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REGIONAL ECONOMIC GROWTH IN CHINA: NEW EVIDENCES FROM PANEL DATA

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Preliminary, not for quotation

ABSTRACT

This essay investigates the contributions of different factors to regional economic growth in China. A statistical analysis on a provincial panel data from 1978 to 2007 confirms the increasing regional inequality in China can be understood as different patterns of regional economic growth, which are affected by factors such as capital and labour inputs, education and institutional variables. We base our study on a growth accounting model with a Cobb-Douglas production function. We find that there are significantly positive associations between education and GDP per worker, total factor productivity and wage. In particular, senior secondary schooling is most important for China's productivity and wage, especially for economic growth. University and above only improves the economic growth, suggesting that government should pay more for the university and above than individuals. The effect of education on economic growth appears to be much stronger after 1994 and mainly occurs in the coastal region. Moreover, institutional variables, such as FDI and openness affect positively, while inflation rate and birth rate have negative effect. The impact of semi-private and private units, fiscal expenditure on education and industrialization on the three productivity proxies are mixed. We conclude that investing in human capital with further market reform will be an effective policy to promote economic growth as well as a remedy to increasing regional inequality.

JEL codes: I28, O43, J31

Keywords: Education, Economic Growth, Regional Inequality, Reform

I. Introduction

Economic reform in China has resulted in unprecedented economic growth since 1978. In the early years of new millennium, however, China found itself with one of the highest degrees of regional inequality in the world and over its history (Yang 2002; Kanbur and Zhang 2005; Fleisher et al 2009). Chinese provinces show quite different growth paths with wide regional disparities in growth rates. The coastal region has experienced higher growth rates than the northeast, interior and far west, which has enlarged productivity and wage disparity between the rich and poor regions.[1] In 1978, the first year of our study, the real GDP per worker of the coastal region was 2,964 Yuan[2], which was only 56% of the industrial northeast and very close to the interior and far west regions. Thereafter, the coastal region grows much faster than the others so that by the last year of our study, 2007, its GDP per worker has increased about 14 fold over the previous thirty years (42,342 Yuan, average growth rate 9.6% per year), which was 5% higher than the old champion - the northeast and double the two laggard regions- the interior and far west (see Figure 1a).

For workers in the four regions, the average real wages are not much different until the major reform following Deng Xiaoping's "South Trip"[3] in 1992. He reaffirmed his belief in policies that encouraged Chinese citizens to follow the profit motive in the quest of personal wealth. This trip thwarted the conservative force that tried to stop market oriented reform following the Tiananmen Square events of 1989. By doing so, it speeded the pace of transition to a market system.

Although urban economic reform began in the period 1983-85, the Chinese economy was still largely operating under the old planning system before 1992, with the share of state-owned enterprises (SOEs) accounting for more than half of gross industrial output. After Deng's visit to south China, the country moved much more quickly towards an open, market economy. In the period 1992 to 1994, the share of

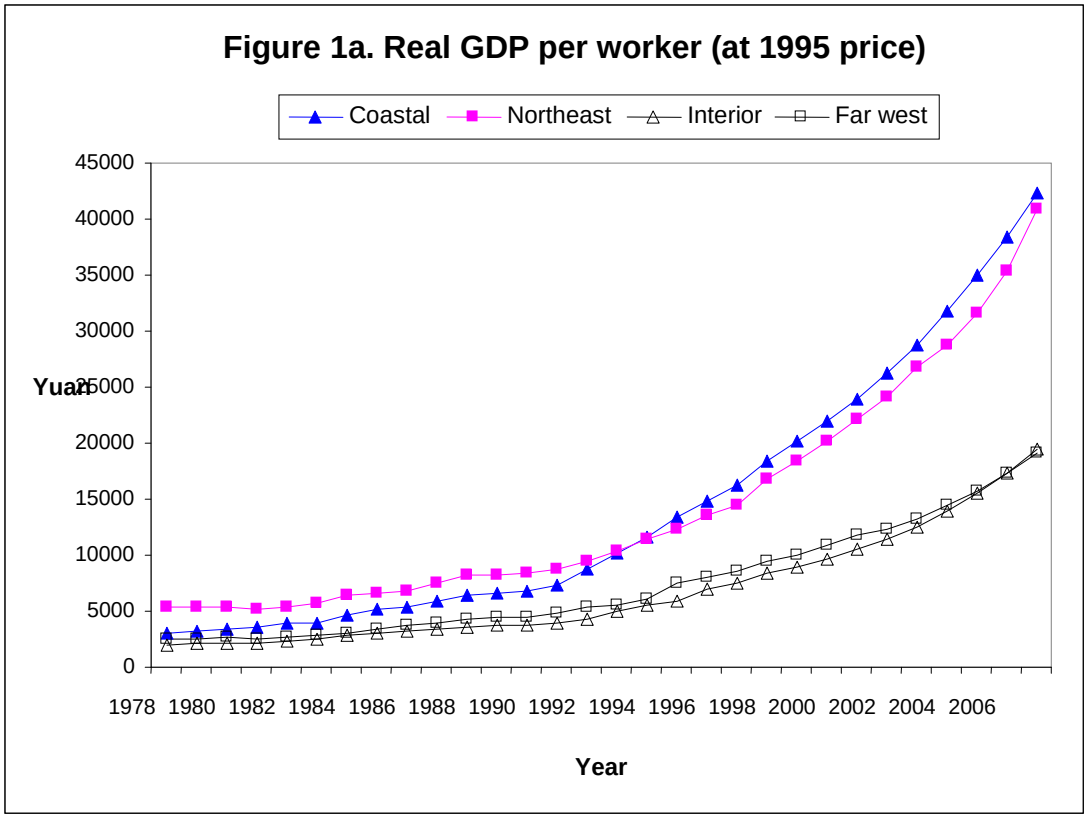
[1] We follow Fleisher et al (2009) and previous research to define the four regions in this study: coastal (Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong-Hainan); northeast (Heilongjiang, Jilin, Liaoning), interior (Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan-Chongqing, Guizhou, Yunnan, Inner Mongolia and Shaanxi) and far west (Gansu, Qinghai, Ningxia and Xinjiang). We have excluded Tibet due to lack of data, combined Chongqing with Sichuan and Hainan with Guangdong to ensure consistency over the entire period of 1978-2007. The division of the four regions is based on research regarding the major economic and geographical clusters in economic growth and development in China. See geographic graph of regions in Appendix.

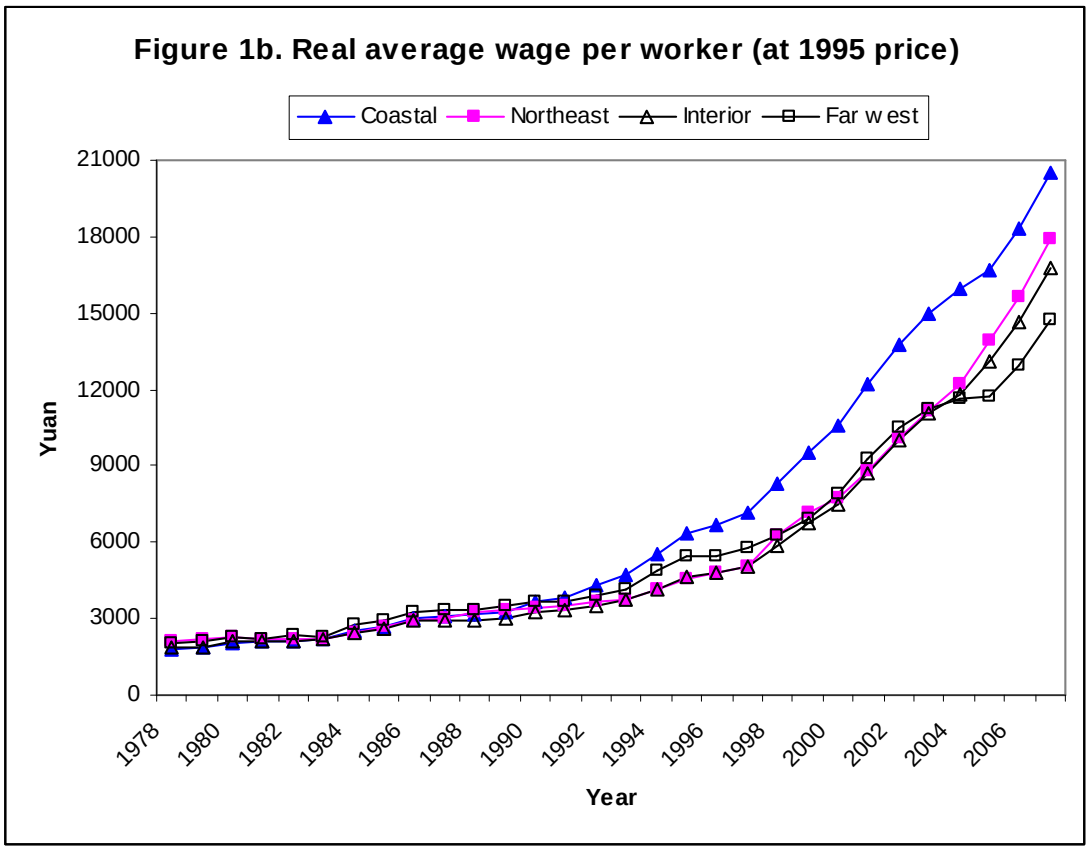
[2] All numbers are based on 1995 RMB Yuan.

[3] In the spring of 1992, Deng Xiaoping visited Coastal region of China (Guangdong and Shanghai). He made various speeches to stress the importance of economic construction in China, and criticized those who were against further economic and openness reforms. The main idea was "To Get Rich Is Glorious".

SOEs in industrial output dropped 14 percentage points (from 48.1% to 34.1%), an annual rate much faster than during the period 1978 to 1992. The SOE share in industrial output fell to 13% by 2003. The year 1994 marked the beginning of withdrawal of government subsidies for loss-incurring SOEs, and this hardening of budget constraints became much more earnest in 1997 (Appleton et al., 2002). There was also a shift toward fiscal federalism after 1994 that, through separating central and local government taxation and relaxing ties between provincial and sub-provincial treasuries and the centre, reinforced imposition of hard budget constraints on SOEs (Ma and Norregaard, 1998; Su and Zhao, 2004; Qian andWeingast, 1997). Fiscal reform made local governments responsible for subsidizing sub-provincial- owned state enterprises, thus providing strong incentives for the local governments to shift their expenditures to projects that would attract FDI, particularly infrastructure projects (Cao et al., 1999). Despite the potential contribution of these reforms to improved economic conditions, implementation was by no means perfect (Ma and Norregaard, 1998). Therefore, we account for the intensification in the impact of market reforms after 1994 in the specification of our empirical models.

It suggests a rigid labour market from the Mao era to the early 1990s, which corresponds to the stable regional inequality before 1994. However, the reform in the labour market combined with the wide regional disparities in growth rates, changes the wage structure in China. In 2007, the average wage in the coastal region was about 14 percent higher than that in the northeast, 22 percent higher than the interior and 40 percent higher than the far west (Figure 1b). Hence, the economic miracle of China in the last thirty years is mainly the coastal region’s miracle and mostly benefits the workers there. For the laggard regions and their workers, the economic performance is much less impressive.

