure.

5. Estimating Labour Productivity

To estimate labour productivity, equation (1) is re-written as follows:

$$VA_{it} = \beta_1 k_{it} + \beta_2 l_{it} + \omega_i + \chi_t + \varepsilon_{it}, \qquad (4)$$

where VA_{it} is value-added per worker (in logs), capital and labour are as before, ω_i represents time invariant characteristics which affect firm performance such as industry, ownership of firm as non-state firms and FIEs from different origin countries may have differential effects from SOEs as well as if the firm is listed and publicly traded on a stock exchange, the industrial sector at the two-digit level to account for different manufacturing sectors, location to control for the province; and also other control variables such as age of firm and if it is part of a multi-plant firm as well as the year of entry into the data set. χ_t is the change in the macroeconomic conditions from year to year, and ε_{it} is the error term. Identifying the specific variables of interest, equation (4) is rewritten as:

$$VA_{it} = \beta_1 k_{it} + \beta_2 l_{it} + \beta_3 LM_{it} + \beta_4 COMP_{ti} + \beta_5 G_{it} + \beta_6 \omega_i + \beta_7 \chi_t + \varepsilon_{it}. \quad (5)$$

Equation (5) further identifies the factors that contribute to labour productivity, such as labour market reforms (LM_{it}), extent of competition ($COMP_{it}$) and globalisation (G_{it}). Equation (5) can be estimated using OLS. As OLS is biased by the presence of unobservables such as managerial ability, a fixed effect estimator removes firm-specific unobservables. However, the potential endogeneity of inputs would call for an IV approach, such as GMM. Robust error terms clustered at the firm level are also estimated.

The various measures for labour market reforms, competition and globalisation are necessarily imperfect as are all proxies. In each of the categories, a variety of measures are utilised to attempt to identify the reforms, e.g., improved returns to education or greater competition, have contributed positively to labour productivity. Although the proxies from the firm-level survey are hypothesised to be exogenous and the relevant diagnostic tests performed and reported, measures are also sought from outside of the panel data set which are evidently exogenous to the firm. The regional and provincial measures are less likely to be subject to endogeneity bias.

Table 8 provides a summary of the descriptives of the variables used in the estimations, while Table 9 provides baseline estimates of labour productivity using the various approaches.

TABLE 8 HERE

TABLE 9 HERE

Table 9 reports the estimated labour productivity function. The OLS specification is revised by the FE estimator which removes the firm-specific time-invariant unobservables. However, as there may still be endogeneity of inputs, so the GMM results are relied upon as unbiased so long as the instruments are valid. The OLS, FE and GMM estimations are reported, along with the relevant diagnostic tests. Reassuringly, the GMM estimates lie between the OLS and FE estimations, suggesting a consistent dynamic panel estimator.

The Sargan test does not reject the validity of the instruments even when the Windmeijer (2005) finite-sample correction is implemented, which addresses the severe downward bias of the standard errors which causes the Sargan test to under-reject. Also, the Difference-in-Sargan test of the validity of the additional lagged differences instruments in the level equations also does not reject the null hypothesis that those instruments are exogenous.

The trend growth rate for labour productivity is found to be comparable between the FE and GMM estimators. Interpreting the GMM estimates, the trend is around 5.7% per annum, indicating a strong rate of growth that is also roughly commiserate with the raw estimates. Before

turning to investigating the various possible factors affecting labour productivity, it is worth taking into account whether there are notable differences across manufacturing sectors.

TABLE 10 HERE

TABLE 11 HERE

To investigate further the possible differences in TFP across industries that could confound the results, Table 10 first presents these estimates by industry after amalgamating the 2 digit categories into 14 sectors, and is followed by Table 11 which estimates factor intensities and TFP by allowing for heterogeneous production technologies.

There is some evidence of decreasing returns to scale based on the significantly negative labour coefficient relative to the average use of labour in two industries which are fairly capital intensive, namely, oil processing, coking and nuclear fuel processing as well as machinery, equipment and instruments. There are also differences in the factor intensity of capital. For the machinery, equipment and instruments sector, the transportation equipment sector and electric power and utilities, there is evidence of significant higher value added per unit of capital relative to the average use of capital. The TFP of the different industrial sectors do not vary significantly from that of the omitted

category of machinery, equipment and instruments, suggesting no significant sectoral differences.

Having established the baseline model and investigated possible differences in TFP across industrial sectors that could have influenced the findings, the next section can proceed to investigate the three factors identified as potentially influential in labour productivity, i.e., labour market reform, competition and globalisation.

6. The contributions of labour market reform, competition and globalisation

A. Labour market reforms

Over the course of China's reform period, a system of allocated labour whereby workers were allocated to jobs for life was replaced by an increasingly competitive labour market (Knight and Song, 2005). The result was greater returns to human capital in the form of wages and compensation was linked to performance rather than an administered pay scale (Yueh, 2004). These labour market reforms – greater returns to education – are posited to improve labour productivity. The human capital of workers has been found as a significant contributor to productivity growth (see Hall and Jones, 1999 who attribute the higher output per worker to the role of human capital in a cross-country growth regression).

Using data from the survey on the human capital of workers and managers as well as exogenous information on returns to education for the

region, the baseline model will be extended to test whether human capital improves value-added per worker in China. The three survey variables used are found in Table 4: share of workers with secondary education and higher education and share of managers with higher education.

The second set of variables measures regional differences in terms of the development of the labour market. Labour market competitiveness is measured by different returns to education, as more competitive labour markets would reward education and human capital more than an administered one. The information is from the 2002 China Household and Income Survey (CHIP), which is a national household survey covering both rural and urban areas with detailed information on individuals' education, employment, income and other personal characteristics (see Gustafsson *et al.,* 2008 for details of the data). Returns to secondary and higher education are calculated for three regions (coastal, central and western) of China and the time frame suits the panel used in this paper. The estimates are found in the Appendix. Beijing, Dandong, Wujiang, Hangzhou, and Zibo belong to the coastal region; Xi'an, Shiyan and Chongqing to the western region; and the rest (Changchun, Chifeng, Shijiazhuang, Shunde) are in the central region. In terms of years of education, the coastal region generates an income premium of nearly 6% for every year of education, while the figures are lower for the central (4.8%) and western (4.7%) regions, though the difference between the latter two is insignificant. The regions with the highest returns to higher and

secondary education are the coastal and western ones, while the central region has lower returns. More competitive labour markets should better reward human capital such as those accumulated in educational attainment, so regional differences should serve as indicators of the effect of labour market reforms on labour productivity that are exogenous to the firm.

TABLE 12 HERE

Table 12 reveals the attainment of secondary education of workers has an insignificant effect on labour productivity, but higher education has a significantly positive effect for both workers and managers. Labour productivity is also found to be lower across all measures of human capital returns in the central region than the others, which is the region with the lowest returns to secondary and higher education as well as to each year of education. The coastal region with the most competitive labour market is found to generate the largest improvements in labour productivity relative to the omitted category of the central region, whereas there is no significant difference between the western and central regions. These estimates indicate that labour market reform resulting in more competitive labour markets have the expected effects on labour productivity in firms which locate in these regions.

