

The Contributing Factors of the Regional
Income Disparity in China

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Abstract

Based on the neo-classical growth theory, this paper intends to use panel data approach to find out the contributing factors of the regional income disparity in China since the economic reform in 1978. After comparing effects of several main factors: non-agriculture level (*NAL*), non-state-owned enterprises level (*NSOL*), international openness level (*IOL*), total investment in fixed assets (*V*) and population growth (*N*) on the regional income inequality in China, the empirical results indicate that non-state-owned enterprise level, international openness level and total investment in fixed assets have significant positive effects on provincial economic growth, while the population growth negatively slow down the economic development.

1. Introduction

From 1978 to 2003, China achieved an annual average Gross Domestic Product (GDP) growth rate of above 9 per cent, a stunning record worldwide and higher than those of any other countries in the world. With its GDP surpassing 11 trillion Yuan (US\$1.33 trillion) in 2003, China has become the world's sixth largest economy.¹ As a result of rapid economic growth, the average income of Chinese people also rose significantly. According to China Statistical Yearbooks (2004), from 1978 to 2003 the net income per rural resident increased from 134 to 2,622 Yuan, at the average annual growth rate of 7.1 percent in real terms; and the disposable income per urban resident increased from 343 to 8,472 Yuan, at an average annual growth rate of 6.8 percent in real terms.

However, China's rapid economic growth was accompanied by serious regional disparities and high income inequality. In 2003, per capita GDP in Shanghai was 46,718 Yuan (US\$5,649), almost 13 times that of Guizhou's 3,603 Yuan (US\$435).² The existing huge disparity tends to worsen if we examine the annual average real GDP growth rate. From 1978 to 1996, the annual average real GDP growth rate of the coastal areas was 11.3 per cent, compared to the rates of 9.6 per

¹ Sources: "Will China's growth sustain 30 more years?" *People's Daily Online*
http://english.people.com.cn/200411/08/eng20041108_163104.html

² Sources: "China Statistical Yearbook" (2004)

cent and 9.4 percent for the middle and western areas respectively.³

In addition, after rapid economic expansion since 1978, the income gap in China has reached the second most serious "Yellow Light" level, or alert level. According to statistics released from the United Nations Development Program in 2005, "the Gini coefficient has reached 0.45 in China; 20 percent of China's population at the poverty end accounts for only 4.7 percent of the total income or consumption; but 20 percent of China's population at the affluence end accounts for 50 percent of the total income or consumption."⁴

In order to analyze the regional convergence in China since the economic reform in 1978, this paper intends to follow the approach of Barro and Sala-I-Martin (1995), use both the absolute and conditional convergence framework to find out the contributing factors of the regional income disparity over 29 provinces of China from 1978 to 2003 and compare different effects of several main factors: non-agriculture level (*NAL*), non-state-owned enterprises level (*NSOL*), international openness level (*IOL*), total investment (*V*) and population growth (*N*) on the regional income inequality in China. In this paper, we investigate the relative growth of regional per capita GDP using both annual and 5-year data, and we choose *NAL*, *NSOL*, *IOL*, *V* and *N* as the relative provincial long-run steady states control variables for conditional convergence.

³ Source: Ma, J. (2000) "The Chinese Economy in the 1990s"

⁴ Source: "China Daily", September 20, 2005.

This paper is organized as follows: relevant studies on regional income disparity are reviewed in section 2; section 3 introduces the data set and the econometric methodology of calculation of variables; section 4 discusses the empirical foundations and presents the econometric models; Section 5 analyzes the empirical results of the contributing factors of regional inequality in China; and the conclusion of the paper is presented in section 6.

2. Literature Review

2.1. The Issue of "Convergence" and its Empirical Research

Since the mid eighties, an issue that whether poor countries tend to grow faster than rich countries has attracted considerable attention in empirical work, i.e. does convergence across counties or regions really exist?

The concept of convergence comes from the idea of the influential paper by Solow (1956). Based on the assumption of diminishing marginal product of capital, the Solow model predicted countries eventually converge to their balanced growth paths where output per capita grows at a constant rate equal to the exogenous growth rate of technology progress and suggested that poor countries would grow faster than rich countries, which leads to the definition of convergence.

However, the prediction from Solow does not coincide with the development of real world economies. According to Romer (2001), over the whole of the modern era, cross-country income differences have widened on average and there has been no strong tendency either toward continued divergence or toward convergence over the past several decades. As a result, the neoclassical growth theory has declined until the papers by Romer (1986) and Lucas (1988) renewed the interest of study in economic growth. Romer (1986) presented a fully specified long-run growth model in which knowledge is assumed to be an input in production that has increasing marginal productivity and technological progress is assumed to be endogenous. Lucas (1988)

also developed growth theory by considering models that emphasize human capital accumulation through schooling or through learning-by-doing.

Another significant contribution worth to mention is given by Mankiw et al. (1992). The findings reported in this paper cast doubt on endogenous growth models mentioned above which assume constant or increasing returns to scale in capital and revived the Solow growth model. In that paper, the authors extended Solow's model to include human capital as well as physical capital and showed that the augmented Solow model provides an excellent description of the cross-country data. The paper also examined the implication of the Solow model for convergence in standards of living. The evidence predicted that countries with similar technologies and rates of accumulation and population growth should converge in income per capita.

In the same period, a large number of literatures have dedicated to applying cross-countries or cross-regions data to investigate economic growth. Baumol (1986) examined convergence among the 16 industrialized countries from 1870 to 1979. The estimate of b is almost exactly equal to -1, which suggests almost perfect convergence: higher initial income on average lowers subsequent growth one-for-one.

Summers and Heston (1988 and 1991) constructed an expanded set of comparable cross-countries national accounts data from 1950 to 1988, i.e. the Penn World Table, made it convenient for researchers to implement the cross-countries empirical work over a long research period. Furthermore, they drew on the table as a

whole and gave a brief empirical description of how the income distribution of the world has been changing in that period. The results suggested that the income share of the poorest and the richest nations went down a little, while the share of the middle income countries went up sharply, which supports the hypothesis of convergence.

Moreover, Dowrick and Nguyen (1989) tested the hypothesis of convergence of per capita GDP and levels of total factor productivity within the OECD countries from 1950 to 1985. The findings indicated that although the convergence of income levels has been weak since 1973, there has been systematic TFP catching up within OECD throughout the postwar period.

The study by Barro (1991) used cross-section annual data of per capita real GDP of 98 countries from 1960 to 1985 to run regressions of growth and indicated that higher initial per capita GDP is substantially negatively related to subsequent per capita growth if initial human capital (proxied by school-enrollment rates) is held constant. Furthermore, given the level of initial per capita GDP, the growth rate is substantially positively related to the starting amount of human capital. Thus, poor countries tend to catch up with rich countries if the poor countries have high per capita human capital level.

Barro and Sala-I-Martin (1991) also examined the growth and dispersion of personal income across U.S. states since 1880 and the evolution of gross state product since 1963. The overall evidence demonstrated that both per capita income and

product in poor states tend to grow faster than in rich states, which also significantly supports the hypothesis of convergence.

In conclusion, the cross-sectional regressions generally found no evidence of absolute convergence for all countries or regions as a whole, but countries with common characteristics or regions within a country exhibited convergence, which means once the determinants of steady-state per capita income have been controlled for, economies converge to a common steady state, i.e. conditional convergence.

