An Empirical Research on the Convergence of Economic Growth of Coastal provinces and Border provinces in China

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Keywords: Beta Convergence, Sigma Convergence, Group Convergence, Stochastic Convergence, Per Capita GDP

Abstract. With China's economy developing, the imbalance of economic growth between Coastal and Border provinces has intensified. This paper selects per capita GDP data of eight coastal provinces and eleven border provinces from 2008 to 2014. Empirical research on the economic growth convergence of these provinces, the convergence will be analyzed from various convergence phenomena (β convergence, σ convergence, Group convergence, stochastic convergence) in the process of economic growth and exploring other possible influencing factors. Finally, according to the results of the calculation and analysis, the paper gives some suggestion on the imbalance of the economic development in the coastal provinces and border provinces.

Introduction

In 1978, the reform and opening-up opened new era of China's economic growth, but exacerbated the imbalance of regional economic growth in China. In 2015, China’s GDP growth rate was only 6.9%, it seemed that China encountered obstacles to development. However, this is key transition period of regional economic development strategy from non-equilibrium state to equilibrium state, followed by “The western development”, “The rise of central China”, “The Belt and Road” and so on, all provides predominant policy guarantees for regional balance development. In March 2016, released “The 13th Five-Year Plan” formally defined the decisive stage of the three major strategies about the realization of the CPC’s first hundred year of struggle goal: Take the regional development strategy as the general foundation; take “The belt and road” construction, the coordinated development of Beijing-Tianjin-Hebei, the Yangtze River economic belt development as the lead, form vertical horizontal economic belt and shape new pattern of regional coordinated progress that elements orderly free flow, main function constraints effectively, equality of basic public services and resource environment can bear[1].

And these are related to convergence theory of regional economic growth. Economic growth convergence means that poor economy will approach rich economy in the long run[2]. If rapid economic growth, a prerequisite for economic development and social progress of a country or a region, will improve people's welfare level, then the convergence of economic growth can enhance people's happiness index more, reflecting the long-term changeable trend
of regional economic differences. Neoclassical growth convergent theory argues that because the marginal benefit of capital in production is decreasing, on condition that regional elements can flow, relatively backward areas will have a higher economic growth rate than relatively developed regions due to higher capital gains, thus economically backward areas will catch up with the developed regions in economic growth and regional per capita output will tend to balance, eventually displaying the convergence of regional economic growth[3].

Accordingly, studying the structural contradictions and economic growth paths and patterns is of great practical significance to stability, coordination and sustainable development of China's economy.

**Literature Review**

Since Solow [4] (Solow, 1956) proposed the convergence hypothesis of economic growth, lots of economic literature used different metrology methods to test the existence and formation mechanism of transnational (regional) economic growth convergence hypothesis in different sample ranges.

Among them, Barrow[5](1991) analyzed the sample data of 87 countries from 1965 to 1975, together with the sample data of 97 countries from 1975 to 1985; Sallai Martin [6] (1996) selected data of 110 countries during 1960 to 1990 as a sample, and carried out an empirical research and tested the economic growth convergence between countries. They got the same conclusion that there’s no absolute convergence, but when introducing the regional dummy variables and economic structure variables into regression equation, there’s more obvious conditional convergence.

Research on our country's economy, Cai Fang, Du Yang[7](2000) considered that in terms of the data of 1978-1998, China's economic growth had the characteristics of the conditional convergence, but the absolute convergence trend was not significant, while Shen Kunrong and Ma Jun[8](2001) used cross-section data proved that there existed obvious club convergence between regions. Zhang Sheng[9](2001) found that there’s convergence phenomenon of internal economic growth in central regions, utilizing the provincial GDP of 1990 to 1998, while Chen Anping and Li Guoping [10] (2004) used the cointegration test method of Bernard and Durlauf [11](1996) to analyze the stochastic convergence of economic growth among provinces, based on the data from 1952 to 2001, found that central region and three regions of economic growth didn’t exist convergence trend. However, the two studies suggested that the economic growth of various provinces in eastern and western regions had convergent trend. Moreover, Guo Qingwang and Jia Junxue[12](2006) proposed that diminishing marginal returns of capital and technology diffusion effect were main factors causing China's inter provincial economic growth convergence, instead policy elements such as local fiscal expenditure have little influence. Dong Xianan [13](2004) also found that capital elements had an important impact, and once the labor market was distorted, it would lead to the development of regional economic polarization.

