Regional Convergence in China

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Abstract

Using panel data sets, this paper implements several empirical approaches to provide strong empirical evidence of absolute and conditional convergence within 25 of China's provinces, over the entire research period, 1953-1998, and during the post-reform period. The conditional convergence model adopted in this paper can relativelly well explain the dynamic transition path of the per capita GDP and labor productivity. Its empirical results also illustrate the positive effects of international openness on China's economic growth.

1. Introduction

Economic growth and equality are major issues in the macroeconomic field, especially in developing countries whose seriously unbalanced economic growth is threatening social stability.

China, with a fast growing pace, is one of the world's largest developing countries. Its growth and the equality of its regions deserve the interest of regional scientists for the following reasons: first, China has almost one-quarter of the world's population. According to the latest population census report of November 2000, the total population in China is 1.295 billion. Second, it has experienced a smooth transition between two contrasting economic regimes, followed by fast growth. This accomplishment has real meaning for all developing countries.

Before the economic reform in 1978, China had a self-sufficient economy; whereas since 1978 it has implemented open and free-market economic policies. The four main differences between these two economic regimes are as follow: first, China had a closed economy before the reform and became an open economy after the economic reform; second, China had a planed economy before 1978 and then became a market-oriented economy; third, the pre-reform economic system emphasized absolute equality while the post-reform economic regime encouraged some regions to pursue prosperity before others; finally, while before 1980 China encouraged population growth, after that, it strictly controlled it. What have been the effects of these changes in the economic system on China's economic performance? Did the new economic system and policies improve

China's economic growth and did the changes help China realize equality? After 1978, China maintained a high growth rate of its national GDP. About the first question, there are some optimistic prospects: Professor Robert A. Mundell predicted that "China's GDP would reach four trillion US dollars by 2020 and eight trillion US dollars by 2040, equal to the predicted figures for Japan at the same time" (China Daily, May 23, 2002. P3). The numbers affirm the hypothesis on China's undoubted economic growth.

Then what about equality? From the old economic system which emphasized absolute equality, to the new institution which gave privileges to some provinces to develop first and then to lead others to develop together, was economic growth balanced across the provinces? Are the poor regions catching up with the rich ones? This paper investigates these issues with the analysis of two endogenous economic indicators, per capita GDP and labor productivity. We will investigate the relative growth of these indicators using both the conditional and the unconditional convergence frameworks of Barro and Sala-I-Martin (1995) between 1953 and 1998 and during the reform period, across 25 of China's provinces. The key premise of the estimated conditional convergence model is that long-run steady states are conditional on international openness.

Definition of Convergence

Before we start the research on the data, it is very necessary to make clear of the definition of convergence.

σ-convergence: According to Barro (1995), it refers to the reduction of the cross-sectional dispersion of output/income indicators. It is measured by standard deviation of the relative logarithm dependent variables. If the standard deviation tends to decline over time, on can conclude that σ-convergence occurs.

Absolute convergence: According to Sala-I-Martin (1996), if all the economies have an identical steady state, then the economies that are further from this steady state will grow faster. This is absolute β-convergence, which indicates that the growth rates of economic indicators, like per capita GDP, are negatively related to their initial level.

Conditional convergence: Still according to Sala-I-Martin (1996), if individual economies have different steady states, then economies that are further from their own steady states will grow faster. This is referred to as conditional convergence.

Why choose international openness as a relative steady-state control variable?

According to neo-classical growth theory, there are two kinds of β-convergence: absolute (unconditional) convergence and conditional convergence. For absolute convergence, all economies have a common steady state. For conditional convergence, the different steady states of individual economies are determined by control variables.

This paper chooses international openness as the relative provincial long-run steady states control variable for conditional convergence. Two aspects of international openness, international trade (INTD) and direct foreign investment (DFIU) will be introduced in the

data section. This kind of regression model indicates that relative provincial levels of international openness determine relative provincial long-run steady states.

China is a country with a long history and a large geographical area, so there are many factors that might lead to an unbalanced economic growth. Why select international openness as the control variable? As summarized previously, one of the differences between the two contrasting economic regimes is whether the economy is open or self-sufficient. Also, throughout China's history, its prosperity was always accompanied by active international communication. The downfall that began in the later XVII century should be attributed to a self-sufficient economic regime. Until now, the relative wealthier provinces have had a relatively higher international openness level, while the poorer provinces were lagging in international openness. So we can conclude that international openness has strong impacts on China's economic growth and reflects the different relative steady state of each province. This conclusion on the effects of openness is in line with Gundlach's (1996). At a later stage of this paper, the dynamic simulation results will further confirm the appropriateness of this predicted conditional convergence model.

This paper follows the Barro and Sala-I-Martin approach to analyze rgional convergece. It exams China's regional convergence from 1953 to 1998 and during the post-reform period. There are other papers use international openness as control variable to analyze conditional convergence.

This paper is organized as follows: the relevant studies on regional convergence in China are reviewed in section 2; section 3 explains the empirical foundations and the

econometric methodologies of both the absolute and conditional convergence; section 4 introduces the data sets and the methodology of calculation of variables;; the results on absolute and conditional convergence of per capita GDP and labor productivity are presented and interpreted in section 5; section 6 presents the dynamic simulation; and the conclusion of the paper is presented in section 7.

2. Previous Studies On China

The question whether China's economic growth leads to regional convergence has been discussed extensively in recent studies.

The paper by Yao and Weeks (2000) used a time-series and cross-sectional panel approach to investigate the tendency and speed of provincial conditional convergence on the per capita GDP. It followed Barro and Sala-I-Martin approach. Yao and Weeks's data covered 28 Chinese provinces during both the pre-reform period (1953-1977) and the reform period (1978-1997). Implementing a 5-year period panel data approach, Yao and Week found evidence of conditional convergence for both of the periods, while the investment ratio was the steady state control variable. Yao and Week concluded that China's provincial conditional convergence speed was 0.414% before 1978, and 2.23% after 1978, but there was no absolute convergence tendency in China before or after the economic reform; the gap between coastal and interior provinces was widening. One noticeable finding is that the cofficients of the steady state control variables are not significant during some periods.

Raiser (1998) used annual data on per capita income from 1978-1992 to estimate the convergence regression and compare the results of β-convergence and σ-convergence. He found evidence for absolute and conditional convergence, but found that the convergence speed had declined since 1985. The control variables for conditional convergence are the rate of enrollment in school and industry structure. Raiser did not pay more attention to the conditional convergence model, but focused on σ-convergence. He

pointed out that the reason why the convergence speed was slowing down was that the gap between coastal and interior provinces had widened since 1985.

The study by Jian, Sache and Warner (1996) investigated absolute convergence and σ-convergence of per capita income, and found evidence of convergence after the economic reform, and pointed out that the tendency towards absolute convergence stopped after 1990. Jian, Sache and Warner mentioned that the gap between coastal and interior provinces was widening as well.

The research by Chen and Fleisher (1995) used both cross-sectional and panel approaches and found evidence of conditional convergence of per capita GDP across China's provinces from 1978 to 1993. Chen and Fleisher set up convergence regression equations conditioned on physical investment share, employment growth, human-capital investment, foreign direct investment, and coastal location. They confirmed the existence of a conditional convergence tendency for the period after 1978. Chen and Fleisher pointed out that the gap between costal and interior provinces was widening, but the gaps within the costal or interior groups were narrowing.

The study by Tsui (1991) tested both the pre and post reform periods, and found evidence of σ-convergence for per capita NMP (Net material Product - nominal gross value of output minus nominal material consumption) and per capita NIU (National Income Utilized – sum of consumption and accumulation) after the economic reform.

Under neoclassical growth theory, these previous papers implemented various empirical approaches to estimate conditional and absolute convergence. They found

evidence of conditional convergence during the economic reform period and concluded that absolute convergence did not exist before the economic reform. They also had the same view that the gap between the coastal and interior provinces was widening along with the deepening of the economic reform. Except Yao and Weeks' (2000), all the other papers mainly used the cross-sectional approach. Chen and Fleisher's (1995) method of calculating the direct foreign investment rate is not a sound one for the panel data approach, because it is not precisely to use only the data of 1992 to represent the real situation of direct foreign investment during the entire period.

3. Empirical Model

This paper continues to investigate China's conditional convergence over a long time span, from 1953 to 1998, and selects international openness as the relative provincial long-run steady states control variable, which is different from all previous papers. It uses both annual and 5-year period panel data approaches, to estimate the conditional convergence regression which is conditioned on international openness. This kind of conditional convergence model explains the relative dynamic transition path of China's economy well. As a consequence, we get strong empirical evidence of convergence for per capita GDP and labour productivity between 1953-1998 and during the post-reform period in China.

This paper also investigates the absolute convergence of the two dependent variables, and provides evidence of absolute convergence as well as of conditional convergence for the same periods. This paper examines σ-convergence as well and does not find evidence of it.

The empirical evidence of absolute and conditional convergences for the entire period, 1953-1998, is quite a new finding compared to those of previous papers.

Unlike previous papers on regional convergencei n China, this paper uses relative data (Coulombe 2000) to explain the dynamic transition path of China. Therefore it implements a different method compared to previous papers studying the convergence in China.