2.2. Cross-Section versus Time Series Technique

With the prosperity of economic growth theories, the modeling methodology experienced a transition from cross-sectional approach, to time series technique, to a panel data technique. The cross-sectional framework was first criticized by Quah (1993). He argued that the cross-country regression procedure is flawed since it assumes that each country has a stable growth path. However, the data of the log of per capita income for 118 countries from 1962 to 1985 show instability in underlying long-run growth patterns for these countries. As a result, the cross-section technique would bias the result of conditional convergence.

Moreover, Evans and Karras (1996) showed that the cross-sectional approach is valid only if economics have identical first-order autoregressive dynamic structures and all permanent cross-economy differences are completely controlled for, which is

seriously inconsistent with the fact.

Another reason for researchers more likely to accept time-series approach might be the existence of random but permanent shocks to per capita income. Campbell and Mankiw (1989), for example, proved the persistence of fluctuations in real GNP using post-war quarterly data from Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, and indicated that there is little evidence for the stochastic convergence among these OECD economies since the test results showed that the logged per capita income includes a unit root.

The paper by Bernard and Durlauf (1995) also reject the convergence hypothesis for 15 OECD economies by using century-long time series and by employing the stochastic definitions for both long-term economic fluctuations and convergence. The inconsistency of conclusions drawn from time-series techniques and that from cross-section approach (Baumol, 1986; Dowrick and Nguyen, 1989) on same economies may cast doubt on the feasibility of cross-sectional methodology.

However, following Perron (1989), we could obtain evidence in support of stochastic convergence and conditional convergence of U.S. regional quarterly real GNP in the postwar period by allowing for the presence of a one-time change in the level or in the slope of the trend function. Also he showed how standard tests of the unit root hypothesis against trend stationary alternatives cannot reject the unit root hypothesis if the true data generating mechanism includes stationary fluctuations

around a trend function which contains a one-time break.

Furthermore, Carlino and Mills (1993) found also evidence in favor of stochastic convergence across U.S. regions during the 1929-1990 periods and regional β -convergence through time-series techniques after allowing for a trend break in 1946. The study of Loewy and Papell (1996) also validated the hypotheses that per capita GDP levels and TFP levels within the OECD have converged in the postwar period. Thus, we could learn from them to eliminate the inconsistency between the cross-section and time-series techniques by allowing for a trend break.

Alternatively, following Coulombe and Lee (1995) and Islam (1995), we could use a panel data approach to pool time-series and cross-country observations to investigate the convergence for a large sample of countries over a long period. Moreover, Coulombe and Tremblay (2004) reviewed the panel data model and pointed out that the familiar approach in panel data analysis of defining the growth rate of the economic indicators and a set of environmental and control variables as logarithm deviations from the cross-sectional sample mean is equivalent to introducing $T-1$ time dummies in the panel data regressions. Secondly, we could use the fixed-effect approach to control for cross-sectional time-invariant heterogeneity. Using these two different skills, we could combine time-series and cross-sectional information properly in the convergence-growth regressions.

In addition, Beck and Katz (1995) pointed out that the analysis of time-series

cross-section data should firstly examine the temporal properties of the data, which could be done with lagged dependent variables, or by transforming the data to eliminate serial correlation of the errors. Standard errors should be calculated using PCSEs, and the combination of OLS with PCSEs allows for more accurate and efficient estimation for time-series cross-section models. Also, Beck (2001) restated using ordinary least squares with panel correct standard errors in the analysis of “time-series-cross-section” (TSCS) data.

2.3. *The Overview of Theories on Chinese Regional Disparity*

In the same time, the issue of Chinese regional inequality has been discussed extensively as well. Numerous empirical studies have focused on Chinese regional convergence in recent periods.

Lardy (1980) provided the first detailed and systematic account of China’s regional inequality and concluded that the regional disparity in China declined over time in the period 1950-1978.

The research by Tsui (1991) explored the change in regional inequality in China from 1952 to 1985 and found out that the interprovincial income gaps did not narrow but with a mild decline since the economic reform. Also the empirical results suggested that there seems to be a positive relationship between fiscal decentralization and regional inequality.

Using an augmented Solow model with cross section and panel data, Chen and Fleisher (1996) found evidence in support of conditional convergence of per capita production across China's provinces from 1978 to 1993. The author chooses physical investment share, employment growth, human-capital investment, foreign direct investment, and coastal location as long-run conditional control variables. The paper projected that, in the near term, overall regional disparity is likely to decline modestly but that the coastal and inland regions' income differentials is likely to increase somewhat.

Jian, Sachs and Warner (1996) examined the tendency towards convergence in real per-capita income among the provinces of China during 1952-1993. The paper did not found strong convergence or divergence during the initial phase of central planning, 1952-1965, found evidence of divergence during the Cultural Revolution period, 1965-1978; and proved convergence after market-oriented reforms began in 1978. During 1990-1993, although convergence continued within the coastal provinces, regional income disparity started to widen again. Moreover, the results showed that this convergence was strongly related to the rise in rural productivity.

The study of Gundlach (1997) indicated that regional output per worker converged across 29 Chinese provinces between 1979 and 1989 with an estimated rate of convergence of 2.2%. The paper also predicted that the rate of convergence of regional output per worker tend to decline after 1989 due to reduced interprovincial

capital flows resulting from fiscal decentralization.

Using annual data of per capita income and conditional convergence methodology, Raiser (1998) chose the rate of enrollment in school and industry structure as control variables, and pointed out a decline of interregional income disparity from 1978 to 1992. He also found a slower rate of convergence since 1985 as a result of the shift of reform emphases from rural sectors to industrial sectors and the fiscal decentralization.

Yao and Weeks (2000) examined both the tendency and the speed towards income convergence among China's provinces during the pre-reform period 1953-1977 and the reform period 1978-1997. The author used the investment ratio as the steady state control variable for the conditional convergence. Although results support the conditional convergence hypothesis for both the periods, China's provincial convergence speeds are surprisingly low.

Yan (2002) implemented both absolute and conditional convergence within 25 of China's provinces, over 1953-1998 and during the post-reform period, and found relatively robust empirical evidence of the presence of absolute and conditional convergence. She chose openness including international trade and direct foreign investment as conditional control variable to determine the provincial long-run steady-state in China and provided significant positive effects of international openness on China's economic growth.

In a word, interprovincial convergence in China has been exhaustively described. The investment share, rate of enrollment, coastal location and foreign direct investment have been talked most extensively as long-run conditional control variables, but there is little academic literature that attempts to analyze empirically the effects of industrialization, free-market level or population growth on China's dynamic transition. This paper uses various control variables together: non-agriculture level (*NAL*), non-state-owned enterprises level (*NSOL*), international openness level (*IOL*), total investment (*V*) and population growth (*N*), and provides a more comprehensive and appropriate framework of Chinese economic growth.

3. Data and econometric methodology

This paper uses pooled time-series cross-sectional observations of 28 Chinese provinces from 1978 to 2003 for the convergence regressions. The raw data mainly came from "China Statistical Yearbook" (1981-2004), which provides relevant data from 1980 to 2003. Other data that was not available from "China Statistical Yearbook" was obtained from "China's National Income, 1952-1995", "China's provincial statistics, 1949-1989" and "Comprehensive statistical data and materials on 50 years of new China".

The data set does not include Hainan, Chongqing and Tibet, two newly established provinces and one province with scarce data. Since the above 3 provinces do not play a key role in China's economy, excluding these provinces will not have significant impact on the analysis of Chinese regional disparity.