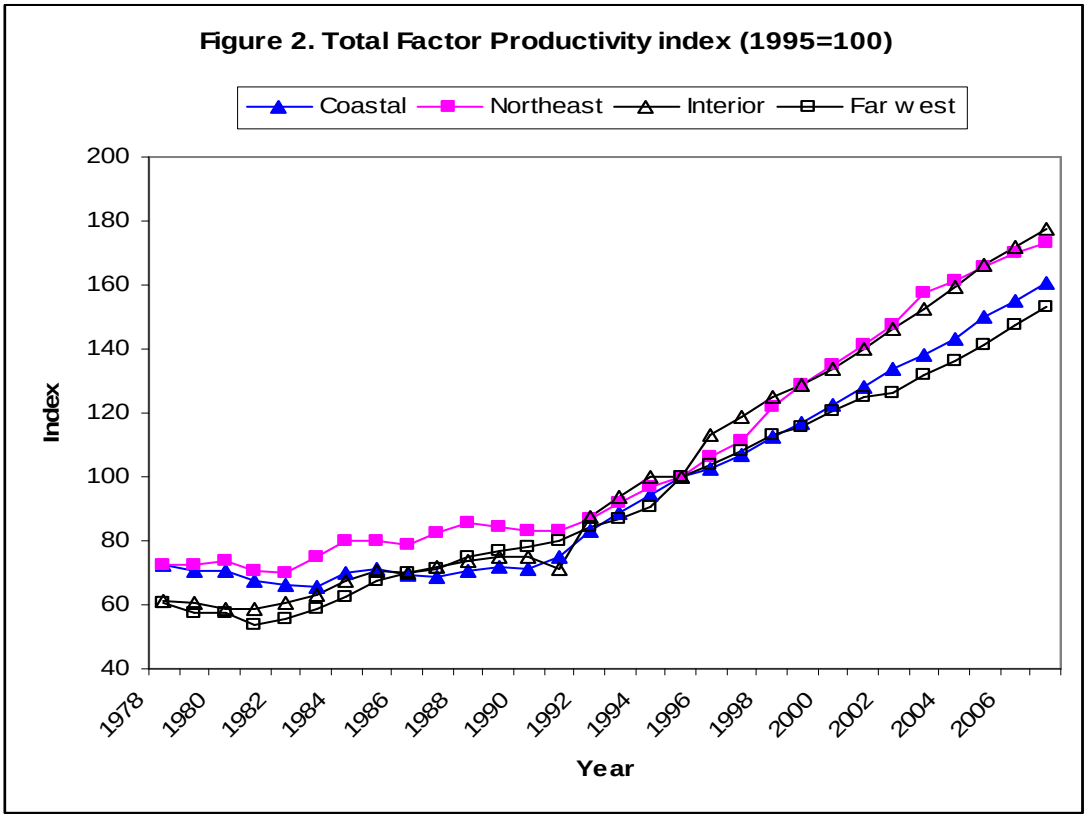




Data sources: Hseuh and Li (1999); various years China Statistical Yearbook (NBS 2009); National Bureau of Statistics (1999).

Moreover, a body of research has shown that total factor productivity (TFP) has played an important role in post-reform growth in China (Chow 1993, Borensztein and Ostry 1996, Young 2003, Wang and Yao 2003, Islam et al 2006, Fleisher et al 2009). Figure 2 shows the TFP index of the four regions over the last thirty years, suggesting alternative periods of "gradualism, stagnation and sharp jumps" in the market process of China's economy (Fleisher et al 2007). The gradualism of reform brings the slow pace of China's transformation which distinguished it from most other formerly planned economies, especially those of Central and Eastern Europe and the much of the Former Soviet Union (Fleisher et al 2005). TFP index increases gradually until the jump around 1992 following Deng Xiaoping's "South Trip". We can find a clear regional disparity in Figure 2. The northeast and interior regions had the higher growth rate of TFP index and left the far west region far behind in 2007.

It is widely hypothesized that education has an important role in production through the direct generation of worker skills and also it is believed through indirect facilitation of technology spillovers (Fleisher et al, 2009). However, the comparison of the role of education in the analysis of GDP per worker, TFP and wage growth is still rare in China. Chen and Fleisher (1996), Fleisher and Chen (1997) and Démurger (2001) provide evidence that education at the secondary or college level helps to explain differences in provincial growth rates. Liu (2007, 2008) demonstrates important external effects of human capital on productivity in rural and urban China. A recent paper by Fleisher et al (2009) provides a framework and evidence expanding our understanding on the role of education in production and in generating productivity growth in China. They find that workers with more than elementary school education have a much higher marginal product than labour with no higher than elementary schooling, and estimate the effect of human capital on TFP growth by domestic innovation activities. However, such effects and especially their impacts on different productivity proxies have not been fully analyzed and compared. In this paper, we analyze and compare the effect of education on the production process, GDP per worker, TFP growth and wages incorporating the institutions variables, such as semi-private and private units, fiscal expenditures on education, openness, FDI, industrialization, inflation rate and birth rate to help in understanding the increasing regional inequality in China.



Data sources: Hseuh and Li (1999); various years of China Statistical Yearbooks (NBS 2009); National Bureau of Statistics (1999)

Developing the economies of the inner regions, so that its income can catch up with the coastal regions, is both an economic challenge and a political necessity in China. So what determines economic growth across the Chinese regions? Or in other words, what explain the difference in growth among them? What are the major factors that drive high economic growth in the coastal region, and what cause the inner regions to lag behind? What are the different impact of the major factors on productivity and wage? What kinds of policies should be carried on according to the characteristics of different regions? This paper intends to address these specific questions by making use of recently available data from the Chinese provinces to study the factors that drive economic growth across the regions. Next section is the literature review; in the section 3 we lay out our methodology; Section 4 describes data sources and measurement; Section 5 reports empirical results of baseline specification and sensitivity tests; Section 6 concludes.

II. Literature Review

Even though it is widely observed that some economies grow faster than others, academics and policy-makers have long been interested by the coexistence of unbalanced, erratic growth paths across countries and regions in the globalizing economy. If the increasing regional inequality in China were not corrected in time, the uneven growth in productivity and wage would not only threaten the ultimate success of China's economic reform, but will also bring about serious social and political unrest (Chen and Feng 2000). Understanding the drivers of the increasing economic gap between rich and poor regions has become an urgent task for Chinese economists.

China needs to learn many lessons from the economic growth path of other countries, especially from the developed economies. In a cross-country setting, numerous theoretical and empirical studies find that growth is determined by physical and human capital, technology adoption, government consumption, privatization, international openness, public policy and political stability (see Barro, 1991, 1997, 2001 and 2002; Barro and Lee 1993, 2001; Chen and Feng 1996; Feng 1997; Prichett 2001; Van Ark, O'Mahony and Timmer 2008). These general cross-country findings shed some light on the problem of China's economic growth.

First of all, Romer (1986, 1990) argues that human capital is the major input to research and development that innovates technologies. Human capital plays a critical role in endogenous growth models, which hold that knowledge-driven growth can lead to a constant or even increasing rate of return. Lucas (1988, 1993) emphasized the human capital accumulation through schooling and learning-by-doing in a growth model. Empirical evidence also has revealed a positive relationship between education and growth. Barro (1991, 1997, 2001 and 2002) identifies that education has positive effects on growth. Mankiw et al (1992) shows that an augmented Solow model that includes accumulation of human as well as physical capital can provide an excellent description of the cross-country data. Levine and Renelt (1992) and Young (l992) also find that human capital invariably exerts a positive impact on growth. Thus, countries with larger initial human capital stock are more likely to have new products and grow faster than other countries.

However, many studies (Behabib and Spiegel 1994; Islam 1995; Krueger 1995; Temple 2001; Pritchett 2001) about the effect of education on growth based on cross-country data cannot produce clear results. A well known reason for this uncertainty is that education systems vary widely across countries with very different institutions,

labour markets and education quality, making it hard to identify an average effect across countries (Temple 1999, Pritchett 2001 and Estevez-Abe et al 2001). This paper investigates the role of education in the production process, economic growth and TFP as well as impacts on wages. After controlling for economic reform variables, we apply an augmented Cobb-Douglas production function to the provincial panel data within one country -China to avoid the problem of different education quality. This paper can firstly contribute to an understanding of the effect of education on economic growth in general as well as an understanding of China's rapid rising regional inequality.

Moreover, Fleisher et al (2009) find that human capital positively affects production and TFP growth in China. Hence, human capital is critical for less developed provinces in China to achieve high economic growth. However, they did not compare the external benefit of education for economic growth with the internal benefit for earnings of workers, which is the second contribution of this paper. Fleisher et al (2004) suggest investigating the returns to education in China to help with the decision of who (government or students) should pay for the tuition fee and living expenses. Deardon et al (2006), O'Mahony and Peng (2008) and Carmichael et al (2009) compare the effect of education and training on productivity and wages for European countries in an attempt to pick up external benefits of education and training. Government can benefit from the increase of economic growth and technology progress, and individuals directly get advantage from increases in the average wage. We not only illustrate the relationship between education and economic growth, but also formally assess the economic benefit of education for different parties. Thus, this paper statistically assesses the benefit of education and draws implications for which side should pay for the costs.

Knight and Song (2001) point out that there are two obvious explanations for the rise in income inequality in China: economic growth and economic reform policies. The Chinese economy may have some unique characteristics because of its history and institutional reform in the previous thirty years (Chen and Feng 2000). Firstly, China's transformation had a sharp acceleration after Deng Xiaoping's famous 1992 "South Trip". Although urban economic reform began in the period of 1983-85, the Chinese economy was still largely a command economy under the old planning system, with the share of state owned enterprises (SOEs) accounting for more than half of gross industrial output (Fleisher et al 2007). After Deng's visit to

south China, the country moved much more quickly towards an open, market economy. The year 1994 marked the beginning of withdrawal of government subsidies for loss-incurring SOE's, and this hardening of budget constraints became much more earnest in 1997 (Appleton et al., 2002). There was also a fiscal decentralization process after 1994 through separating central and local government taxation and reinforcing imposition of hard budget constraints on SOEs (Qian and Weingast 1997; Ma and Norregaard 1998; Su and Zhao 2004). Hence, we follow the same line of Fleisher et al (2007) to account for the structural break of Chinese market reforms around 1994 in the specification of our empirical models.

Secondly, the cross-country growth literature also points to the political role that the central government can play in improving the laggard regions' economic growth. Since the widening productivity and wage gap between the coastal and inner regions can lead to political unrest and polarization, the Chinese central government has emphasized the importance of the inner areas' growth and development. Ma (1995), Ma and Norregaard (1998) and Chen and Feng (2000) argued that the central government policies should not be biased in favour of the coastal region. If the central government decides to provide financial help to the inland, less developed regions, funds should be used in ways that achieve maximum growth, such as establishing schools, improving health care, and building inter-provincial infrastructure. The conventional wisdom suggests that the decentralization of fiscal revenue raising and spending decisions can improve the efficiency of the public sector, cut the budget deficit and promote economic growth because local governments are better positioned than the centre government to locate and monitor the fiscal expenditure more efficiently.(Oates,1972). It is also confirmed by numerous studies on intergovernmental fiscal relations in China (Agarwala 1992). Hence, we investigate the effect of provincial fiscal expenditure on economic growth, TFP index and average wage in this paper.

