International Journal of u- and e- Service, Science and Technology
Vol.9, No. 6 (2016), pp.125-132
http://dx.doi.org/10.14257/ijunesst.2016.9.6.12

# Research on the Convergence of Regional Informatization Development of China

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***Abstract***

*In this paper, informatization level of 31 provinces, municipalities and autonomous regions of China from 2003 to 2013 is measured by establishing evaluation index system of informatization. Based on this, the convergence of provincial informatization level is studied by σ convergence, β convergence and club convergence test method. The analysis shows that the coefficient of variation has decreased year by year and σ convergence is significant. Nationwide, regression coefficient β is significantly negative. Therefore, β convergence exists. The convergence rate has a trend of acceleration. This indicates that the development speed of informatization of backward areas is faster than that of the advanced ones. It may be possible that all areas will reach a relatively consistent state in the future. The β convergence test by dividing the whole nation into eastern, central and western China indicates that β convergence is significant in all three areas. It means that club convergence exists. The convergence rate of central China is the fastest and those of eastern and western China are relatively low.*

***Keywords****: Informatization, σ convergence, β convergence, club convergence, China*

## 1. Introduction

Continuously improving the informatization level and vigorously building information society are the focus faced by China currently. It has aroused great concern of experts and scholars. They are doing researches on informatization development from many aspects. Wei [1] has evaluated the current situation of informatization development in China, analyzed opportunities and challenges faced by the information industry and put forward some corresponding strategies. Song [2] has analyzed the development process and spatio-temporal pattern of China's informatization and found that the informatization levels of four areas of China are different significantly. The level is decreasing gradually from east to west. But the development rate of central and western China is faster than eastern China. So the gap among areas is narrowed. Xu [3] and Jiang *et al.* [4] have studied the relationship between informatization and economic growth in China and found that informatization can really promote regional economic growth and there is a bidirectional granger causal relationship between the two. Mi [5], Guan *et al.* [6] and Li *et al.* [7] have studied the relationship between informatization and rural new industrialization, science and technology progress and energy efficiency, found that the former has a positive influence on the latter three and put forward a series of suggestions. Previous studies have found that there is a relatively large difference among areas and provinces in China and the difference is undergoing a series of changes over time. So, it is worth studying whether the informatization level of different provinces has a convergence trend and whether all provinces can reach a relatively consistent state in the future. This paper will test and analyze the convergence of regional informatization level from 2003 to 2013 by σ convergence, β convergence and club convergence test method and draw a

ISSN: 2005-4246 IJUNESST

corresponding conclusion.

## 2. Research Methods and Data Sources

The research object of this paper is the informatization level of 31 provinces, municipalities and autonomous regions of China from 2003 to 2013. And the data sources are *China Statistical Yearbook* and Support System for China Statistics Application.

### 2.1. Index System of Informatization Level

This paper refers to some references [2-8] and selects per capita telecom business, internet penetration rate and mobile phone penetration rate as three indices to construct the evaluation index system of informatization level, as shown in Table 1.

**Table 1. Evaluation Index System of Informatization Level**

| | Index | Weight |
|---|---|---|
| Informatization index | Per capita telecom business | 0.3939 |
| | Internet penetration rate | 0.3030 |
| | Mobile phone penetration rate | 0.3030 |

This paper adopts Analytic Hierarchy Process (AHP) by multi expert decision to determine the weights of each index in the evaluation index system, as shown in table 1. Each index data will be standardized by the maximum value method. Standardized data will be multiplied by the weight and the obtained value will be added to get the informatization index of every province from 2003 to 2013.

### 2.2. σ Convergence

σ convergence is about the deviation on the cross section. If the σ value is decreasing over time, σ convergence exists. It means that the difference of regional informatization level is narrowing.

If the σ value is increasing over time, σ convergence does not exist. It means the difference is widening [9,10]. The method used to test σ convergence includes standard deviation and coefficient of variation. Considering from the relative difference angle, this paper adopts the coefficient of variation to test σ convergence of regional informatization level. The formula is as follows

$$\sigma = \sqrt{\sum_i (Y_i - \overline{Y})^2 / N} \quad (1)$$

$$CV = \sigma / \overline{Y} \quad (2)$$

Where $Y_i$ is the informatization index of No. i region, $\overline{Y}$ is the average informatization index of all regions, N is the number of regions. σ is the standard deviation of informatization level and CV is the coefficient of variation.