Increasing the human capital of workers, specifically the proportion with higher education, by 1% will result in a 23% improvement in labour productivity. Similarly, increasing the share of managers with higher education by a comparable amount will improve labour productivity by nearly 13%. Locating in the coastal provinces with more competitive labour markets will raise labour productivity by 36.2% as compared with the interior or western regions. All of the measures suggest that more competitive labour markets will generate greater labour productivity.

B. Competition

One of the main conclusions from studies of other transition economies undergoing transformation from centrally planned to market economies is the importance of competition (see Estrin 2002). For instance, Earl and Estrin (2003) found that labour productivity increased in Russia due to increased product market competition, among others.

The extent of private sector competition in China will be measured by the responses of firms which assess the extent of competition in their markets as well as by exogenous measures of marketisation and private sector development in the province. Firms were asked to assess the extent of product market competition in their industry on a scale of 1-3, where 1 is fierce, 2 is standard and 3 is low. Competition is also measured by two province-level variables. First, the NERI China Marketization Index is used as a measure of the extent of market-oriented development of the province. The

share of private sector output in the total industrial output of a province is the other measure. Both of these would contemplate the extent of market forces driving competition that are outside the purview of the firm.

TABLE 13 HERE

Table 13, column (2) indicates that perceived product market competition increases value-added per worker. The coefficient in column (1) was insignificant when estimated by OLS, but becomes significant in the GMM estimates. As GMM addresses simultaneity bias, the estimates are preferred if the explanatory variable can be argued to be exogenous. As this question picks up perceptions of firms, it may well not be exogenous to the performance of the firm, so the effect should be interpreted cautiously and competition will be measured by provincial level variables that are more likely to be exogenous. Firms which perceive that they are in competitive markets are the more productive ones, lending support to the notion that competition improves productivity.

This conclusion is supported by the provincial level measures of the extent of competition. The NERI Marketization Index finds that greater market development increases labour productivity (see column 4). As the most recent index only provides indicators up to 2002, the estimation included only the first three years of data, but the effect was nevertheless significant. This is

supported by another measure of the extent of competition, which is the share of private sector output in a province. This measure also has a positive and significant effect on labour productivity as seen in column (6). Neither measure is perfect in capturing the extent of competition, but their findings are consistent and support the hypothesis that greater market development increases labour productivity. Moving an increment on the perceived competition variable is associated with a 10% increase in labour productivity, while one increment move in the NERI index induces an 8% improvement. Increasing the share of private sector output in total provincial output by 1% will generate a 41% increase in labour productivity.

C. Globalisation

A notable event in the 2000s for China is its accession to the WTO in 2001, although greater opening and global integration had occurred significantly throughout the 1990s (see e.g., Yueh, 2006, for the estimate that China's export-to-GDP ratio doubled between 1990 to 2000 from 15% to 30% which is in the range of the Asian export-led economies of Singapore and occurred prior to WTO accession). Exposure to global markets is likely to improve efficiency due to the greater competitive pressures and potential to learn from the practices and more advanced know-how of international firms (see Kraay, 1999 who found that exporting increased labour productivity by 10% for a panel of Chinese enterprises over the period, 1988-1992). However, a number of studies contend that when micro rather than aggregate data is

used, exporting does not induce efficiency but rather that more productive firms self-select into export markets (see e.g., a review article by Wagner, 2007, who examined 54 firm-level studies from 34 countries covering the period 1995-2006 and concluded that exporting does not improve efficiency but that productive firms export; see also Clerides *et al*., 1998 and Melitz, 2003 respectively for theoretical concepts of firm heterogeneity and empirical studies that find that productive firms sell internationally while less productive ones serve the domestic market). Globalisation effects will be investigated using the information on whether exporting and technology transfers from foreign firms affect labour productivity. Again, exogenous measures of the extent of global integration of the province, e.g., export share of total provincial GDP, will be included.

TABLE 14 HERE

Both the extent of exporting by a firm or the province proves to be significantly positive in increasing labour productivity, as seen in columns (4) and (6) in Table 14. An increase in export share of 1% is associated with a nearly 10% increase in labour productivity for a firm, while the same increase at the provincial level will result in a 12% increase in value-added per worker.

Globalisation does not solely refer to exports. The other side of the equation is long-term capital flows either in the form of JVs or WOFEs. For

some years, China's FDI policy was geared at attracting foreign capital which had more advanced technology. As such, China exerted considerable control over FDI through soliciting and approving investments that could help its firms upgrade and move up the value chain. Therefore, although it became less common after WTO accession when FDI controls loosened, some JVs included technology transfer agreements signed whereby the foreign partner transferred technological know-how to the Chinese-foreign entity as part of the JV agreement. This is a rare measure of direct transfer of technology often assumed to be embodied in FDI that could generate productivity gains in developing countries. By including this variable, whether such technology transfer agreements are valuable in improving labour productivity in China can be investigated.

Of the 163 Chinese-foreign joint ventures, some 26 signed technology transfer agreements. These agreements are signed at the time of the formation of the JV, so should not be endogeneous with respect to current firm performance. The average age of such JVs is around 8.7 years, indicating that establishment in 1996-1997, which is the same mean age as JVs which did not sign technology transfer agreements. The oldest JVs were formed in 1979 at the start of market-oriented reforms. As Guangdong is included in the survey and it was one of the earliest provinces to open right at the start of reform, the data captures the earliest to the latest JVs which received technology transfers which were in 2005. The mean value of the agreement

was 14.39 million RMB with a largest contract worth 400 million RMB. Interestingly, often the Chinese side insisted on these transfers as they would be less costly than presumably licensing the same technology given the monopoly pricing of intellectual property. Thus, around 43% of such agreements were bundled as part of the capital investment in the JV without payment of additional consideration, supporting the favourable position of obtaining technology via this route instead of via the open market. Around one-fifth (21.1%) of firms reported producing new products with the technology obtained in these transfer agreements.

Table 14 column (2) shows that the signing of a technology transfer agreement increases labour productivity in a firm by nearly 57%, making it the largest contributor to productivity gains amongst the variables investigated in this paper. The other globalisation variables also reveal the association between exports and labour productivity. The third factor hypothesised to improve value-added per worker is therefore also supported.

7. Conclusion

Trend productivity growth measured in terms of value-added per worker has been a strong 5.7% per annum from 2000-2005. There are no notable industrial sectoral differences in terms of TFP, though there are different factor intensities, notably the higher value-added produced per unit of capital

in the machinery, equipment and instruments sector, the transportation equipment sector and in electric power and utilities.