The central government led by Premier Zhu Rongji launched the "Western Development Strategy" in 1999 to boost the laggard interior and far west regions.[4] The main components of the strategy include the development of infrastructure,

[4]The policy covers 6 provinces (Gansu, Guizhou, Qinghai, Shaanxi, Sichuan-Chongqing, and Yunnan), 5 autonomous regions (Guangxi, Inner Mongolia, Ningxia, Tibet, and Xinjiang), all in the laggard interior and far west regions. These provinces and autonomous regions contain 72% of mainland China's area, but only about 28% of its population, and about 17% of its total economic output, as of 2007 (CSY 2008).

enticement of foreign investment, increased efforts on ecological protection (such as reforestation), promotion of education, and retention of talent flowing to richer provinces. As of 2006, a total of 1 trillion Yuan has been spent building infrastructure in western China (see more details in Goodman 2004). Another example, the northeast was one of the earlier regions to industrialize in China, focusing mainly on equipment manufacturing including the steel, automobile, shipbuilding, aircraft manufacturing, and petroleum refining industries. Recent years, however, has seen the stagnation of the northeast's heavy-industry-based economy, as China's economy continues to liberalize and privatize. Hence, the central government led by Premier Wen JiaBao has initialized the "Revitalize the Northeast" campaign in 2003. This paper will statistically assess the effect of these policies on the regional economic growth and draw out implications for policy.

According to the endogenous growth model (Romer, 1986), long-run economic growth can continue indefinitely due to technological within the economic system. A highly industrialized country or region often has the knowledge and technology that accelerate economic growth, based on the advances of technological revolutions and renovations. Knowledge spillover allows each unit of capital investment to increase the level of technology for all firms, as well as the stock of physical capital. Chen and Feng(2000) mention that the trend of industrialization in China is consistent with progress of technological innovation and upgrading. Therefore, different levels of industrialization in China across provinces may cause growth rates to vary. They use the gross output value of industry as a percentage of provincial income (INDUSTRY) as an index for industrialization, and find it has a positive impact on growth. We follow their method to estimate the effect of degree of industrialization for the three productivity proxies in this paper.

Thirdly, Chinese reform aims to transform the rigid public-owned economy into a flexible mixed economy. Using data for advanced European countries, Peng and Siebert (2007, 2008) find that the wage rigidity (especially in the public-owned enterprises) harms the economy of laggard regions by delaying their recovery from disadvantageous shocks. Chen and Feng (2000) argue that a larger share of production by non-state-owned enterprises could result in higher economic growth in the coastal

region of China. To the extent that collective-owned and private[5] units are more efficient and lead to higher growth, the inland regions should encourage the establishments of non-state-owned enterprise. Consequently, curtailing the widening coastal-inland regional income gap can be effectively achieved by promoting semi-private or private enterprises. Fleisher et al (2007) measure the degree of market reform in the local economy by proportion of urban labour employed in private firms. We calculate the share of staff and workers worked in the three kinds of enterprises by state owned units (SOEs), collective-owned units and private units and assess the effect of privatization on economic growth, TFP and wage.

Fleisher et al (2009) argue that, besides the spontaneous growth of semi-private and private enterprises, another major force pushing the China's economy toward market has been the introduction of (partial) foreign ownership through foreign direct investment (FDI).The direction of FDI is obviously encouraged by exogenous geographical and political factors such as proximity to major ports, decisions to create special economic zones and free trade areas, local institutional characteristics such as laws and regulations, contract enforcement, and so on, local expenditures on infrastructure, schools, etc., and by labour market conditions. FDI has facilitated the transformation of the state-owned and the collective sectors, and potentially bring in new production and managerial technologies with their attendant spillovers (Liu, 2009). Therefore, we also account for the regional inequality with the foreign direct investment

Fourthly, in Levine and Renelt's (1992) systematic study of numerous economic factors that may account for long-run aggregate economic growth, trade and investment are identified as major inputs for growth, although the effect of trade on growth weakens when controlled by investment. Chen and Feng (2000) also argue that international trade is conducive to a region's growth and development. Laggard regions should allow resources to shift to economic uses where they have a comparative advantage. In the case that the transaction cost in foreign trade is high for interior and far west regions, they should engage in inter-region trade in order to benefit from any spillovers from international trade. Restrictions to international or between regions trade are detrimental to economic growth in these provinces and

[5] "Private units" include cooperative enterprises, Joint enterprises, Limited liability enterprises, share-holding enterprises, private enterprises, self-employed individual, Funds from HongKong, Macro and Taiwan, Foreign funded enterprises.

weaken the global and national economies. Thus, we measure an openness variable as the sum of export and import and assess its effect on regional productivity and wage.

Finally, theoretical and empirical literatures discussed the effect of inflation rate and birth rate for the economic growth in China. The Tobin-Mundell hypothesis states that anticipated inflation causes portfolio adjustments that lower the real rate of interest and raise investment and growth. Stockman (1981) finds that a higher level of anticipated inflation reduces economic activities, thus lowering investment and growth. De Gregorio (1993) suggests that the effect of the inflation level on investment is negligible if the elasticity of inter-temporal substitution is sufficiently small. Chen and Feng (2000) find a negative effect of inflation on growth, since this economic uncertainty depresses economic activity to different extent across provinces. In this paper, the inflation rate is measured by the general consumer price index.

China started its one-child policy in 1979. The one-child per-family policy, however, was initially applied only to the Han Chinese, and by way of affirmative policies, all ethnic minorities in China were allowed to have two or more children until the end of the 1980s (Qian, 1997). In some provinces, like Tibet, there is no restriction on the number of children per family (Deng, 1995). Li and Zhang (2007) examine the impact of the birth rate on economic growth by using a panel data set of 28 provinces in China over twenty years. They find that the birth rate has a negative impact on economic growth. Their finding not only supports the view of Malthus, but also suggests that China's birth control policy is indeed growth enhancing. We estimate the impact of birth rate on the three productivity proxies.

III. Methodology

Theoretical Background

To assess the contribution of the various inputs to aggregate economic growth, we apply the growth accounting framework. This methodology was first introduced by Solow (1957) and later developed in Kendrick (1961) and especially by Dension (1962). Jorgenson and Griliches (1967) extended and refined the analysis by considering changes in the quality of capital and labour, and by building a "dual approach" to growth accounting in which the Solow residual is calculated using the growth rates of factor prices instead of factor quantities.

It is based on production possibility frontiers where gross output is a function of capital, labour, intermediate input and technology, which is indexed by time, T.

The difference between gross output and the intermediate input is value added. The production function is given by:

$$Y_i = f_i(K_i, L_i, T)$$

Where Y is value added, K is an index of capital service flows and L is an index of labour service flows. i represent the 28 provinces.

Under the assumptions of competitive factor markets, full input utilisation and constant returns to scale, the growth of value added can be expressed as the cost-share weighted growth of inputs and technological change, using the trans-log function form in such analyses:

$$\Delta \ln Y_{it} = \overline{V}^K_{it} \Delta \ln K_{it} + \overline{V}^L_{it} \Delta \ln L_{it} + \Delta \ln A^Y_{it}$$

The above equation indicates the proportion of value added growth accounted for by growth in capital services, labour services and technical change as measured by Total factor productivity (TFP), respectively. A reflects Hicks-neutral technical change. Because of our approach to capital measurement, it only includes disembodied technical change. $\overline{V^i}$ denote the two-period average share of input i in nominal output defined as follows:

$$V^K_{it} = \frac{P^K_{it} K_{it}}{P^Y_{it} Y_{it}},\ V^L_{it} = \frac{P^L_{it} L_{it}}{P^Y_{it} Y_{it}}$$

$$\text{And } \overline{V}^K + \overline{V}^L = 1$$

Empirical Specifications

Firstly, we estimate a regional aggregate production function, in which inputs are specified to include physical capital and five categories of labour: workers with no schooling, workers with primary schooling, workers with junior secondary schooling, workers with senior secondary schooling and workers with university and above[6]. The standard fixed effects (FE) specification is as follows:

$$\ln Y_{it} = \alpha_0 + \alpha_1 K_{it} + \sum_{m=1}^{5} \beta_m Lm_{it} + \alpha_2 S + \sum_{j=1}^{4} \varphi_j R_j + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{it}$$

where Y_{it} is the real GDP; K_{it} is real capital stock; $L1_{it}$ - $L5_{it}$ are the five groups of workers; S is a dummy variable to measure whether there exists a structure break in 1994 (=0 before 1994 and 1 for 1994 and thereafter); R_j and T_t are region and time

[6] University and above: college, university, graduate and higher level.

dummies; and ε_{it} is a random error term. For the three subscripts, i represent 28 provinces, j denote 5 regions and t represents years from 1978-2007. We also try two sensitivity tests for the aggregate production function: 1) adding variables interacted with the year-break dummies to capture the structure break around 1994; (2) adding variables interacted with the regional dummies to capture the growth patterns in the four regions.

Secondly, the fixed effect models are applied to examine the impact of five kinds of educational attainments and institutional variables on GDP per worker, TFP index and average wages. We present the basic FE specification as follows:

$$\ln YL_{it} = \beta_0 + \beta_1 \ln KL_{it} + \sum_{m=2}^{5} \chi_m Em_{it} + \sum_{n=2}^{3} \delta_n On_{it} + \beta_2 F_{it} + \beta_3 \ln OP_{it} + \beta_4 \ln FDI_{it}$$
$$+ \beta_5 lND_{it} + \beta_6 INF_{it} + \beta_7 BR_{it} + \sum_{j=1}^{4} \chi_i R_j + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{it}$$

$$\ln TFP_{it} = \beta_1 + \sum_{m=2}^{5} \chi_m Em_{it} + \sum_{n=2}^{3} \delta_n On_{it} + \beta_2 F_{it} + \beta_3 \ln OP_{it} + \beta_4 \ln FDI_{it}$$
$$+ \beta_5 lND_{it} + \beta_6 INF_{it} + \beta_7 BR_{it} + \sum_{j=1}^{4} \chi_i R_j + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{it}$$

$$\ln AW_{it} = \beta_0 + \beta_1 \ln KL_{it} + \sum_{m=2}^{5} \chi_m Em_{it} + \sum_{n=2}^{3} \delta_n On_{it} + \beta_2 F_{it} + \beta_3 \ln OP_{it} + \beta_4 \ln FDI_{it}$$
$$+ \beta_5 lND_{it} + \beta_6 INF_{it} + \beta_7 BR_{it} + \sum_{j=1}^{4} \chi_i R_j + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{it}$$

where YL_{it} is the GDP per worker; KL_{it} is real capital stock per worker; TFP_{it} is the total factor productivity index; AW_{it} is the real annual earnings per worker; $E2_{it}$ - $E5_{it}$ are the ratios of workers with primary schooling, junior secondary schooling, senior secondary schooling and university and above to the total employment; $O2_{it}$ - $O3_{it}$ represent the ratios of staff and workers worked in the collective-owned and private enterprises to total staff and workers; F_{it} is the education expenditure share of total provincial fiscal expenditure; OP_{it} is the real sum of export and import per worker; FDI_{it} is the real foreign direct investment; IND_{it} is the gross output value of "INDUSTRY" as a percentage of provincial gross GDP; INF_{it} is the inflation rate

measured by the general consumer price index; BR_{it} is the birth rate of population; R_j and T_t are region and time dummies; and ε_{it} is a random error term.