3.1. *Dependent Variable*

In this paper, relative provincial per capita GDP is chosen as the dependent variable to represent regional income difference in China. This variable is the ratio of each province's per capita GDP to the unweighted mean of per capita GDP of all provinces. The advantage of using relative data is to guarantee common trends and common shocks to be extracted from pooled convergence regression in order to get unbiased results.

3.2. Long-run Steady-State Control Variables

Various aspects of provincial long-run steady states control variables: non-agriculture level (*NAL*), non-state-owned enterprises level (*NSOL*), international openness level (*IOL*), total investment in fixed asset (*V*) and population growth (*N*) will be introduced in the data set to explain the regional disparity in China. All these control variables are still relative ones divided by their unweighted sample means, and are transformed in logarithmic form.

3.2.1. Non-Agriculture Level (NAL)

Due to some historical reasons, the inter-provincial industrialization and urbanization levels in China exhibit huge differences. Chinese registered residence management system strictly constrain people from switching out of agriculture into other sectors where productivity is higher, therefore, the income of rural people is largely below that of urban people and the inter-provincial income disparity between rural and urban residents is probably one of the contributing factors of Chinese income inequality as a whole. The ratio of urban residents' income to rural residents' income was 1.7 in 1983, the lowest point since the economic reform, increased to 2.65 in 1999, 2.79 in 2000, and 2.90 in 2001, and reached 3.11 in 2002.⁵ Figure 1 described the post-reform movement of net income of rural residents and disposable

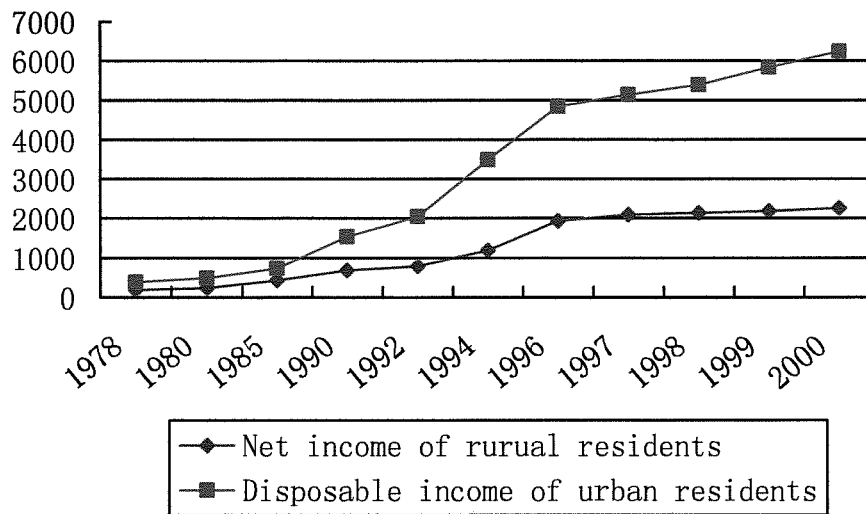
⁵ Source: Chen, G.H.(2004) "The situation and reason analysis of Chinese income distribution" <http://www.opentimes.cn/to/laigao/2004/0222-03-002.htm>

income of urban residents and clearly shows the tendency of continuously widening rural and urban income differences.

Consequently, the non-agriculture level (*NAL*) is the first control variable chose to represent the effect of industrialization or namely the transition of China from a dual economy to an industrial economy, which can be computed by the ratio of the sum of employment population in the secondary and tertiary sectors to the total employment population in the whole country.

Figure 1

(Unit: RMB Yuan)



3.2.2. Non-State-Owned Enterprises Level (NSOL)

Another and probably more important reason to stimulate and sustain China's economic development over the past 20 years is the bloom and rapid growth of

non-state-owned enterprises, such as collectively owned enterprises, privately owned enterprises, foreign-investment enterprises, and shareholding enterprises. Since non-state-owned enterprises generally enjoy more autonomy in production planning, price setting and other operational management, they usually link to higher productivity and more efficiency. Thus, we will choose the non-state-owned enterprises level (*NSOL*) as another long-term steady-state control variable to estimate the inter-provincial convergence in China. *NSOL* is computed by the ratio of the gross output of non-stated-owned enterprises to GDP. And it can be used also to reflect the process of marketization and the decline of government control over microeconomic activities, which is the key feature of the economic reform since 1978.

3.2.3. International Openness Level (*IOL*)

In addition to China's domestic economic reforms since 1978, including rural reform, state-owned enterprise reform and transition of economic system from a Soviet-type planned economy to a market economy, the open-door policy and export promotion strategies are also essential elements of the Chinese economic reforms. The international openness level (*IOL*) is thus chosen to assess the extent of integration of Chinese economy into the global economy and reflect trade performance or impact of trade policies. It can be obtained using the trade share (imports + exports) over GDP.

3.2.4. Investment (I)

The existing and continuously widening inter-provincial income disparity relies partly in the differentiated investment policies toward regional economic development. As the purpose of encouraging some people and regions to prosper before others, certain regions enjoyed abundant government investment, even leading to over-investment and low-level duplicated constructions in certain sectors, while other less-developed regions suffered severe inadequacy of investment. In this paper, we use provincial total investment in fixed asset as a proxy to measure the impact of investment on regional inequality in China.

3.2.5. Population growth (N)

On the other hand, population growth is one of the main driving forces behind the changes in regional disparity in China. Since the beginning of the second half of twentieth century, Chinese people and government have gradually recognized the problem of overpopulation. From the end of 1970's, the central government carried out "birth control" policy, and the crude birth rate dropped significantly. As a consequence, we will include the variable of provincial population growth in the model to investigate its influence.

3.3. Dummy variables

Chinese economy could be divided into at least two groups: coastal and inland provinces to reflect the difference of economic growth paths and preferential economic policies of the government. Therefore, in our empirical model, we introduce a dummy variable DCOAST, which takes the value 1 for all coastal provinces and the value 0 for other provinces.

3.4. Econometric methodology

There are four econometric techniques worth to mention: firstly, all relevant variables used in the convergence-growth model are converted into the logarithmic form. Following the methodology of Coulombe (2004), all variables should be defined as logarithm deviations from the unweighted cross-sectional sample mean to eliminate the common trends and common shocks (such as the productivity slowdown or the oil shock). As a result, we could get five logarithmic relative time-series cross-sectional control variables: *LNAL*, *LNSOL*, *LIOL*, *LV* and *LN* which vary both across provinces and over time. Secondly, we use cross-section weight (PCSE) approach to control for cross-sectional time-invariant heterogeneity. Moreover, in order to extract the effect of short-run business cycles, we use AR correction for annual data and also use 5-year data set to eliminate the serial correlation.

Fourthly, China's regions are very differently endowed with resources and

have developed to different degrees. Accordingly, this paper divides all Chinese provinces into 3 regions: the Eastern provinces, the Central provinces and the Western provinces, to estimate the specific convergence tendency within each group. The abbreviation of provinces is showed in the Table 1 and the constituents of each region are listed in the Table 2 in the Appendix.

4. Empirical model

This paper uses the neo-classical Solow growth model as theoretical foundation to investigate three different concepts of convergence: σ -convergence, absolute β -convergence and conditional β -convergence of 28 Chinese provinces over a long time span after the economic reform in 1978.

4.1. σ -convergence

According to Barro (1995), σ -convergence refers to the reduction of the cross-sectional dispersion of output indicator, and it is measured by the standard deviation (SD) of the relative logarithm dependent variables. If we observe a decline of the standard deviation over time, we can conclude that σ -convergence occurs. Results of σ -convergence estimation are presented in Figure 2 to Figure 5.