The hypotheses that labour market reform, competition and globalisation result in increased labour productivity were supported except for the secondary education of workers which had no impact. As nearly two-thirds of workers have secondary education attainment, there is not more to be gained if this proportion increases. Rather, improving higher education for workers and managers would improve productivity. This is consistent with high levels of secondary educational enrolment in China as compared with much lower levels of attainment of tertiary education. In the first 30 years of reform, secondary education returns have improved as have the productivity of workers. At this stage of development, higher education is more important.

Perhaps the largest factor influencing labour productivity, though, is whether a Chinese-foreign joint venture signed a technology transfer agreement. By signing one, labour productivity is boosted by at around 57%. Not distinguishing joint ventures which have signed such agreements from plain vanilla ones, therefore, could confound the productivity gains from FDI and under-estimate the importance of China's selective policy toward foreign investors.

The findings suggest that capital infusion embodying technological know-how as well as market-oriented reforms in factor and product markets have made significant contributions to improving labour productivity in the

2000s. In particular, China's policy of obtaining technology as part of forming JVs appears to be successful in improving labour productivity. Labour productivity is a key factor in China's continuing growth prospects. Obtaining technology, as well as encouraging competition and further labour market reforms aimed at higher education would be fruitful. Sustaining China's development will therefore require attention to maintaining the momentum of its market-oriented reforms as its firms seek to increase their value-added per worker which will induce longer term growth effects if the improvements take the form of sustained productivity enhancements.

References

Arellano, M. and Bond, S.R. (1991). "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations," *The Review of Economic Studies,* 58, 277-297.

Blomström, M. and Sjöholm, F. (1999). "Technology transfer and spillovers: Does local participation with multinationals matter?" *European Economic Review,* 43, 915-923.

Blundell, R.W. and Bond, S.R. (1998). "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics,* 87, 115-143.

Blundell, R.W. and Bond, S.R. (2000). "GMM estimation with persistent panel data: An application to production functions," *Econometric Reviews,* 19, 321-240.

Clerides, S., Lach, S., and Tybout, J. (1998), "Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco," *Quarterly Journal of Economics,* 113, 903-47.

Dougherty, S., Herd, R. and He, P. (2007). "Has a private sector emerged in China's industry? Evidence from a quarter of a million Chinese firms," *China Economic Review,* 18, 309-34.

Earl, J. and Estrin, S. (2003). "Privatization, competition, and budget constraints: Disciplining enterprises in Russia," *Economics of Planning*, 36, 1-22.

Estrin, S. (2002). "Competition and corporate governance in transition," *Journal of Economic Perspectives*, 16, 101-124.

Gustafsson, B., Li, S. and Sicular, T. (2008). *Inequality and Public Policy in China.* Cambridge: Cambridge University Press.

Hall, R.E. and Jones, C.I. (1999). "Why do some countries produce so much more output per worker than others?" *Quarterly Journal of Economics,* 114, 83-116.

Hansen, L. (1982). "Large sample properties of Generalized Method of Moments estimators," *Econometrica*, 50, 646-660.

Jefferson, G.H., Hu, A.G.Z., and Su, J. (2006). "The sources and sustainability of China's economic growth," *Brookings Papers on Economic Activity,* 2, 1-60.

Jefferson, G.H., Rawski, T.G. (1994). "Enterprise reform in Chinese industry," *The Journal of Economic Perspectives*, 8, 47-70.

Jefferson, G.H., Rawski, T.G., Li, W. and Zheng, Y. (2000). "Ownership, productivity change, and financial performance in Chinese industry," *Journal of Comparative Economics,* 28, 786-813.

Jefferson, G.H. and Su, J. (2006). "Privatization and restructuring in China: Evidence from shareholding ownership, 1995-2001," *Journal of Comparative Economics*, 34, 146-166.

Knight, J. and Song, L. (2005). *Towards a Labour Market in China.* Oxford: Oxford University Press.

Knight, J. and Yueh, L. (2004). "Job mobility of residents and migrants in urban China," *Journal of Comparative Economics,* 32, 637-660.

Kokko, A. (1996). "Productivity spillovers from competition between local firms and foreign affiliates," *Journal of International Development*, 8, 517-530.

Kraay, A. (2006). "Exports and economic performance: Evidence from a panel of Chinese enterprises," in Hoekman, B.M. and Javorcik, B. (eds), *Global Integration and Technology Transfer,* Washington DC: The World Bank, pp. 139-160.

Melitz, M.J. (2003). "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica,* 71, 1695-725.

National Bureau of Statistics (NBS). (2006). *China Statistical Yearbook*. Beijing: China National Bureau of Statistics.

Solow, R. (1956), "A contribution to the theory of economic growth," *Quarterly Journal of Economics,* 70, 65-94.

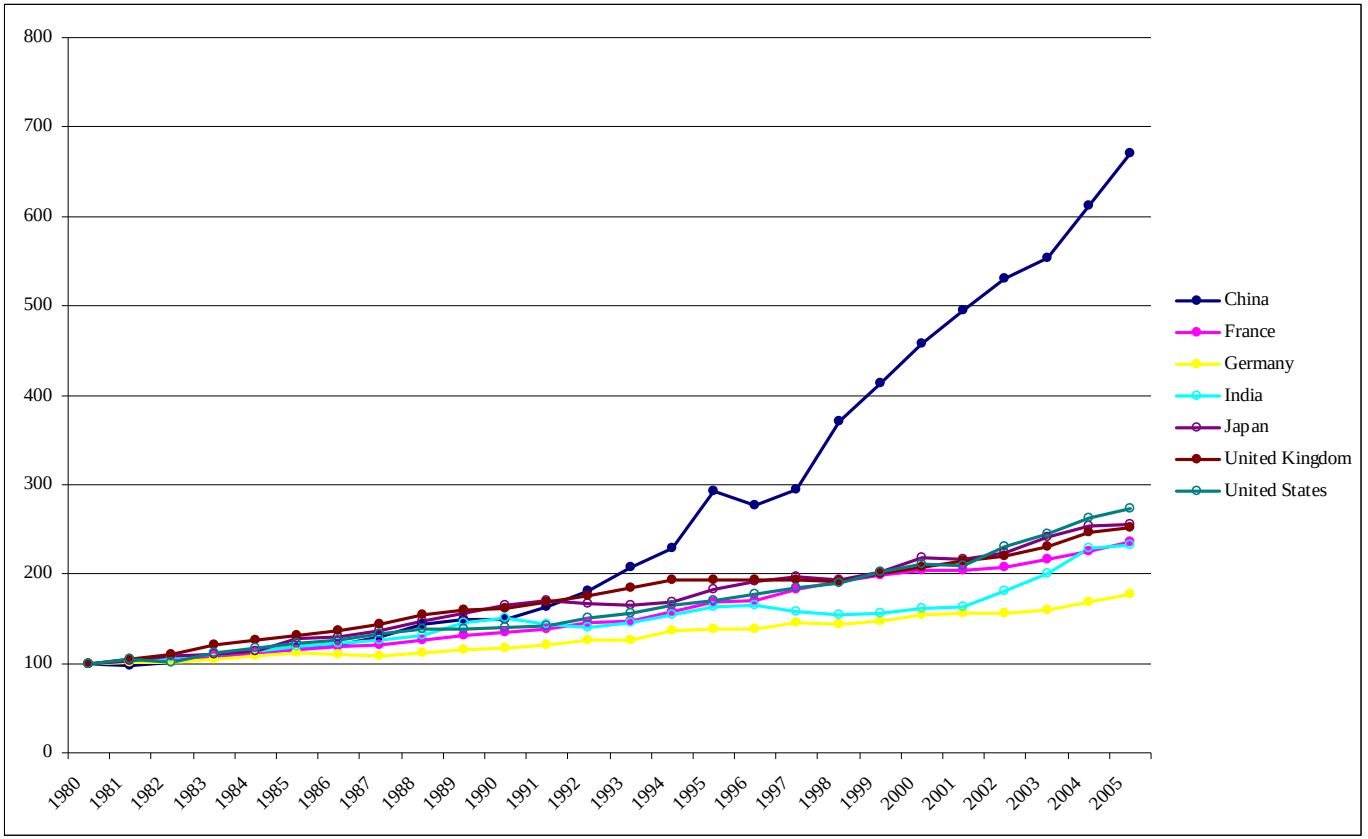
Wagner, J. (2007). "Exports and productivity: A survey of the evidence from firm-level data," *The World Economy,* 30, 60-82.

