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Descriptive Study of 2009-2013 China Area per Capita GDP

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Abstract: This paper studied area level per capita GDP data from 2009 to 2013 in China. The bar chart, bubble chart and map chart are used to display a growth trend on area per capita GDP. It is pointed out that areas with higher Per Capita GDP have relative lower growth rate on Per Capita GDP. Moran's I coefficients and Geary's C coefficients are used to measure the Spatial autocorrelation in the Per capita GDP data. The results of Moran's I coefficient and Geary's c coefficients test showed that global spatial autocorrelation are accepted, while local spatial autocorrelation are rejected.

Keywords: China GDP, Area per Capita GDP, Spatial Analysis

1. Introduction

Gross domestic product (GDP) is defined by the Organization for Economic Co-operation and Development (OECD) as "an aggregate measure of production equal to the sum of the gross values added of all resident, institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)." The more familiar use of GDP estimates is to calculate the growth of the economy from year to year (and recently from quarter to quarter). The pattern of GDP growth is held to indicate the success or failure of economic policy and to determine whether an economy is 'in recession'.

Recently years, China's total GDP has ranked in the second in the world, and some economists predict that China's GDP will catch up United States' in 15 years. China economic has attracted many researchers in the world. However, China Per Capita GDP are still relative lower than that of western countries. This paper does a description study on China Per Capita GDP. The data used in this paper are obtained from China Statistical Yearbook, published by National Bureau of Statistics of China.

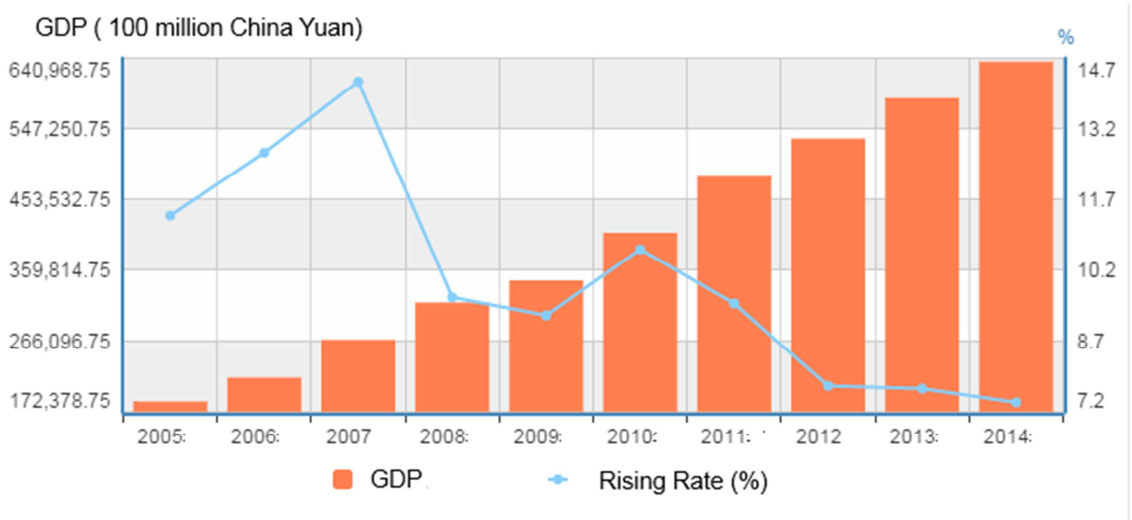

Figure 1. *The China GDP and its increasing rate from 2005 to 2014.*

There are 28 provinces and 4 municipalities directly under the Central Government of China mainland. Beijing, Shanghai, Tianjin, Chongqing are the four municipalities, and Beijing and Shanghai are two very important cities in China and the World.Beijing is located in the north of China, which is the center of North China and capital of China. Shanghai is in the east of China, and the areas around Shanghai is the richest part in China.

As shown in Figure 1, from 2005 to 2014, China GDP is always in rising status, although it increasing rate is decreasing. However, in 2014, its increasing rate is still about 7.2%, which is relative high figure comparing 2.4% of United Status and negative increasing rate in some Europe countries. In 2005, China GDP is only about 17237.8 Billion (China Yuan), but in 2014, it is almost 4 times more. With this high speed development, in 2007 and 2010, China catch up with Germany and Japan respectively. At the same time China's population keeps relative stable, so the rising rate of Per Capita GDP is similar to that of total GDP.