The neo-classical Solow-Swan growth model used in this paper as a theoretical foundation introduced three concepts of convergence: one is σ-convergence, the other two are absolute β-convergence and conditional β-convergence.

3.1 *σ-convergence*

According to Barro (1995), σ-convergence refers to the reduction of the cross-sectional dispersion of output/income indicators. One can use the standard deviation (SD) of the relative logarithm dependent variables to measure it. If the standard deviation tends to decline over time, one can conclude that σ-convergence occurs.

3.2 *Asolute Convergence*

According to Sala-i-Martin (1996), if all the economies have an identical steady state, then the economies that are further from this steady state will grow faster. This is absolute β-convergence, which indicates that the growth rates of economic indicators, like per capita GDP, are negatively related to their initial level. Equation (1) is the formula of absolute β-convergence.

$$\text{Log}(RY_{i,t} / RY_{i,t-1}) = -\gamma_1 \text{Log}RY_{i,t-1} + \mu_{i,t} \qquad (1)$$

In equation (1), $RY_{i,t}$ is the relative per capita GDP divided by the sample mean for economy *i* at time *t*. $RY_{i,t-1}$ is the initial level of the relative per capita GDP in economy *i*. $\text{Log}(RY_{i,t}/ RY_{i,t-1})$ is the growth rate of the relative per capita GDP. Alternatively, RY mayl be replaced by RPDTY, relative labour productivity. Due to the use of relative data, a constant term is not included in any of the equations in this paper. γ_1 is the convergence

parameter that is equal to $(1- e^{-\beta})$, where β is the annual speed of convergence. If γ_1 is positive and less than one,[1] then the data set exhibits absolute convergence toward a common steady state (Sala-i-Martin 1996). If a 5-year period data set is used, the formula for absolute β-convergence will be: [2]

$$\text{Log}(RY_{i,t}/ RY_{i,t-5}) = -\gamma_1 \text{Log}RY_{i,t-5} + \mu_{i,t} \qquad (1')$$

while the annual convergence speed is $-\ln(1- \gamma_1)/5$. The estimation of absolute convergence in this paper will apply equations 1 and 1' under different data sets. Results of absolute β-convergence estimation are presented in Tables 4.1, 4.2 and 4.3'.

3.3 *Conditional Convergence*

Still according to the definition of Sala-i-Martin (1996), if individual economies have different steady states, then economies that are further from their own steady states will grow faster. This is referred to as conditional convergence. In other words, conditional convergence exists if the growth rates of economic indicators, like per capita GDP or labor productivity, are negatively related to the initial level of the economic indicator after holding some control or environment variables fixed. In the steady state, the per capita factors' growth rate is the rate of technological progress, and it declines during the transition towards the steady state. These characteristics are the same as those of absolute convergence. Equation (2) shows the formula for conditional convergence.

Note 1: That $\gamma_1 = 1- e^{\beta}$ is positive, and $-\gamma_1$ is negative are evidence of convergence. All the tables of estimation results in this paper report $-\gamma_1$ only.
Note 2: Equations 1-5 use annual data sets, while equations 1'-5' use a 5-year period data set.

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 X_{i,t-1} + \gamma_3 AR_{i,t} + \mu_{i,t} \quad (2)$$

In equation (2), $X_{i,t-1}$ is the control variable that determines the steady state of economy *i*. Like equation (1), there is no constant term due to the use of relative variables. γ_1 is the conditional convergence parameter which is equal to $(1- e^{-\beta})$. If γ_1 is positive and less than one, then the data set exhibits conditional convergence toward the steady state. β is the annual convergence speed (Sala-i-Martin.1996). AR is the serial correlation correction variable.[3] $\mu_{i,t}$ is an error term for the residuals. Equation (2') is the formula that uses 5-year period data.

$$\text{Log}(RY_{i,t}/RY_{i,t-5}) = -\gamma_1 \text{LogRY}_{i,t-5} + \gamma_2 X_{i,t-1} + \mu_{i,t} \quad (2')$$

3.3.1. *With Fixed cross-sectional FINTD and FDFIU*

Estimation of conditional convergence with fixed cross-sectional FINTD and FDFIU will follow equation (2) and (2'). The exact specifications estimated in this paper are given in equations (3a)-(5a). All the three equations are also estimated with RPDTY replacing RY. The dummy variable, DCOAST, will be added in equation 5a.

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 \text{LnFINTD}_i + \gamma_3 AR_{i,t} + \mu_{i,t} \quad (3a)$$

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 \text{LnFDFIU}_i + \gamma_3 AR_{i,t} + \mu_{i,t} \quad (4a)$$

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 \text{LnFINTD}_i + \gamma_3 \text{LnFDFIU}_i + \gamma_4 \text{Dcoast} + \gamma_5 AR_{i,t} + \mu_{i,t} \quad (5a)$$

The subscript *i* denotes the individual province, $\text{LogRY}_{i,t-1}$ is the initial quantity of

Note 3: With 5-year period data, the AR are not included. With annual data, the equation are re-estimated with a correction for separate AR(1) for all sections.

the relative per capita GDP of province *i*. If 5-year period data are used, the subscript for the initial level will be $t\text{-}_5$. FINTD and FDFIU are cross-sectional variables that have only one observation for each province. The dummy will address the effects of economic policies. If the convergence parameter γ_1, which is equal to $(1\text{-}e^{-\beta})$, is positive and less than 1, then the individual provinces converge to their own particular relative steady states. The convergence speed is assumed identical across the provinces. $\mu_{i,t}$ is the error term that reflects the impacts of regional shocks.

It is worthwhile to start with estimating the per capita GDP and labor productivity with international trade share (FINTD) and direct foreign investment (DFIU) respectively. Then one can combine them to test the convergence regression again, in order to examine the difference that each international openness variable makes to the model.

3.3.2. *With Relative time-series cross-sectional VINTD(-1) and VDFIU(-1)*

The lagged value of VINTD and VDFIU will be implemented when the estimation of conditional convergence is tested with the relative time-series cross-sectional VINTD and VDFIU. The estimating equations are given by equations (3b)-(5b).

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 \text{LnVINTD}_{i,t-1} + \gamma_3 AR_{i,t} + \mu_{i,t} \quad (3b)$$

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 \text{LnVDFIU}_{i,t-1} + \gamma_3 AR_{i,t} + \mu_{i,t} \quad (4b)$$

$$\text{Log}(RY_{i,t}/RY_{i,t-1}) = -\gamma_1 \text{LogRY}_{i,t-1} + \gamma_2 \text{LnVINTD}_{i,t-1} + \gamma_3 \text{LnVDFIU}_{i,t-1} + \gamma_4 \text{Dcoast}\ \gamma_5 + AR_{i,t} + \mu_{i,t} \quad (5b)$$

Equations (3b)-(5b) reflect the effects of international trade and direct foreign investment on per capita GDP or labor productivity. With 5-year period data, because the numbers of time-series observations of VINTD and VDFIU are much less than that of the

cross-sectional observations, the econometrics software used (Eviews) always alert that the regression is "nearly singular matrix". So 5-year period data are not suitable for the estimation using equation 3b-5b. Adding DCOAST or not does not affect the findings.

3.3.3 *The different convergence paths of coastal and interior provinces*

Previous papers pointed out that the dynamic transition paths of coastal and interior Provinces are different. So Dcoast is introduced to reflect the different dymanic convergence paths in equation 5a. The other methodology is to estimate coastal and interior provinces separately to investigate the particular convergence tendency within each group.

4. Data and Method

First of all, China's statistic system will be introduced to dispel the concerns about the data sets used in this paper.

Before implementing the economic reform and the open-door policy in 1978, the Chinese statistical system adopted the MPS (System of Material Product), which was to meet the requirement of the central planning economic institution and the main output measurement indicator was (NI) National Income. The MPS does not take into account the income from services.

In 1978, China's statistical system began its transition to the western countries' SNA (System of National Accounts) that uses GDP (Gross Domestic Products) as the main output measurement indicator. In 1985, China began to estimate its GDP.

The data set in this paper comes from Hsueh and Li (1999), and China's statistical bureau (1999), both of which provide information on income that is directly comparable with the data of other developed economies. The raw data that cover the years from 1953 to 1995 came from Hsueh and Li's "*National Income data set*" (1999); the raw data that cover 1996 to 1998 was obtained from the "*Comprehensive statistical data and materials on 50 years of new China*", which was compiled by the Department of Comprehensive Statistics of the National Bureau of Statistics in 1999.

In this paper, the panel data with time-series and cross-sectional observations cover 46 years (1953-1998) and include 25 Chinese provinces. The data sets exclude the two newly established provinces, Hainan and ChongQing, and four provinces without data,

Tibet, SiChuang, Shaaxi and Jiangxi. Since the excluded provinces do not have a significant impact on China's economy as a whole, the analysis of the remaining 25 provinces can provide sufficient results on China's entire economy.