Windmeijer, F. (2005). "A finite sample correction for the variance of linear efficient two-step GMM estimators," *Journal of Econometrics*, 126, 25-51.

Wu, H.X. (2001). “China's comparative labour productivity performance in manufacturing, 1952–1997 Catching up or falling behind?” *China Economic Review,* 12, 172-189.

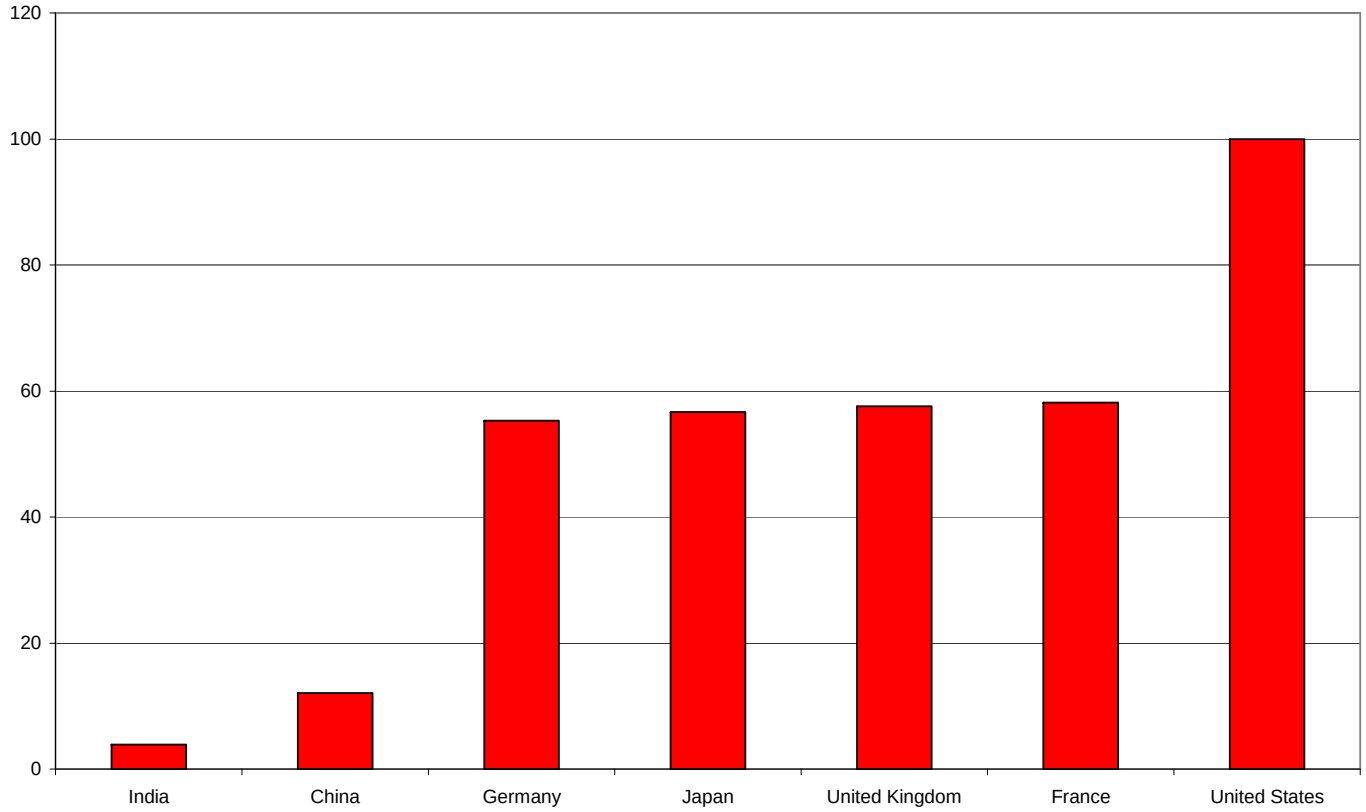
Yueh, L. (2004). “Wage reforms in China during the 1990s,” *Asian Economic Journal,* 18, 149-164.

Yueh, L. (2006). “China’s competitiveness, intra-industry and intra-regional trade in Asia,” in Yao, Y. and Yueh, L. (eds.), *Globalisation and Economic Growth in China*, Singapore: World Scientific Co. Pte. Ltd., pp. 139-158.



