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GROWTH ACCOUNTING FOR THE CHINESE PROVINCES 1990-2000: INCORPORATING HUMAN CAPITAL ACCUMULATION

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ABSTRACT

This paper examines the linkage between aggregate real output, capital, labour, education, and productivity within a growth accounting framework for 27 Chinese provinces between 1990 and 2000. The results suggest that human capital has had a significant role in facilitating economic growth of all of the provinces throughout the 1990s. Regional disparities in factor accumulation are also considered. The results suggest that uneven distribution of resources between the coastal and inland provinces increased the regional gap in economic growth throughout the 1990s.

KEYWORDS: China, Economic growth, Human capital, Reform

JEL CLASSIFICATION: O40, O15, O53

GROWTH ACCOUNTING FOR THE CHINESE PROVINCES 1990-2000: INCORPORATING HUMAN CAPITAL ACCUMULATION

1 INTRODUCTION

China's economy has experienced extraordinary growth since reforms started in 1978. During the 1990s, GDP per capita in China has grown at a remarkable 8.4 per cent a year (WDI online, World Bank). While a large literature exists which explores the sources of economic growth in China, results from empirical studies are still the subject of a heated debate. In recent years, increasing attention has been paid to the role of education in facilitating China's economic growth. The purpose of this study is to estimate the role of education in facilitating growth in China at the provincial level over the course of the 1990s within a neoclassical growth accounting framework.

The contribution of the paper is fourfold.

First, we use a growth accounting framework to consider the contribution of human capital to economic growth in China using provincial data. Few growth accounting exercises for China have considered the contribution of education to output growth. Wang and Yao (2003) highlight the growth role of education by incorporating human capital accumulation as a factor of production. Using data at the national level, Wang and Yao (2003) find that the contribution of human capital stock accounted for 11 per cent of GDP growth from 1978 to 1999. Wang and Hu (1999) incorporate human capital accumulation into a growth accounting framework at the provincial level; however, their study is limited because the production elasticities were assumed to be the same for all provinces, although the authors admitted that "application of the same set of production elasticities to the analysis of economies in different stages of development may not be appropriate" (Wang & Hu, 1999: 238). We address this problem by using provincial factor shares in our growth accounting exercise. We find that the labour share varies between the provinces and on average was higher in the inland provinces than in the coastal provinces. As the contribution of each factor input is sensitive to its output elasticity, a specified factor share for each province is essential for utilizing the growth accounting approach using provincial level data.

Second, we construct our measure of human capital stock in terms of average years of schooling of the labour force for each province. Some earlier studies have used the enrolment ratio of a certain level of schooling as the educational variable. The enrolment ratio, however, as a flow variable, might not be the best proxy. As children currently enrolled at school have not yet joined the labour force, a time lag coupled with demographic transition makes the link between the current student pool and the future labour force not immediate. Educational attainment, in terms of the total amount of formal education received by the labour force, is a stock variable. The average years of schooling has become the most commonly used specification of the stock of human capital in the literature (see e.g. Barro and Sala-i-Martin, 1995; Barro, 2001; Benhabib and Spiegel, 1994; Krueger and Lindahl, 2001). This measure, however, has not been widely used in empirical studies on China, with the exception of Wang and Yao (2003), who constructed annual national data of the average years of schooling of the population aged between 15 and 64 from 1952 to 1999. Following the methodology employed in Wang and Yao (2003) at the national level, we construct average years of formal schooling per capita at the provincial level to measure human capital stock for each of the 27 Chinese provinces in 1990 and 2000.

Third, in this paper, our dataset extends up to 2000 to capture the effects of socio-economic changes in the second half of the 1990s. Throughout the 1990s, China's economy and society underwent substantial reform, including growing educational attainment, readjustment in the structure of the labour force and increasing regional income disparities. Existing studies for China have used provincial data ending in 1995 (see eg Ezaki and Sun, 1999; Wang and Hu, 1999; Wu, 2000).

Fourth, we explore the regional characteristics of factor accumulation. Foreshadowing our main results, we find that the average contribution of physical capital to GDP growth was higher for the coastal provinces than for the inland provinces and the average contribution of human capital to output was higher for the inland provinces than for the coastal provinces. This implies that answers to the question as to why physical capital investment and human capital stock increased at different rates and affected economic growth to different extents among the provinces may lead us to identify the determinants of widening regional disparities in China. Therefore, we closely examine the nature of regional differences in physical capital and human capital accumulation with the view that closer scrutiny of these issues may throw further light on the reasons for regional disparities in economic growth.

The remainder of the paper is set out as follows. The next section provides a brief review of existing studies of the nexus between economic growth and human capital in China. Section 3 sets out the growth accounting methodology. The results from the growth accounting exercise are presented in Section 4. Section 5 extends the analysis to present results from an augmented growth approach. The results are discussed in Section 6 and the conclusions and implications are contained in the final section.

2 EXISTING STUDIES ON THE GROWTH ROLE OF EDUCATION IN CHINA'S ECONOMY

Not only have very few growth accounting exercises for China specified the contribution of education to output growth, but also the majority of these studies have focused on specific sectors such as examining productivity performance in the agricultural and industrial sectors. Compared to the abundant literature on sectoral productivity, economy-wide studies are rare. In an early article, Li (1992) estimates that the growth rate of total output was 9.2 per cent from 1979 to 1994 and the growth rate of Total Factor Productivity (TFP), which was negative before the reforms, rose to an average 3.8 per cent per year in the post-reform period. Recent studies throw some doubts on such high figures. Borensztein and Ostry (1996) argue that productivity growth is substantially lower. One reason is that the estimated growth residual may be exaggerated by the absence of human capital from the growth-accounting calculations. Using Barro and Lee's (1996) estimates of human capital in China, they employ a simple growth accounting exercise, assuming shares of 0.5, 0.25, and 0.25 for capital, raw labour, and human capital, respectively. And they find that TFP growth declines by an average of 1.0 percentage point per year over the period 1979-1990. In other words, part of TFP growth should be attributed to the contribution of human capital.

Focusing on productivity growth in the Chinese provinces during the period 1981-1995, Wu (2000) finds that China's economic growth in the 1980s was attributed to technical efficiency improvements and growth in inputs; while in the 1990s technological progress become a more important driving force of China's economic growth. In another study, Wang and Meng (2001) find that TFP growth in industry was 1.2 per cent, 2.5 per cent, and 7.3 per cent for the periods 1953-1977, 1978-1991, and 1992-1997, respectively. Since there was a dramatic increase in foreign investment in the 1990s, the authors test whether the technological progress which was brought about by foreign investment caused the sudden increase of TFP growth. However, their result implies that foreign investment was not the main cause of the extraordinary TFP growth of the 1990s. Moreover, there is no evidence to suggest that sources other than the combined effect of institutional reform, technological progress and improvement in resource allocation could have caused the rapid progress in productivity during the post-reform period. Thus, the authors concluded that industrial TFP growth during 1992-1997 appears to represent a statistical error. Using deflated GDP data, the authors estimate that TFP growth in the entire economy was 2.3 per cent per year during 1978-1991, and about 2.6 per cent per year during 1992-1997.