The data are organized in two different ways in order to eliminate the effects of short-term business cycles. First in annual data sets, we use an AR correction (variable to eliminate serial correlation) to remove the regional business cycles. Second, we use a five-year interval periodical data approach that divides evenly the total sample of the 1953-1998 period into 10 sub-periods. Beginning in 1953, the sub-periods last 5 years and end in 1998. Fortunately, the most meaningful year, 1978, is included in this sample. In the estimation section, the convergence regressions are examined using both kinds of data sets, in order to provide robust evidence of convergence in China.

According to the methodology of Coulombe (2000), all basic data are relative ones. The relative data are computed from the ratio of individual provincial quantity to unweighted cross-provinces' mean.[54] The advantage of using relative data is that it eliminates the common shocks in economy when pooled time-series cross-sectional convergence regression is estimated.

Note 4: The sample mean is changed with the range of the sample. Table 12 uses the sample mean of 11 coastal provinces, while Table 13 uses the sample mean of 14 interior provinces. All the other Tables use the sample mean of 25 of China's provinces.

4.1 *Dependent Variable – relative per capita GDP and relative Labor Productivity*

The relative per capita GDP of province *i* is the ratio of per capita GDP of province *i* to the unweighted provincial mean. Relative labor productivity can be obtained using the same method. Labor productivity in each province is computed from the ratio of the individual province's GDP to total employment of this specific province.

4.2 *Long-run Steady State Control Variables – INTD and DFIU*

Relative international trade (INTD) and relative direct foreign investment utilization (DFIU) are used as the two appropriate variables to reflect the relative provincial level of international openness. Their combination explains the provincial relative international openness level.

The measurement of international trade (INTD) is the trade share over GDP. It is computed from the following equation:

INTD = (international imports + international exports)/GDP

The computation of direct foreign investment (DFIU) uses the same kind of equation:

DFIU = (direct foreign investments + foreign loans)/GDP

In order to get relative INTD and DFIU, we must divide international trade and direct foreign investment by their unweighted cross-sectional sample means. As a consequence, we get the relative time-series cross-sectional variables: VINTD and VDIFU. Only lagged international openness is used as a steady state control variable. In order to provide robust empirical evidence of China's convergence, two kinds of INTD and DFIU are

used: one which varies both across provinces and time, (VINTD and VDFIU); and one which varies only across provinces, (FINTD and FDFIU) [5]

The provincial fixed cross-sectional FINTD and FDFIU are the unweighted average of each province's own relative VINTD and VDFIU. So the relative fixed cross-sectional FINTD and FDFIU variables have only one observation for each province. The cross-sectional data reflect the relative international trade share and the direct foreign investment level of each province. This kind of computation of direct foreign investment is much more precise than Chen's and Fleisher's analysis (1996) for the panel data approach. Because nearly no direct foreign investment happened in China before 1978, a convergence regression conditioned on DFIU is estimated only for the post-reform period. Table 1 and Table 2 list the relative level of FINTD and FDFIU.

Finally, the relative variables are converted into logarithmic form,[6] so all the variables (excluding dummy variable) in this paper are relative ones, and are in logarithmic form. They measure the logarithmic deviation from the sample mean.

Note 5. The relative time-series cross-sectional INTD and DFIU are referred to as VINTD and VDFIU, respectively; the fixed cross-sectional INTD and DFIU are referred to as FINTD and FDFIU, respectively in the latter parts of the paper.

Note 6. The dependent variables are LogRY and LogRPDTY.
The independent variables are LnVINTD(-1) and LnVDFIU(-1) or LnFINTD and LnFDFIU

4.3 *Dummy Variable*

A dummy variable is also included to reflect the effects the government economic policies. COAST is the dummy variable that divides the cross-sectional sample into two sub-groups: coastal provinces for which the dummy variable takes the value 1, interior provinces for which it is equal to 0. It proxies the differences between coastal and interior provinces in terms of international openness level and the steady states of per capita GDP/labour productivity. Table 3 shows which of the provinces are defined as coastal provinces. The regional classification is according to economic policy, rather than geographical definition, so Beijing is defined as a coastal province. This is the same classification as in previous papers.

Table 1 Relative International Trade Share (FINTD)

Anhui	0.270	Jilin	0.537
Beijing	1.116	Jiangsu	0.828
Fujian	3.659	Liaoning	2.006
Guangdong	4.474	Shandong	0.985
Gansu	0.222	Ningxia	0.516
Guangxi	0.710	Qinghai	0.252
Guizhou	0.200	Shanxi	0.268
Hebei	0.601	Shanghai	2.784
Henan	0.241	Tianjin	2.586
Heilongjiang	0.413	Xinjiang	0.430
Hubei	0.412	Yunnan	0.417
Hunan	0.406	Zhejiang	0.694
Inner Mongolia	0.320		

Table 2 Relative Direct Foreign Investment (FDFIU)

Anhui	0.321	Jilin	0.281
Beijing	1.224	Jiangsu	1.835
Fujian	1.433	Liaoning	1.189
Guangdong	7.474	Shandong	1.036
Gansu	0.048	Ningxia	0.037
Guangxi	0.497	Qinghai	0.010
Guizhou	0.058	Shanxi	0.121
Hebei	0.383	Shanghai	2.391
Henan	0.359	Tianjin	0.978
Heilongjiang	0.398	Xinjiang	0.196
Hubei	0.612	Yunnan	0.091
Hunan	0.424	Zhejiang	0.793
Inner Mongolia	0.028		

Table 3 Regional Classification

Beijing	Coast	ShanDong	Coast
TianJin	Coast	HeNan	Interior
HeBei	Coast	HuBei	Interior
ShanXi	Interior	HuNan	Interior
Inner Mongolia	Interior	GuangDong	Coast
LiaoNing	Coast	GuangXi	Coast
JiLin	Interior	GuiZhou	Interior
HeiLongJiang	Interior	YunNan	Interior
ShangHai	Coast	GanSu	Interior
JiangSu	Coast	QingHai	Interior
ZhengJiang	Coast	NingXia	Interior
AnHui	Interior	XinJiang	Interior
FuJian	Coast		

5. Estimates and Interpretation

This paper estimated models of absolute and conditional convergence for both per capita GDP and labor productivity for the entire period and post reform period. Before soing so, however, it examines σ-convergence.

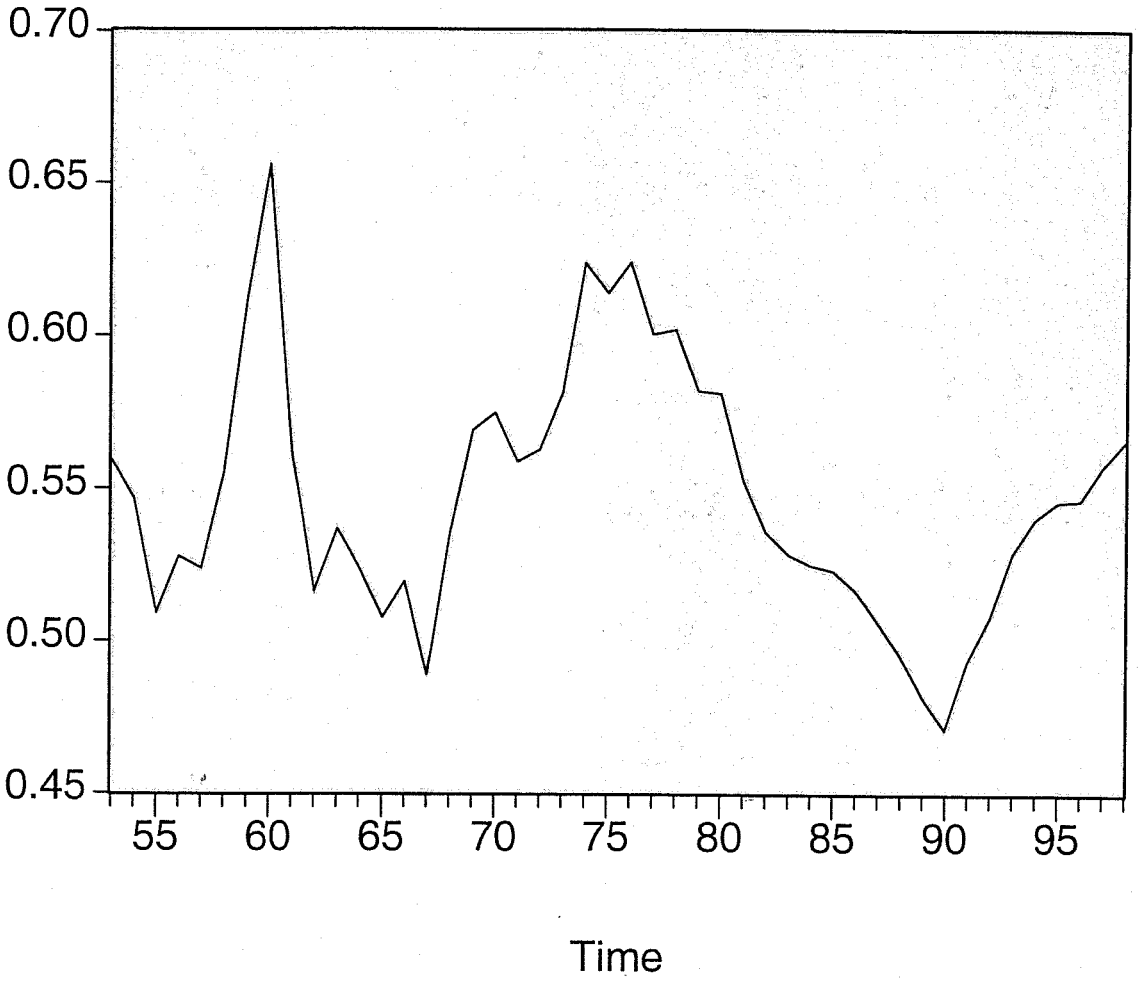
5.1 σ-convergence

Figure 1 displays the standared deviation (SD) of relative per capita GDP. From 1953 to 1978, the standard deviation (SD) fluctuated over time. The government of China did not have much experience in managing the economy just after the establishment of the People's Republic of China. As a consequence, the vision of economic policies was short-term and the policies changed often. After more than one century of war, China's national economic power was almost nil, so China's economy was sensitive to the political and economic environment. There were three major events that had strong negative effects on economic growth. They were the Great Leap Forward (1958), the three-year natural disasters (1960-1962), and the Cultural Revolution (1966-1976). The standard deviations (SD) fluctuated because economic growth fluctuated during that period; and it shows no evidence of σ-convergence between 1953-1978.