As discussed in the previous section, previous research suggests the year 1994 may be a structure break for China's economy while four regions have very different growth pattern in China (Fleisher et al 2007, 2009). Hence, we applied a more sophisticated specification to test the 1994 structure break and the disparity in regional development patterns. For example, the sensitivity test for structure break in GDP per worker is as follows:

$$\begin{aligned}\ln YL_{it} &= \beta_0 + \beta_1 \ln KL_{it} + \sum_{m=2}^{5} \chi_m Em_{it} + \sum_{n=2}^{3} \delta_n On_{it} + \beta_2 F_{it} + \beta_3 \ln OP_{it} + \beta_4 \ln FDI_{it} \\ &+ \beta_5 lIND_{it} + \beta_6 INF_{it} + \beta_7 BR_{it} + \beta_8 \ln KL_{it} * S + \sum_{m=2}^{5} \theta_m Em_{it} * S + \sum_{n=2}^{3} \gamma_n On_{it} * S + \beta_9 F_{it} * S \\ &+ \beta_{10} \ln OP_{it} * S + \beta_{11} \ln FDI_{it} * S + \beta_{12} lIND_{it} * S + \beta_{13} INF_{it} * S + \beta_{14} BR_{it} * S \\ &+ \sum_{j=1}^{4} \chi_i R_j + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{it}\end{aligned}$$

where S is the structure break dummy variable. After 1994 is the base period. The sensitivity tests for regional disparity in GDP per worker are similar, just replacing the structure break dummy with the regional dummies $rd2$ - $rd4$, which for the northeast, interior and far west regions. The coastal is the baseline region. Hence, coefficients of interactions are the incremental effect of specific period/region on the baseline period/region.

IV. Measurement and Data Description

Measurement

To illustrate the effect of education and market reform on productivity and wage, we need to measure variables such as value added, number of employed persons, labour compensation, educational attainments, share of staff and workers in the enterprises with different ownership, fiscal expenditure on education, export/import, FDI, inflation rate and birth rate. Our data are from various years of the China Statistical Yearbook (NBS), Population Census (State Council Population Census Office and the NBS Population Division, 1985, 1993 and 2001), Hsueh and Li (1999) and National Bureau of Statistics (1999).

Firstly, there are various kinds of price index used in this paper. The implicit GDP deflators are applied as in many previous studies (Rawski, 1993; Maddison, 1998; Woo, 1998; Wu, 2000) to deflate nominal values into real ones using 1995 as our base year; this is used mainly for GDP, FDI, imports and exports. The exchange rates for converting US$ into RMB are the middle rate of reference exchange rate, derived from the National Bureau of Statistics (1999) and CSY (2000 and 2007). To transfer the nominal capital stock into the real value, we mainly use the "price index of investment in fixed assets" from the national CSY as capital deflator. This capital deflator is collected by the urban survey team of National Bureau of Statistics (NBS) since 1991, based on 600 enterprises and expanding to 4500 enterprises after 1998. For years before 1991, we splice the price index of investment in fixed assets to the GDP implicit deflator. The inflation rate is measured by the change of the general consumer price index.

Secondly, we follow the methods in Timmer et al (2007) to construct the capital service in China. The starting point is the perpetual inventory method (PIM), introduced by Goldsmith (1951). The PIM consist of adding the net investment data of the current year to an assumed base year of capital stock. Assuming geometric depreciation, the general formula is given by:

$$K_t = (1-\varphi)K_{t-1} + I_t \tag{8}$$

where K_t is capital stock, φ is the depreciation rate. I_t is the investment which refers to investment in fixed assets.

Our investment data comes from National Bureau of Statistics (1999) and various years of CSY. It is categorize into three categories - buildings and structures, machinery and equipment, and other assets. The "other assets" refers to the expense related to the structure and installation projects and to the purchase of equipment. We follow Fu (2008) suggestion to reallocate the 'other investment' into structure and equipment according to their ratio in investment excluding 'other investment'.

Hulten and Wykoff (1981) estimated depreciation rates of 3.7 percent for structures and 13.3 percent for equipment in the US. The Chinese official depreciation rates are unusually low, in line with the overestimated service life of fixed assets in the absence of markets during the central planning period (Wu and Xu 2002). Since the National Bureau of Statistics does not provide life length and depreciate rates for

the different kinds of investments, we derive depreciation rates based on Chinese tax regulations.[7] The capital stock formula is (for example, structure) as following:

$$K_{it}^{S} = (1-\delta^{S})K_{i,t-1}^{S} + I_{it}^{S}$$

For the aggregation of capital services over the different asset types, it is assumed that aggregate services are a translog function of the services of individual assets. It is assumed that the flow of capital services for each asset type is proportional to its stock, independent of time. Hence the index of capital input K is a translog quantity index of structure assets and equipment assets. The Tornqvist quantity index of individual capital types as follows:

$$\Delta \ln K_{it} = \sum_{k} \overline{w}_{k,it}^{K} \Delta \ln K_{k,it}$$

where $\Delta \ln K_{k,it}$ indicates the growth of capital stock by capital type k (structure and equipment) and weights are given by the period average shares of each type in the value of capital compensation. As we assume that marginal revenues are equal to marginal costs, the weighting procedure ensures that inputs which have a higher price also have a larger influence in the input index. Hence,

$$\Delta \ln K_{it} = \overline{w}_{it}^{S} \Delta \ln K_{it}^{S} + \overline{w}_{it}^{E} \Delta \ln K_{it}^{E}$$

where $\overline{w}_{it}^{S}$ are the period-average shares of structure assets in total capital costs in province i at time t, and similarly for equipment assets. Weights are given by the average shares of each component in the value of capital compensation

$\overline{W}_{sit}^{K} = \frac{1}{2}(W_{sit}^{K} + W_{i,t-1}^{K})$ and $W_{sit}^{K} = (\sum_{k} P_{sit}^{K} K_{it}^{s})^{-1} P_{sit}^{K} K_{it}^{s}$, where P_{sit}^{K} is the price of capital service from structure.

Rental prices, or user-cost of capital, can be estimated using the standard approach grounded in the arbitrage equation derived from neo-classical theory of investment, introduced by Jorgenson (1963) and Jorgenson and Griliches (1967). In equilibrium, an investor is indifferent between two alternatives: buying a unit of capital at investment price P_{sit}^{I}, collecting a rental fee and then selling the depreciated

[7] Before 1994, the legal life of structure is 40 years, and equipment's legal life is 18 years. After 1994, the structure's legal life is 30 years, and equipment's legal life is 13 years. Thus, the geometric depreciation rates for structure are 5 percent or 7 percent, and for equipment are 11 percent or 15 percent, with the 1994 as break.

structure asset for $(1-\delta_s)P^I_{si,t+1}$ in the next period, or earning a nominal rate of return i_{sit}, on a different investment opportunity. The cost-of-capital equation is:

$$P^K_{s,it} = P^I_{si,t-1} i_{sit} + \delta_s P^I_{sit} - [P^I_{sit} - P^I_{si,t-1}]$$

This formula shows that the rental fee is determined by the nominal rate of return, the rate of economic depreciation and the asset specific capital gains. The nominal rate of return in our paper is the one-year deposit rate, and the asset price is the capital deflator of investment for structure.

Thirdly, we calculate the TFP growth following O'Mahony and Timmer (2009). It is based on the index number approach which we described in the section 3.

$$\Delta \ln A^Y_{it} = \Delta \ln Y_{it} - \bar{V}^K_{it} \Delta \ln K_{jt} - \bar{V}^L_{it} \Delta \ln L_{jt}$$

$\bar{V}^L_{it}$ denote the two-period average labour share, which is defined as the ratio of labour compensation to GDP. According to the income approach, GDP is the sum of labour remuneration, depreciation, operating surplus and net taxes on production. To avoid the potential underestimation of labour shares due to non-reported incomes, we use labour remuneration[8] rather than wage bill to measure labour compensation. Furthermore, Holz (2006) suggests splitting net taxes on production between labour and capital, where capital is represented by depreciation and the operating surplus. Thus, labour compensation in this paper is the sum of labour remuneration and part of net taxes on production.

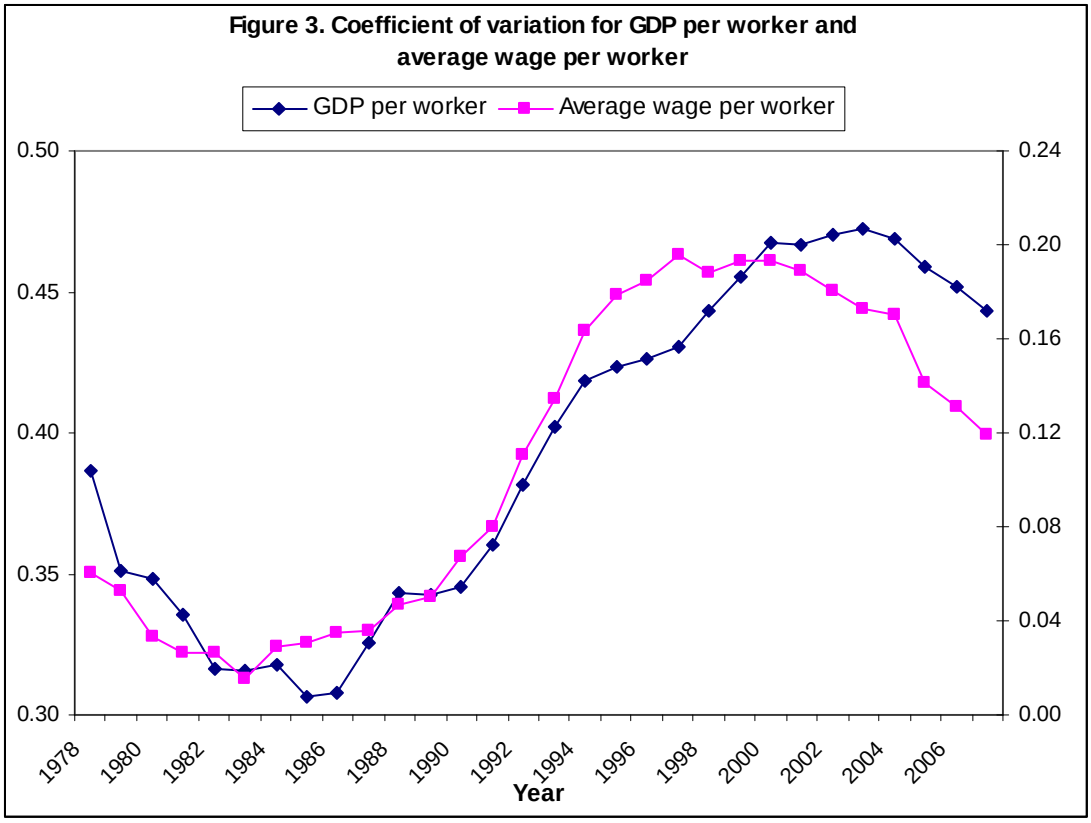
Last but not least, other variables are mainly from Hseuh and Li (1999), various years of China Statistical Yearbooks (NBS 2009) and National Bureau of Statistics (1999). Educational variables are the share of educational attainment of the employed persons. The ownership variables (state-owned, semi-private and private) are the proportions of staff and workers employed in the state-owned, collective-owned and the private enterprises. Fiscal expenditure on education is the "culture, Education, Scientific and health" expenditure share of local fiscal expenditure. Openness is the sum of export and import. Industrialization is the "INDUSTRY" GDP

[8] Labour remuneration not only refers to the total payment of various forms to workers including wages, bonuses and allowances earned in cash or other kinds, but also includes all benefits such as free medical services, medicine expenses, transport subsidies, social insurance, and housing fund paid by the employers.

share of total economy. Inflation rate is the change of general consumer price index (1995=1). Birth Rate is the population's birth rate. All the monetary values were deflated with 1995 price.