**Data Collection & Description**

Combine the characteristic of economic development of various provinces, based on “the reform and opening-up policy" and the provinces "The Belt and the Road" strategy, we chose eight coastal provinces namely Zhejiang, Shanghai, Guangdong, Jiangsu, Fujian, Hainan, Tianjin, Liaoning, and eleven border provinces namely Guangxi, Xinjiang, Shanxi, Gansu,
Yunnan, Inner Mongolia, Ningxia, Tibet, Heilongjiang, Shaanxi, Qinghai, to study the economic convergence problem.

Considering per capita GDP, as important macroeconomic indicators, can be used to measure people’s living standard, we select it as main economic indicator of convergence. Meanwhile, out of the availability, scientificity, and the interpretation for problem of indicators, we determined 15 adjustment factors, such as the urban unemployment rate, the local finance general budget revenue and residents' consumption level. Related data can be obtained via the relevant national bureau of statistics website.

**Convergence Model of Regional Economic Growth**

As a prediction of economic growth convergence, the essence of hypothesis is that the disparity in per capita economic growth level between different economies is shrinking. According to the specific situation of economies which are studied, the convergence hypothesis of economic growth is shown as the following four types.

**Beta Convergence Hypothesis**

As the earliest hypothesis form about economic growth convergence, absolute beta convergence was controversial until Mankiw, Romer, and Weill [14](1996) introduced “Human capital variable” that the expanded model had better ability of explanation. Conditional beta convergence came into being.

**Absolute Beta Convergence**

Absolute beta convergence describes reverse change relation between economic growth rate and the initial economic level. So the economic gap between relatively backward economies and relatively developed economies tends to diminish over time. Using Sa la-I-Martin[15] (1996) classic convergence regression model, we introduce an average annual growth rate of GDP per capita and perform a Log regression analysis based on the initial year GDP per capita, thus,

\[
r_{i,t} = \alpha - \beta \log\left(\frac{y_{i,t}}{y_{i,1}}\right) + \varepsilon_{i,t}
\]

(1)

Among them, \(r_{i,t} = \log\left(\frac{y_{i,t}}{y_{i,1}}\right) / t\) refers to the average annual growth rate of GDP per capita of the i-th economy during t years; \(y_{i,t}\) refers to the real GDP per capita of the i-th economy at year t; \(y_{i,1}\) refers to the real GDP per capita of the i-th economy in initial year.

Therefore, only when (1) is statistically significant and \(\beta > 0\), that is, the average annual growth rate is significantly negatively correlated with the initial level, it indicates that there’s a tendency of gradual reduction for the per capita GDP between the N economies. That is, there is the tendency of absolute beta convergence; on the contrary, there is no convergence.

**Conditional Beta Convergence**

Actually, there’re great differences in resource endowments status in different parts and these factors will have direct or indirect impacts on regional economic development. This is contradictory to the conditional beta convergence hypothesis that other factors affecting
economic growth are the same. Therefore, introducing these other factors into the equation (1) to expand the model to get,

\[ r_{i,t} = \alpha - \beta \log(y_{i,t}) + \Phi X_{i,t} + \epsilon_{i,t} \quad (2) \]

Among them, represents a vector composed of those control variables that may affect the economy, such as human capital, industrialization level, local fiscal revenue, etc.

Similarly, when the inspection results are statistically significant and \( \beta > 0 \), there’s a tendency of conditional beta convergence between \( N \) economies; on the contrary, there’s no conditional convergence.