If CV is decreasing over time, $CV_{t+1} < CV_t$, σ convergence exists. If CV is increasing or unchanged over time, σ convergence does not exist.

### 2.3. β Convergence

According to the definition of β convergence by Barro *et al.*, [9,11-13], in the process of regional informatization, if the development speed of backward areas is faster than advanced ones and the former could catch up with the latter after a period of time, we say that β convergence exists. Usually, we test the relationship between the growth rate and

 

the initial value and judge whether there is a significant negative correlation between the two. Then we will determine whether β convergence exists. The test model is shown in Equation 3.

$$(\ln Y_{it} - \ln Y_{i0})/t = \alpha + \beta \ln Y_{i0} + \varepsilon, \varepsilon \square N(0, \sigma^2) \quad (3)$$

Where $Y_{i0}$ and $Y_{it}$ are the No. i region's informatization indices of the first year and No. t year respectively, $(\ln Y_{it} - \ln Y_{i0})/t$ is the average growth rate of No. i region's informatization level in t years. α is a constant term, β is the convergence coefficient and ε is the random term. When β is less than 0 and significant, β convergence exists. It means the informatization's development speed of backward areas is faster than that of advanced ones. The value of β is greater, the convergence speed is faster. When β>0, β convergence does not exist.

According to the convergence coefficient, we can calculate convergence speed θ and half-life period τ. The formulae are

$$\theta = -\ln(1 + t\beta)/t \quad (4)$$

$$\tau = -\ln 2/\ln(1 + \beta) \quad (5)$$

### 2.4. Club Convergence

Club convergence refers to the convergence phenomenon occurred in the regions that have similar initial conditions and structural characteristics of development and mainly study whether there is a convergence phenomenon in the same club [11, 14]. According to the provincial informatization index, we can see that the informatization levels in eastern, central and western China are obviously different. Eastern China is high and central and western China are low. It shows an obvious agglomeration and differentiation phenomenon and club convergence probably exists in each of the three areas. Therefore, this paper will test the club convergence in the three areas. The division of the three areas is shown in Table 2.

**Table 2. Division of Eastern, Central and Western China**

| Area | Provinces, municipalities and autonomous regions |
|---|---|
| Eastern China | Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan |
| Central China | Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan |
| Western China | Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang |

## 3. Empirical Study

First, each index data of 31 provinces, municipalities and autonomous regions from 2003 to 2013 is standardized by the maximum value method. Second, standardized data is multiplied by its weight. Finally, the obtained value is added to get the informatization index.

### 3.1. σ Convergence

Informatization indices of each province are substituted into Equation 1 and Equation 2. Then the standard deviation and coefficient of variation of each year's informatization index are calculated. The CV values are presented in Table 3 and also used to draw Figure 1.

**Table 3. Coefficient of Variation of Informatization Level between 2003 and 2013**

| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CV | 0.6956 | 0.6371 | 0.5873 | 0.5363 | 0.4980 | 0.4420 | 0.3680 | 0.3327 | 0.3015 | 0.2855 | 0.2659 |

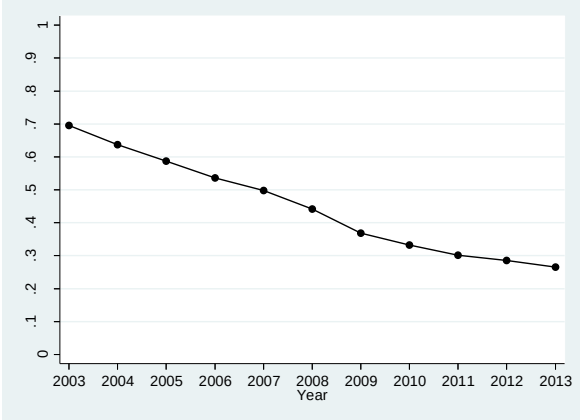


**Figure 1. Coefficient of Variation of Informatization Level between 2003 and 2013**

From Table 3 and Figure 1, we can see that the coefficient of variation of 31 provinces, municipalities and autonomous regions shows a downward trend in the period from 2003 to 2013. The value is down from 0.6956 in 2003 to 0.2659 in 2013, a decrease of 61.77%. σ convergence is significant. Regional differentiation of informatization shows a gradually narrowing trend and the digital gap is becoming smaller.