4.2. Absolute β -convergence

From Sala-I-Martin (1996), absolute β -convergence indicates a negative relationship between the growth rates of an economy and its initial economic level. In other words, the lower a country or a region's income per person, the faster its growth. However, there exists a strict presupposition under the hypothesis of absolute β -convergence, that is, all economies should have same economic characteristics, such as investment share, population growth rate, depreciation rate, production

function, etc. and thus all economies have an identical steady state. "Differences in average income stem only from differences in where countries stand relative to the common balanced growth path." ⁶ Equation (1) gives the absolute β -convergence regression model:

$$\ln (RY_{i,t} / RY_{i,t-1}) = - \gamma_1 \ln RY_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

In this equation, $i = 1, 2, \dots, 28$ for the 28 Chinese provinces in the sample and $t = 0, 1, 2, \dots, 25$ where period 0 corresponds to 1978 and period 25 to 2003. $RY_{i,t}$ is the relative per capita GDP obtained by dividing the per capita GDP by the unweighted sample mean for province i at time t . $RY_{i,t-1}$ is defined as the initial level of the relative per capita GDP for province i . $\ln (RY_{i,t} / RY_{i,t-1})$ is thus the growth rates of relative per capita GDP for province i , and $\varepsilon_{i,t}$ is the residuals or the error term for the regression.

The annual speed of convergence β could be computed from the equation (1) using the following formula:

$$\beta = - \ln(1 - \gamma_1). \quad (2)$$

If we use 5-year data, the equation of absolute β -convergence regression model will be:

$$\ln (RY_{i,t} / RY_{i,t-5}) = - \gamma_1 \ln RY_{i,t-5} + \varepsilon_{i,t} \quad (3)$$

and the annual convergence would be thus:

$$\beta' = - \ln(1 - \gamma_1) / 5 \quad (4)$$

⁶ Sources: Romer, D. (2001) "Advanced Macroeconomics"

If the estimation result of γ_1 is positive and less than one, we could confirm an absolute β -convergence toward the common steady state. The regression results of absolute β -convergence are shown in Tables 3.

4.3. The panel data model for conditional β -convergence

According to Sala-I-Martin (1996), if individual economies have different steady states, economies that are further from their own steady states will grow faster, which referred to conditional β -convergence. In this case, there is a persistent component of cross-sectional income differences. “But differences that stem from countries being at different points relative to their balanced growth paths gradually disappear as the countries converge to those balanced growth paths.” (D. Romer, 2001) This implies that after holding some control or environment variables Z fixed, the growth rates of economic indicators Y , like per capita GDP, may negatively relate to its initial economic. Equation (3) shows the panel data model for conditional β -convergence:

$$\ln (RY_{i,t} / RY_{i,t-1}) = - \gamma_1 \ln RY_{i,t-1} + Z'_{i,t-p} \Phi + v_{i,t}$$

$$\text{where } v_{i,t} = \mu_i + \varepsilon_{i,t} \quad (5)$$

P is the number of lags (usually 0 or 1) used for the Z variables. Again, μ_i refers to the provincial specific fixed effects, and $\varepsilon_{i,t}$ is the residuals or the error term for the regression. Also, for the 5-year data, the model will be:

$$\ln(RY_{i,t}/RY_{i,t-5}) = -\gamma_1 \ln RY_{i,t-5} + Z'_{i,t-p} \Phi + v_{i,t}$$

$$\text{where } v_{i,t} = \mu_i + \varepsilon_{i,t} \quad (6)$$

For the empirical analysis of the conditional β -convergence in China, we use lagged time-series cross-sectional $LNAL(-1)$, $LNSOL(-1)$, $LIOL(-1)$, $LV(-1)$ and $LN(-1)$ in the regression equation:

$$\begin{aligned} \ln(RY_{i,t}/RY_{i,t-1}) = & -\gamma_1 \ln RY_{i,t-1} + \gamma_2 \ln NAL_{i,t-1} + \gamma_3 \ln NSOL_{i,t-1} + \gamma_4 \ln IOL_{i,t-1} \\ & + \gamma_5 \ln V_{i,t-1} + \gamma_6 \ln N_{i,t-1} + \gamma_7 DCOAST_{i,t} + \gamma_8 AR_{i,t} + v_{i,t} \end{aligned}$$

$$\text{where } v_{i,t} = \mu_i + \varepsilon_{i,t} \quad (7)$$

For 5-year data, we use:

$$\begin{aligned} \ln(RY_{i,t}/RY_{i,t-5}) = & -\gamma_1 \ln RY_{i,t-5} + \gamma_2 \ln NAL_{i,t-5} + \gamma_3 \ln NSOL_{i,t-5} + \gamma_4 \ln IOL_{i,t-5} \\ & + \gamma_5 \ln V_{i,t-5} + \gamma_6 \ln N_{i,t-5} + \gamma_7 DCOAST_{i,t} + v_{i,t} \end{aligned}$$

$$\text{where } v_{i,t} = \mu_i + \varepsilon_{i,t} \quad (8)$$

The equation (7) & (8) combine the impact of non-agriculture level, non-state-owned level international openness level, total investment and population growth on the provincial convergence paths of per capita GDP and examines their different contributions to Chinese economic growth. Note that, with annual data, we use AR(1) in the conditional convergence model to remove regional business cycles; for 5-year data, AR is not included.

5. Empirical results

5.1. σ - convergence

The overall standard deviation (SD) of annual relative per capita GDP is illustrated in Figure 2. We could clearly see a sharp decline of the dispersion of relative per capita GDP from 1978 to 1990 and a continuous increase of SD from 1990 to 2003. Although there is no obvious evidence of σ - convergence for the entire research period, the figure strongly support the σ - convergence over 1978-1990 and divergence thereafter. This finding is consistent with the results of Yan (2002).

Figure 2 σ - convergence for all provinces



In order to analyze the underlying reasons of movement of SD of relative per capita GDP described in Figure 2, this paper divides all Chinese provinces into 3 regions: the Eastern provinces, the Central provinces and the Western provinces, and provides specific σ - convergence tendency within each group in Figure 3, 4 and 5. From these figures, the convergence over 1978-1990 was mainly due to the catching-up within Eastern provinces, while the SD fluctuated within Central and Western provinces and shows no clear tendency of convergence. Nevertheless, the divergence trend after 1990 was primarily resulted from the widening gap within Western provinces, which is a quite new finding compared to previous studies.