From 1978 to 1990, the SD declined sharply; there was strong evidence of σ-convergence. The convergence was due to the economic reform, which led some coastal provinces to grow first. Some previously poor provinces' fast development drove the convergence tendency.

After 1990, the SD increased over time, which is evidence of divergence. According to Jian (1996), it was due to the widening gap between the coastal group and the interior group.

Figure 1 -- Sigma-Convergence



5.2 *Absolute Convergence*

The absolute convergence model is estimated both with annual data (eq'n (1)), and with 5-year period data (eq'n (1')). Tables 4 and 5 show the results from the annual data approach, while Table 6 illustrates the results from the 5-year period data approach.

From Table 4, it is clearly noticeable that the estimated convergence parameters, $(-\gamma 1)$ of per capita GDP and labor productivity are statistically significant and have a negative sign. The results display evidence of absolute convergence between 1953-1998 and during the reform period. In order to eliminate the effects of short-term business cycles, AR is added in the estimation equation, while results are showed in Table 5. The estimation results still show evidence of absolute convergence, but with a higher R^2 and the better statistic value of Durbin-Watson. Furthermore, the null hypothesis of no convergence is then rejected at the 5% critical level for per capita GDP in the overall samples, while it is at a 10% critical level in Table 4.1.

The alternative approach, the 5-year period data approach, whose results are in Table 6, provides further evidence of absolute convergence, too. Though both empirical approaches provide strong evidence of absolute convergence, the convergence speeds are very slow. It will take 77 years 7 to eliminate half of the initial gap.

From the two approaches, this paper found strong evidence of absolute convergence between 1953-1998 in China, though the convergence speed was much

Note 7: This result is computed from the post-reform convergence speed.

slower than in developed countries. This finding is quite new compared to results from previous studies.The use of relative data sets (which reflect more precisely the provincial relative economic level and eliminate the common economic shock) appears to be the decisive factor in getting different results regarding convergence.

The evidence of absolute convergence over the entire period reflects the real economy in China. During the era that emphasized absolute equality, the government subsidized the poor provinces, especially Xinjiang, NingXia, and Inner-Mongolia, the minority nationality provinces. There are nearly no international communications over that period and the economic growth is extremely slow. During the reform period, some originally poor coastal provinces, like Fujian and Shandong with high international openness level, developed very fast to catch up with relative wealthier ones. All these factors drove a weak tendency towards absolute convergence during the entire period.

Table 4 Absolute Convergence (Equation 1) -- without $AR_{i,t}$

	1953-1998		1978-1998	
	per capita GDP	**Labor Productivity**	**per capita GDP**	**Labor Productivity**
$-\gamma 1$	-0.00653(0.004)*	-0.00918(0.003)***	-0.0108(0.003)***	-0.00982(0.003)***
Convergence speed	0.7%	0.9%	1.0%	1.0%
Number of Obs.	1150	993	525	519
R^2	0.002	0.007	0.007	0.012
Durbin-Watson St.	2.07	2.01	1.50	1.54

(Note: The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. AR is NOT included as a regressor. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error terms are in parentheses. Estimations are tested using Eviews 3.1)

Table 5 Absolute Convergence – with $AR_{i,t}$

	1953-1998		1978-1998	
	per capita GDP	**Labor Productivity**	**per capita GDP**	**Labot Productivity**
$-\gamma 1$	-0.00789(0.004)**	-0.0107(0.003)***	-0.0113(0.004)***	-0.0116(0.003)***
Convergence speed	0.8%	1.0%	1.0%	1.2%
Number of Obs.	1125	966	525	515
R^2	0.0460	0.0620	0.161	0.170
Durbin-Watson St.	1.98	1.98	1.95	1.99

(Note: The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. The equation was re-estimated with a correction for AR(1) autocorrelation. The estimation is based on the heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error terms are in parentheses. Estimations are tested using Eviews 3.1)

Tabel 6 Absolute Convergence (Equation 1') -- 5-year period data

	1953-1978		1978-1998	
	Per capita GDP	**Labor Productivity**	**per capita GDP**	**Labor Productivity**
$-\gamma 1$	-0.0294(0.013)**	-0.0462(0.009)***	-0.0304(0.012)***	-0.0454(0.009)***
Convergence speed	0.6%	0.9%	0.9%	0.9%
Number of Obs.	225	192	125	120
R^2	0.019	0.075	0.033	0.086
Durbin-Watson St.	1.94	1.81	1.70	1.60

(Note: The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. AR is NOT included as a regressor. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error terms are in parentheses. Estimations are tested using Eviews 3.1 with 5-year period data)

5.3 *Conditional Convergence*

In total, six different models of consitional convergence were estimated. Both the annual and the 5-year period panel data were used to estimate each equation. For all equation for both per capita GDP and labour productivity, the convergence coefficient of per capita GDP and labour productivity, $-\gamma 1$, remained significant at the 5% level of significance with a negative sign. So the evidence in facour of conditional convergence is strong. The discussion in the remainder of this section is based mainly on the annual data approach, which has the same empirical implications as the 5-year period approach.

Table 1 presents the fixed cross-sectional relative international trade openness (FINTD) level of each province. The provincial average of FINTD is equal to 1. Table 1 gives us a straightforward view of provincial relative international openness. Shanghai and Guangdong are the wealthiest provinces and have relatively higher international trade openness positions. The poorest provinces, Guizhou, Anhui and Henan, have a relatively lower level of openness to international trade. Table 1 reveals the phenomenon that two extreme exist, and that there is inequality between coastal provinces and interior provinces. The coastal group has a much higher international openness level than the interior group. The average level of international trade openness for coastal provinces is 1.9, and it is 0.34 for the interior provinces.

Table 2 lists the fixed cross-sectional relative direct foreign investment utilization (FDFIU) levels of each province. The provincial average is again 1. The wealthier

provinces, Shanghai and Guanddong, have relatively higher foreign investment utilization levels. The poorer provinces, Guizhou and Gansu, have relatively the lowest foreign investment utilization levels. The DFIU also has two extremes. The average level for the coastal group is 1.73 and is 0.21 for the interior provinces.

The apparent difference between the international openness levesl of coastal and interior provinces is controlled for by adding the the dummy variable, DCOAST. In equations 3 and 4, the convergence parameters are significant wether Dcoast is added or not. In equation 5a, though the significance of the convergence parameters is not related with Dcoast, the dummy makes all the control variables significant, which indicates that the coastal preference openness policies affects the international openness distribution.

To test the difference that each international openness variable makes to the model, three different regressions are designed. Equation 3 adds only INTD as a control variable while equation 4 only adds DFIU. Equation 5 adds both of them as control variables. [8]

For the estimaties for the entire period between1953-1998, only international trade openness (INTD) is included as a steady state control variable due to the inavailability of data on direct foreign investment before 1978. All the research regarding direct foreign investment (DFIU) will focus on the post-reform period.

Note 8: The Fixed Effect has been examined in all the conditional convergence regressions;

5.3.1 *Per capita GDP*

5.3.1.1 Overall Result

Tables 6 and 7 show the empirical results for equations 5a and 5b. Per capita GDP is the income measure while international trade and direct foreign investment are used as control variables. DCOAST is added as a dummy variable in equation 5a.

The convergence parameters, $-\gamma 1$, are statistically significant at the 1% critical level and imply a negative relationship between economic growth and the initial level of income, which indicates that the hypothesis of conditional convergence during the economic reform period cannot be rejected.

Most importantly, the point estimaties of $\gamma 2$ and $\gamma 3$ for the per capita GDP in Tables 6 and 7 are positive and significantly different from zero at the 5% critical level (at least). This indicates that both foreign investment and international trade have an effect on the long-run relative steady state position of the Chinese regions. As a result, a region with a higher level of international openness tends to be wealthier in the long - run. This is the most important result of this paper. It indicates that both INTD and DFIU can be used together as proxies for the long-run relative steady state of the per capita GDP at the regional level in China.