In recent years, increasing attention has been paid to the role of education in Chinese economic growth, mainly in the framework of new growth theories. Using cross-provincial pooled data between 1978 and 1989, Chen and Feng (2000) found that an increase in private and semi-private enterprises, higher education and international trade resulted in an increase in economic growth in China. At the same time, these factors also contributed to uneven growth between the provinces.

However, Maurer-Fazio (1999), using data from the Chinese Household Income Project 1988 and the Chinese Labour Market Research Project 1992, found that differences in the rates of return to human capital between the coast and inland, and among the provinces are statistically insignificant. More interestingly, Chen and Fleisher (1996) find a statistically insignificant relationship between human capital investment and growth at the provincial level when their measure of human capital relates to secondary schooling, but in a later study (Fleisher and Chen, 1997) when their measure of human capital investment is university-level education, they find a positive relationship between human capital and TFP growth. Meanwhile, in a study measuring human capital by the gross enrolment rate in senior secondary school at the city level for 1995, Jones *et al*. (2003) fail to find evidence of a robust correlation between human capital and economic growth. While results from the cross-provincial studies are inconclusive, evidence from time series data at the national level lends support to the role of education in facilitating growth. In a series of empirical studies, Narayan and Smyth (2004a, 2004b, 2005) examine the relationship between human capital stock, real investment, exports and real income in China within a cointegration and vector error-correction framework. Based on annual data from 1960 to 1999, their findings suggest that human capital accumulation has been important in explaining real income, real investment and real exports in the long run. Probably, more accurate data at the national level, a longer time span and a larger pool of observations are reasons for these more favourable results, compared with those from studies at the provincial level. Studies using micro data also find increasing private returns to education during the economic reform period (see e.g. Liu, 1998; Li, 2003; Zhang *et al*., 2002).

Within the framework of the traditional neoclassical growth model, most empirical studies have paid little attention to specifying the effects of education on growth. However, among the very few studies which do, Young (2000) and Wang and Yao (2003) highlight the growth role of education, to differing extents. Young (2000) estimates a growth rate of 1.1 percent per annum for human capital in the non-agricultural sector during the period 1978 to 1998 in China. Improvement of labour quality may reflect changes in educational attainment or human capital accumulation; nonetheless, in Young's (2000) accounting exercise, education was not specified as a stock variable. Wang and Yao's (2003) study, however, incorporates human capital accumulation as a factor of production. Differing in both the definition and measure of human capital growth to Young (2000), Wang and Yao (2003) apply the perpetual inventory method to construct current human capital stock by adding net graduates at the different levels of schooling to the stocks of the previous year. Based on data on annual graduates from the different schooling levels, they obtain time series data on the average years of schooling per capita in the working-age population from 1952 to 1999. In their study, this figure rises from 0.91 years of schooling per capita in 1952 to 5.89 years of schooling in 1999, with a growth rate of 4.28 per cent per year over the period 1953 to

1999, and 2.08 per cent per year over the reform period from 1978 to 1999. From 1978 to 1999, human capital stock accounted for 11 per cent of GDP growth. After incorporating human capital, the growth of total factor productivity still contributed 25.4 per cent of economic growth in the reform period.

Wang and Hu (1999) conducted a growth accounting study at the provincial level for the period 1978 to 1995 to examine the economic sources of uneven regional development. They used the average years of schooling for the population as a proxy for human capital stock. According to their results, “human capital played little role in [explaining] economic growth for all provinces, accounting for barely 5 per cent” (Wang and Hu, 1999: 150). This is much smaller than Wang and Yao’s (2003) later national estimate for the period 1978-1999. The small human capital effect, which Wang and Hu (1999) found, most likely reflects their assumption that all provinces have the same set of output elasticities of capital, labour and human capital. As mentioned in the introduction, this does not appear to be a reasonable assumption.

DATA AND GROWTH ACCOUNTING METHODOLOGY

The growth accounting framework essentially decomposes aggregate growth into the relative contribution of factor inputs (physical capital and labour) and a residual that captures technological progress and other “black box” elements. In conventional growth accounting, the standard production function takes the form of:

$$Y = AF(K, L) \qquad (1)$$

where Y represents output, A represents the level of technology, K is the stock of capital, and L is the labour force. Incorporating the accumulation of human capital as a factor of production, we obtain the following aggregate production function:

$$Y = AK^{\alpha}(LH)^{\beta} \qquad (2)$$

where, in addition to the variables defined above, H is the stock of human capital, measured by the average years of schooling of the total population. Hence, *LH* is a skill-adjusted measure of labour input, while α and β are output elasticities with respect to physical capital and skill-augmented labour, where $\alpha + \beta = 1$.

Taking logs and differentiating both sides of Equation (2) yields:

$$G_Y = G_A + \alpha G_K + \beta(G_L + G_H) \qquad (3)$$

where G_Y is the growth rate of real GDP, G_A is growth in TFP, and G_K, G_L, and G_H represent the growth rates of K, L and H in Equation (2) respectively. Thus, the growth rate of aggregate output is decomposed into growth of TFP and a weighted average of the growth rates of physical capital and skill-augmented labour. The assumption of constant returns to scale, that is $\alpha + \beta = 1$, implies that these weights are given by the shares of these inputs in aggregated output.

In constructing the data set for this study, we have used ‘Comprehensive Statistical Data and Materials on 50 Years of New China‘, and Hsueh, Li and Liu (1993) for data from 1949-1989 and *China Statistical Yearbook* for data from 1990 to 2000. Chongqing is combined with Sichuan province. Since data for Hainan, Tibet and Qinghai are only available spasmodically before 1990 these provinces are not included. Therefore, we have data for 27 provinces in this study. The rate of GDP growth (GY) depends on provincial GDP in real terms. “Indices of GDP” are available at the provincial level in *Comprehensive Statistical Data and Materials on 50 years of New China* (for 1991-1998), and *China Statistical Yearbook* (for 1999 and 2000) (1990=100).

Following the approach in Wang and Yao (2003), real capital stock for the aggregate economy is estimated using the standard perpetual inventory approach.[*] First, to estimate the initial level of capital stock in 1990, “fixed assets accumulation” from 1949 to 1989 for each of the 27 provinces was used, which is available in the Hsueh, Li and Liu (1993) data set. The value of accumulation of fixed assets for a given year is given by “subtracting the depreciation of fixed assets and major repairs funds from the value of increase in fixed assets” (Hsueh, Li and Liu, 1993). Thus, summing up “fixed assets accumulation” in all years for 1949-1989 for a certain province yields its initial capital stock in 1990 (see Hsueh, Li and Liu, 1993, for more details).