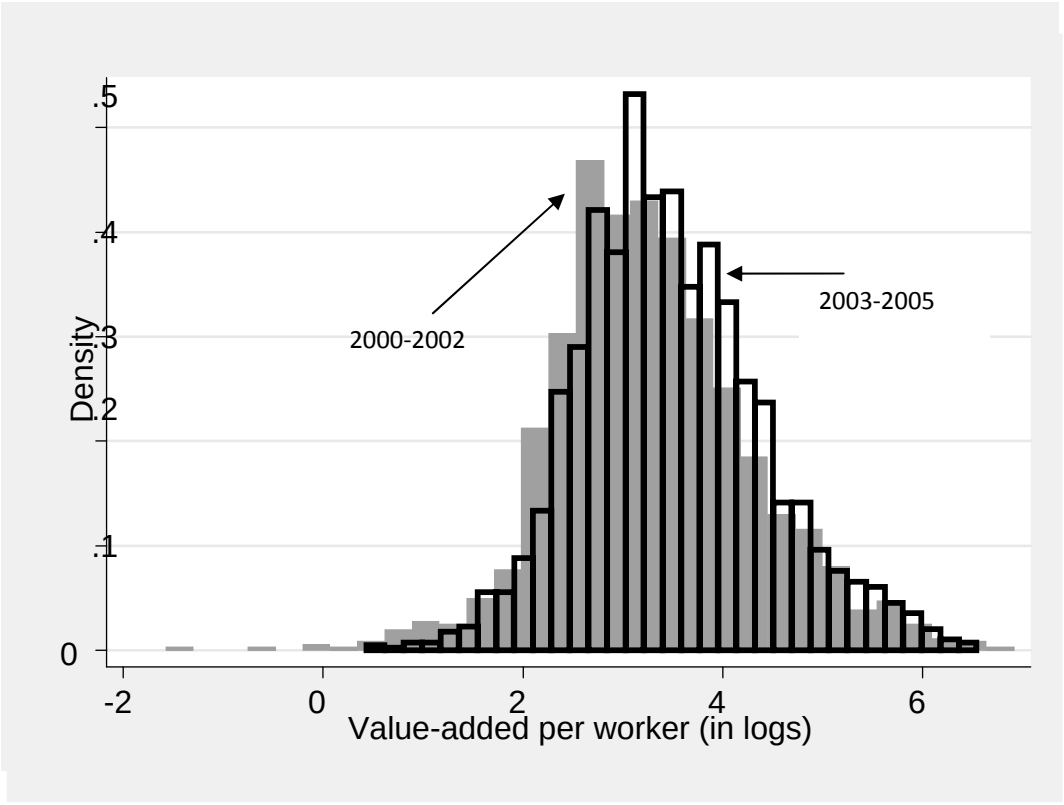
Source: ILO.

Figure 1
GDP per Worker in Manufacturing (1980=100), 1980-2005



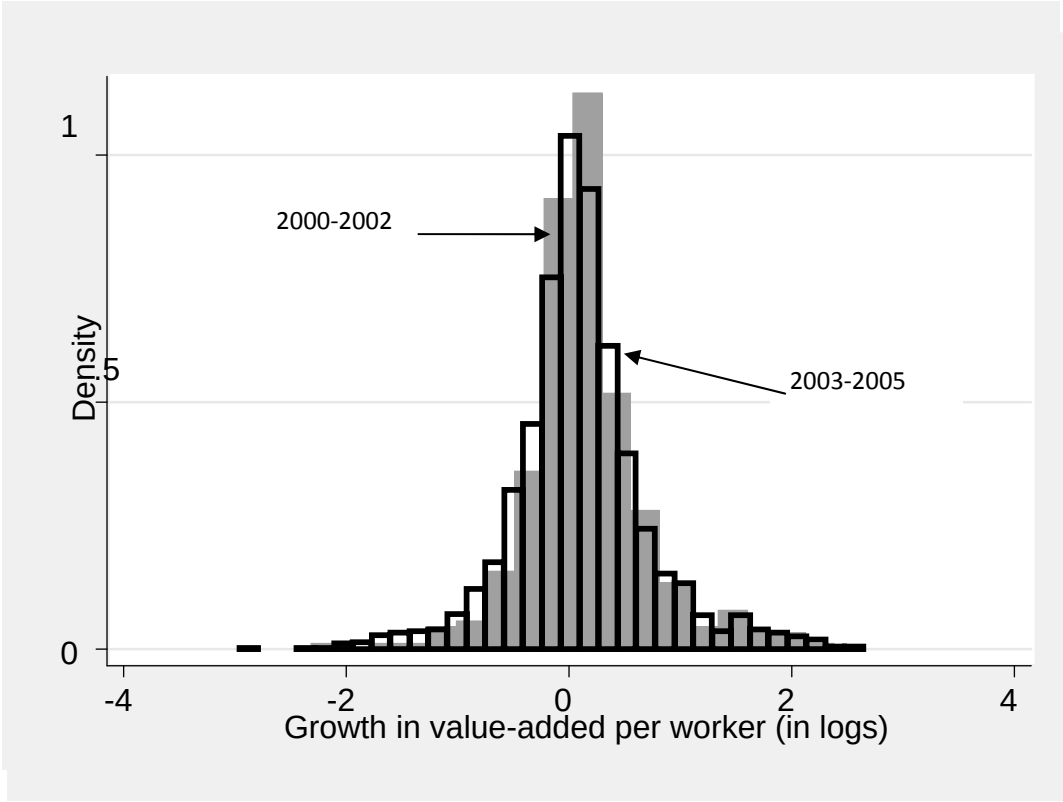
Source: ILO.

Figure 2
Comparative Labour Productivity (USA=100), 2005



Note: Values are only reported for those firms with four years or more of data.

Figure 3
Labour Productivity Levels, 2000-2005



Note: Values are only reported for those firms with four years or more of data.

Figure 4
Labour Productivity Growth Rate, 2000-2005

Country	GDP per worker (1990 US$ at PPP)	GDP per worker in manufacturing (1997 US$ at PPP)
India	2,421	4,089
China	5,772	12,642
Germany	19,477	57,849
Japan	21,979	59,281
France	22,099	60,835
United Kingdom	22,412	60,235
United States	30,519	104,606

Source: International Labour Organisation (ILO).

Table 1
Labour Productivity in Comparative Perspective, 2005

	2000 -2005	2000 -2002	2003 - 2005
Average value-added per worker (RMB)	50,249	47,613	51,181
Average annual growth rate of VA per worker	4.77%	9.72%	1.48%
Average sales per worker (RMB)	373,768	282,583	412,237
Average annual growth rate of sales per worker	13.54%	11.77%	14.71%
Average profit per worker (RMB)	2,032	1,911	2,099
Average annual growth rate of profit per worker	6.33%	12.72%	2.07%

Note: Values are only reported for those firms with four years or more of data (n=4,090).

Table 2
Levels and Growth Rates of Real Labour Productivity

Firms		Value-added (in RMB)			Employees (number)			Capital stock (in 100 RMB)			Wage bill (in 100 RMB)		
Ownership type	N	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median
SOE	470	47,078	118,475	8,773	1,071	2,189	320	117,606	316,789	16,955	23,134	108,439	3,472
Privatised SOE	175	11,081	24,127	4,268	266	335	172	20,421	62,664	6,497	3,047	5,124	1,200
Private firm	370	6,702	11,510	3,203	184	214	117	12,665	25,808	4,745	2,076	2,930	1,115
Greater China JV	64	22,975	54,190	9,753	519	1,198	269	40,569	59,081	13,486	8,285	19,436	3,717
Other JV	99	55,335	137,210	14,448	825	1,910	283	105,412	287,332	23,476	21,089	77,185	5,351
Greater China WOFE	41	28,657	46,897	12,344	888	1,362	320	64,765	93,148	22,170	15,081	26,207	5,606
Other WOFE	41	37,007	75,847	109,863	707	1,310	280	91,480	195,711	297,780	11,693	21,244	5,137

Notes: Eight firms did not indicate their ownership type and are omitted.