2. The Area per Capita GDP

The area level per capita data are listed in the table 1, and it contains 5 years data from 2009 to 2013. Similar to China GDP overall increasing trend, Per Capita GDP in all areas is increasing. As shown in Figure 2, there are 8, 4, and 1 areas in the first chart (marked as 12000) in year 2009, 2010, 2011 respectively, but in year 2012 and 2013 no area is in that chart. At the same time, the charts with larger marked values all have experienced increasing process but with different extent. Just as reported by articles in Medias, Chinese citizens are becoming richer and richer. With this phenomena, Chinese people spend more and more money for shopping in the world.

Table 1. *The Per Capita GDP (China Yuan) for 31 areas in China mainland from 2009 to 2013.*

No.	Areas	Per Capita GDP (China Yuan)				
		2009	2010	2011	2012	2013
1	Beijing	66940	73856	81658	87475	93213
2	Tianjin	62574	72994	85213	93173	99607
3	Hebei	24581	28668	33969	36584	38716
4	Shanxi	21522	26283	31357	33628	34813
5	Neimenggu	39735	47347	57974	63886	67498
6	Liaoning	35149	42355	50760	56649	61686
7	Jilin	26595	31599	38460	43415	47191
8	Heilongjiang	22447	27076	32819	35711	37509
9	Shanghai	69164	76074	82560	85373	90092
10	Jiangsu	44253	52840	62290	68347	74607
11	Zhejiang	43842	51711	59249	63374	68462
12	Anhui	16408	20888	25659	28792	31684
13	Fujian	33437	40025	47377	52763	57856
14	Jiangxi	17335	21253	26150	28800	31771
15	Shandong	35894	41106	47335	51768	56323
16	Henan	20597	24446	28661	31499	34174
17	Hubei	22677	27906	34197	38572	42613
18	Hunan	20428	24719	29880	33480	36763
19	Guangdong	39436	44736	50807	54095	58540
20	Guangxi	16045	20219	25326	27952	30588
21	Hainan	19254	23831	28898	32377	35317
22	Chongqing	22920	27596	34500	38914	42795
23	Sichuan	17339	21182	26133	29608	32454
24	Guizhou	10971	13119	16413	19710	22922
25	Yunnan	13539	15752	19265	22195	25083
26	Xizang	15295	17319	20077	22936	26068
27	Shanxi	21947	27133	33464	38564	42692
28	Gansu	13269	16113	19595	21978	24296
29	Qinghai	19454	24115	29522	33181	36510
30	Ningxia	21777	26860	33043	36394	39420
31	Xinjiang	19942	25034	30087	33796	37181

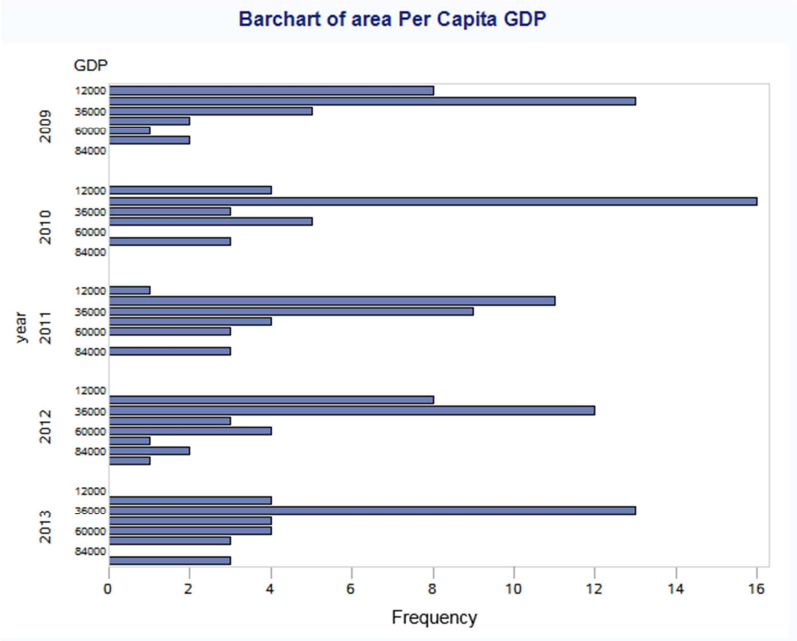

Figure 2. *The bar chart of area Per Capita GDP. The horizontal axis is the frequency and the longitudinal axis are the GDP values (Unit: China Yuan). The bar charts are divided into 5 groups by the years.*