The prices of fixed assets did not experience great changes until the economic reform implemented in the 1980s. And it has only been since 1991 that China formally started compiling a price index for fixed asset investment. Hence, the investment deflator at the provincial level is derived from the “price index of investment in fixed assets” available in *China Statistical Yearbook* for the period 1991-2000. To construct a time series of physical capital stock from investment flows, we also need the average rate of depreciation of capital. Here, a depreciation rate of 5 per cent as employed in Wang and Yao (2003) is adopted, which was the average rate of depreciation for state owned enterprises from 1981-1992. Sensitivity tests, reported in Wang and Yao (2003:

[*] Specifically, the value of capital stock in a given year equals the value of the capital stock of the previous year, plus real investment inflows during that year, less depreciation of the initial capital during that year:

$$K(t) = K(t-1) + I(t) - \delta K(t-1) = (1-\delta)K(t-1) + I(t)$$

where t is time, K(t) is the capital stock at time t, I(t) is the real investment inflows at time t, and δ is the depreciation rate.

37), indicated that the growth rate of real capital stock during the period 1978-1999 was robust to different depreciation rates varying between 5 per cent and 15 per cent.

The rate of labour input growth (G_L) is estimated from data on population aged between 15 and 64 at the provincial level, which are available in the fourth national census in 1990 and the fifth national census in 2000. Thus, the average annual growth rate of labour input is derived from the changes in the economically active population from 1990 to 2000. As a measure of the overall growth of the labour force, this data does not contain any information on working hours and educational level of workers.

We use a proxy for human capital stock to capture the contribution of changes in the educational attainment of the labour force to the quality of labour input. The average years of formal schooling per person of the total population in a certain province is introduced as a proxy for human capital stock. First, data for educational attainment of the total population by province are taken from the national censuses for the years 1990 and 2000. Next, based on this direct data on attainment levels, for each province, average years of schooling (AYS) per capita are calculated as:

$$AYS = (5 * H_1 + 8 * H_2 + 10.5 * H_3 + 14 * H_4) / POP \qquad (4)$$

Here H*i* is the number of persons for whom *i* is the highest level of schooling attained; *i* =1, for primary school, 2 for junior secondary school, 3 for senior secondary school and secondary technical school and 4 for college and above. The number before H*i* represents the duration of the *i*th level of schooling (which is adopted from Wang and Yao, 2003). POP is the total population. With this formula, we obtain the change of average educational attainment of the total population between 1990 and 2000 for all the 27 provinces. The average increase over the decade of the 1990s was 1.39 years.

In a study of the effect of education on economic growth in Brazil, Lau *et al.* (1993) argue that their finding of a 1.34 year increase in the average education of the labour force in Brazil over the period 1970-1980 was a very significant achievement. China has the largest population in the world, at 1,135 million in 1990 and 1,263 million in 2000 (WDI online, World Bank). This figure is ten times that of Brazil's population of 96 million in 1970 and 126 million in 1980 (WDI online, World Bank). Meanwhile, China's GDP per capita accounted for only one ninth of Brazil's GDP per capita in 1980, but it increased to half that of Brazil by 2000 (WDI online, World Bank). Considering these facts, the 1.39 year increase in average years of schooling per person over the ten years from 1990-2000 is a substantial achievement for China. Wang and Yao (2003) find a 2.06 per cent growth rate of human capital stock in the reform period (1978-1999) per year. In this study, the annual growth rate of human capital accumulation is 2.6 per cent at the national level during the period 1990 to 2000.

We also need estimates of factor shares. Chow (1993) used a value of 0.4 for the labour share from 1952-1980. Hu and Khan (1997) used labour shares of 0.386 and 0.453 for the pre-reform and reform periods respectively. Li *et al* (1993) used average labour income shares of 0.462 and 0.536 for the pre-reform and post-reform periods respectively. Wang and Yao (2003) used a value of 0.5 for the overall economy-share of labour over the reform period 1978-1999. Young (2000) estimates the share attribution to labour using national income data and obtains a value of 0.6.

Ezaki and Sun (1999) applied data of "payment for labourers" available in *China Statistical Yearbook* for the labour shares. In their study, the 3-year averages of data at the provincial level for 1993-1995 were applied to the whole period 1981-1995. Similarly, in this study, the provincial distribution share of labour (β) depends on "payment for labourers/labourers' remuneration" from the *China Statistical Yearbook*. As defined in the *China Statistical Yearbook*, *2001* this data "refers to the whole payment of various forms earned by the labourers from the productive activities they are engaged in, including wages, bonuses and allowances the labourers earned in monetary form and in kind. It also includes the free medical services provided to the labourers and the medicine expenses, traffic subsidies and social insurance fee paid by the labourers' working units for them" (China Statistical Yearbook, 2001: 85). At the provincial level, data is only available for 1993 to 2000. Thus, we applied the seven-year averages for the period 1993-2000 to the whole period 1990-2000. Adopting this method, the labour share at the national level, which is the average of the provincial shares, is 0.54, which is consistent with the estimates in previous studies cited above.

RESULTS OF GROWTH ACCOUNTING FOR PROVINCES

Table 1 presents the results from the growth accounting analysis for the 27 provinces. It also includes results obtained for the two aggregate regions (coastal provinces and inland provinces) and national averages. Several observations are worth noting. First we look at the national figures. As can be seen from Table 1, real GDP grew at 10.64 per cent per annum over the period 1990-2000. Real capital stock grew at an average annual growth rate of 12.68 per cent. Remaining as the most important source of output growth, accumulation of physical capital contributed 55.49 per cent of growth throughout the 1990s. Meanwhile, growth of TFP and human capital achieved average annual growth rates of 2.45 per cent, and 2.55 per cent, respectively, both exceeding that of labour, which maintained a low 1.77 per cent rate. In other words, TFP growth accounted for 22 per cent of total output growth from 1990-2000, while the average contribution of human capital to GDP growth was 13 per cent.

Insert Table 1

Table 1 shows that there is a considerable disparity in real GDP growth between the coastal and inland provinces. The average growth rate of GDP for the period 1990 to 2000 was approximately 3 percentage points higher for the coastal provinces than the inland provinces. At the provincial level, the growth rate in the fastest growing provinces of Fujian and Guangdong were almost twice as high as those of the lowest growth rates in Inner Mongolia and Ningxia. While there are two provinces in the group of coastal provinces growing at rates lower than the national average, there are only 4 of the 16 inland provinces growing faster than the national average.

Besides the disparity in real GDP growth, wider discrepancy in the growth of capital stock accumulation is found between the average capital growth rate of the coastal provinces (15.03 per cent) and inland provinces (11.06 per cent). Among the coastal provinces, there is only one province, Liaoning, whose capital growth rate is lower than the national average. By comparison, among the inland provinces, there is only one province, Sichuan, whose capital growth rate is above the national average. The average contribution of capital to GDP growth was especially high for the coastal provinces (62.5 per cent) compared with the inland provinces (50.67 per cent) over the decade of the 1990s. Nevertheless, it should not be ignored that each of these 27 provinces experienced an extraordinary increase in its capital stock during this period. In all but three provinces (Auhui, Jiangxi, and Gansu), capital stock was growing faster than GDP. In Shanghai, the difference between the increases of capital stock and GDP was the largest (more than 5 percentage points). Overall, Table 1 suggests that those provinces with faster capital accumulation also experienced more rapid output growth.