Table 3
Average Firm Characteristics

Firms		Value-added per worker (in RMB)			Capital per worker (in RMB)			Annual wage bill per worker (in RMB)			Hourly wage per worker (in RMB)			Average working week (in hours)		
Ownership type	N	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median	Mean	Standard deviation	Median
SOE	470	44,844	61,245	26,378	94,490	256,425	56,741	13,637	10,215	11,246	6.10	3.18	5.28	42.9	5.9	40
Privatised SOE	175	41,816	51,648	24,561	71,031	123,777	36,503	11,089	6,537	9,688	4.41	1.50	4.17	46.1	6.5	48
Private firm	370	42,363	47,728	26,419	72,327	89,465	44,060	11,315	8,113	9,800	4.61	2.44	4.40	47.1	7.3	48
Greater China JV	64	54,990	65,591	34,669	115,044	190,531	53,107	17,819	14,019	14,131	6.16	3.02	5.26	45.4	7.1	44
Other JV	99	87,603	112,056	57,525	155,933	241,601	81,624	22,313	20,389	16,670	6.60	3.33	5.56	42.8	5.6	40
Greater China WOFE	41	56,533	108,963	27,201	116,560	268,357	59,824	17,019	8,859	14,476	5.22	2.06	4.72	46.1	8.0	44
Other WOFE	41	44,844	61,245	26,378	160,755	184,121	109,149	18,794	10,570	16,522	6.22	4.75	5.56	44.2	7.9	40

Notes: Eight firms did not indicate their ownership type and are omitted.

Table 4
Average Firm Characteristics per Worker

	Share of workers with secondary education (%)	Share of workers with higher education (%)	Share of managers with higher education (%)
SOE	64.1	19.9	44.4
Privatised SOE	63.7	16.4	28.5
Private firm	59.0	17.8	33.7
Greater China JV	63.8	27.7	47.3
Other JV	62.2	22.5	16.3
Greater China WOFE	68.3	23.8	23.8
Other WOFE	55.0	27.1	51.8
Average across firms	61.9	19.8	40.3

Note: The human capital of the labour force is estimated based on bands reported by personnel managers. The questions asked for the shares of employees and managers with secondary or higher education with a choice of responses as follows: (1) 0-20%, (2) 20-40%, (3) 40-60%, (4) greater than 60%. The average share is computed taking average of all of the mid-point of the bands, e.g., 20-40% is computed as 30%. As the maximum value is 0.8 or 80%, this is an under-estimate. This is counter-balanced by the lower band for which 10% is estimated for estimates of 0-20%.

Table 5
Human Capital of Labour Force

	Percentage of publicly listed firms (%)
SOE	12.2
Privatised SOE	1.6
Private firm	1.3
Greater China JV	2.9
Other JV	2.7
Greater China WOFE	1.7
Other WOFE	8.8
Average across firms	5.8

Table 6
Percentage of Listed Companies

Percentage:	0-1	1-3	3-5	5 -10	10 -20	>20	**Average export share (%)**
SOE	33.8	16.5	10.4	12.1	9.2	18.1	**13.2**
Privatised SOE	41.1	15.2	14.4	11.5	5.3	12.6	**9.9**
Private firm	47.4	15.9	9.5	8.4	9.3	9.6	**7.9**
Greater China JV	29.0	11.6	5.6	15.5	12.5	25.7	**18.6**
Other JV	24.3	19.5	6.8	11.3	13.2	24.9	**16.3**
Greater China WOFE	47.3	16.1	2.7	14.3	8.0	11.6	**7.7**
Other WOFE	21.5	15.4	0.7	13.4	18.1	30.9	**19.4**
Average across firms	36.7	16.1	9.5	11.3	9.6	16.7	**11.5**

Note: The total for each ownership type does not sum up to 100% due to missing values. The average export share is computed taking average of the mid-point of the bands of the reported export shares, e.g., 10-20% is computed as 15%. As the maximum value is 0.6 or 60%, this is an under-estimate. This is counter-balanced by the lower band for which 0.05% is estimated from the band of 0-1%.

Table 7
Share of Exports in Total Output

Variable	Mean	Standard Deviation	Minimum	Maximum
Value added per worker (in logs)	3.405019	0.9614361	-1.571625	6.910009
Employees (in logs)	5.513498	1.296366	0	9.472474
Capital (in logs)	3.887226	1.203353	-0.5191292	9.196653
SOE	0.3534966	0.4780904	0	1
Privatised SOE	0.0885217	0.2840731	0	1
Private Chinese firm	0.2027147	0.4020513	0	1
Greater China JV	0.0468728	0.2113815	0	1
Foreign JV	0.0644141	0.2455068	0	1
Greater China WOFE	0.024491	0.1545792	0	1
Foreign WOFE	0.0275893	0.1638049	0	1
Listed company	0.0513881	0.2208043	0	1
Share of workers with secondary education (in logs)	-0.4358727	0.5604294	-2.302585	0
Share of workers with higher education (in logs)	-1.428458	0.9562638	-2.302585	0
Share of managers with higher education (in logs)	-0.9490729	0.9441268	-2.302585	0
Coastal region	0.2832694	0 4506194	0	1
Central region	0.2425494	0.4286564	0	1
Western region	0.2092063	0.4067719	0	1
Perceived competition in industry (1-3)	1.24049	0.4641803	1	3
NERI Marketization Index (1-10)	1.930776	3.113895	0	9.74
Share of private sector output in provincial total (in logs)	-0.8571019	0.4687703	-2.114447	-.1746237
Share of exports in firm's total output (in logs)	-3.442075	1.748414	-5.298317	-.5108256
Share of export in provincial GDP (in logs)	-1.995306	1.00656	-3.468063	-.0835622
Signed technology transfer agreement (value of 0 or 1)	0.0702179	0.2555655	0	1

Table 8
Summary of Variables

Dependent variable: ln VA/L	(1) OLS	(2) FE	(3) GMM
ln L	-0.1237***	-0.2762***	-0.1335***
	(0.0230)	(0.0294)	(0.0413)
ln K	0.2793***	0.1416***	0.2559***
	(0.0188)	(0.0192)	(0.0948)
Year dummies			
2001	0.1050***	0.0576*	0.0867***
	(0.0346)	(0.0346)	(0.0301)
2002	0.2300***	0.1578***	0.1717***
	(0.0398)	(0.0349)	(0.0384)
2003	0.2640***	0.1822***	0.1798***
	(0.0399)	(0.0362)	(0.0417)
2004	0.3184***	0.2034***	0.2084***
	(0.0439)	(0.0384)	(0.0439)
2005	0.4347***	0.2891***	0.2837***
	(0.0456)	(0.0432)	(0.0439)
Constant	2.3045***	3.6498***	2.9539***
	(0.2628)	(0.2062)	(0.3796)
Observations	4253	4253	4253
R-squared		0.133	
Adjusted R-squared	0.304		
AR1			0.000
AR2			0.058
AR3			0.379
Sargan p-value			0.085
Difference-in-Sargan p-value			0.283

Notes: Omitted variables in OLS are Shiyan in Hubei, the first year of the data, and the industrial sector of coal mining and cleaning. Additional controls for OLS include firm age, multi-plant firm, ownership type, listed company, city dummies, industrial sector and year of appearance in data set and being an outlier. For system GMM, the Sargan tests suggest the exogeneity of the instruments, while the autocorrelation test for serial correlation in the structure of the error terms cannot reject AR1 but can reject AR2, so the lags are taken from *t-2* for the endogenous factor inputs. Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1.