Figure 3 σ - convergences for Eastern provinces



Figure 4 σ - convergence for Central provinces

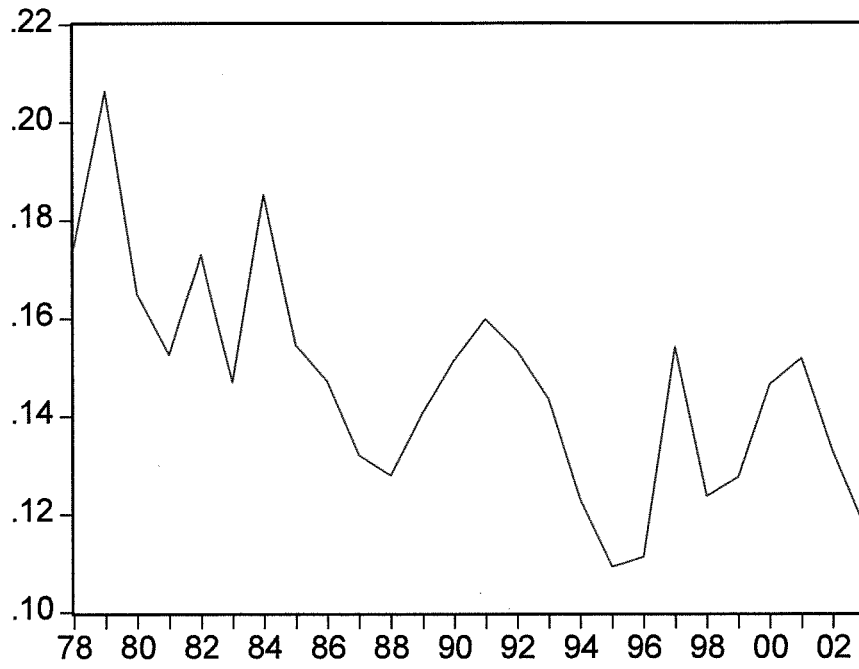
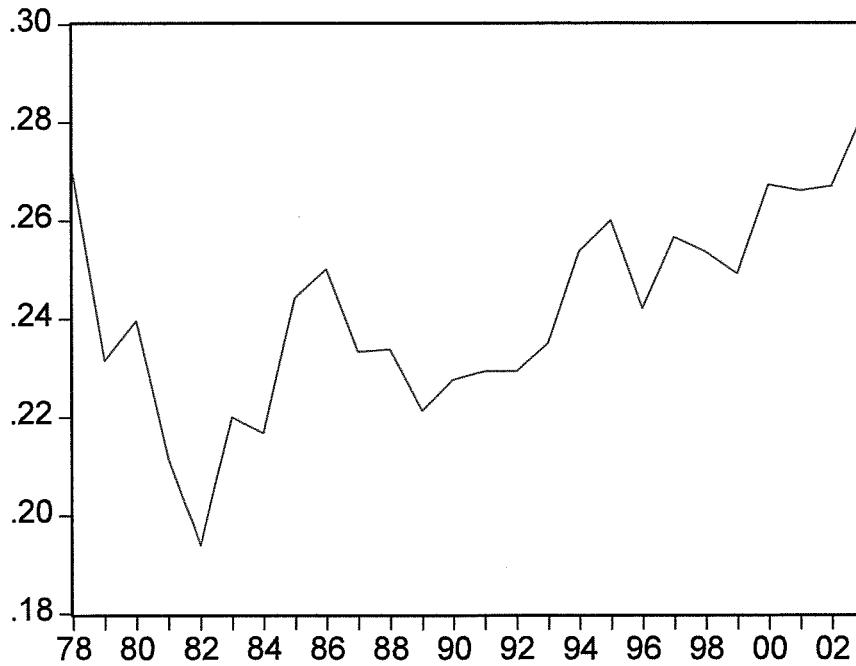


Figure 5 σ - convergence for Western provinces



5.2. Absolute convergence

The absolute convergence is estimated using equation (1) for annual data and equation (3) for 5-year data. Regression results are presented in Table 3-1. Using annual data, the coefficient of estimated convergence parameter, $-\gamma_1$, is negative but not significant even at 10 per cent level. Moreover, the convergence speed toward the steady state is very slow, less than 1%. Therefore, we could not find strong evidence of absolute convergence through the whole research period. With 5-year data, the model remove some effects of short-run economic fluctuation, and results ameliorate to some extent, but they are still not significant to support the absolute convergence trend in post-reform period of China.

This finding appears quite different with previous studies of Yan (2000), because she found strong evidence of absolute convergence of Chinese provinces in the period from 1978 to 1998. The main reasons of this discrepancy may be explained by the continuous widening inter-provincial income gap over 1999-2003 (see Figure 2) and her excluding of three poor provinces from the data set, Sichuan, Shaanxi and Jiangxi.

This paper also examines the absolute convergence within each group of provinces: Eastern provinces, Central provinces and Western provinces in Table 3-2. The estimation results seem more illuminating in the sense that they demonstrate separately the growth paths of these regions and explain well the driving forces that

Table 3-1. Absolute Convergence of GDP per Capita, 1978-2003

Dependent variable: Log relative GDP per capita			
Annual data		5-year data	
- γ_1	-0.002674(0.002) ^d	- γ_1	-0.017795 (0.013) ^d
Convergence speed	0.3%	Convergence speed	0.4%
# of Observations	700	# of Observations	140
R ²	0.001798	R ²	0.010277
Durbin-Watson St.	1.547527	Durbin-Watson St.	1.575577

Table 3-2. Absolute Convergence of GDP per Capita, 1978-2003

(Within groups of provinces)

Dependent variable: Log relative GDP per capita					
Eastern provinces		Central provinces		Western provinces	
- γ_1	-0.007586 (0.0045) ^c	- γ_1	0.001830 (0.0049) ^d	- γ_1	0.01045 (0.005) ^b
convergence speed	0.8%	convergence speed	0.2%	convergence speed	1%
# of Observations	288	# of Observations	144	# of Observations	240
R ²	0.149515	R ²	0.023816	R ²	0.05876
Durbin-Watson St.	1.934306	Durbin-Watson St.	1.829739	Durbin-Watson St.	1.94436

(Note: The estimation method is Pooled EGLS (cross-section weights). Standard errors are calculated using PCSEs. Standard error terms are presented in parentheses beside the estimated coefficients. No serial correlation correction variable AR in the regressions. The a, b and c denote that the null hypothesis can be rejected at 1%, 5% and 10% critical levels respectively, and d otherwise. Estimations are obtained using Eviews 5.0)

counteract the overall absolute convergence trend. From Table 3-2, we clearly see an absolute convergence in Eastern provinces at the 10% significance level, but simultaneously a divergence trend for Western province, significant at 5% level. These results are quite consistent with what we have drawn from the estimation of σ -convergence in the last section.

5.3. Conditional convergence

The conditional convergence is estimated using equation (7) for annual data and equation (8) for 5-year data. The estimation results are reported in Table 4. It is clear that for both annual and 5-year data, the convergence coefficient of log relative GDP per capita, $-\gamma_1$, is negative and significant at 1 per cent level, which strongly supports the conditional convergence hypothesis in the post-reform period of China, and the annual convergence speed is around 4 %. Also, all control variables: *NSOL*, *IOL*, *V*, *N* have significant effect on the growth rate of GDP per capita whether we introduce the dummy variable or not, *DCOAST*, to control for the effects of coastal location of provinces, except Non-Agriculture Level (NAL), which is not significant for 5-year data. Thus, we eliminate dummy variable *DCOAST* and *NAL*, and test the model again. The new results of regression are presented in Table 5.