The contribution of labour to GDP growth varies from 3.56 per cent in Anhui to 18.09 per cent in Ningxia. On average, a slightly larger percentage of output growth was explained by the growth of the labour force among the inland provinces. But it did not exceed 10 per cent. Among all provinces, discrepancy in the growth of human capital stock is even smaller than that in labour growth. However, the contribution of human capital stock to GDP growth demonstrates regional disparities. This figure was 15.79 per cent when averaged among the inland provinces, compared with an average of 9.2 per cent for the coastal provinces. As there is not much difference in the growth rate of human capital stock between the two regions, the differences in its contribution to output growth may be caused by the higher labour share in the inland provinces compared with the coastal provinces. Take Guizhou as an example, where the growth rate of human capital was 2.73

per cent, slightly higher than the national average (2.55 per cent). However, with the highest labour share across the country (0.6335), the contribution of human capital to GDP growth was the largest in Guizhou of the 27 provinces (21 per cent). Shanghai is at the opposite end of the spectrum. With the smallest labour share (0.3529) and the lowest growth rate of human capital (1.68 per cent), growth of human capital accounted for only 5.2 per cent of output growth, the smallest figure among all the provinces. In sum, findings from growth accounting for the provinces over the entire period of 1990-2000 indicate that accumulation of human capital contributed substantially to economic growth. The finding that 13.4 per cent of output growth could be explained by the growth of human capital stock at the national level is consistent with the findings of Wang and Yao's (2003) study that human capital accumulation accounted for 11 per cent of China's economic growth during 1978-1999.

TFP growth was higher for the inland provinces than the coastal provinces. Correspondingly, the average TFP contribution to GDP growth for the inland provinces was higher than that for the coastal provinces. However, there was an extraordinarily negative TFP growth rate in Shanghai, the only negative figure in all the results. When Shanghai was omitted from the group of coastal provinces, the average TFP growth in the group rose to 2.76 per cent annum (from 2.41 per cent) and the TFP contribution to GDP growth also increased to 22.23 per cent (from 19.39 per cent). Although the inland provinces demonstrated a larger average TFP contribution to output growth, a closer look at the individual provinces indicates large disparities within the inland provinces. On the one hand, provinces with the largest TFP contribution to GDP growth are found in the group of the interior provinces, such as Anhui (38.85 per cent) and Jiangxi (37.23 per cent); on the other hand, provinces with the poorest performance are also found in this group, such as Ningxia (4.79 per cent) and Heilongjiang (7.48 per cent). In contrast to the more homogeneous coastal provinces, wider discrepancies exist in technical progress among the inland provinces.

The finding that Shanghai exhibited a negative TFP growth rate during the 1990s requires some further explanation. This result is consistent with the findings of previous studies in the literature. Ezaki and Sun (1999) also found that the average rate of TFP growth of Shanghai during the period 1981-1995 was negative and a positive rate was recorded only for the years between 1991 and 1995. In another investigation of productivity growth in China in the 1980s and 1990s, Wu (2000) discovered that the three largest cities (Beijing, Shanghai, and Tianjin) had the worst record of technological progress and the lowest rates of TFP growth across the country.

In her study, Wu (2000: 286-287) gives some possible explanations for the low TFP growth in the largest cities in China. First, these cities have undergone painful changes during the reform period due to the dominance of the state sector in their economic structure. Second, the largest cities might benefit less from the success of the rural sector due to their relatively small agricultural sectors. Third, less developed cities and provinces have performed better in terms of technical catch-up because of the so-called “advantage of backwardness”. These explanations are insightful in understanding the Shanghai case. Among the three largest cities, Shanghai has the heaviest “dominant state sector” in its economic structure. Hence, there are serious problems arising from a large number of laid-off workers, reforms to state-owned enterprises and restructuring of sunset industries. Furthermore, as some scholars in China have pointed out, directed by a strategy to develop the tertiary industry or service sector in the early 1990s, Shanghai slowed down its investment and technological innovation in manufacturing industries and replaced it by huge investment in financial and trade infrastructure. It is also argued that Shanghai’s declining productivity in manufacturing is evidence of inefficiency of its manufacturing factories (Zhang, 2003). Hence, it is argued that the growth of the Shanghai economy depends heavily on capital accumulation.

The regional disparity between provinces is one of the crucial issues facing the Chinese economy. From an aggregate perspective, the growth accounting analysis reveals the gap in economic capacity between provinces, emphasizing the regional characteristics of factor accumulation. Another important indicator of regional disparity is the gap in income between provinces. Table 2 presents real GDP per capita for each province at constant 1990 prices for 1990 and 2000 in both absolute and relative terms, as well as changes from 1990 to 2000. As shown in the table, the gap between provinces in the coastal area and those in inland China has widened in relative terms to the national average (China=1). In 2000, there was only one province, Guangxi, in the group of coastal provinces, whose GDP per capita (2986 RMB) was much lower than the national average (4843 RMB). By comparison, there was no inland province whose GDP per capita reached the national average. Overall, the average GDP per capita in the group of coastal provinces was 2.4 times that in the group of interior provinces. In 2000 GDP per capita in Shanghai, the richest province, was eight times that of Guizhou, the poorest province. All provinces in the coastal area improved their positions relative to Guizhou, although not all of their positions relative to the national average changed much over the period 1990-2000. Examining the position of each province, especially the rich provinces, relative to the poorest province (Guizhou), reveals increasing polarization in income levels between the provinces over the course of the 1990s.

Insert Table 2

As shown in Table 2, figures for the inland provinces are mixed. In absolute values, GDP per capita for the inland provinces increased remarkably in the 1990s. However, measured in relative levels to the national average (China=1), 11 out of the 16 inland provinces experienced negative changes. For example, GDP per capita in Hunan increased from 1218 RMB in 1990 to 3136 RMB in 2000 (in real terms), but in both years, it was 65 per cent of the average per capita GDP of the country. This means that only four interior provinces were slightly better-off in comparison to the national average over the period 1990-2000. These four provinces - Anhui, Jiangxi, Henan, and Hubei - are the four inland provinces whose growth rates of real GDP were higher than the national average in the above analysis. Nevertheless, in relative terms compared to Guizhou (Guizhou=1), the average GDP per capita of the inland provinces was better-off during the years between 1990 and 2000. Comparing the magnitudes of relative increases in income between the coastal and inland provinces, though, both in terms of relative levels to the national average and in relative levels to Guizhou, the coastal provinces demonstrated greater changes over the period.