Table 9
Determinants of Labour Productivity

Sector	Share of total industry (%)
Mining	1.06
Food, beverages & tobacco	13.17
Textiles, apparel & leather products	11.63
Wood, furniture & paper products	6.54
Crafts, other manufacturing & non-specified	1.15
Oil processing, coking & nuclear fuel processing	1.54
Chemicals & chemical products	13.75
Rubber & plastic products	3.75
Non-metallic mineral products	6.25
Metal processing & products	8.94
Machinery, equipment & instruments	7.02
Transportation equipment	11.73
Electrical machinery & equipment	7.12
Electric power & utilities	6.35

Note: The proportion of firms in each of the industrial sectors is reported. The total share of industry sums to 100%. The 2-digit industrial codes have been grouped into 14 industrial sectors as follows: (1) Mining includes: Coal mining and cleaning; Black metal mining; Non-ferrous metal mining; Non-metallic mining; (2) Food, beverages & tobacco includes: Food processing; Food manufacturing; Beverages; Tobacco; (3) Textiles, apparel & leather products include: Textiles; Textiles and garments, shoes, hats manufacturing; Leather, fur, feathers, cashmere and its products; (4) Wood, furniture & paper products includes: Wood processing and timber, bamboo, rattan, brown grass products; Furniture manufacturers; Paper and paper products; (5) Crafts, other manufacturing & non-specified includes: Printing and recording media; Cultural sporting goods manufacturing; Crafts and other manufacturing industries; Not specified; (6) Oil processing, coking & nuclear fuel processing; (7) Chemicals & chemical products includes: Chemicals and chemical products; Chemical fibre manufacturing; (8) Rubber & plastic products includes: Rubber products; Plastic products; (9) Non-metallic mineral products; (10) Meta processing &products includes: Black metal smelting and pressing; Non-ferrous metal smelting and pressing; Fabricated metal products; (11) Machinery, equipment & instruments includes: General equipment; Special equipment; (12) Transportation equipment; (13) Electrical machinery & equipment includes: Electrical machinery and equipment; Communication equipment, computer and other electronic equipment; Instrumentation and culture, office machinery; (14) Electric power & utilities includes: Waste resources and recycling waste materials processing; Electricity, heat production and supply; Gas production and supply; Water production and supply.

Table 10
Distribution of Industrial Sectors

Dependent variable: ln VA/L	System GMM		
Sector	**ln L**	**ln K**	**TFP**
Mining	-0.0098	0.7920	-3.3984
	(1.0355)	(0.5982)	(8.3198)
Food, beverages & tobacco	-0.3680	-0.4957	3.5671
	(0.4164)	(0.3419)	(3.1411)
Textiles, apparel & leather products	-0.3375	-0.0750	1.3714
	(0.2292)	(0.2579)	(2.5155)
Wood, furniture & paper products	0.7067	0.0855	-4.9246
	(1.4110)	(0.3052)	(7.2116)
Crafts, other manufacturing & non-specified	-0.3119	-0.3663	2.8020
	(0.2732)	(0.3066)	(2.6545)
Oil processing, coking &	-0.3128*	-1.0452	5.6573
nuclear fuel processing	(0.1686)	(0.9290)	(4.4906)
Chemicals & chemical products	0.1683	0.2749	-2.3685
	(0.3015)	(0.2468)	(2.4159)
Rubber & plastic products	0.2491	0.4503	-3.5020
	(0.2855)	(0.4037)	(2.3927)
Non-metallic mineral products	-0.0668	0.2267	-1.1796
	(0.3466)	(0.3592)	(3.0707)
Metal processing & products	-0.1010	0.0288	0.0717
	(0.2427)	(0.2656)	(2.4727)
Machinery, equipment & instruments	-0.3772**	0.4713*	
	(0.1689)	(0.2849)	
Transportation equipment	-0.0128	0.3661**	-1.8632
	(0.2176)	(0.1589)	(2.3527)
Electrical machinery & equipment	0.2587	0.2423	-2.8772
	(0.3214)	(0.3308)	(2.1765)
Electric power & utilities	-1.0783	0.9512*	1.5589
	(0.7032)	(0.5386)	(4.9624)
Intercept			3.3194**
(omitted category TFP)			(1.4181)
Observations		4346	
AR1		0.000	
AR2		0.014	
AR3		0.685	
Sargan p-value		0.218	
Difference-in-Sargan p-value		0.228	

Notes: Both models contain *t-1* year and city dummies are also included with Shiyan as the omitted city. The omitted category is 'machinery, equipment and instruments,' such that the intercept is the TFP of the omitted category and the TFP measure for the various industrial sectors indicates whether it is significantly different from the omitted sector. The lags of the endogenous factor inputs are taken from *t-2.* Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1.

Table 11
Labour Productivity by Sector

Dependent variable: ln VA/L	(1) OLS	(2) GMM	(3) OLS	(4) GMM	(5) OLS	(6) GMM
ln L	-0.1230***	-0.1515***	-0.1237***	-0.1152***	-0.1230***	-0.1291***
	(0.0218)	(0.0426)	(0.0230)	(0.0416)	(0.0218)	(0.0422)
ln K	0.2624***	0.2348**	0.2793***	0.2415***	0.2624***	0.2193**
	(0.0188)	(0.0952)	(0.0188)	(0.0937)	(0.0188)	(0.0943)
Human capital in firm:						
Secondary education	-0.0615	-0.0591			-0.0615	-0.0743
of workers (in logs)	(0.0415)	(0.0453)			(0.0415)	(0.0453)
Higher education	0.2256***	0.2165***			0.2256***	0.2328***
of workers (in logs)	(0.0402)	(0.0485)			(0.0402)	(0.0474)
Higher education	0.0617**	0.1266***			0.0617**	0.1280***
of managers (in logs)	(0.0280)	(0.0427)			(0.0280)	(0.0415)
Regional labour market competitiveness:						
Coastal provinces			0.6250***	0.2821***	0.5953***	0.3092***
			(0.1104)	(0.0567)	(0.1074)	(0.0551)
Western provinces			-0.1316	-0.0076	-0.1738	-0.0373
			(0.1237)	(0.0736)	(0.1194)	(0.0686)
Constant	2.8612***	3.6434***	2.4361***	2.8124***	3.0350***	3.5034***
	(0.2764)	(0.4484)	(0.2652)	(0.3661)	(0.2808)	(0.4316)
Observations	4253	4309	4253	4309	4253	4309
Adjusted R^2	0.336		0.304		0.336	
AR1		0.000		0.000		0.000
AR2		0.069		0.062		0.074
AR3		0.373		0.375		0.370
Sargan p-value		0.011		0.020		0.023
Difference-in-Sargan p-value		0.077		0.589		0.123