### 3.2. β Convergence

Provincial informatization indices are substituted into Equation 3 and the regression result is shown in Table 4.

**Table 4. β Convergence Test of the Whole Nation**

| | 2003-2013 | | | 2003-2007 | | | 2008-2013 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | t | P | Coefficient | t | P | Coefficient | t | P |
| α | 0.0164 | 2.01 | 0.054 | 0.0893 | 4.39 | 0.000 | -0.0168 | -2.22 | 0.034 |
| β | -0.0577 | -17.09 | 0.000 | -0.0564 | -6.69 | 0.000 | -0.0788 | -13.46 | 0.000 |
| Convergence rate (%) | 8.60 | | | 6.39 | | | 10.02 | | |
| Half-life period (year) | 11.66 | | | 11.94 | | | 8.44 | | |
| $R^2$ | 0.9097 | | | 0.6069 | | | 0.8620 | | |
| Adj $R^2$ | 0.9066 | | | 0.5933 | | | 0.8572 | | |
| F | 292.16 | (0.0000) | | 44.77 | (0.0000) | | 181.12 | (0.0000) | |

From Table 4, we can see that, in the 2003-2013 period, regression coefficient β is -0.0577 and passes the significant test of 1%. It confirms that β convergence of informatization development exists significantly in the whole nation. That is, growth rate and initial level of informatization have a significantly negative relationship. The development speed of backward areas is fast, much rapider than advanced areas. There is a trend that the backward will catch up with the advanced. We put β value into Equation 4 and Equation 5 to get the corresponding convergence rate and half-life period, which are

 

8.60% and 11.66 years. At the national level, the entire period is divided into 2003-2007 and 2008-2013 two periods and we conduct regressions in them. The test results show that regression coefficient β of two periods are -0.0564 and -0.0788 and they all pass the significant test of 1%. It means β convergence exists in each period. The convergence rates are 6.39% and 10.02% and the half-year periods are 11.94 and 8.44 years. Thus, the convergence rate of first 5 years is slower than that of the entire period, and the rate of last 6 years is quicker than the entire period and much faster than the first 5 years. It indicates that the regional differentiation of informatization is shrinking quickly. The development speed of backward areas is accelerating greatly and the backward areas will catch up with the advanced ones in a shorter time.

### 3.3. Club Convergence

β convergence is tested in eastern, central and western China and the obtained results are shown in Table 5-7.

**Table 5. β Convergence Test of Eastern China**

| | 2003-2013 | | | 2003-2007 | | | 2008-2013 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | t | P | Coefficient | t | P | Coefficient | t | P |
| α | 0.0109 | 1.04 | 0.324 | 0.0710 | 3.04 | 0.014 | -0.0166 | -1.20 | 0.259 |
| β | -0.0621 | -11.56 | 0.000 | -0.0697 | -5.78 | 0.000 | -0.0790 | -5.25 | 0.001 |
| Convergence rate (%) | 9.70 | | | 8.17 | | | 10.05 | | |
| Half-life period (year) | 10.81 | | | 9.59 | | | 8.42 | | |
| $R^2$ | 0.9369 | | | 0.7879 | | | 0.7541 | | |
| Adj $R^2$ | 0.9299 | | | 0.7643 | | | 0.7268 | | |
| F | 133.67 | (0.0000) | | 33.43 | (0.0003) | | 27.61 | (0.0005) | |

**Table 6. β Convergence Test of Central China**

| | 2003-2013 | | | 2003-2007 | | | 2008-2013 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | t | P | Coefficient | t | P | Coefficient | t | P |
| α | -0.0242 | -0.79 | 0.458 | 0.0069 | 0.07 | 0.947 | -0.0511 | -1.95 | 0.099 |
| β | -0.0705 | -6.16 | 0.001 | -0.0871 | -2.34 | 0.058 | -0.0972 | -5.57 | 0.001 |
| Convergence rate (%) | 12.21 | | | 10.71 | | | 13.31 | | |
| Half-life period (year) | 9.48 | | | 7.61 | | | 6.78 | | |
| $R^2$ | 0.8634 | | | 0.4765 | | | 0.8380 | | |
| Adj $R^2$ | 0.8407 | | | 0.3892 | | | 0.8110 | | |
| F | 37.94 | (0.0008) | | 5.46 | (0.0581) | | 31.04 | (0.0014) | |