According to Table 5, the convergence parameter, $-\gamma_1$, is still statistically significant at 1 per cent with negative sign for both annual and 5-year data, which

Table 4. Conditional Convergence of GDP per Capita, 1978-2003

Dependent variable: Log relative GDP per capita			
Annual data		5-year data	
- γ_1	-0.040188(0.009) ^a	- γ_1	-0.188888(0.038) ^a
γ_2 (LNAL)	0.018659(0.009) ^b	γ_2 (LNAL)	0.040230(0.038) ^d
γ_3 (LNSOL)	0.026218(0.007) ^a	γ_3 (LNSOL)	0.079961(0.025) ^a
γ_4 (LIOL)	0.007593(0.003) ^a	γ_4 (LIOL)	0.062892(0.010) ^a
γ_5 (LV)	0.007943(0.004) ^b	γ_5 (LV)	0.058738(0.014) ^a
γ_6 (LN)	-0.005941(0.002) ^b	γ_6 (LN)	-0.055955(0.012) ^a
γ_7 (DCOAST)	0.002601(0.003) ^d	γ_7 (DCOAST)	0.025184(0.011) ^b
Convergence speed	4%	Convergence speed	4%
# of Observations	572	# of Observations	110
R ²	0.173047	R ²	0.427458
Durbin-Watson St.	1.979901	Durbin-Watson St.	2.071665

Table 5. Conditional Convergence of GDP per Capita, 1978-2003

(Without *Non-Agriculture Level* and dummy *DCOAST*)

Dependent variable: Log relative GDP per capita			
Annual data		5-year data	
- γ_1	-0.026078(0.006) ^a	- γ_1	-0.149563(0.027) ^a
γ_2 (LNSOL)	0.028925(0.006) ^b	γ_2 (LNSOL)	0.098732(0.025) ^a
γ_3 (LIOL)	0.006571(0.003) ^a	γ_3 (LIOL)	0.055828(0.010) ^a
γ_4 (LV)	0.006218(0.004) ^c	γ_4 (LV)	0.056032(0.015) ^a
γ_5 (LN)	-0.006584(0.041) ^a	γ_5 (LN)	-0.058723(0.013) ^a
Convergence speed	3%	Convergence speed	3%
# of Observations	572	# of Observations	110
R ²	0.166793	R ²	0.384679
Durbin-Watson St.	1.976356	Durbin-Watson St.	2.083955

(Note: The estimation method is Pooled EGLS (cross-section weights). Standard errors are calculated using PCSEs. Standard error terms are presented in parentheses beside the estimated coefficients. No serial correlation correction variable AR in the regressions. The a, b and c denote that the null hypothesis can be rejected at 1%, 5% and 10% critical levels respectively, and d otherwise. Estimations are obtained using Eviews 5.0)

provides strong evidence in favor of conditional convergence. This result is in agreement with that of Yan (2002) while she used only international openness level as long-run steady state control variable. In addition, the positive and significant coefficients of *NSOL*, *NIOL* and *IV* implied that the non-state-owned enterprise level, international openness level and total fixed asset investment all have strong beneficial impacts on Chinese provincial economic growth. On the other hand, the negative coefficient of N, γ_5 , indicates that there exists a negative relationship between the population growth rate and the economic development.

This finding, especially the effects of non-state-owned enterprise level, is quite new compared to other relevant studies on Chinese economic development, and has particular significance for analyzing provincial economic growth in China. Before the economic reform, the government emphasized absolute socialist and planned economy, almost all firms and enterprises correspondingly were state-owned or collective-owned and directed through a centrally planned system. Although at the early stage of economic reform, State-Owned-Enterprises (SOEs) have achieved significant progress and made great contribution to the rapid development of national economy, with the deepening of the reform process, the deteriorating performance of SOEs requires timely reform designed to improve the incentives and efficiency of SOEs and to enhance manager's autonomy in decision-making. The following is a good statement of that claim.

Between 1978 and 1997, the SOEs' share in total industrial output fell from 78 per cent to 27 per cent ... Along with the relatively low output growth rate, the SOEs' financial performance declined steadily. In 1997, 46 per cent of SOEs were operating at a loss, and the number of employees in these enterprises accounted for 41 per cent of total SOE employees. (Ma, 2000, p.92).

Therefore, reforming SOEs and development of private economy, a substantial part of actual economic reforms, would boost Chinese economic growth and speed up the inter-provincial convergence tendency. Some examples could give some light to this point. First of all, let us consider the economic development of province Zhejiang and Hubei. As illustrated in Figure 6, the logarithmic relative per capita GDP of Zhejiang and Hubei were very close each other at the beginning of economic reform in 1978. However, with the economic reform, the relative per capita GDP of Zhejiang increased very fast, whereas Hubei almost remained constant without changing too much. In fact, Zhejiang province is located in the southern bank the Yangtze River Delta on the southeastern coast of China, and Hubei Province is located at the mid-stream point of the Yangtze River. The initial development level, natural resources and economic structure of two provinces were similar before the reform. But what forces resulted in the continuously widening huge income gap between these two provinces? Figure 7, 8 and 9 may help to answer this question.

Figure 6. Logarithmic Relative GDP per capita for Province ZJ and HUB

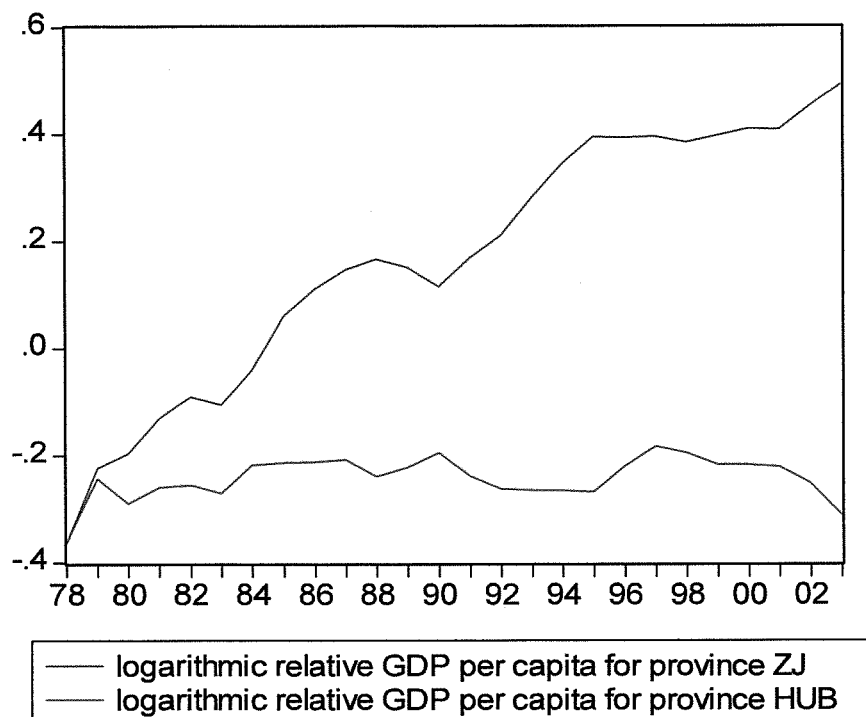


Figure 7. Logarithmic Relative International Openness Level for Province ZJ and HUB