Notes: All explanatory variables are the same as in Table 9 System GMM estimator, with the addition of human capital variables. Human capital in firms refers to the share of workers or managers with secondary or higher education. The omitted category of regional labour markets is the central region. The Sargan tests refer to the exogeneity of the instruments, while the autocorrelation test for the system GMM cannot reject AR1, so the lags of the endogenous factor inputs are taken from *t-2*. Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1.

Table 12
Labour Productivity Estimates with Measures of Human Capital

Dependent variable: ln VA/L	(1) OLS	(2) GMM	(3) OLS	(4) GMM	(5) OLS	(6) GMM
ln L	-0.1252***	-0.1152***	-0.1231***	-0.1209***	-0.1233***	-0.1022**
	(0.0230)	(0.0419)	(0.0230)	(0.0411)	(0.0230)	(0.0410)
ln K	0.2832***	0.2780***	0.2791***	0.2407**	0.2792***	0.2434***
	(0.0190)	(0.0954)	(0.0188)	(0.0955)	(0.0188)	(0.0931)
Perceived competition	-0.0153	-0.1017**				
(rank variable: 1-3)	(0.0467)	(0.0493)				
NERI Marketization Index			0.0408**	0.0807***		
(scale: 1-10)			(0.0178)	(0.0194)		
Share of private sector in province (log of non-state to total industrial output)					0.3418***	0.4086***
					(0.0780)	(0.0907)
Constant	2.2409***	2.9012***	2.0610***	2.4577***	2.7985***	3.3366***
	(0.2678)	(0.3972)	(0.2886)	(0.4071)	(0.2796)	(0.3744)
Observations	4140	4196	4253	4309	4253	4309
Adjusted R^2	0.316		0.305		0.306	
R^2						
AR1		0.000		0.000		0.000
AR2		0.077		0.160		0.077
AR3		0.288		0.373		0.479
Sargan p-value		0.060		0.028		0.265
Difference-in-Sargan p-value		0.866		0.370		0.456

Notes: All explanatory variables are the same as in Table 9 System GMM estimator, with the inclusion of additional competition variables. The perception of competition measure is ranked from 1-3 with 1 as the most competitive and 3 as the least. The NERI Marketisation Index is compiled by the National Economic Research Institute of China and the most recent period available, 2000-2002 is used (http://www.neri.org.cn/special/200407neri.pdf). The NERI Index is scaled between 1-10 based on aggregating and weighting 5 measures: (1) role of government, (2) economic structure, (3) inter-regional trade, (4) factor market development, and (5) legal framework. Share of private sector in provincial industrial output is measured from 2000-2005. The Sargan tests refer to the

exogeneity of the instruments, while the autocorrelation test for the system GMM cannot reject AR1, so the lags of the endogenous factor inputs are taken from *t-2*. Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1.

Table 13
Labour Productivity Estimates with Measures of Competition

Dependent variable: ln VA/L	(1) OLS	(2) GMM	(3) OLS	(4) GMM	(5) OLS	(6) GMM
ln L	-0.1744***	-0.1234*	-0.1344***	-0.1715***	-0.1024***	-0.1158***
	(0.0334)	(0.0745)	(0.0242)	(0.0466)	(0.0232)	(0.0407)
ln K	0.2559***	0.4562***	0.2746***	0.3335***	0.2969***	0.2405***
	(0.0264)	(0.1438)	(0.0196)	(0.0965)	(0.0186)	(0.0928)
Technology transfer agreement	0.4802***	0.4523*				
(dummy=1 if yes or 0 if no)	(0.1801)	(0.2414)				
Firm exports in total output			0.0668***	0.0986***		
(log of exports to total output)			(0.0149)	(0.0196)		
Provincial exports/GDP					0.1049***	0.1212***
(log of exports to GDP)					(0.0258)	(0.0236)
Constant	2.7539***	2.2383***	2.7948***	3.2399***	2.5705***	3.1671***
	(0.4213)	(0.6879)	(0.3435)	(0.4771)	(0.3209)	(0.3754)
Observations	1964	1964	3789	3789	4309	4309
Adjusted R^2	0.383		0.345		0.277	
AR1		0.000		0.000		0.000
AR2		0.060		0.080		0.068
AR3		0.313		0.642		0.370
Sargan p-value		0.715		0.147		0.104
Difference-in-Sargan p-value		0.733		0.947		0.397

Notes: All explanatory variables are the same as in Table 9 System GMM estimator, with the inclusion of additional measures of technology transfers and exports. Technology transfer agreement is a dummy variable that equals 1 if the joint venture signed one and zero otherwise. Firm share of exports in output is the log of total exports as a ratio of total output of the firm. Provincial export to GDP ratio is also measured. Exports are converted from US$ into RMB at average exchange rates for the relevant year. The Sargan tests refer to the exogeneity of the instruments, while the autocorrelation test for the system GMM cannot reject AR1, so the lags of the endogenous factor inputs are taken from *t-2.* Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1.

Table 14
Labour Productivity with Measures of Globalisation

Appendix

	Year of education	No schooling	Illiteracy	Primary	Secondary school	Technical school	College	University	Graduates
		Primary school			Secondary school		Higher education		
Entire country	0.0587 (0.0024)	-0.1792 (0.0393)			0.2133 (0.0166)		0.4600 (0.0198)		
Regions:									
Coast	0.0599 (0.0043)	-0.1282 (0.0725)			0.2728 (0.0269)		0.5110 (0.0327)		
Central	0.0481 (0.0038)	-0.1326 (0.0664)			0.1324 (0.0269)		0.3557 (0.0314)		
West	0.0470 (0.0040)	-0.1471 (0.0555)			0.1763 (0.0285)		0.4398 (0.0338)		

Source: CHIP survey, 2002.

Notes: The dependent variable is hourly income. Reported statistics are for returns to a year of education in the first column and to levels of education attained in the next three columns. The omitted category is lower secondary school. The control variables were gender, ethnic minority status, Communist Party member, occupation, industrial sector of employer, ownership type of employer, and quality of education. For the entire sample, n was 9,337. Coefficients are reported with standard errors in parenthesis.

Returns to Year and Level of Education