**Table 7. β Convergence Test of Western China**

| | 2003-2013 | | | 2003-2007 | | | 2008-2013 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficient | t | P | Coefficient | t | P | Coefficient | t | P |
| α | 0.0078 | 0.27 | 0.796 | 0.0843 | 1.07 | 0.309 | -0.0143 | -0.77 | 0.459 |
| β | -0.0618 | -5.53 | 0.000 | -0.0562 | -1.88 | 0.089 | -0.0799 | -6.16 | 0.000 |
| Convergence rate (%) | 9.62 | | | 6.37 | | | 10.20 | | |
| Half-life period (year) | 10.87 | | | 11.98 | | | 8.32 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $R^2$ | 0.7536 | | | 0.2616 | | | 0.7914 | | |
| Adj $R^2$ | 0.7290 | | | 0.1878 | | | 0.7706 | | |
| F | 30.59 | (0.0003) | | 3.54 | (0.0892) | | 37.94 | (0.0001) | |

As shown in Table 5-7, in the period of 2003-2013, the regression coefficient β of three areas are -0.0621, -0.0705 and -0.0618. They all pass the significant test of 1%. It indicates that β convergence exists in all three areas and club convergence truly exists. Corresponding convergence rates are 9.70%, 12.21% and 9.62% and half-life periods are 10.81, 9.48 and 10.87 years. The convergence rates of the three are faster than the whole nation and half-life periods of them are shorter than the whole nation. It means the informatization levels in the three areas can get to stable state much faster and three areas have formed their own convergence clubs. In the three areas, the convergence rate of central China is the fastest and is 2.51 and 2.59 percentage points higher than eastern and western China. It will be the first to achieve relatively consistent informatization development level. Eastern China is slower and western China is the slowest. But the latter two's difference is little. East is only 0.08 percentage point higher than west.

From the two periods of 2003-2007 and 2008-2013, we can see that all β values of the three areas are negative and pass the significant test of a maximum of 10%. It means that three areas in the two periods all have significant β convergence. The convergence rates of eastern China are 8.17% and 10.05%, those of central China are 10.71% and 13.31% and those of western China are 6.37% and 10.20%. The rates of the last 6 years of the three areas all are higher than those of the first 5 years and the formers are 1.88%, 2.6% and 3.83% above the latter ones. That is, the convergence rates of the last 6 years are accelerated. And the increase of western China is the largest, that of central China is the second and that of western China is the smallest. Among the three areas, the convergence rates of central China is the highest not only in the first 5 years but also in the last 6 years and is much higher than those of eastern and western China. In the first 5 years, eastern China is the second and western China is the slowest. But the situation of the two areas of the last 6 years is contrary to the first 5 years. It reflects that the convergence rate of western China is speeding up and has exceeded that of eastern China.

## 4. Conclusion

This paper establishes the evaluation index system of informatization level and adopts σ convergence, β convergence and club convergence test method to study the convergence of regional informatization level. It finds that, in the period of 2003-2013, the coefficient of variation of the whole nation shows a downward trend year by year. This means σ convergence exists. Using β convergence test model finds that the regression coefficient β is significantly negative in 2003-2013. β convergence exists. The convergence rate is 8.60% and the half-life period is 11.66 years. Nationwide, β convergence exists significantly in the 2003-2007 and 2008-2013 two periods. And the convergence rate of the last 6 years is higher than that of the first 5 years. It shows an accelerating trend. β convergence tests in the eastern, central and western China find that β convergence in all three areas is significant. It means club convergence phenomenon is obvious. The situation of the three areas in the two periods is similar to the whole nation. The three all show an accelerating convergence speed. In the three areas, convergence rate of central China is the quickest in each period. The rate of eastern China is the second in the first 5 years and the third in the last 6 years. But the situation of western China is contrary to it.

Therefore, although the pattern of informatization level of China does not change greatly in recent years, informatization development shows an obvious trend of convergence. Backward areas are trying their best to catch up with the advanced ones.

 

The formers' development speed had surpassed the latter ones'. All of them will be possible to reach a relatively consistent state in the future. The provinces in each of the three areas will reach the consistent state much faster. It requires the government to put more resources to the development of informatization of central and western China. We should accelerate the construction speed of information infrastructure and support the development of information industry vigorously in order to promote the informatization level of the central and western China and improve the level of the whole country finally.

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