In Tables 8, 9 and Table 10, 11, only one international openness variable is used as proxy for the long-run relative steady state. The estimated coefficients of FINTD and FDFIU also imply that international openness has a positive effect on economic growth.

When only one international openness variable is used as a long-run relative steady state control variable, the general conclusion is consistent with the results in Tables 5 and 6.

The significant coefficients of Dcoast in Table 6 and 7 illustrate that natural geographical location and national coastal preference policies generated economic structure shocks during the reform period. China's economic openness policy gave the coastal provinces privileges on custom duty and tax. Jiangsu, Zhejiang and Shandong were relatively poor agricultural coastal provinces before the economic reform. The rapid growth of poor coastal provinces after 1978, due to their relatively higher international openness level, narrowed the gap with wealthier regions.

One objective of this paper is to examine whether international openness had effects on China's economy for the entire period. Tables 8 and 10 present the results: from 1953 to 1998, conditional convergence cannot be rejected if conditioned on international trade.[9] This result presents a new view compared to that of previous ones. It indicates that international openness has positive effects on long-run relative steady-states under any kind of economic regimes. There are two good examples. Originally, both Heilongjiang and Liaoning were heavy industry centers of China, and their per capita level of GDP were very close to each other before the economic reform. After the reform, the international openness level of Liaoning improved very fast, while Heilongjiang's did not develop well. As a consequence, as shown in Figure 2.1, Liaoning's per capita GDP

Note 9: Due to the unavailability of DFIU for the entire period, equations 4 and 5 cannot be tested.

kept ahead of Heilongjiang's, and the gap widened before 1995. (The reason why Liaoning's performance declined is out of the study range of this paper). Figure 2.2 shows the comparison between Anhui and Fujian, both of which were poor provinces with a bad agriculture environment. But Fujian's higher international openness level drove its economy into the wealthier group, while Anhui is still a poor province with a lower international openness level.

Table 6. Results of Conditional Convergence on *FINTD* and *FDFIU* (Equation 5a)

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.0324(0.004)***	-0.0280(0.004)***
γ_2 (FINTD)	0.00643(0.0030**	0.0103(0.003)***
$\gamma 3$ (FDFIU)	0.00457(0.002)**	0.00471(0.002)***
Dcoast	0.0200(0.003)***	0.0142(0.003)***
Convergence speed	3.2%	2.8%
No. of Obs.	525	511
R^2	0.276	0.270
SE of regression	0.04	0.04
Durbin-Watson St.	2.00	2.00

Table 7 Results of Conditional Convergence on lagged *VINTD* and *VDFIU* (Equation 5b)

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.0401(0.008)***	-0.0251(0.004)***
γ_2 (VINTD)(-1)	0.0150(0.004))***	0.0165(0.004)***
$\gamma 3$ (VDFIU)(-1)	0.00456(0.001)**	0.00233(0.001)*
Dcoast	0.0146(0.004)***	0.0117(0.004)***
Convergence speed	4.0%	2.5%
Number of Obs.	345	345
R^2	0.368	0.321
SE of regression	0.04	0.04
Durbin-Watson St.	1.92	1.96

(Note for table 6 and 7: Regressions are processing separate AR(1) or AR(2) to correct serial correlation. The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Estimations are tested using Eviews 3.1)

Table 8 Results of Conditional Convergence on *FINTD* (Equation 3a)

	1953-1998		1978-1998	
	per capita GDP	**Labor Productivity**	**per capita GDP**	**Labor Productivity**
$-\gamma 1$	-0.0204(0.005)***	-0.0160(0.004)***	-0.0369(0.007)***	-0.0254(0.004)***
γ_2 (FINTD)	0.0105(0.002)***	0.00660(0.002)***	0.0162(0.004)***	0.0154(0.003)***
Convergence speed	2.0%	1.6%	3.7%	2.5%
Number of Obs.	1125	966	525	515
R^2	0.062	0.068	0.189	0.204
SE of regression	0.07	0.07	0.04	0.05
Durbin-Watson St.	1.98	1.98	1.94	1.99

Table 9 Results of Conditional Convergence on *FDFIU* (Equation 4a)

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.0208(0.005)***	-0.0181(0.004)***
γ_2 (FDFIU)	0.00597(0.001)***	0.00649(0.001)***
Convergence speed	2.1%	1.8%
Number of Obs.	525	515
R^2	0.189	0.202
SE of regression	0.04	0.05
Durbin-Watson St.	1.94	1.98

Table 10 Conditional Convergence on lagged VINTD (Equation 3b)

	1953-1998		1978-1998	
	per capita GDP	**Labor Productivity**	**per capita GDP**	**Labor Productivity**
$-\gamma 1$	-0.0177(0.005)***	-0.0147(0.004)***	-0.0182(0.005)***	-0.0194(0.004)***
γ_2 (VINTD)(-1)	0.00812(0.002)***	0.00610(0.002)***	0.00652(0.003)**	0.00977(0.003)***
Convergence speed	1.8%	1.5%	1.8%	1.9%
Number of Obs.	918	841	517	509
R^2	0.092	0.085	0.180	0.192
SE of regression	0.07	0.07	0.04	0.04
Durbin-Watson St.	1.96	1.99	1.96	2.00

Table 11 Results of Conditional Convergence on lagged *VDFIU* (Equation 4b)

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.0161(0.005)***	-0.0104(0.002)***
γ_2 (VDFIU)(-1)	0.00601(0.001)***	0.00411(0.001)***
Convergence speed	1.6%	1.0%
Number of Obs.	345	345
R^2	0.329	0.280
SE of regression	0.04	0.04
Durbin-Watson St.	1.95	1.95

(Notes for table 8-10: Regressions are processing separate AR(1) to correct serial correlation. The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error term in parentheses. Estimations are done using Eviews 3.1)