FURTHER EXPLORATION: RESULTS FROM AN AUGMENTED GROWTH APPROACH

From Table 1 we can see human capital stock in terms of average years of schooling per capita is important in explaining provincial economic growth. The problem is that the significant role played by human capital stock may be assigned in advance through the allocation of factor shares. Therefore, in this section, an alternative regression approach is used to dispense with the assumption that the factor social marginal products coincide with the observable factor prices. This alternative regression approach is an alternative growth accounting approach, which is different from the "non-econometric" standard growth accounting approach. Barro (1998: 6) pointed out that "the main advantage of the regression approach is that it dispenses with the assumption that the factor social marginal products coincide with the observable factor prices". Nonetheless, "the usually preferred approach to TFP estimation is the non-econometric one".

In this section, a regression analysis based on cross sectional data for 27 Chinese provinces in 1990 and 2000 is applied in an attempt to test the assumption of constant returns to scale, and to explain the reasons for the difference in the TFP level between provinces. In the usual form of a regression framework, the growth rate of output, G_Y, is regressed on the growth rates of inputs, G_k and G_L. In this study, the standard form is extended to allow for variations in factor shares and TFP growth. Equation (5) presents the regression framework where growth of real GDP (Y) is explained by growth of real investment (IV) and population by education level, degree of government expenditure (GOV= government consumption expenditure/GDP) and trade (TI = [imports + exports]/GDP), and a region-specific dummy variable for the coastal provinces (DC)[†]. Note total population is decomposed into five groups with different levels of schooling.

[†] For an alternative regression analysis to explain differences of TFP growth, TFP can be regressed on explanatory variables such as GOV, TI and DC used in this study (see eg. Smyth & Lu, 2003). However, as the regression approach is intended to be used to estimate growth effects of capital and labour inputs and

$$\ln Y_{it} = c_0 + \alpha_1 \ln IV_{it} + \sum_{j=1}^{5} \beta_j Lj_{it} + \alpha_2 GOV_{it} + \alpha_3 TI + \alpha_4 DC_{it} + \varepsilon_{it} \quad (5)$$

where Lj is population for whom *j* is the highest level of schooling attained; *j* =1, for no schooling (or less than primary schooling), 2 for primary schooling, 3 for junior secondary schooling, 4 for senior secondary and secondary technical schooling and 5 for college education and above. This disaggregation of population allows the education factor to enter the production function. If different education levels have an effect on growth, we should find that the estimated coefficients β_j should vary with *j*.

Ezaki and Sun (1999) run a similar regression as an extension of conventional growth accounting for the Chinese provinces for 1981-1995 in order to explain the growth of TFP. Their specification includes explanatory variables other than the production factors (labour and capital inputs), i.e. the degree of marketization (the ratio of investment of non-state enterprise to total investment), the degree of openness (the ratio of foreign direct investment to total investment and the ratio of total exports and imports to GDP), and dummy variables for the provinces in the middle region and western region, respectively. Their results indicate that non-state enterprises, foreign direct investment and the regional dummy variables are important common factors explaining TFP growth in each province. In this study, in addition to the production factors, we include government expenditure, trade and a regional dummy variable for the coastal provinces in our specification. We hypothesise that government expenditure has a negative effect on growth. Government consumption expenditure represents government intervention which reduces economic efficiency. Hence the correlation with government expenditure and growth should be negative. Trade is hypothesised to have a positive effect on growth. East Asia's historical experience suggests that an export-oriented development strategy can drive economic growth in a developing country by raising its productivity, improving efficiency and increasing its technical progress. Economic growth is hypothesised to be higher in the coastal provinces, reflecting the impact of geographic location on provincial economic performance.

Before we move to the empirical analysis, we test the hypotheses of constant returns to scale and that the output elasticities of the population with different education levels β_j are the same: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$. The results are presented in Table 3. According to the results, the hypothesis of constant returns to scale cannot be rejected, but the hypothesis that the output

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also to test the constant return to scale assumption, here we just extend the standard form regression to include the extra explanatory variables, with growth of real GDP being the dependent variable.

elasticities of the population with different education levels are the same is rejected at the 5 percent level of significance. This result implies that the effect of differences in the education of the populace on growth varies.

Insert Tables 3 & 4

The results of estimation from Equation (5) are reported in Table 4. The relative magnitudes of the estimated parameters of the population with a certain education are consistent with the existence of an effect of education. The findings display an education effect, where the estimated effect of population without an education or with less than primary education (L1) is negative while that of the population with a primary school education is 27 per cent and statistically significant at 5 percent. The estimated effects of the other three levels of education are not statistically significant.

Using nonparametric estimation techniques and panel data from the Barro and Lee (1996) data base, Kalaitzidakis *et al.* (2001) found evidence of a nonlinear effect of human capital on economic growth. Their findings are consistent with the theoretical suggestion that there exist threshold levels of human capital. In another study, Lau *et al*. (1993) also found a threshold effect for human capital in Brazil during the 1970s. While we did not find such an effect in this study, the positive sign on the coefficient of population with secondary education and the negative sign on the coefficient of population with higher education suggest this issue merits further research.

The results in Table 4 suggest that government expenditure had a negative effect on GDP growth, consistent with results from existing studies on regional disparities in China (see e.g. Cai *et al.*, 2002). Trade, measured by total exports and imports as a proportion of GDP, displayed a small but still positive effect on growth at the 15 percent level of significance. This is consistent with the existing literature on China's economic growth (see e.g. Chen and Feng, 2000; Ezaki and Sun, 1999; Kanbur and Zhang, 2003). The coefficient on the dummy variable for the coastal provinces was also positive and statistically significant, which was consistent with prior expectations.

DISCUSSION OF THE RESULTS

The findings on regional disparities are consistent with the results of several extant studies. In terms of real per capita GDP, per capita consumption or expenditure, or gross value of industrial and agricultural outputs of the Chinese provinces, most studies have found that disparities between the coast and inland have increased sharply in the 1990s (see e.g. Bao *et al.*, 2002; Jian, *et al.*, 1996; Kanbur and Zhang, 1999; Lee 2000; Song *et al*., 2000; Yang, 2002; Ying, 1999). The findings in the proceeding section have confirmed the large gap in GDP growth and the widening gap in GDP per capita between the coastal and inland provinces over the 1990s. A question arises, therefore, about the causes of the uneven growth of the provinces. This issue is examined by focusing on differences in capital investment and human capital stock across provinces.

The results from the growth accounting exercise indicated that physical capital accumulation contributed more than 50 per cent of China's economic growth over the 1990s. Faster growth of the coastal provinces is attributable to faster accumulation of factors in these areas. The differences between the coastal provinces and inland provinces were much larger in the growth rate of capital stock than in the growth rates of labour, human capital stock and technical progress over the period. This poses a question as to why capital stock increased at a faster rate in some provinces than others. An answer to this question will help to explain the causes of widening regional disparities. The first step to the answer is to distinguish between different sources of capital investment. Subsequent to doing this, we examine the differences between provinces in relation to these different sources of capital investment.