Data Description

Before we analyze the cross-province data in China, we conduct a preliminary statistical examination of regional inequality and compare the growth rates. China was under the Central planning economic system before 1978, so all administrative divisions are nearly equally poor. Regional disparity appeared and increased after 1986 in Figure 3, which measure the regional inequality as the coefficient of variation of labour productivity (left axis) and average wage (right axis) among four regions. Hence, this measure of inequality has risen sharply in the 1990s and kept the high level during the early years of 2000s. There is a decline in the regional inequality after 2003 which may have resulted from the "western development strategy" and "revitalize the Northeast", but is still at a much higher level than in 1978. Another interesting phenomenon is that the changes in the wage inequality always happen before the changes in the productivity inequality. For example, the coefficient of variation of average wages among four regions began increasing in 1983, while the coefficient of variation of labour productivity began increasing in 1986. Following the same line, regional inequality of wages has decreased since 2000, while regional inequality of labour productivity has decreased since 2003. This movement in tandem suggests that the reform in the labour market may trigger the different growth path of regions.



Both Fleisher (2005) and Heckman (2005) have noted that China's investment in human capital at the level of education beyond the junior high school level (the compulsory 9-year education) until very recently has been very small in comparison with nations at similar levels of per capita income and economic development, and its geographical dispersion has been large. In 2007, the government expenditures on education were 2.43% of GDP and had been below 3% in most years since 1992 (CSY 2008, NBS 2009), much lower than the average of 5.1% in developed countries (Fleisher et al 2009). Starting in 1999, the Chinese government increased education expenditures sharply aiming for 4% of GDP before 2010. As shown in table 1, with the EU KLEMS Database, we compare the proportions of medium-skilled[9] and high-skilled workers among China, EU-15[10], USA, Japan and Korea. In 2005, high-skilled share in China is the lowest (6.7 percent) and Korea is the highest (47.3 percent). It is above 30 percent in USA and Finland.

[9] Medium-skilled: Different definition across countries, similar to China's "Primary school + Junior secondary school + Senior secondary school".
[10] EU-15: Australia, Belgium, Denmark, Finland, France, Germany (1978-1991 data for West Germany), Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and UK.

Table 1. Educational attainments of workers by countries: International comparison: Medium-skilled workers (%)

Year	China	Aus tralia	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Korea	Luxem bourg	Nether lands	Portugal	Spain	Sweden	UK	USA
1978	38.2				29.4		59.1			86.8	49.5	34.8						50.6	58.8
1979	40.8				30.9		58.9			87.1	50.2	36.0		75.8				52.4	59.7
1980	43.4		33.1	44.3	32.2	46.7	59.1			87.3	51.6	37.2		76.7		7.3		53.8	60.7
1981	46.2		33.6	45.8	33.1	46.8	59.8			87.6	52.1	38.2		77.7		7.8	62.7	55.2	60.6
1982	48.9	38.3	33.9	47.0	34.0	47.0	60.9			88.1	52.9	39.6		78.5		8.5	62.9	55.8	60.6
1983	51.9	37.5	34.0	48.4	35.0	48.4	61.1			88.5	54.2	41.1		79.5		9.1	63.0	56.4	61.4
1984	54.5	36.8	34.0	49.4	36.1	50.0	61.5			88.6	55.7	42.2		80.5		10.0	63.1	57.1	61.0
1985	57.3	36.1	34.2	50.5	37.2	51.3	61.6			89.0	56.6	43.2		82.0		10.8	63.3	62.7	61.4
1986	60.0	35.5	34.2	51.4	37.6	52.9	61.8			89.3	57.2	44.3		82.3		11.4	63.4	59.2	61.6
1987	62.6	35.9	35.4	52.4	38.1	54.1	62.6			89.6	58.3	45.1		82.5		13.4	63.5	60.8	61.8
1988	65.0	36.5	36.4	53.7	39.7	55.0	63.1		63.0	89.8	59.2	45.3		82.8		14.8	63.1	61.7	61.4
1989	67.3	36.9	37.5	54.7	40.2	56.4	63.6		64.4	90.0	60.2	45.6		83.0		16.4	62.9	63.4	61.5
1990	69.5	36.3	38.8	55.6	39.9	57.3	64.1		65.4	90.1	61.5	45.8		83.2		17.3	62.6	64.3	61.6
1991	72.0	35.8	40.6	56.5	39.7	57.9	64.3		67.1	90.3	62.2	46.0		83.4		18.1	62.3	64.1	61.6
1992	74.2	35.5	42.4	57.3	39.6	58.8	64.8	27.5	68.4	89.7	62.9	46.4	29.0	83.6	10.1	18.9	62.0	64.4	62.1
1993	76.2	35.3	44.3	59.2	39.5	59.8	64.9	28.9	69.6	89.7	63.6	46.8	30.7	84.1	10.6	20.1	63.0	64.9	62.6
1994	78.2	35.2	46.0	59.9	40.6	60.7	64.9	30.0	68.1	89.7	64.3	47.5	32.5	83.8	10.9	21.4	63.7	67.8	62.6
1995	79.7	34.7	47.4	60.4	41.1	61.9	64.9	30.9	68.0	89.6	65.0	47.3	33.2	83.7	11.4	22.3	64.8	68.5	61.9
1996	81.3	34.8	48.5	61.1	41.7	62.2	65.0	31.6	69.0	89.5	65.2	46.9	34.0	83.7	11.8	23.9	65.4	69.2	61.9
1997	85.0	34.9	49.3	62.0	42.2	62.7	65.0	33.3	70.0	89.2	65.6	46.7	39.3	83.4	11.3	24.9	65.7	70.6	61.2
1998	85.1	35.1	50.0	62.7	42.5	63.5	64.7	35.1	70.3	88.9	66.1	45.4	45.0	83.0	10.9	25.7	66.2	70.7	61.1
1999	85.2	35.3	50.7	63.1	43.0	63.9	63.9	37.0	70.1	88.6	66.0	45.1	50.8	82.2	11.7	26.7	65.1	70.4	60.5
2000	86.0	35.3	52.2	63.3	43.6	64.5	63.0	38.1	70.2	88.3	66.4	46.6	49.9	81.9	12.1	27.9	65.5	70.1	60.4
2001	86.7	35.4	53.3	63.7	43.9	64.8	62.6	38.1	70.1	87.9	66.5	45.5	49.0	82.2	12.4	28.2	65.4	69.6	60.1
2002	86.4	35.7	54.2	64.1	44.2	65.4	62.9	38.8	68.8	87.5	66.4	43.8	48.8	82.5	12.7	28.6	65.8	69.9	59.1
2003	86.1	35.9	54.9	64.7	44.6	64.9	63.1	40.0	69.4	87.1	66.6	43.8	48.6	83.3	13.2	29.2	65.4	69.4	58.6
2004	86.5	37.5	55.6	64.6	45.0	65.7	63.3	42.2	69.0	86.6	66.3	44.3	48.2	82.0	13.6	30.1	65.5	69.0	58.6
2005	85.5	39.1	56.4	63.9	45.9	65.7	62.1	42.6	69.0	86.1	66.0	43.1	47.7	81.8	14.5	32.2	64.6	68.8	58.5

Table 1. Educational attainments of workers by countries: International comparison: High-skilled workers (%)

Year	China	Australia	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Korea	Luxembourg	Netherlands	Portugal	Spain	Sweden	UK	USA
1978	0.7				16.1		4.9			4.5	11.7	18.4						4.7	18.5
1979	0.7				16.5		5.1			4.6	12.2	18.3		4.2				4.8	19.3
1980	0.8		7.2	2.9	17.0	5.9	5.2			4.7	12.9	18.4		4.3		7.9		5.1	20.2
1981	0.9		7.4	3.1	17.8	6.0	5.3			4.8	13.6	18.6		4.4		8.2	10.2	5.5	20.8
1982	1.0	6.0	7.6	3.2	18.7	6.1	5.5			5.0	14.0	18.8		4.6		8.4	10.3	6.0	22.1
1983	1.1	6.4	7.7	3.3	19.7	6.8	5.7			5.1	14.3	19.1		4.8		9.7	10.4	6.6	22.2
1984	1.2	6.8	7.8	3.4	20.6	7.0	5.9			5.6	14.9	20.3		5.0		10.2	10.5	7.1	23.5
1985	1.3	7.1	7.9	3.5	21.6	7.1	6.1			5.8	15.0	21.3		5.2		10.6	10.6	8.0	23.6
1986	1.4	7.4	8.0	3.7	23.0	7.3	6.3			5.9	15.4	22.1		5.5		10.8	10.6	8.2	24.0
1987	1.5	8.5	8.4	3.8	24.6	7.7	6.5			6.0	15.9	22.8		5.8		11.3	10.7	8.1	24.3
1988	1.7	9.5	8.9	3.9	24.1	8.5	6.8		9.4	6.2	16.0	23.8		6.1		11.4	10.8	8.5	24.8
1989	1.8	10.6	9.4	4.1	24.6	8.6	7.0		9.9	6.5	16.5	24.8		6.4		12.4	11.0	8.6	25.2
1990	1.9	12.2	10.0	4.3	26.0	9.0	7.2		10.3	6.6	16.6	26.0		6.7		12.7	11.2	9.2	25.8
1991	2.1	13.2	10.6	4.6	27.9	9.3	7.4		10.5	6.8	17.1	27.2		7.0		13.2	11.5	9.4	26.4
1992	2.2	13.7	11.1	4.7	29.6	10.0	7.8	15.1	10.9	6.9	17.7	27.7	13.8	7.5	9.5	13.5	11.7	11.2	26.2
1993	2.3	14.1	11.6	5.0	31.1	10.4	8.2	15.7	11.5	7.1	18.0	28.5	14.7	7.5	9.7	14.3	11.4	11.8	26.5
1994	2.5	14.4	12.1	5.5	31.0	10.8	8.4	16.1	11.0	7.4	18.6	29.0	15.8	7.8	9.7	15.2	11.9	12.0	26.7
1995	2.6	14.6	12.6	5.8	32.0	11.1	8.3	16.7	12.1	7.8	19.1	30.6	15.4	8.1	9.5	15.5	12.1	12.7	27.3
1996	2.8	15.1	13.1	6.0	32.5	11.4	8.2	17.1	12.9	8.0	19.7	32.8	15.1	8.6	9.6	16.6	12.3	12.9	27.5
1997	3.5	15.7	13.5	6.3	32.9	12.0	8.2	17.6	12.8	8.5	20.4	34.2	14.9	9.2	8.8	16.8	12.6	13.4	27.8
1998	3.5	16.4	13.8	6.5	32.7	12.4	9.0	18.5	13.4	9.0	21.2	37.1	14.7	9.5	8.0	17.3	12.8	14.1	28.6
1999	3.8	16.8	14.0	6.8	32.8	13.1	8.9	18.4	14.2	9.5	22.0	38.6	14.8	11.0	8.2	17.7	13.7	15.1	28.7
2000	4.7	17.8	14.3	7.0	32.8	13.6	8.8	18.8	14.4	10.0	22.9	39.2	15.0	9.7	8.4	18.4	16.3	16.0	29.0
2001	5.5	18.3	14.7	7.3	33.6	14.0	9.1	19.0	14.7	10.5	23.9	41.4	15.0	9.5	8.6	19.3	17.2	16.5	29.4
2002	5.9	19.5	15.0	7.7	34.2	14.2	9.4	19.8	16.2	11.0	24.5	44.3	15.2	10.0	8.9	19.6	17.2	17.0	30.4
2003	6.9	20.2	15.2	8.1	34.6	13.9	9.7	20.1	17.5	11.5	25.4	45.1	15.2	10.9	10.0	20.1	18.8	18.0	31.3
2004	7.3	19.6	15.3	8.3	35.0	14.5	9.9	22.4	18.1	12.1	25.9	45.8	15.5	12.5	11.4	20.9	18.8	18.7	31.5
2005	6.7	19.6	15.4	8.3	35.0	15.3	9.5	22.4	18.6	12.8	26.3	47.3	16.9	12.9	11.6	21.6	19.9	18.9	31.7