Figure 2.1 LRY In HLJ and LN

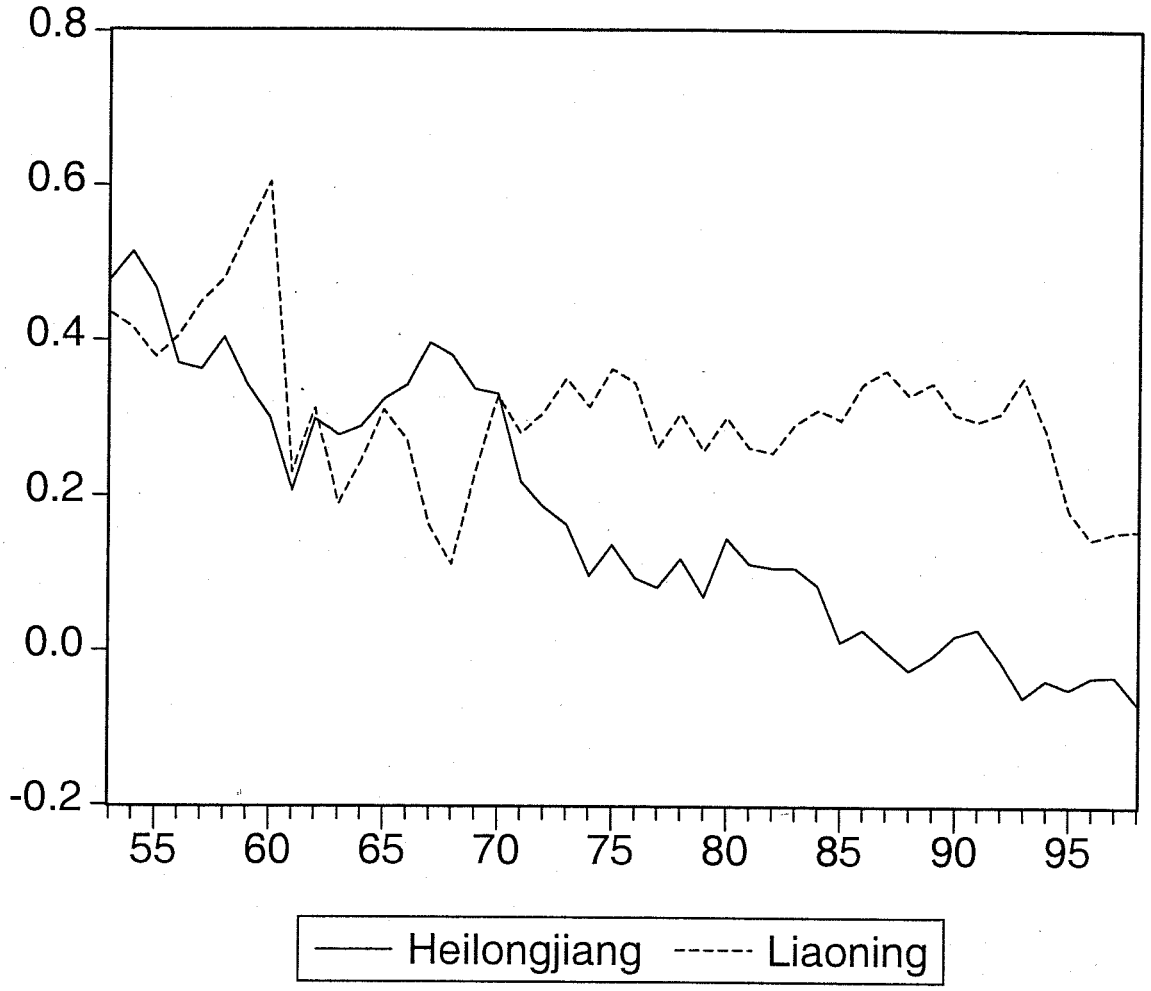
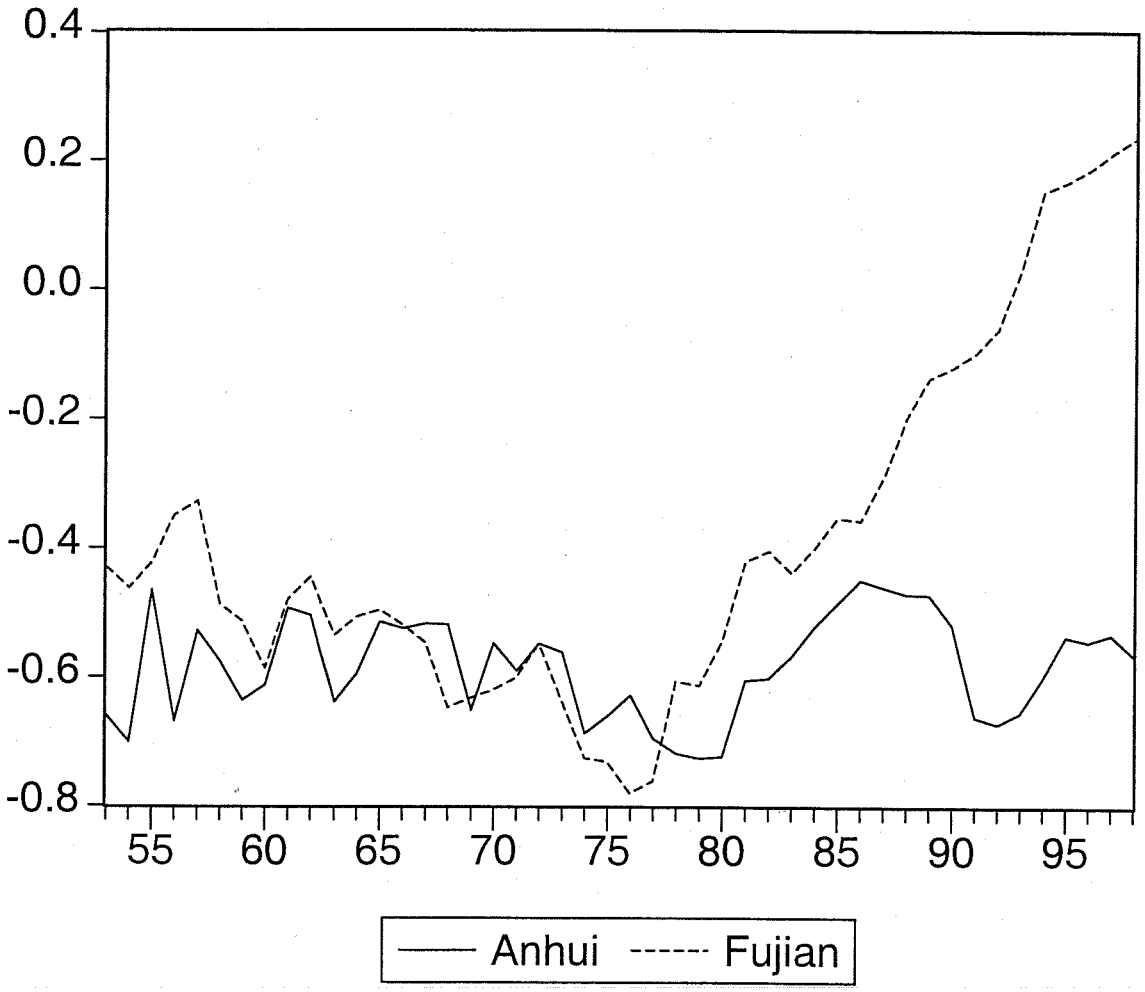


Figure 2.2 LRY In AH and FJ



5.3.12 Long-Run *Elasticity*

Elasticity is used to measure the effects of independent variables on dependent variables. It indicates how much the dependent variables will increase due to a 1% increase in the independent variables.

This paper will examine the elasticity of FINTD and FDFIU on long-run per capita GDP and labor productivity, respectively. From equation 5a, one can solve for the relative long-run steady state of per capita GDP for each province, RY*. [10]

$$\frac{\Delta \text{ LogRY}_i^*}{\Delta \text{ LogINTD}_i} = \frac{\gamma 2}{1-\gamma 1} \qquad (6)$$

$$\frac{\Delta \text{ LogRY}_i^*}{\Delta \text{ LogDFIU}_i} = \frac{\gamma 3}{1-\gamma 1} \qquad (7)$$

From equations 6 and 7, it is easy to find that the elasticity of INTD and DFIU on per capita GDP is $\gamma 2/(1-\gamma 1)$ and $\gamma 3/(1-\gamma 1)$, respectively.

The coefficients of INTD and DFIU in Table 7 imply that the elasticity of INTD on per capita GDP is 0.20 while the elasticity of DFIU on per capita GDP is 0.16. A 100 percent increase in international trade will induce a 20 percent increase in per capita GDP in the long-run, while a 100 percent increase in direct foreign investment will cause a 16 percent increase in per capita GDP.

Note 10: Hold DFIU fixed when compute the elasticity of INTD on per capita GDP and hold INGD fixed when compute the elasticity of DFIU on per capita GDP

5.3.13 *Convergence within coastal and interior provinces* [11]

Table 12 illustrates the evidence of conditional convergence after 1978 within coastal provinces, and it indicates that the convergence speed was much higher than that of the nation's. The coefficient of relative international trade (INTD) is positive and significant, which indicate that the long-run relative level of the dependent variables is determined by international openness.

The coefficient of DFIU is insignificantly positive. The positive sign displays the positive effects of DFIU on China's economy, but the insignificance of DFIU means it had not contributed to convergence. This is due to the distribution of DFIU. In relatively poor provinces, DFIU was focused on labor-intensive industries, while in relatively wealthy provinces, DFIU contained more technical and management factors and generated more output. For example, the wealthier Shanghai and Beijing provinces had a relatively better foreign investment structure than those relatively poor coastal provinces. So across coastal provinces, DFIU does not have a significant impact on convergence.

Table 13 presents evidence on convergence within interior provinces. The convergence speed is faster than the nation's as well.

So within the coastal or interior groups, the relatively poor provinces improved international openness and gradually caught up with the relatively wealthier ones. The results confirm Chen's (1996) affirmation that the gap within each group was narrowing

Note 11: The gap between coastal and interior groups has been created only after the economic reform in 1978, so it is not correct to study the two groups respectively before 1978.

and that also led to the national convergence trend. But as the gap between the two groups were widening (Chen, 1996), the nation's convergence speed was slower.

Table 12. Conditional Convergence among Coastal Provinces (Equation 5b)

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.0604(0.012)***	-0.0546(0.012)***
γ_2 VINTD(-1)	0.0180(0.006))***	0.0175(0.005)***
$\gamma 3$ VDFIU(-1)	0.00202(0.003)	0.00148(0.002)
Convergence speed	6.0%	5.5%
Number of Obs.	167	167
R^2	0.449	0.348
SE of regression	0.03	0.04
Durbin-Watson St.	1.92	2.00

(Note: the cross-sectional observations are 11 coastal provinces)

Table 13. Conditional Convergence among Interior Provinces (Equation 5b)

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.0523(0.012)***	-0.0217(0.002)***
γ_2 (VINTD)(-1)	0.0521(0.011)***	0.00425(0.009)***
$\gamma 3$ (VDFIU)(-1)	0.00351(0.001)***	0.00332(0.001)***
Convergence speed	5.2%	2.1%
Number of Obs.	178	178
R^2	0.221	0.321
SE of regression	0.03	0.04
Durbin-Watson St.	1.96	1.80

(Note: the cross-sectional observations are 14 interior provinces. Regressions are processing separate AR(1) to correct serial correlation. The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error term are in parentheses. Estimations are done using Eviews 3.1)

5.2.2 *Labor productivity*

In Tables 6 and 7, the results illustrate that the convergence parameters, $-\gamma 1$, for labor productivity are significant at a 1% critical level and with a negative sign after 1978, which is strong evidence of conditional convergence. Tables 8-10 provide further evidence of convergence for labor productivity. However, we find that the convergence rate of labor productivity is slower than that of per capita GDP.

More importantly, the estimated coefficients of INTD and DFIU are positive and significant, which illustrates the positive effects of international openness on labor productivity as on per capita GDP, though in Table 7, the parameter of DFIU is only significant at the 10% critical level. The empirical results indicate that INTD and DFIU could be combined together to act as proxies for the relative long-run steady state of labor productivity at the provincial level in China, too. Results from Table 8-10 illustrate the significant positive effects of international openness on labor productivity as well.