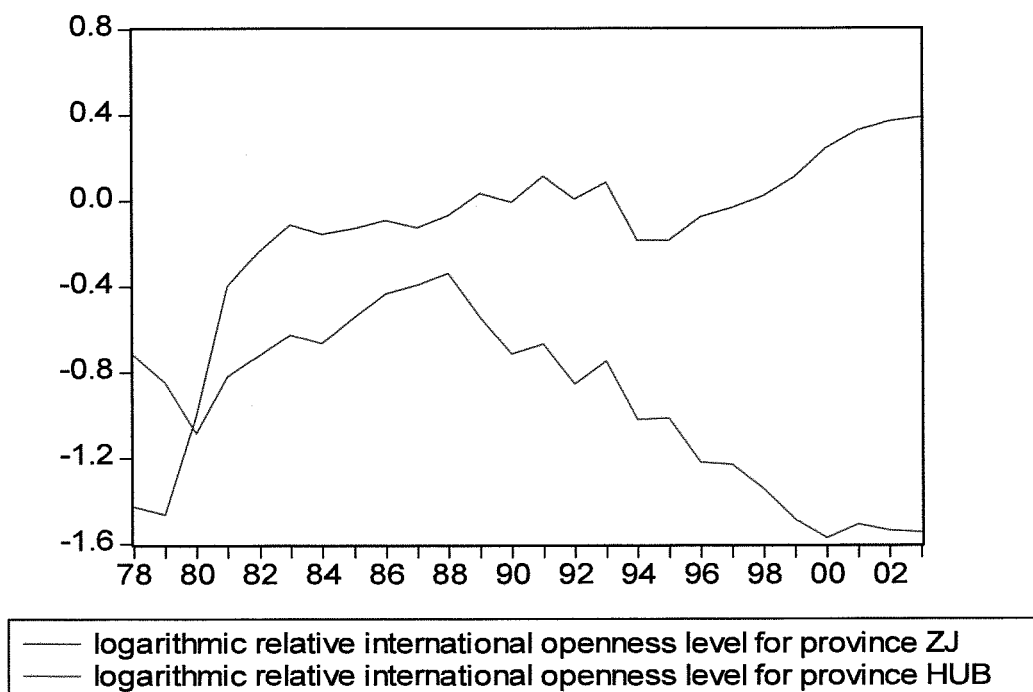


Figure 8. Logarithmic Relative Fixed-Asset Investment for Province ZJ and HUB

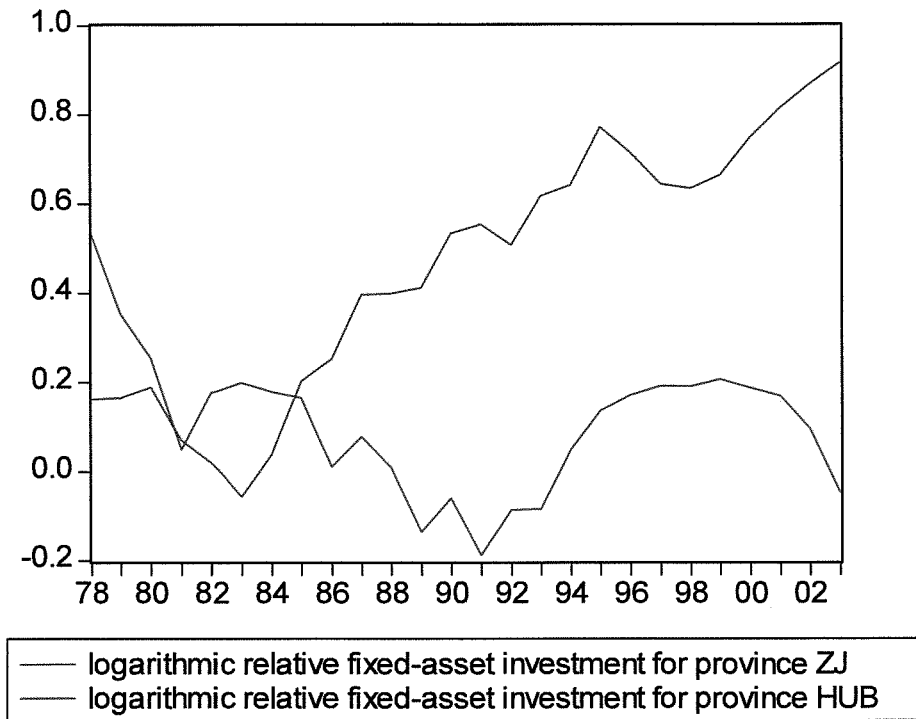
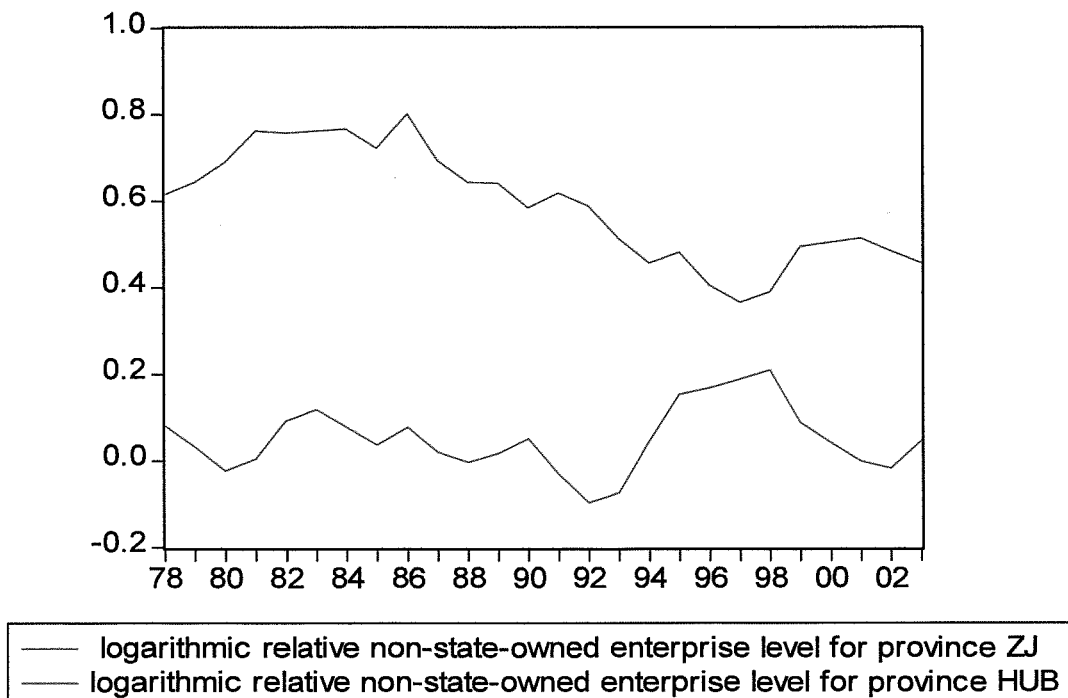


Figure 9. Logarithmic Relative Non-State-Owned Enterprise Level for Province ZJ and HUB



From Figure 7, 8 and 9, we could observe that the increasingly improving international openness level and total fixed-asset investment, as well as the higher non-state-owned enterprise level of Zhejiang province remarkably accelerated the prosperity of Zhejiang's economy in the post-reform period, while Hubei province did not developed very well at the same time with a diminishing international openness level, total investment and lower non-state-owned enterprise level. This finding is equivalent to the estimation results of conditional convergence.

Similarly, the comparison between Hebei and Shanxi provides another evidence in support of the positive effects of non-state-owned enterprise level and investment on the economic growth. With higher total investment and non-state-owned enterprise level, per capita GDP of Hebei advanced very quickly whereas that of Shanxi exhibited a decline as a whole, and the gap widened further after 1990's. Figure 10, 11, and 12 illustrate the relevant economic development of province Hebei and Shanxi.

In conclusion, the conditional convergence cannot be rejected for inter-provincial economy of China over 1978 to 2003, if we conditioned on non-state-owned enterprise level, international openness level, total investment and population growth. Among them, non-state-owned enterprise level, international openness level and total fixed-asset investment all have positively significant impacts on economic development, while the population growth has negative influences. The

annual convergence speed is around 3 per cent for both annual and 5-year data. On the other hand, the non-agriculture level, which represents the transition of China from a dual economy to industrial economy, although claimed by lots of development economists in China, is not significant to explain the inter-provincial economic disparity in China.