Data source: EU KLEMS Database (http://www.euklems.net/)

As shown in table 2, the disparity of the shares of educational attainment is large among the four regions. In the previous thirty years, the northeast region has the largest share of medium-skilled workers and the coastal region has the largest share of high-skilled workers. The annual growth rate of educational attainments in the far west regions are highest, 3.9 percent for the medium-skilled workers and 9.6 percent for the high-skilled workers, respectively.

Table 2. Educational attainments of workers by regions in China

	Medium-skilled workers (%)				High-skilled workers (%)			
Year	Coastal	Northeast	Interior	Far west	Coastal	Northeast	Interior	Far west
1978	50.06%	50.90%	28.52%	24.23%	1.06%	1.15%	0.33%	0.40%
1979	52.29%	54.85%	31.25%	26.41%	1.17%	1.30%	0.38%	0.46%
1980	54.60%	58.75%	34.09%	28.35%	1.27%	1.47%	0.43%	0.53%
1981	56.87%	62.45%	37.04%	30.63%	1.39%	1.64%	0.49%	0.61%
1982	59.12%	65.92%	40.11%	33.11%	1.50%	1.83%	0.55%	0.71%
1983	61.54%	69.29%	43.28%	35.02%	1.59%	2.02%	0.62%	0.80%
1984	63.61%	72.38%	46.47%	37.48%	1.72%	2.21%	0.70%	0.93%
1985	65.75%	75.22%	49.67%	40.11%	1.84%	2.41%	0.78%	1.07%
1986	67.84%	77.77%	52.79%	42.88%	1.96%	2.61%	0.87%	1.24%
1987	69.82%	80.09%	55.91%	45.51%	2.07%	2.82%	0.96%	1.42%
1988	71.68%	82.12%	58.90%	48.10%	2.18%	3.03%	1.06%	1.63%
1989	73.46%	83.92%	61.71%	50.65%	2.31%	3.25%	1.17%	1.86%
1990	75.10%	85.49%	64.45%	53.00%	2.45%	3.47%	1.28%	2.10%
1991	77.17%	86.85%	67.24%	55.67%	2.56%	3.69%	1.40%	2.40%
1992	79.09%	88.00%	69.89%	58.17%	2.68%	3.91%	1.53%	2.73%
1993	80.85%	88.99%	72.39%	60.04%	2.80%	4.14%	1.66%	3.05%
1994	82.45%	89.79%	74.71%	62.15%	2.94%	4.36%	1.81%	3.43%
1995	83.87%	90.45%	76.34%	65.61%	3.00%	4.60%	1.97%	4.03%
1996	85.16%	90.97%	78.28%	67.44%	3.10%	4.84%	2.13%	4.52%
1997	85.37%	89.25%	84.83%	74.13%	4.05%	6.87%	2.62%	4.06%
1998	85.25%	90.18%	85.12%	72.39%	4.34%	5.69%	2.48%	4.62%
1999	86.06%	90.26%	84.74%	75.06%	4.78%	5.97%	2.74%	5.60%
2000	87.02%	90.62%	85.41%	75.89%	5.39%	6.22%	3.86%	6.12%
2001	87.95%	90.99%	86.08%	76.71%	6.01%	6.46%	5.00%	6.66%
2002	86.66%	91.07%	86.21%	77.32%	7.57%	6.86%	4.61%	7.17%
2003	85.63%	89.60%	86.58%	76.88%	8.60%	8.50%	5.44%	8.32%
2004	85.81%	90.90%	87.13%	77.57%	8.97%	7.71%	6.01%	9.33%
2005	86.51%	88.83%	85.00%	75.80%	8.05%	9.02%	5.39%	8.51%
2006	86.67%	89.93%	86.69%	77.42%	8.70%	8.10%	5.06%	6.80%
2007	87.33%	89.90%	87.42%	79.19%	8.57%	8.43%	5.14%	7.04%

Note: “Medium-skilled”: primary school, junior secondary school and senior secondary school; “High-skilled”: college, university, graduate and higher level.

Table 3: Data description of economic growth in China, 1978-2007

1978	GDP	Capital input	Labour input	TFP index	Average wage	Medium education	High education	Semi-private	Private	Fiscal expenditure on education	FDI	Industrialization	Inflation rate	birth rate
Coastal	**487.05**	**330.48**	**1,620.33**	**71.70**	**1,765.56**	**0.406**	**0.135**	**0.260**	**0.000**	**0.163**	**0.149**	**0.511**	**0.239**	**0.018**
	203.35	127.14	1,030.16	30.11	267.93	0.131	0.094	0.084	0.000	0.038	0.283	0.142	0.033	0.005
Northeast	**512.26**	**650.00**	**968.79**	**69.19**	**2,148.35**	**0.400**	**0.108**	**0.225**	**0.000**	**0.164**	**0.012**	**0.582**	**0.238**	**0.018**
	236.44	321.10	306.14	9.98	374.22	0.057	0.010	0.021	0.000	0.025	0.021	0.093	0.008	0.002
Interior	**336.01**	**395.41**	**1,644.25**	**59.88**	**1,899.64**	**0.238**	**0.039**	**0.182**	**0.000**	**0.181**	**0.020**	**0.357**	**0.244**	**0.021**
	150.78	262.05	761.09	29.82	223.53	0.088	0.019	0.039	0.000	0.037	0.030	0.075	0.028	0.005
Far west	**92.11**	**166.55**	**366.40**	**74.37**	**2,347.42**	**0.282**	**0.061**	**0.102**	**0.000**	**0.164**	**0.016**	**0.424**	**0.256**	**0.024**
	52.40	145.01	274.05	40.67	698.58	0.171	0.027	0.017	0.000	0.054	0.027	0.081	0.010	0.005
1994														
Coastal	**2,857.89**	**4,072.56**	**2,364.72**	**95.00**	**5,645.59**	**0.667**	**0.212**	**0.226**	**0.093**	**0.301**	**319.81**	**0.445**	**0.861**	**0.013**
	1,538.77	2,004.02	1,495.95	2.57	1,300.58	0.092	0.141	0.061	0.048	0.040	297.77	0.059	0.011	0.004
Northeast	**1,825.21**	**2,916.78**	**1,591.58**	**96.10**	**4,127.91**	**0.725**	**0.215**	**0.255**	**0.034**	**0.271**	**70.40**	**0.434**	**0.864**	**0.014**
	789.50	1,481.34	385.25	1.91	355.78	0.035	0.025	0.040	0.016	0.040	56.72	0.049	0.004	0.001
Interior	**1,538.65**	**1,981.94**	**2,545.58**	**101.01**	**4,167.03**	**0.652**	**0.111**	**0.187**	**0.023**	**0.296**	**33.37**	**0.365**	**0.845**	**0.018**
	805.46	725.85	1,133.37	20.28	623.32	0.131	0.045	0.033	0.012	0.030	23.57	0.060	0.014	0.003
Far west	**392.32**	**778.82**	**641.60**	**92.03**	**4,890.40**	**0.573**	**0.171**	**0.136**	**0.010**	**0.285**	**3.22**	**0.337**	**0.843**	**0.021**
	293.58	562.92	567.57	6.02	799.19	0.107	0.045	0.027	0.009	0.019	2.20	0.043	0.009	0.001
2007														
Coastal	**12,592.06**	**24,299.67**	**2,973.91**	**164.04**	**23,379.05**	**0.659**	**0.305**	**0.048**	**0.533**	**0.287**	**459.60**	**0.453**	**1.241**	**0.011**
	6,564.79	11,935.24	1,944.08	22.61	6,838.41	0.153	0.170	0.014	0.123	0.030	278.92	0.092	0.052	0.002
Northeast	**6,575.94**	**12,561.80**	**1,609.10**	**184.02**	**17,573.20**	**0.760**	**0.226**	**0.068**	**0.306**	**0.238**	**164.53**	**0.451**	**1.220**	**0.007**
	2,666.00	6,009.67	489.52	24.59	2,055.49	0.005	0.006	0.006	0.013	0.019	141.50	0.035	0.002	0.001
Interior	**5,972.67**	**11,725.66**	**3,070.30**	**175.51**	**16,232.26**	**0.760**	**0.166**	**0.064**	**0.295**	**0.262**	**71.79**	**0.412**	**1.300**	**0.012**
	3,144.93	5,030.78	1,642.01	26.00	2,359.01	0.036	0.052	0.020	0.046	0.023	67.58	0.064	0.120	0.002
Far west	**1,322.58**	**3,619.24**	**690.24**	**159.28**	**15,894.84**	**0.686**	**0.182**	**0.031**	**0.251**	**0.270**	**5.82**	**0.415**	**1.303**	**0.015**
	918.69	2,221.17	515.31	11.69	2,265.78	0.050	0.038	0.014	0.070	0.030	6.86	0.022	0.062	0.001

Note: "GDP": 100 million Yuan. "Capital input": 100 million Yuan. "Labour input": Employed persons, 10,000 persons. "TFP index": 1995=100. "Average wage": Yuan. "Medium education" is the combination of "Primary school" and "Junior secondary school", and "High education" consists of "Senior secondary school" and "University and above", represent the proportions of employed persons with different educational attainments. "Semi-private": the proportion of staff and workers employed in the collective-owned units. "Private": the proportion of staff and workers employed in the private units. "Fiscal expenditure on education": "Culture, Education, Scientific and health" share of local fiscal expenditure. "FDI": Foreign direct investment stock, 100 million Yuan. "Industrialization": "Industry" share of total GDP. "Inflation rate": General Consumer Price index (1995=1). "Birth Rate": population's birth rate. All the monetary values were deflated with 1995 price.