Based on the point estimates of Table 6 and the formulae 6 and 7, the elasticity of international trade on labor productivity is 0.37, while the elasticity of direct foreign investment on labor productivity is 0.17. Both of them are higher than those of per capita GDP, so international openness has a stronger impact on labor productivity than on per capita GDP.

6. Dynamic Simulation

The main results of this paper suggest that international openness inferences the relative long-run steady states of each province. In this section, this prediction will be evaluated by comparing the actual and predicted path of conditional convergence of the relative per capita GDP, following the method proposed in Coulombe (2000).

The dynamic simulation is carried out using an annual data set. 1978 is the first year for the simulation using equation 5a. The steady state control variables are fixed international trade (FINTD), direct foreign investment (FDFIU) and Dcoast. The results are displayed in Figure 3, which shows that in most of cases, the predicted path and the actual path fit.

First, we examine the relationship between the actual path and the steady state. After 1978, most of the provinces were getting closer to their own long-run steady states. Some provinces reached their steady states after 1990, like Gansu, Hubei, Jilin, Liaoning, Shandong, and NingXia. Four provinces had reached their steady state before 1990: Jiangsu, Xinjiang, Yuanan and Zhejiang. According to the neo-classical growth theory, the closer the economy is getting to its steady state, the slower the growth speed is. So the convergence speed will be slowing down gradually when all the provinces are getting closer to their steady states. This can be an additional answer to Raiser's finding that the convergence speed was slowing down after 1985.

There are some cases in which the actual and predicted paths do not fit well, like in Jiangsu and Zhejiang. Both of them were fast developing coastal provinces, and they

benefited from all the privileges authorized to the coastal special areas since the economic reform. In order to determine their relative steady states, international openness is not enough; some other policy factors should also be taken into account. These provinces' relative steady states shown in this paper are lower than the actual ones. But due to the less time-series observation,[12] one can not find the new relative steady states for them. It is also noticeable that there is a time shock around 1995 for Liaoning, which is due to the reform of the state owned enterprises (this topic is out of this paper's range). After the shock, there should be a new lower relative steady state for LiaoNing.

Though there are some special cases, the predicted model in this paper can explain relatively well the relative dynamic path of per capita GDP and labor productivity during the economic reform period.

Note 12: The system alerts that it is "nearly singular matrix" when more control variables are added in the regression.

7. Conclusion

Based on the neo-classical Solow-Swan growth theory, this paper uses various empirical approaches to verify the economic convergence in China, and gets relatively robust empirical evidence of the presence of absolute and conditional convergence between 1953-1998 and during the post economic reform period.

Many papers mention that openness has a positive effect on economic growth, but there is no empirical research focusing on economic growth and international openness in China. This paper uses a conditional convergence model, with international trade and direct foreign investment to represent the international openness level and to act as long-run relative steady state control variables, to explain China's dynamic transition. The results from regression analysis and dynamic simulations illustrate that international openness is a good proxy to determine the provincial long-run relative steady state in China.

The other contribution of this paper is that it uses the relative data approach to provide strong evidence of absolute and conditional convergence between 1953-1998, which is not the common conclusion of previous studies. This finding goes along with Barro and Sala-i-Martin's conclusion that convergence should exist within a homogeneous group of economies, like within a country.

It also finds an answer to a previous paper, which pointed out that the convergence speed was slowing down after 1985. The reason is that most of the provinces were getting much closer to their steady states.

The other finding is that annual data and 5-year period data lead to the same conclusion. It indicates that the 5-year period data approach is a sound method for studying China's long-run economic convergence path.

From this paper's analysis, one can conclude that improving China's international openness level will speed up its convergence tendency and economic growth.