Capital investment can be financed from three sources: local capital, inter-provincial capital movements, and foreign capital. Early studies show that interregional capital flows dissipated substantially during the course of reform, especially after the mid-1980s when all provinces had become financially more independent, as a result of decentralization (e.g. Wang and Hu, 1999; Renard, 2002). Hence, domestic investment in most provinces was predominantly financed by local savings (Kraay, 2000; Wang and Hu, 1999: 154; Wang and Yao, 2003). As Wang and Yao (2003: 44) put it, "a high and rising saving rate is one of the most striking features of the Chinese economy during transition." Wang and Hu (1999) also find a strong correlation between the savings rate (savings/GDP) and GDP per capita for the provinces during the period 1978-1995. They argued that the rich provinces had relatively more ability to achieve higher capital investment through higher levels of local savings than the poor provinces. This is in line with our findings. The positive correlations between the growth rate of GDP and capital stock and between GDP per capita and capital stock are evident in Table 1 and Table 2. The coastal provinces with faster economic growth had higher GDP per capita and exhibited more rapid accumulation of capital.

Foreign investment is another important source of increasing capital stock. Since 1991, China has become the largest recipient of foreign direct investment (FDI) among all developing countries (Wang and Hu, 1999: 156). A large literature exists which addresses the key role of FDI in driving the rapid growth of China in the 1990s (e.g., Berthelemy and Demurger, 2000; Bao *et al.*, 2002; Chen and Feng, 2000; Fleisher and Chen, 1997; Jones *et al.*, 2003). But the spatial distribution of foreign capital across China has been highly uneven, reflecting geographic factors and preferential policies.

Since the market reforms started in 1978, the central government's regional development strategies have favoured the coastal provinces. The key component of this reform, the Open-Door Policy, was launched, opening up certain areas along the coast to attract FDI and promote foreign trade in the early 1980s. Since 1980, five special economic zones (SEZs) have been established. In 1984, the state further opened 14 coastal cities to overseas investment. Shortly afterwards, the central government expanded the open coastal areas, extending into an open coastal belt.

All the open areas acquired considerable economic autonomy, including the authority to approve large-scale investment projects, the freedom to grant tax concessions to foreign investors, and the right to retain a higher proportion of earned foreign exchange (Wang and Hu, 1999: 178). In addition, they also enjoyed preferred tax treatments and received preferential resource allocations (Litwack and Qian, 1998). In addition, different open areas were also permitted to adopt different preferential policies depending on their local economic characteristics. Beside free trade zones, preferential policies in terms of reducing or eliminating customs duties and income tax are common in economic and technological development zones and certain SEZs. The Shanghai Pudong New Zone has enjoyed special preferential policies which are not yet extended to the other open areas. For instance, in addition to tax reduction policies, the central government also permits the Pudong New Zone to allow foreign businesses to open financial institutions and run tertiary industries. The state has given Shanghai permission to set up a stock exchange, expand its examination and approval authority over investments and allow foreign-funded banks to engage in RMB business. As a consequence, since 1992, the Shanghai Pudong New Zone has made great progress in both absorbing foreign capital and accelerating the economic development of the Yangtze River valley.

A number of studies have emphasized the important role of preferential policies in causing regional inequality in China (see e.g., Demurger *et al.* 2002; Jacobs, 1997; Jones *et al.*, 2003; Wang and Hu, 1999; Yang, 2002). Giving each province a weight that reflects the type of economic zone that it hosts, Demurger *et al.* (2002) constructed a policy index for each of the 30 provinces from 1978 to 1998. Their findings show that the index was highest for the coastal cities with provincial status (Beijing, Shanghai, and Tianjin) and lowest for the central and north western provinces.

The geographic advantage of the coastal provinces that enabled them to achieve higher capital returns has been emphasized by many studies (see e.g., Bao *et al.*, 2002; Batisse, 2002; Brun *et al.*, 2002; Demurger *et al.*, 2002; Yang, 2002). China has a large landscape, stretching from temperate to subtropical zones. As mountains and plateaus account for 59 per cent of the total land (China Statistical Yearbook 2003: 6), there are topographic constraints on economic development. The physical location of the coastal provinces gives them another advantage in attracting FDI and foreign trade. As Demurger *et al.* (2002: 449) put it, "the low cost of water transportation makes the coastal provinces and areas along navigable rivers that flow to the sea better suited to be platforms for producing manufactured exports." Bao *et al.* (2002) found that coastline length was the most important factor, while the effects of distance and elevation were relatively weak factors in explaining ability of provinces to attract capital flows.

By incorporating human capital accumulation into growth accounting, we found that human capital stock does play a significant role in economic growth for all provinces, especially the inland provinces. To find the regional characteristics that affect human capital accumulation, we start through taking a closer look at changes in human capital stock at the provincial level in the 1990s. Table 5 provides the average number of years of formal schooling per person by province in 1990 and 2000. It shows that all provinces achieved higher educational attainment in 2000. In absolute terms, human capital stock increased remarkably over the decade. Unlike the large discrepancy in physical capital accumulation, provinces appeared to perform more equally in human capital accumulation. Overall, in 2000 the average years of schooling for the inland provinces were 5.95 years and that of the coastal provinces were 6.76 years.

Insert Table 5

However, some results in Table 5 are less encouraging. The average educational attainment of the inland provinces was lower than that of the national average in both 1990 and 2000. Guizhou, the poorest province in terms of GDP per capita, had the lowest level of educational attainment in 2000, merely 4.68 schooling years per capita. Besides Guizhou, Yunnan, Gansu, and Ningxia have the next poorest performance in their average years of schooling, with 4.91 years, 5.17 years, and 5.48 years, respectively. Each of these provinces are poor interior provinces. A study of disparities in basic education among counties in China between 1994 and 1997 showed that there was widening educational inequality between urban and rural counties and that poor counties were significantly disadvantaged in terms of per student recurrent expenditure, teacher quality, and physical conditions of schools (World Bank, 1999). On the one hand, decentralization has diversified education funding and provided increased autonomy and flexibility in school-level management by increasing mobilization of local resources. On the other, devolution has also brought serious problems of inequity both within and across provinces. Provinces which have experienced rapid economic growth have benefited from more financial resources. Variation in local resources has translated into disparities in capital construction and teacher salaries and in the quantity and quality of teaching facilities and materials.

Insert Table 6

The regional differences in educational inputs help explain the regional differences in educational attainment. Table 6 shows educational expenditure of the provinces through using two indicators to reveal the contribution of two sources of educational investment: NGE measures the share of non-government funds in total educational expenditure; while GE captures the ratio of expenditure on education in total government expenditure. It is shown in Table 6 that the average share of educational funds from non-government sources in total educational funds was 5 per cent higher in the coastal provinces than in the inland provinces in 2000. By comparison, the differences in the average share of government expenditure on education (measured by GE) between the inland and coastal governments were much smaller, with 16.49 per cent for the coastal provinces and 15.01 per cent for the inland provinces. These findings confirm that it was the provinces with the fastest economic growth which benefited from more financial resources, especially non-government resources.