**Sigma Convergence Hypothesis**

If \( \beta \) convergence is a mean convergence, then \( \sigma \) convergence is a variance convergence, its concept is also closest to our intuitive understanding of economics, that is, the economic differences in different regions tend to decrease. So it means to indiscriminately deal with the cross-sectional data among regions and carry out tests. Usually we adopt Gini coefficient, Coefficient of variation, Theil entropy to measure and decompose. Here we use standard deviation to analyze the economic growth convergence of coastal provinces and border provinces in China, namely:

\[
D_t = \sqrt{\frac{1}{N} \sum_{i=1}^{N} \left( y_{i,t} - \frac{1}{N} \sum_{i=1}^{N} y_{i,t} \right)^2} \quad (3)
\]

In this equation, represents the sample standard deviation of GDP per capita for \( N \) economies at year \( t \), measuring the degree of dispersion of absolute GDP per capita. If, then we call the \( N \) economies with T-stage convergence; while for any year, there are, then the \( N \) economies with a consistent convergence.

**Club Convergence Hypothesis**

Economies with different initial conditions will probably converge to different equilibrium steady-state levels in the long term. Therefore, this paper utilize a method based on endogenous growth theory—regression method, to give an empirical analysis on the club convergence of economic growth in 19 coastal and border provinces of China from year 2008 to 2014.

Similar to \( \beta \)-convergence, log regression is established on the target decomposed by explanatory variables, that is,

\[ \log y_{i,t} = \varphi_i \mu_t + \epsilon_{i,t} \quad (4) \]

Where, \( \varphi_i \) is the inherent characteristics, \( \mu_t \) is the common element and \( \epsilon_{i,t} \) is the random error term. Therefore, we construct the relative transfer coefficient \( h_{i,t} \) to better indicate the degree that the \( i \)-th economy deviates from its path of co-growth in its economic development path, that is,
\[ h_{i,t} = \log y_{i,t} / \left( \sum_{i=1}^{N} \log y_{i,t} / N \right) \]  

In the presence of convergence, all economies will move in the same direction. Further, for \( t = [\gamma T], [\gamma T] + 1, \ldots, T \), Phillips and Sul[16](2007) utilized the relative transfer coefficient variance of each economy to construct the section ratio and perform the regression once again, as it follows,

\[
\log \left( \frac{v_i^2}{v_i^2} \right) - \log \left( \log (t) \right) = a + b \log t + \mu_i
\]  

Where \( v_i^2 = \sum (h_{i,i} - 1)^2 / N \). According to the time span of corresponding data, we take \( \gamma = 0.3 \). If the statistic \( t \) of this regression analysis is significant, we confirm that there is no convergence between these economies.

**Random Convergence Hypothesis**

Assuming that the logarithmic value of GDP per capita of each district converges to equilibrium level according to unit root testing method, the relative GDP (\( RGDP_i \)) can be written as,

\[
RGDP_i = RGDP^* + u_i
\]  

Where, \( RGDP_i \) refers to unchanging equilibrium differences, and \( u_i \) refers to the derivation of relative GDP from equilibrium level. Further, \( u_i \) can be decomposed into a deterministic linear trend and a stochastic process under the dynamic one of convergence hypothesis in the research of Baumol[17](1986) with \( RGDP^* \) not equal to zero,

\[
u_i = v_0 + \beta t + v_t \]

Where, \( v_0 \) refers to the initial derivation of relative GDP per capita from equilibrium level, and \( \beta \) refers to the deterministic convergence speed. The GDP per capita of this district will take on stochastic convergence properties, for the reason that \( RGDP_i \) will still return to the equilibrium level. Otherwise, it will show no stochastic convergence.