Table 3 describes the variables used in this paper. In 1978, the real GDP in the coastal region (487) were less than those of the northeast (512), while they were double the size of the northeast in 2007 (12,592 and 6,575). The capital service shows the similar disparities. The growth of TFP index in the northeast regions is impressive, starting from 70.45 in 1978, increased to 96.21 in 1994, and then achieved the highest TFP index than other regions at 179.15. The coastal region enjoys the fastest growth in wage among the four regions. The share of university and above has increased more than six fold over the last thirty years in the coastal region (from 0.02 in 1978 to 0.13 in 2007), which on average have produced more human capital than those inner regions. These results, consistent with cross-country economic growth data, point to the importance of education in promoting economic growth.

Table 3 also compares several relevant factors that may affect growth, such as the share of staff and workers in state-owned, collective-owned and private enterprises as measure of ownership reform; import and export as measure of openness; fiscal expenditure on education as measure of fiscal decentralization. We can make several observations based upon Table 3. Firstly, the share of non-state enterprise has been increasing over time and now is higher than state owned enterprises in the coastal provinces. In 1978, all four regions had a share of SOEs more than 70 percent, even nearly 90 percent in the far west region. Thereafter, the SOEs share of staff and workers has declined to the range of 60-70 percent in the three inner regions and even lower in the coaster region (only 42 percent) in 2007.

Secondly, the fiscal expenditure on education was highest in the interior region in 1978 (0.181), and other regions are nearly the same (0.164). But in 1994, this expenditure share in the coastal region is the highest (0.301), nearly doubled than in 1978. After 1994, this expenditure share decreased in all regions, and the coastal region remain the highest level, showing the stronger fiscal decentralization in the coastal region.

Thirdly, the coastal provinces tend to be more engaged in foreign trade, while inner provinces tend to be less. The openness index (import and export, 43 million Yuan) in the coastal was a little bit higher than the second open region - northeast (28 million Yuan) and 40 times of the laggard far west region in 1978. The openness in coastal (2,086 million Yuan) was four times of that in the northeast (568 million Yuan) and still 20 times of the far west region in 1994. The gap was even bigger in 2007, the import and export in the coastal was five times of the northeast, and still 37 times of the far west region in 2007. The openness of these coastal provinces is likely an important factor conducive to higher growth.

Fourthly, the FDI was similarly low for all regions in 1978, less than 0.5 million Yuan. But in 1994, FDI in the coastal region increased more than 600 folds comparing to 1978, and nearly 5 times of the northeast region, 10 times of the interior region, and 100 times of far west region. The gaps decreased sharply until 2007 for coastal-northeast (3 times) and coastal-interior (6 times), but remain 100 times for coastal-far west comparison.

Finally, the degree of industrialization in the far west region was the highest (0.582) in 1978, and then decreased to 0.43-0.45 after 1994. The similar pattern is for the coastal region. The industrialization of the interior region keeps increasing in the previous 30 years. All four regions experienced the similar inflation rate which increased from 0.23-0.25 in 1978, then to 0.84-0.86 in 1994, and then to 1.22-1.30 in 2007. On the contrary, the birth rate keeps decreasing for all regions resulting from the one-child policy, while the far west region always has the highest birth rate than other three regions.

V. Empirical results

This section reports statistical results estimating cross-region productivity and wages from 1978 to 2007 in China. Table 4 presents the estimation results from the production function. The estimated output elasticity of capital, workers with university and above is positive and significant, which are consistent with the literature. The economic performance significantly improved after 1994, confirming the structural break in China's economy, especially on the university and above. The coefficients of workers with secondary schooling show insignificant results demanding more sophisticated specification. From the sensitivity tests, we find that

the junior secondary schooling mainly benefits output after 1994 and in the northeast and interior regions, while the effect of the senior secondary schooling is mainly before 1994 and in the coastal region. The goodness of fit is quite satisfactory, with the within R-square as high as 0.98.

Table 4: Production function estimation, fixed-effect models, 1978-2007

	Regression (1)	Regression (2)		Regression (3)			
Dependent variable: log(GDP)	Overall effect	After 1994	Before 1994 (Incremental)	Coastal region	Northeast Region (Incremental)	Interior region (Incremental)	Far west Region (Incremental)
Log(Capital)	0.492***	0.423***	0.208***	0.468***	0.254**	-0.039	0.083
	(0.011)	(0.013)	(0.021)	(0.018)	(0.098)	(0.027)	(0.085)
Log(workers with low education)	-0.151***	-0.116***	0.023	-0.132***	-0.004	-0.218***	-0.028
	(0.016)	(0.027)	(0.025)	(0.022)	(0.080)	(0.034)	(0.089)
Log(workers with medium education)	-0.033	0.127**	-0.086*	-0.079*	0.025	0.332***	0.138
	(0.030)	(0.039)	(0.042)	(0.040)	(0.237)	(0.069)	(0.269)
Log(workers with high education)	0.217***	0.170***	-0.155***	0.650***	-0.610**	-0.636***	-0.415
	(0.025)	(0.026)	(0.036)	(0.042)	(0.228)	(0.058)	(0.254)
Year1994	0.242***						
	(0.022)						
R-squared	0.969	0.973		0.971			
N	840	840		840			

Notes:

1. Hainan is included in Guangdong; and Chongqing is included in Sichuan. Tibet is excluded for lack of continuous data.
2. Year 1994=1 if year>=1994; 0 otherwise.
3. Standard errors are in the parentheses. The stars *, ** and *** indicate the significance level at the 5%, 1% and 0.1%, respectively for two-tail test.
4. “Low-skilled”: no schooling; “Medium-skilled”: primary school, junior secondary school and senior secondary school; “High-skilled”: college, university, graduate and higher level.
5. “GDP”: 100 million Yuan. “Capital”: 100 million Yuan. “Workers”: Employed persons, 10,000 persons. All the monetary values were deflated with the base of 1995.
6. Low education: no schooling; Medium education: primary schooling plus junior secondary schooling; High education: senior secondary schooling plus university and above

Table 5 is the baseline specification to estimate education effect on GDP per worker, TFP index and average wage. Capital accumulation accelerates growth and wage, especially growth. University and above is good for economic growth, but no effect on TFP and wage. The senior secondary schooling improves all the three productivity proxies, and benefits economic growth more than TFP and workers' earnings. On the contrary, the effects of the junior secondary schooling are all negative.

We also add the market reform factors as control variables, such as semi-private and private units, fiscal expenditure on education, openness, FDI, industrialization, inflation rate and birth rate. Fiscal expenditure, inflation rate and birth rate negatively affect economic growth, which is consistent with the literatures. FDI and industrialization enhance the TFP index, while industrialization is bad for earnings. The advantageous factors for wage are fiscal expenditure on education, private units, openness and FDI. FDI is the only institutional variable which helps all three productivity proxies, with highest coefficient on economic growth. Openness benefits growth more than earning, and industrialization promote technological progress more than economic growth. Birth rate greatly hampers the economic growth (-13.370) and TFP (-15.181), fortunately not on wage.

Table 5: Baseline estimations, fixed effect models and GMM models

Dependent variable	Log (GDP per worker)		Log (TFP index)		Log (Average wage)	
	FE	GMM	FE	GMM	FE	GMM
L. Log (GDP per worker)		0.785***				
		(0.025)				
L. Log (TFP index)				0.744***		
				(0.023)		
L. Log (Average wage)						0.768***
						(0.027)
Log(Capital per worker)	0.241***	0.102***			0.206***	0.084***
	(0.012)	(0.014)			(0.012)	(0.016)
Medium education	0.305***	0.012	0.473***	0.093*	0.200***	0.021
	(0.060)	(0.037)	(0.064)	(0.041)	(0.058)	(0.047)
High education	1.191***	-0.098	0.632**	0.093	1.692***	-0.100
	(0.172)	(0.092)	(0.192)	(0.098)	(0.168)	(0.116)
Semi-private	-1.001***	-0.028	-0.708***	-0.237*	-0.974***	-0.118
	(0.145)	(0.089)	(0.160)	(0.104)	(0.141)	(0.108)
Private	0.879***	0.131*	0.295***	0.097*	1.345***	0.293***
	(0.084)	(0.051)	(0.088)	(0.048)	(0.082)	(0.071)
Fiscal expenditure on education	-0.006	0.074	-0.301*	0.028	-0.219	-0.155
	(0.115)	(0.064)	(0.129)	(0.071)	(0.112)	(0.080)
Log(FDI)	0.026***	0.008***	0.009***	0.008***	0.008**	0.004*
	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Industrialization	0.507***	0.095	1.164***	0.036	-0.584***	-0.155*
	(0.095)	(0.057)	(0.106)	(0.060)	(0.092)	(0.069)
Inflation rate	0.362***	0.042*	0.219***	0.033	0.347***	0.078***
	(0.036)	(0.018)	(0.040)	(0.019)	(0.035)	(0.021)
Birth rate	-7.643***	-6.291***	-13.255***	-6.064***	-6.837***	-7.178***
	(1.769)	(0.951)	(1.978)	(1.030)	(1.726)	(1.186)
R-squared	0.978		0.871		0.977	
N	840	784	840	784	840	784

Notes:

1. Hainan is included in Guangdong; and Chongqing is included in Sichuan. Tibet is excluded for lack of continuous data.
2. Standard errors are in the parentheses. The stars *, ** and *** indicate the significance level at the 5%, 1% and 0.1%, respectively for two-tail test.
3. "GDP per worker": 10,000 Yuan. "Capital per worker": 10,000 Yuan. "No schooling", "Primary school", "Junior secondary school", "Senior secondary school" and "University and above": the proportion of employed persons with different educational attainments. "Semi-private": the proportion of staff and workers employed in the collective-owned units. "Private": the proportion of staff and workers employed in the private units. "Fiscal expenditure on education": "Culture, Education, Scientific and health" share of local fiscal expenditure. "Openness": export plus import, 100 million Yuan. "FDI": Foreign direct investment, 100 million Yuan. "Industry": "Industry" share of total GDP. "Inflation rate": General Consumer Price index (1995=1). "Birth Rate": population's birth rate. All the monetary values were deflated with 1995 price.
4. Medium education: primary schooling plus junior secondary schooling; High education: senior secondary schooling plus university and above

We next carried out the sensitivity tests to identify the disparity in two time periods (1978-1993 and 1994-2007) and four regions (coastal, northeast, interior and far west). The results are reported in Table 6 and 7.