**Figure 10. Logarithmic Relative GDP per capita
for Province HEB and SAX**

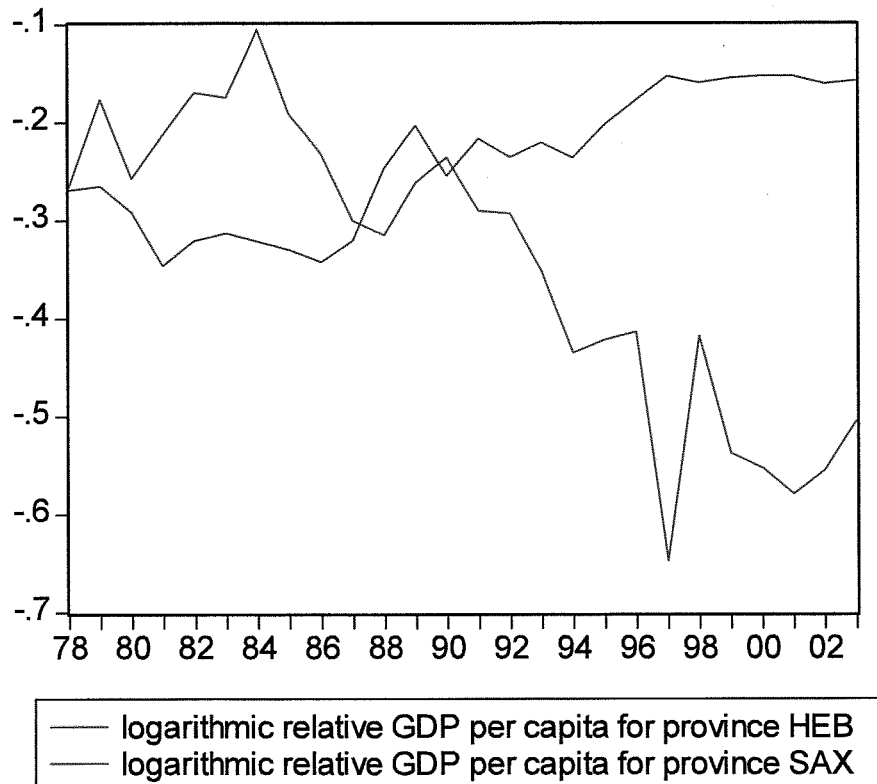


Figure 11. Logarithmic Relative Non-State-Owned Enterprise Level for Province HEB and SAX



— logarithmic relative non-state-owned enterprise level for province HEB
 — logarithmic relative non-state-owned enterprise level for province SAX

Figure 12. Logarithmic Relative Fixed Asset Investment for Province HEB and SAX



— logarithmic relative fixed asset investment for province HEB
 — logarithmic relative fixed asset investment for province SAX

5.4. Long-run elasticity of NSOL, IOL, V and N

We now turn to analysis of quantitative effects of control variables: NSOL, IOL, V and N on the long-run per capita GDP. The term “elasticity” is then used since it measures the proportional (or percent) change in one variable relative to the proportional change in another variable.

The elasticity of NSOL, IOL, V and N are γ_3 / γ_1 , γ_4 / γ_1 , γ_5 / γ_1 and γ_6 / γ_1 respectively in the equation (8).⁷ Using estimation results in Table 5, it is easy to obtain the elasticity of NSOL, IOL, V and N on long-run relative per capita GDP. The quantitative results of long-run effect of control variables are presented in Table 6.

Table 6. Long-run effect of control variables

Dependent variable: Log relative GDP per capita			
Annual data		5-year data	
Elasticity to NSOL	1.1092	Elasticity to NSOL	0.6601
Elasticity to IOL	0.2520	Elasticity to IOL	0.3733
Elasticity to V	0.2384	Elasticity to V	0.3746
Elasticity to N	-0.2525	Elasticity to N	-0.3793

⁷ From equation (8), The elasticity of NSOL, IOL, V and N are $-\gamma_3 / (-\gamma_1)$, $-\gamma_4 / (-\gamma_1)$, $-\gamma_5 / (-\gamma_1)$ and $-\gamma_6 / (-\gamma_1)$, i.e., γ_3 / γ_1 , γ_4 / γ_1 , γ_5 / γ_1 and γ_6 / γ_1

Accordingly, if the non-state-owned enterprise level of a province augments 10 per cent compared to the average of other province, the log relative per capita GDP would be higher by an amount ranging from 6.6 to 11.1 per cent at the long-run steady state. On the other hand, 10 per cent increase in population growth of a province above the average would lead to a lower log relative per capita GDP by an amount ranging from 2.5 to 3.8.

6. Conclusion

Based on the neo-classical economic growth model, this paper analyzes the post-reform evolution of relative per capita GDP across 28 provinces in China and investigates the contributing factors of regional income disparity, using several convergence definitions and empirical approaches.

The estimation results reject the absolute convergence hypothesis over the whole research period, 1978-2003. The reason may partly be explained by the divergence trend within Central and West provinces.

However, the paper provides relatively robust empirical evidence of conditional convergence, after controlling the relative provincial non-state-owned enterprise level, international openness level, total fixed-asset investment and the population growth. Explicitly, *NSOL*, *IOL* and *V* all have significant positive effects on provincial economic growth, while the population growth has negative influences. The non-agriculture level (*NAL*), although claimed by lots of development economists in China as a representation of Chinese transition from a dual economy to an industrial economy, is not significant to explain the inter-provincial economic disparity in China.

The annual convergence speed, estimated with both annual and 5-year data, is around 3 per cent, much higher than previous studies of Yan (2002) where she used only international openness level as the long-run steady state control variable.

As a result, reforming SOEs and development of private economy, improving China's openness and integration into the global economy, increasing total fixed-asset investment and moderate control of the population growth rate should be the main focus of Chinese economic strategies, in order to boost its economic growth and inter-provincial convergence tendency.

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Appendix:

Table 1. Abbreviation of provinces

Provinces	Abbreviation	Provinces	Abbreviation	Provinces	Abbreviation
Anhui	AH	Hubei	HUB	Sichuan	SC
Beijing	BJ	Hunan	HUN	Shandong	SD
Fujian	FJ	Inner Mongolia	IM	Shanghai	SH
Guangdong	GD	Jilin	JL	Shaanxi	SHX
Gansu	GS	Jiangsu	JS	Tianjin	TJ
Guangxi	GX	Jiangxi	JX	Xinjiang	XJ
Guizhou	GZ	Liaoning	LN	Yunnan	YN
Hebei	HEB	Ningxia	NX	Zhejiang	ZJ
Henan	HEN	Qinghai	QH		
Heilongjiang	HLJ	Shanxi	SAX		

Table 2. The Classification of Chinese provinces

Coastal provinces ⁸	BJ, FJ, GD, GX, HEB, JS, LN, SD, SH, TJ, ZJ
Inland provinces	AH, GS, GZ, HEN, HLJ, HUB, HUN, IM, JL, JX, NX, QH, SAX, SC, SHX, XJ, YN
Eastern provinces	BJ, FJ, GD, HEB, HLJ, JL, JS, LN, SD, SH, TJ, ZJ
Central provinces	AH, HEN, HUB, HUN, JX, SAX
Western provinces	GS, GX, GZ, IM, NX, QH, SC, SHX, XJ, YN

⁸ HEB (Hebei) and BJ (Beijing) are defined as coastal provinces according to their economic performance and economic policies rather than by geographic division.