**Empirical Test on Coastal and Border Provinces of China**

**The overall economic growth of coastal and border provinces**

With given significant level \( \alpha = 0.10 \), we got the critical value \( t_{0.05} \) with the degree of freedom is 17. We conclude that the coastal and border provinces show no convergence in the economic growth on the result of statistical significant regression, consistent with most scholars’ research results. Further, the statistic \( t_\beta \) in coastal provinces isn’t significant, with the regression results of border provinces \( \hat{\beta} < 0 \), that border provinces have absolute \( \beta \)-convergence without obvious convergence characteristics.
Table 1. The result of absolute $\beta$ convergence.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Area</td>
<td>$\hat{\beta}$</td>
<td>-0.022</td>
<td>-0.058</td>
<td>-0.061</td>
<td>-0.058</td>
<td>-0.052</td>
</tr>
<tr>
<td></td>
<td>$t_{\hat{\beta}}$</td>
<td>-1.780</td>
<td>-2.823</td>
<td>-2.979</td>
<td>-2.942</td>
<td>-3.093</td>
</tr>
<tr>
<td>Border Area</td>
<td>$\hat{\beta}$</td>
<td>0.009</td>
<td>0.016</td>
<td>0.011</td>
<td>-0.001</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>$t_{\hat{\beta}}$</td>
<td>0.189</td>
<td>0.642</td>
<td>0.524</td>
<td>-0.063</td>
<td>-0.922</td>
</tr>
<tr>
<td>All Area</td>
<td>$\hat{\beta}$</td>
<td>-0.042</td>
<td>-0.021</td>
<td>-0.031</td>
<td>-0.033</td>
<td>-0.032</td>
</tr>
<tr>
<td></td>
<td>$t_{\hat{\beta}}$</td>
<td>-1.780</td>
<td>-1.815</td>
<td>-2.813</td>
<td>-3.450</td>
<td>-3.936</td>
</tr>
</tbody>
</table>

The whole society investment in fixed assets has the greatest impact on the convergence of economic growth of coastal and border provinces

The model of absolute convergence illustrates that the economic growth rate varies with the initial GDP per capita in different regions. Therefore, other adjustment factors are introduced to study the conditional $\beta$ convergence of economic growth in coastal and border provinces to judge the influence.

In view of the strong correlation between the economic indicators, it is possible to magnify influence of some indicators when performing regression analysis.

Therefore, a stepwise regression method is utilized to introduce the economic variables into the model individually. The regression coefficient reaches at most significant when the overall social fixed asset investment is introduced into with the goodness of fit being highest, that is $R^2 = 0.171187$. The goodness of fit increases to a statistically significant degree after introducing into the total retail sales of consumer goods, that is $R^2 = 0.275326$, so it plays an important role in stabilizing economic growth that ensures the two variables being moderate. Therefore, the convergence is mainly influenced by total retail sales of social consumer goods, the resident population and passenger volume, and the coefficients of the regression parameters are no longer significant when introducing other variables, even though the goodness of fit has been improved in this model.

Thus, there are four factors influencing the economic growth of China's coastal and border provinces, that are the total fixed asset investment, total retail sales of social consumer goods, the resident population and passenger volume, simultaneously being the main factors and necessary conditions to promote border areas to catch up with the coastal areas which have been developed at an early stage.
There exists a consistent convergence of economic in coastal and border provinces.

Figure 1. Fluctuations of GDP per capita in coastal and border provinces.

Economic level of coastal areas is obviously higher than that in border areas. Therefore, it is necessary to compute the corresponding mean value of the GDP per capita as showed in the table above.

There are four salient properties of the standard deviation time series of the GDP per capita in coastal and border areas and the whole areas. First, the standard deviation of GDP per capita in the two regions decreases in a slight amplitude, showing the general convergence but partial divergence in the economic growth. Second, the GDP per capita in coastal and border provinces have been increasing in recent years, with the standard deviation of overall GDP per capita decreasing slightly in 2014, which shows the in-band convergence but inter-band divergence of the GDP per capita. Third, there is a consistent β-convergence of economic growth in coastal and border provinces from 2008 to 2014.

The GDP per capita in selected coastal and border cities is probably “transversal” convergence without converging to a common equilibrium steady-state path.