Figure 3 -- Dynamic Simulation 1

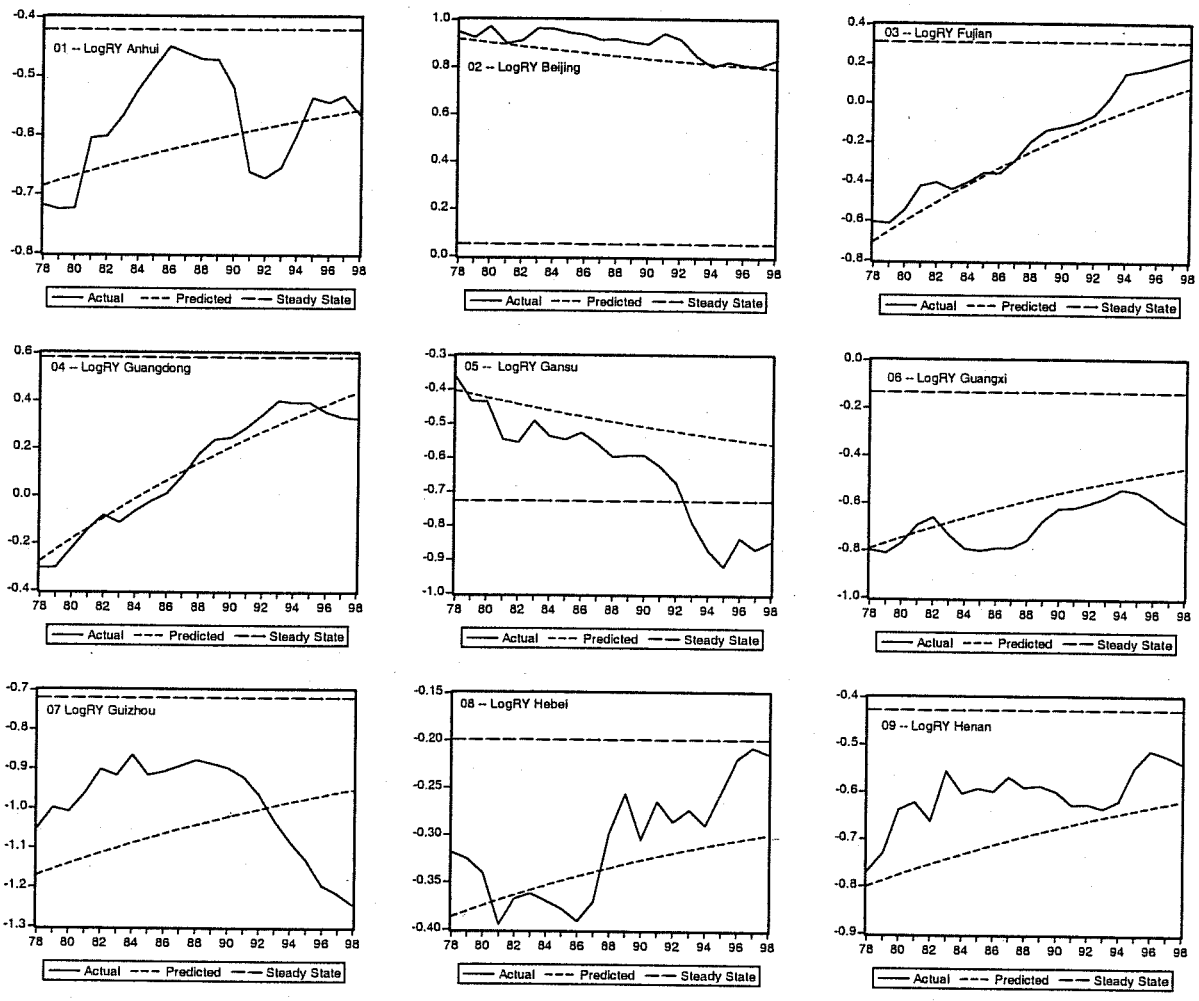


Figure 3 -- Dynamic Simulation 2

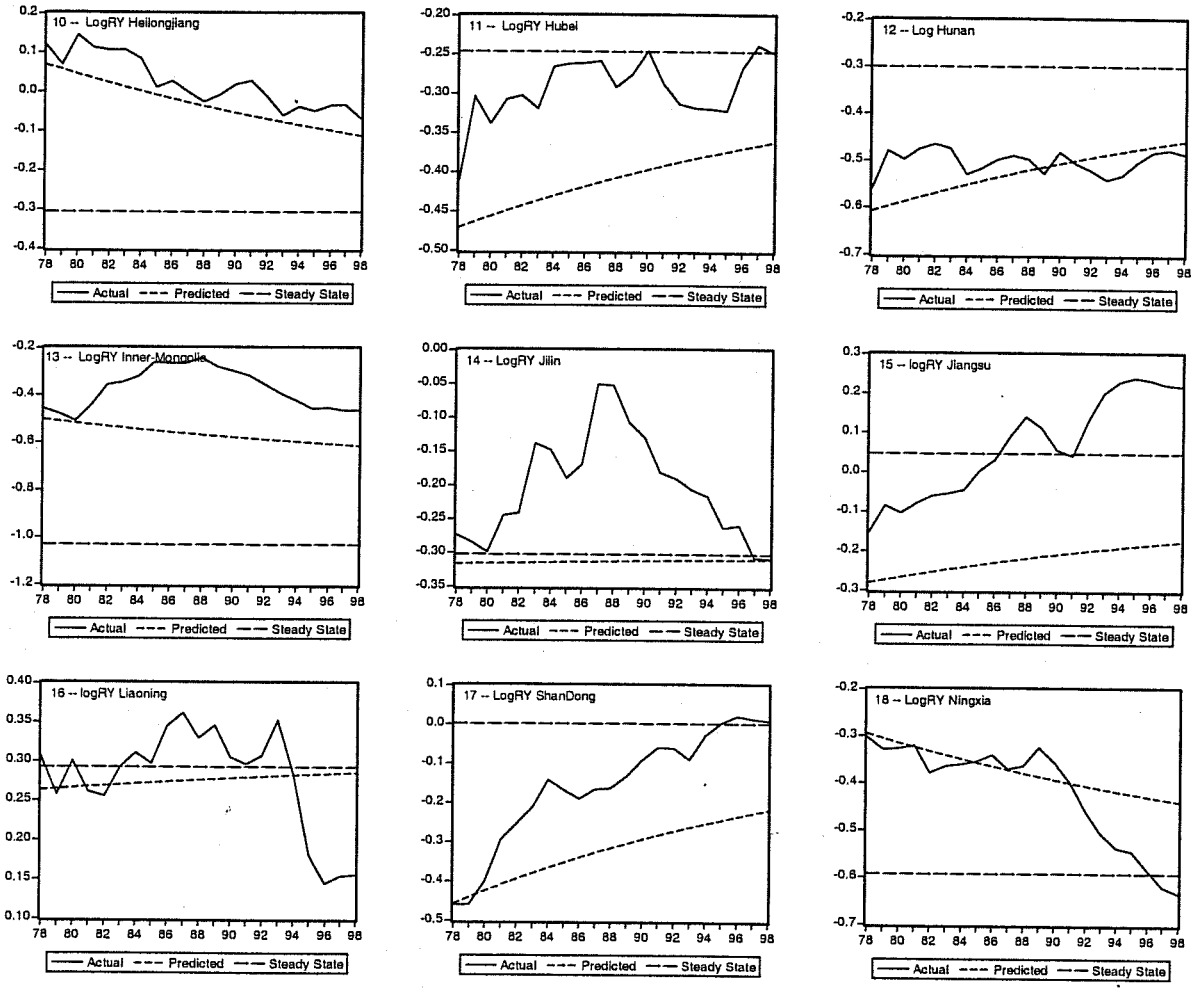
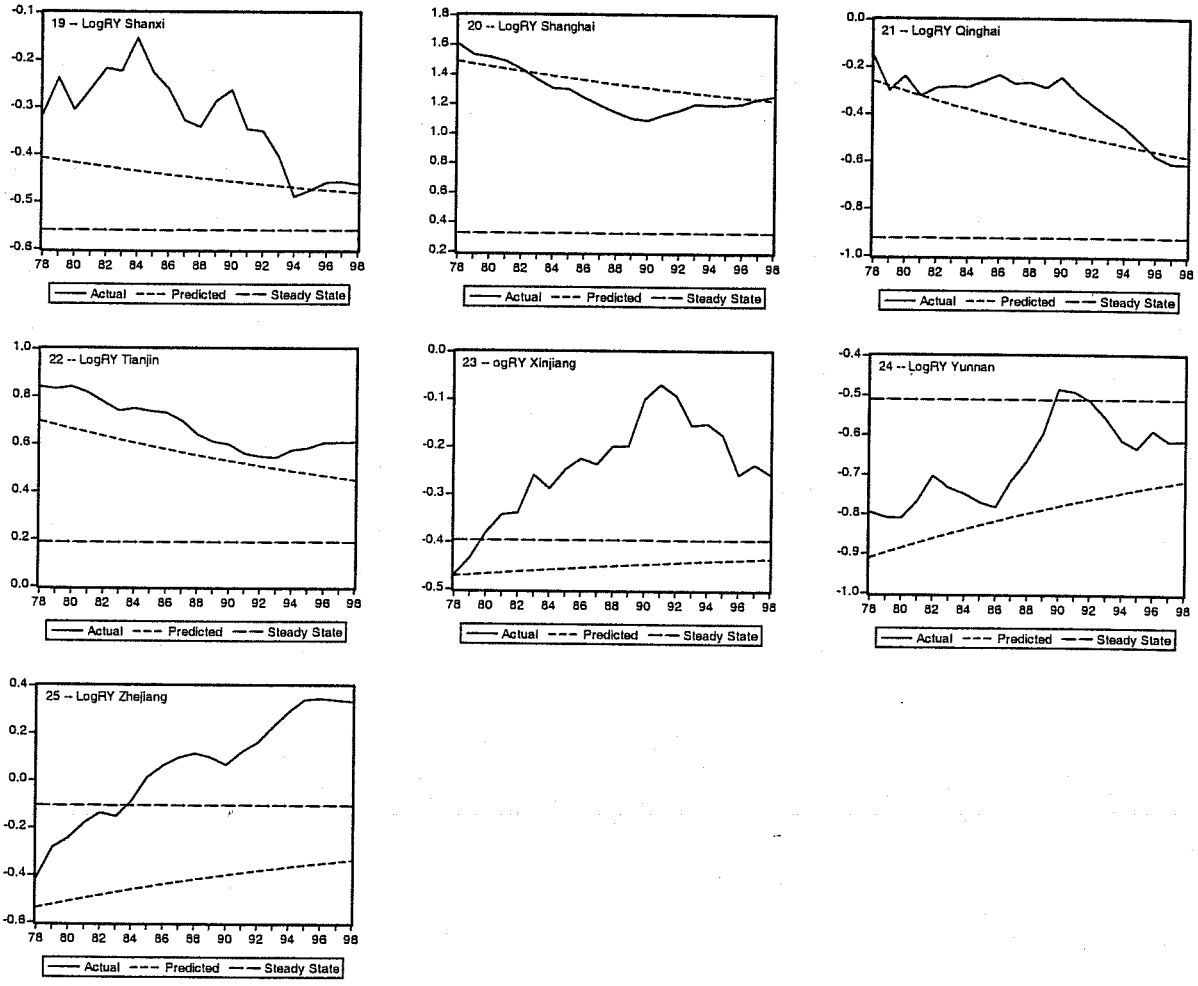


Figure 3 -- Dynamic Simulatin 3



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Appendix:

5-year period data

Conditional convergence on fixed FINTD and FDFIU

Table A1 Results of Conditional Convergence on *FINTD* and *FDFIU* (Equation 5a')

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.108(0.025)***	-0.104(0.012)***
γ_2 (FINTD)	0.0332(0.019)*	0.0245(0.012)**
$\gamma 3$ (FDFIU)	0.020(0.008)***	0.0200(0.007)***
Convergence speed	2.2%	2.1%
Number of Obs.	125	120
R^2	0.211	0.297
SE of regression	0.11	0.11
Durbin-Watson St.	1.65	1.67

(Notes: The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. Do not process AR-correction. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error termare in parentheses. Estimations are done using Eviews 3.1)

In Table A1, fixed INTD and DFIU are used together as proxies of the long-run relative steady state. The convergence parameters, $-\gamma 1$, are significant at a 1% critical level with a negative sign, which indicate the tendency of convergence.

More importantly, the coefficient of FINTD and FDFIU are positive and significant with only one at a marginal 10% critical level, which confirm the conclusion that international openness is a good proxy to the relative long-run steady state.

Compared to Table 6, the 5-year period data approach has a higher R^2 and a lower statistic value of Durbin-Waston.

Conditional Convergence on Lagged VINTD and VDFIU

Table A2 Results of Conditional Convergence on lagged *VINTD* and *VDFIU* (Equation 5b')

	1978-1998	
	per capita GDP	**Labor Productivity**
$-\gamma 1$	-0.107(0.017)***	-0.103(0.003)***
γ_2 (VINTD)(-1)	0.0428(0.012)***	0.727(0.008)***
$\gamma 3$ (VDFIU)(-1)	0.0297(0.003)***	0.178(0.002)***
Convergence speed	2.2%	2.2%
Number of Obs.	60	60
R^2	0.802	0.922
SE of regression	0.10	0.10
Durbin-Watson St.	1.45	1.63

(Notes: The ***, ** and * illustrate that the null hypothesis can be rejected at 1%, 5% and 10% critical levels, respectively. Do not process AR-correction. The estimation is based on the White heteroscedasticity consistent covariance matrix estimator (HCCME), which allows for asymptotically valid inferences in the presence of heteroscedasticity. Error term are in parentheses. Estimations are done using Eviews 3.1)

In Table A2, lagged VINTD and VDFIU are used as steady state control variables. The convergence parameters, $-\gamma 1$, are significant at a 1% critical level for both per capita GDP and labor productivity, and with a negative sign to show the convergence tendency.

The parameters of VINTD(-1) and VDFIU(-1), $\gamma 2$ and $\gamma 3$, are significant at a 1% critical level and with a positive sign, which still confirm the conclusion that international openness has positive effects on economy and is a good proxy of the long-run relative steady state in China.

Compared with Table 7, the 5-year period approach has a much higher R^2.