In table 6, before 1994, economic growth mainly benefit from primary schooling, FDI and inflation rate, TFP from collective-owned units and inflation rate, and wage from capital, primary schooling, university and above, collective-owned units and inflation rate.

After 1994, senior secondary schooling, private units, openness and industrialization accelerate economic growth significantly; FDI and industrialization advance the technology, and senior secondary schooling, private units, fiscal expenditure on education and birth rate improve workers' earnings. Openness has significantly positive effect on economic growth, which is consistent with the hypothesis that Deng's "South Trip" did mark acceleration in China's transformation from a planned economy to a market economy The senior secondary schooling improves economic growth more than wage, and industrialization helps TFP more than economic growth. Inflation rate hinder all three productivity proxies, and birth rate damages the economic growth and TFP.

Table 6: Sensitivity tests for structure break (Y1994), fixed effect models, 1978-2007

Dependent variable	Log (GDP per worker)		Log (TFP index)		Log (Average wage)	
	After 1994	Before 1994 (Incremental)	After 1994	Before 1994 (Incremental)	After 1994	Before 1994 (Incremental)
Log(Capital per worker)	0.180***	0.622***			0.176***	0.236***
	(0.011)	(0.145)			(0.012)	(0.025)
Medium education	0.206**	-0.204	0.261**	0.622***	0.067	0.232
	(0.072)	(0.168)	(0.089)	(0.145)	(0.075)	(0.118)
High education	2.281***	-0.875***	0.828***	-0.204	2.326***	-1.154***
	(0.192)	(0.235)	(0.237)	(0.168)	(0.200)	(0.154)
Semi-private	-0.011	-0.349	-0.068	-0.875***	-0.178	-0.464*
	(0.158)	(0.463)	(0.200)	(0.235)	(0.164)	(0.203)
Private	2.835***	0.594*	0.701	-0.349	2.488***	-1.496***
	(0.383)	(0.253)	(0.478)	(0.463)	(0.400)	(0.392)
Fiscal expenditure on education	-0.330**	-0.010	-0.291	0.594*	-0.320**	0.786***
	(0.119)	(0.007)	(0.152)	(0.253)	(0.124)	(0.206)
Log(FDI)	0.026***	-0.219	0.014***	-0.010	0.014***	-0.010
	(0.003)	(0.158)	(0.003)	(0.007)	(0.003)	(0.006)
Industrialization	0.493***	0.007	1.087***	-0.219	-0.460***	-0.260
	(0.102)	(0.100)	(0.129)	(0.158)	(0.107)	(0.147)
Inflation rate	0.383***	-10.187***	0.119	0.007	0.245**	0.172*
	(0.077)	(3.080)	(0.095)	(0.100)	(0.080)	(0.081)
Birth rate	-5.401**	3.772***	-7.582***	-10.187***	-3.237	-7.289**
	(1.697)	(0.111)	(2.182)	(3.080)	(1.771)	(2.655)
R-squared	0.984		0.878		0.981	
N	840		840		840	

Note:

1. Hainan is included in Guangdong; and Chongqing is included in Sichuan. Tibet is excluded for lack of continuous data.
2. Standard errors are in the parentheses. The stars *, ** and *** indicate the significance level at the 5%, 1% and 0.1%, respectively for two-tail test.

Table 7: Sensitivity tests for 4 regions, fixed effect models, 1978-2007

Dependent variable	Log (GDP per worker)				Log (TFP index)				Log (Average wage)			
	Coastal region	Northeast region (Incremental)	Interior region (Incremental)	Far west region (Incremental)	Coastal region	Northeast region (Incremental)	Interior region (Incremental)	Far west region (Incremental)	Coastal region	Northeast region (Incremental)	Interior region (Incremental)	Far west region (Incremental)
Log(Capital per worker)	0.207***	0.315***	-0.079**	-0.161					0.171***	0.146	-0.035	0.068
	(0.016)	(0.086)	(0.025)	(0.132)					(0.015)	(0.081)	(0.024)	(0.125)
Medium education	0.177*	0.230	0.352*	1.557***	-0.161	1.586***	0.325*	1.136**	0.121	0.295	0.462***	-0.002
	(0.090)	(0.383)	(0.138)	(0.431)	(0.089)	(0.426)	(0.149)	(0.410)	(0.085)	(0.364)	(0.131)	(0.409)
High education	1.142***	-0.755	1.685***	0.166	-0.186	0.889	2.685***	1.769	2.470***	-1.921**	-0.219	-2.897***
	(0.217)	(0.701)	(0.370)	(0.798)	(0.257)	(0.837)	(0.439)	(0.953)	(0.206)	(0.666)	(0.352)	(0.758)
Semi-private	-1.059***	0.973	0.683*	-0.136	-0.394	-0.806	0.803*	-0.510	-0.871***	1.000	-0.720*	1.851
	(0.174)	(0.591)	(0.344)	(1.398)	(0.201)	(0.692)	(0.398)	(1.661)	(0.165)	(0.561)	(0.326)	(1.328)
Private	0.659***	0.606	1.166***	0.823	0.459***	0.384	0.485*	0.069	1.079***	2.144***	1.401***	2.089**
	(0.089)	(0.474)	(0.175)	(0.688)	(0.103)	(0.465)	(0.194)	(0.693)	(0.084)	(0.450)	(0.166)	(0.653)
Fiscal expenditure on education	-0.135	-0.269	0.168	-0.671	0.021	-0.336	-0.122	-1.248	-0.116	-0.672*	0.075	-0.585
	(0.140)	(0.356)	(0.220)	(0.769)	(0.166)	(0.414)	(0.262)	(0.913)	(0.133)	(0.338)	(0.209)	(0.730)
Log(FDI)	0.043***	-0.058***	-0.022***	-0.024	0.024***	-0.049***	-0.019**	-0.010	0.018***	-0.030***	-0.006	-0.002
	(0.003)	(0.009)	(0.005)	(0.016)	(0.004)	(0.010)	(0.006)	(0.018)	(0.003)	(0.008)	(0.005)	(0.015)
Industrialization	0.763***	-1.497***	0.145	-0.460	1.774***	-2.125***	-1.257***	-1.402	-0.366**	-0.750*	0.489*	-1.361*
	(0.127)	(0.344)	(0.239)	(0.611)	(0.145)	(0.386)	(0.280)	(0.725)	(0.120)	(0.327)	(0.227)	
												(0.580)

Inflation rate	0.512***	-0.343**	-0.339***	-0.173	0.293***	-0.242	-0.083	-0.120	0.480***	-0.368**	-0.465***	0.015
	(0.042)	(0.125)	(0.077)	(0.203)	(0.049)	(0.141)	(0.091)	(0.233)	(0.040)	(0.119)	(0.073)	(0.193)
Birth rate	-2.637	-10.494	-5.263	6.286	-11.856***	-0.815	-4.954	29.096*	5.143*	-10.291	-5.086	-4.488
	(2.278)	(6.661)	(3.459)	(11.016)	(2.683)	(7.773)	(4.076)	(11.943)	(2.163)	(6.325)	(3.284)	(10.460)
R-squared	0.985				0.899				0.985			
N	840				840				840			

Note:

1. Hainan is included in Guangdong; and Chongqing is included in Sichuan. Tibet is excluded for lack of continuous data.
2. Standard errors are in the parentheses. The stars *, ** and *** indicate the significance level at the 5%, 1% and 0.1%, respectively for two-tail test.
3. "GDP per worker": 10,000 Yuan. "Capital per worker": 10,000 Yuan. "No schooling", "Primary school", "Junior secondary school", "Senior secondary school" and "University and above": the proportion of employed persons with different educational attainments. "Semi-private": the proportion of staff and workers employed in the collective-owned units. "Private": the proportion of staff and workers employed in the private units. "Fiscal expenditure on education": "Culture, Education, Scientific and health" share of local fiscal expenditure. "Openness": export plus import, 100 million Yuan. "FDI": Foreign direct investment, 100 million Yuan. "Industry": "Industry" share of total GDP. "Inflation rate": General Consumer Price index (1995=1). "Birth Rate": population's birth rate. All the monetary values were deflated with 1995 price.
4. Medium education: primary schooling plus junior secondary schooling; High education: senior secondary schooling plus university and above

Table 7 shows the different growth pattern for the four regions. Capital accumulation more benefits the coastal and northeast regions, which consistent with the higher degree of industrialization shown in table 2. University and above improves far west region's economic growth and interior region's TFP. Senior secondary schooling benefits more in the coastal region, while the junior secondary schooling helps more in the other three regions.

According to those reform variables, FDI and industrialization have more effect in the coastal region on economic growth and TFP. The coastal region also is favoured more by openness on growth and wage. Semi-private and private units, fiscal expenditure on education, inflation rate and birth rate also increase workers' wage in the coastal region. The economic growth relies on the private units and openness in the interior region, but relies on birth rate in the far west region. Collective-owned units benefit TFP both in the interior and far west regions.

VI. Conclusions

China's spectacular economic growth has benefited its provinces and regions unequally. We confirmed that the regional pattern of the growth can be analyzed as production functions of several factors, which include educational attainments, semi-private and private units, and fiscal expenditures on education, openness, FDI, industrialization, inflation rate and birth rate. This paper mainly examines the educational effect on GDP per worker, TFP index and wage incorporating the market reform factors.

The empirical results are robust to alternative model specifications and the sensitivity tests. According to the five kinds of educational attainments, senior secondary schooling is most important for China's productivity and wage, especially for economic growth. University and above only improves the economic growth. Among the reform variables, FDI and openness affect positively, while inflation rate and birth rate have negative effect. The impact of semi-private and private units, fiscal expenditure on education and industrialization on the three productivity proxies are mixed. Society can get more benefit from the senior secondary schooling, openness and FDI than workers, and workers are more favoured by private units than society.

The year 1994 is a structure break for economic growth pattern after "open-up" policy, since the effects are generally much larger and statistically significant, mainly

reflecting in senior secondary schooling and private units. The four regions represent different economic patterns. University and above is good for growth in the far west region, and for TFP in the interior region. Senior secondary schooling benefits more in the coastal region, while the junior secondary schooling helps more in the other three regions. FDI, industrialization and openness have more effect in the coastal region on economic growth.

Last but certainly not least, we can have some policy implications to promote economic growth and decline regional disparity according to their characteristics. The coastal region relies on capital accumulation, senior secondary schooling, openness and industrialization to promote productivity. Its old champion - the northeast region, benefits from the capital accumulation and junior secondary schooling. Consistent with Figure 2, the interior region can investment more on university and above, private unit and openness to accelerate technology growth. The laggard far west region needs to increase the share of higher educated workers for economic growth. Generally speaking, the fiscal expenditure on education, inflation rate and birth rate should be controlled across China.

Appendix Geographic graph of four regions

(1)Coastal: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong-Hainan;

(2)Northeast: Heilongjiang, Jilin, Liaoning;

(3)Interior: Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan-Chongqing, Guizhou, Yunnan, Inner Mongolia and Shaanxi;

(4)Far west: Gansu, Qinghai, Ningxia and Xinjiang.

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