To ensure the independence of the sample data, that is, there is no relation between economy samples, firstly, H-P filter is utilized to eliminate the periodic fluctuation components of the sample data, that is, adjust the loss function as small as possible.

\[
M = \sum_{i=1}^{T} (x_i^p)^2 + \hat{\lambda} \sum_{j=2}^{T} \left[ \left( x_{i,j}^p - x_i^c \right) - \left( x_{i,j}^p - x_{i,j-1}^p \right) \right]^2
\]  

(9)

Where, \(x_i^p, x_i^c\) refers relatively to the long-term developments trends and periodic fluctuation characteristics of economies in the development progress.

Similarly, to exclude the influence of geographical location, considering that a spatial dissimilarity variable can be decomposed into a filtered non-spatial dependent variable and a residual spatial dependent variable, we deal with the spatial dependencies with the help of Spatial Filtering Technology by Getis and Ord [18] (1992), then we obtain the filtered GDP per capita with spatial dependence.

\[
y_i^* = y_i \left[ \sum_{j=1}^{n} w_{ij} (d)/(n-1) \right] / G_i (d)
\]  

(10)
Where \( G_i(d) = \sum_{j=1}^{n} w_{ij}(d) y_i / \sum_{j=1}^{n} y_j, j \neq i \) is the constructed statistic; \( w_{ij} \) is a denoting functions, indicating whether the distance between the two economies is less than or equal to the preset spatial distance.

According to the model and expression in Section 4.2, we found that the transfer coefficient of GDP per capita in Shanghai and Tianjin is higher among the selected coastal areas, which also shows the rapid economic development of the two places. Although Hainan Province has played the leading role in the tourism industry in recent years, the economic growth rate remains far from that of the Yangtze River Delta, the Pearl River Delta and the coastal provinces of Beijing, Tianjin and Hebei. Among the provinces along the border, the relative transfer coefficient of Inner Mongolia Autonomous Region is significantly higher than the rest of the region, which may be related to the development of agriculture and animal husbandry in recent years, while the rest of the province's economic growth is relatively close and the relative transfer coefficient is more concentrated.

Further, the convergence equation comes as: The test statistic \( t_p = -9.426309 \) is far less than the critical value under the significant level of 5%, thus, we reject the original hypothesis that the sample data has global convergence, that is the 19 coastal and border provinces is probably a “transversal” convergence without converging to a common equilibrium steady-state path.

**There is no Stochastic Convergence in the Economic Growth of Coastal and Border Provinces**

Based on the testing result of each significant levels, the value of testing statistic \( t \) is larger than Mackinnon critical value of corresponding unit root testing, which indicates that there exists unit root in the series of GDP per capita, for the reason that the sequence is unstable. Therefore, there is no stochastic convergence in the economic growth of coastal and border cities and all cities.

**Conclusion**

This paper makes an empirical analysis on the convergence of economic growth in coastal and border cities of China. The strategic measures have played a role in narrowing regional economic growth imbalances in recent years. There is an absolute \( \beta \)-convergence and \( \alpha \)-convergence in the economic growth of overall coastal and border provinces with no phenomenon of stochastic convergence.

Therefore, it is necessary to strengthen the management of economic growth, make full use of the leading role of the coastal provinces and continue to carry out the strategy of “On Belt One Road”. Control over the internal differences between the coastal and border provinces is greatly required to promote the regional development and economic integration among areas.

In addition, it is vital to control the difference of economic growth by adjusting the regulation of investment in fixed assets of the whole society. The input of labor force, the transportation capacity of public transport and the consumption level of residents are dispensable factors to stimulate the economy. Therefore, reasonable allocation of regional resources is required to solve the weak economic growth in backward areas due to the lack of input on the factors and the irrational configuration, thereby accelerating economic growth and...
narrowing the regional differences. In addition, underdeveloped areas should commerce from
the resource characteristics and their own advantages, according to local conditions, develop
resource processing industry and labor-intensive industries, optimize the industrial structure
and product development, and accelerate the development of the characteristics economy
advantageous industries with market prospective.

Acknowledgment
This research was finally supported by Student Research Training Program in Southwest
Jiaotong University of Sichuan Province (Grant No.2016101).

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