CONCLUSION AND IMPLICATIONS

Over the first two decades of market reform, substantial educational and economic disparities emerged in China. This study has attempted to address two questions: 1) what have been the effects of physical capital and human capital accumulation on economic growth of the 27 Chinese provinces between 1990 and 2000; 2) to what extent do regional disparities in factor accumulation affect economic growth.

By incorporating human capital stock as a factor of production, the linkage between aggregate real output and capital, labour, education, and productivity has been examined within a framework of growth accounting. The main findings are: first, economic growth in China's provinces depends heavily on the accumulation of physical capital stock, which accounted for around 55 per cent of GDP growth at the national level. Second, human capital stock plays an important role in facilitating growth in all the provinces, contributing to 13 per cent of output growth on average between 1990 and 2000. Third, the regional income disparities between the coast and inland provinces are substantial. As far as GDP per capita, the average years of schooling per capita and the growth rates of output and capital stock, our findings suggest that the coastal provinces are relatively prosperous and that the inland provinces lag behind.

The empirical analysis suggests that uneven distribution of resources between the coastal and inland provinces increased the regional gap in growth. Preferential policies and geographic characteristics have enabled the coastal provinces to increase capital stock at a faster rate. The rapid economic growth benefited the coastal provinces with more financial resources. As a consequence, these provinces have achieved higher educational attainment. When the market reforms were launched, it was believed by the policymakers that if certain regions were allowed to prosper first, their affluence would eventually trickle down to other regions (Wang and Hu, 1999: 177-179). However, recent empirical studies suggest that spillover effects have been insufficient to reduce regional income inequality, especially in western China (see Brun *et al.* 2002).

The challenge to policymakers is to address the disparities mainly arising from inequalities in the educational finance system. Here, the central government may take a more active role in balancing the present uneven distribution of educational investment across the country. On the one hand, the central government should increase intergovernmental transfers to provide more educational grants to help equalize the access of education for children in poor areas. On the other hand, the central government should guide and monitor investment in education from other non-government resources, via setting standards for private schools, paving the way for social donations to education and cooperating with international organizations.

Within the neoclassical framework, this study has attempted to assess the linkage between human capital stock and output growth. Future research could examine the role of the labour market in this process. Are there sufficient wage differentials to encourage individuals to acquire more schooling? Will greater freedom for individuals to change jobs have a positive effect on growth? Will migration between the provinces reduce the regional gap in educational attainment or increase it? What factors are essential in transferring a successful education system to successful economic development? Further study is needed on these topics to find the mechanism through which an effective labour market enables education to fuel economic growth.

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Table 1: Growth accounting for national, regional and provincial economies of China: 1990-2000

	Averaged for the period 1990 - 2000									
	Growth rate (%)					Labour	Contribution (%)			
	Y	K	L	H	TFP	Share	K	L	H	TFP
National	10.64	12.68	1.77	2.55	2.45	0.5369	55.49	8.96	13.40	22.15
Coast	12.24	15.03	2.05	2.42	2.41	0.4942	62.50	8.18	9.92	19.39
Inland	9.54	11.06	1.58	2.64	2.38	0.5662	50.67	9.50	15.79	24.04
COAST										
Beijing	10.39	12.82	3.04	2.00	1.33	0.4836	63.71	14.17	9.31	12.82
Tianjin	10.99	12.92	1.87	1.93	2.49	0.4852	60.54	8.24	8.54	22.68
Hebei	12.20	14.94	1.40	2.90	2.91	0.5310	57.44	6.09	12.60	23.87
Liaoning	8.65	10.86	1.18	1.79	1.55	0.4763	65.75	6.50	9.84	17.91
Shanghai	11.41	16.78	2.79	1.68	-1.03	0.3529	95.17	8.64	5.20	-9.00
Jiangsu	13.32	16.50	1.34	2.64	3.04	0.4966	62.34	4.99	9.84	22.83
Zhejiang	14.03	16.74	1.66	2.39	3.27	0.4709	63.11	5.56	8.03	23.30
Fujian	14.81	17.78	2.49	3.30	3.22	0.5158	58.15	8.66	11.49	21.71
Shandong	13.09	13.72	1.30	2.73	3.8	0.4575	56.86	4.54	9.54	29.07
Guangdong	14.50	17.51	4.03	2.55	2.51	0.5053	59.73	14.04	8.90	17.33
Guangxi	11.21	14.79	1.46	2.69	3.45	0.6608	44.74	8.59	15.88	30.79

	Growth rate (%)					Labour	Contribution (%)			
	Y	K	L	H	TFP	Share	K	L	H	TFP
INLAND										
Shanxi	9.01	9.56	1.60	1.98	2.5	0.5106	51.93	9.04	11.24	27.78
Inner Mongolia	7.87	11.60	1.85	2.40	0.66	0.5971	59.38	14.00	18.20	8.41
Jilin	9.77	11.91	1.82	2.12	2.64	0.6003	48.72	11.19	13.03	27.06
Helongjiang	8.17	10.98	1.30	2.10	0.61	0.4515	73.74	7.18	11.60	7.48
Anhui	11.53	10.45	0.76	3.43	4.48	0.5422	41.48	3.56	16.11	38.85
Jiangxi	11.12	10.87	1.66	3.04	4.14	0.6302	36.15	9.42	17.20	37.23
Henan	10.90	12.30	1.13	2.79	3.75	0.6141	43.54	6.34	15.70	34.41
Hubei	11.26	13.40	1.80	2.86	2.85	0.5717	50.99	9.16	14.54	25.32
Hunan	9.92	11.87	1.20	2.57	3.11	0.6250	44.88	7.55	16.18	31.39
Sichuan	9.86	13.66	0.47	1.96	2.63	0.5723	59.24	2.72	11.38	26.66
Guizhou	8.26	9.39	1.04	2.73	2.43	0.6335	41.68	7.95	20.91	29.47
Yunnan	9.25	10.52	2.17	3.26	1.07	0.4589	61.51	10.78	16.18	11.52
Shannxi	8.56	8.97	1.38	2.82	2.41	0.5907	42.88	9.51	19.45	28.16
Gansu	9.10	8.45	1.36	3.13	2.77	0.5346	43.23	7.99	18.36	30.41
Ningxia	8.14	11.09	2.55	2.76	0.39	0.5776	57.54	18.09	19.58	4.79
Xinjiang	9.95	11.89	3.17	2.33	1.57	0.5491	53.87	17.50	12.88	15.76

Notes

Y: real GDP; K: real capital stock;L: Labour force, population aged 15-64; H: Average years of schooling per capita.

Table 2. GDP per capita (at constant 1990 prices) by province: 1990-2000

	1990			2000			2000 minus 1990	
	GDP p.c.	**China=1**	**Guizhou=1**	**GDP p.c.**	**China=1**	**Guizhou=1**	**China=1**	**Guizhou=1**
National	1886	1.00	2.37	4843	1.00	2.86	0.00	0.49
Coast	2681	1.42	3.37	7417	1.53	4.38	0.11	1.01
Inland	1340	0.71	1.68	3072	0.63	1.81	-0.08	0.13
COAST								
Beijing	4538	2.41	5.70	10180	2.10	6.01	-0.31	0.31
Tianjin	3590	1.90	4.51	9243	1.91	5.46	0.01	0.95
Hebei	1455	0.77	1.83	4436	0.92	2.62	0.15	0.79
Liaoning	2713	1.44	3.41	6159	1.27	3.64	-0.17	0.23
Shanghai	5894	3.12	7.40	14253	2.94	8.42	-0.18	1.02
Jiangsu	2093	1.11	2.63	7087	1.46	4.19	0.35	1.56
Zhejiang	2120	1.12	2.66	7740	1.60	4.57	0.48	1.91
Fujian	1741	0.92	2.19	6329	1.31	3.74	0.39	1.55
Shandong	1794	0.95	2.25	6072	1.25	3.59	0.30	1.33
Guangdong	2496	1.32	3.14	7103	1.47	4.20	0.15	1.06
Guangxi	1059	0.56	1.33	2986	0.62	1.76	0.06	0.43

1990 2000 2000 minus 1990
GDP p.c. China=1 Guizhou=1 GDP p.c. China=1 Guizhou=1 China=1 Guizhou=1

INLAND								
Shanxi	1481	0.79	1.86	3189	0.66	1.88	-0.13	0.02
Inner Mongolia	1476	0.78	1.85	2954	0.61	1.74	-0.17	-0.11
Jilin	1743	0.92	2.19	4185	0.86	2.47	-0.06	0.28
Helongjiang	2019	1.07	2.54	4345	0.90	2.57	-0.17	0.03
Anhui	1162	0.62	1.46	3479	0.72	2.05	0.10	0.59
Jiangxi	1125	0.60	1.41	3140	0.65	1.85	0.05	0.44
Henan	1081	0.57	1.36	2999	0.62	1.77	0.05	0.41
Hubei	1516	0.80	1.90	4192	0.87	2.48	0.07	0.57
Hunan	1218	0.65	1.53	3136	0.65	1.85	0.00	0.32
Sichuan	1129	0.60	1.42	2047	0.42	1.21	-0.18	-0.21
Guizhou	796	0.42	1.00	1693	0.35	1.00	-0.07	0.00
Yunnan	1212	0.64	1.52	2561	0.53	1.51	-0.11	-0.01
Shannxi	1219	0.65	1.53	2673	0.55	1.58	-0.10	0.05
Gansu	1077	0.57	1.35	2335	0.48	1.38	-0.09	0.03
Ningxia	1392	0.74	1.75	2625	0.54	1.55	-0.20	-0.20
Xinjiang	1792	0.95	2.25	3606	0.74	2.13	-0.21	-0.12

Table 3: Tests of hypotheses of constant returns to scale and that the output elasticities of the population with different education levels are the same

Hypotheses	F-statistic	Probability
$\alpha_1+\beta_1+\beta_2+\beta_3+\beta_4+\beta_5=1$	0.004685	0.945742
$\beta_1=\beta_2=\beta_3=\beta_4=\beta_5$	3.438750	0.015709

Table 4: Regression analysis across provinces 1990 and 2000

Explanatory variables	Coefficient	t-Statistic
lnIV	0.632800*	11.35928
lnL1	-0.179477*	-2.418429
lnL2	0.268717**	2.117974
lnL3	0.268416	1.286988
lnL4	0.040432	0.242089
lnL5	-0.035679	-0.244208
GOV	-1.210907**	-2.041019
TI	6.46E-05***	1.560036
DC	0.099646*	2.665699
C	0.834100*	2.674819
R-squared	0.977356	

Notes: *denotes variable is statistically significant at 0.01 level; ** denotes variable is statistically significant at 0.05 level; *** denotes that the variable is statistically significant at the 0.15 level. The t-statistics are heteroskedastic consistent.

Table 5. Average years of schooling per capita by provinces: 1990-2000

	H (=AYS)		
	1990	2000	2000-1990
National	4.89	6.28	1.39
Coast	5.33	6.76	1.42
Inland	4.58	5.95	1.37
COAST			
Beijing	6.87	8.39	1.52
Tianjin	6.16	7.47	1.31
Hebei	4.73	6.32	1.59
Liaoning	5.81	6.95	1.14
Shanghai	6.63	7.84	1.21
Jiangsu	4.97	6.47	1.50
Zhejiang	4.78	6.07	1.29
Fujian	4.42	6.14	1.72
Shandong	4.71	6.19	1.48
Guangdong	4.99	6.44	1.45
Guangxi	4.61	6.03	1.42
INLAND			
Shanxi	5.24	6.4	1.16
Inner Mongolia	4.97	6.32	1.35
Jilin	5.51	6.81	1.30
Helongjiang	5.51	6.8	1.29
Anhui	3.98	5.61	1.63
Jiangxi	4.42	5.99	1.57
Henan	4.72	6.24	1.52
Hubei	4.79	6.38	1.59
Hunan	4.91	6.35	1.44
Sichuan	4.71	5.73	1.02
Guizhou	3.56	4.68	1.12
Yunnan	3.54	4.91	1.37
Shannxi	4.71	6.25	1.54
Gansu	3.78	5.17	1.39
Ningxia	4.16	5.48	1.32
Xinjiang	4.82	6.09	1.27

Table 6: Education expenditure by province in 2000

COAST	NGE	GE	INLAND	NGE	GE
Average	32.30	16.49	Average	27.23	15.01
Beijing	30.02	13.56	Shanxi	28.78	16.96
Tianjin	34.79	16.50	Inner Mongolia	20.29	12.03
Hebei	29.17	17.72	Jilin	26.72	13.74
Liaoning	26.09	12.72	Helongjiang	24.47	12.83
Shanghai	30.56	13.82	Anhui	31.99	16.69
Jiangsu	35.15	19.86	Jiangxi	33.23	17.07
Zhejiang	39.18	18.13	Henan	32.18	17.36
Fujian	29.43	19.11	Hubei	43.20	15.64
Shandong	28.96	19.26	Hunan	42.70	14.63
Guangdong	40.59	13.40	Sichuan	32.65	13.95
Guangxi	31.39	17.30	Guizhou	19.67	15.77
			Yunnan	16.15	15.05
			Shannxi	28.93	14.15
			Gansu	19.21	14.63
			Ningxia	20.27	13.29
			Xinjiang	15.23	16.42

Source: China Statistical Yearbook 2001

Notes:

NGE = (Non-governmental educational funds)/(Total educational funds)

GE = (Educational expenditure)/(Total government expenditure)