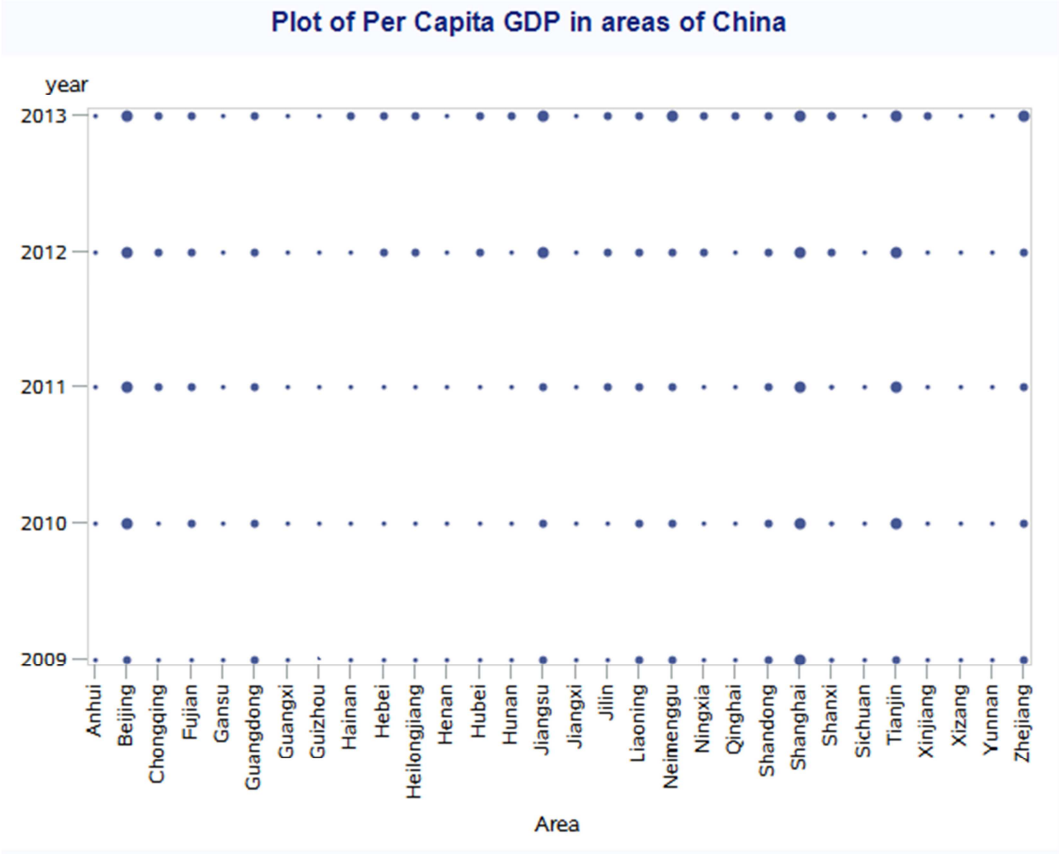

Figure 3. *The Bubble Chart of area Per Capita GDP. The horizontal axis is all the area list, and the longitudinal axis are the years from 2009 to 2013. The size of bubble is proportional to the value scale of Per Capita GDP (Unit: China Yuan) at the corresponding area and year.*

Figure 4. *The map of average growth rate on Per Capita GDP. In this map, all areas are marked by bubbles. The size of bubble is proportional to the value scale of average growth rate of Per Capita GDP at the corresponding area.*

The Bubble Chart of area Per Capita GDP is shown in Figure 3.The size of bubble is proportional to the value scale of Per Capita GDP (Unit: China Yuan) at the corresponding area and year. It can be seen from the plot that the rank of Per Capita GDP of each area keeps stable, although different areas have different growth rate. For the areas like Beijing and Shanghai, the bubbles from 2009 to 2013 have little changes in the size, which means its growth rate is at a small scale. However, for the areas like Jiangsu and Heilongjiang, bubbles have a significant changes in size, and it is because these areas have a high growth rate.

The average Per Capita GDP map is shown in Figure 5. The average Per Capita GDPare calculated by the mean value of Per Capita GDP value from 2009 to 2012. In this figure, all areas are marked by bubbles. The size of bubble is proportional to the value scale of average value of Per Capita GDP at the corresponding area. It can be seen that the areas in the east China along the coast line and Beijing have relative large bubbles. This phenomena is opposite to that is shown in Figure 4 as these areas have relative small bubbles. However, it is very reasonable that the higher Per Capita GDP the more difficult to increase it.

3. The Spatial Autocorrelation of Area per Capita GDP

In this section, the spatial autocorrelation among the Per Capita GDP data is investigated. The average Per Capita GDP for all areas is the target objective variable. It can be seen from the Figure 5 that large bubbles are distributed along the coastline in the east of China. The Moran's I coefficient and Geary's Ccoefficient are used to measure the spatial autocorrelation.

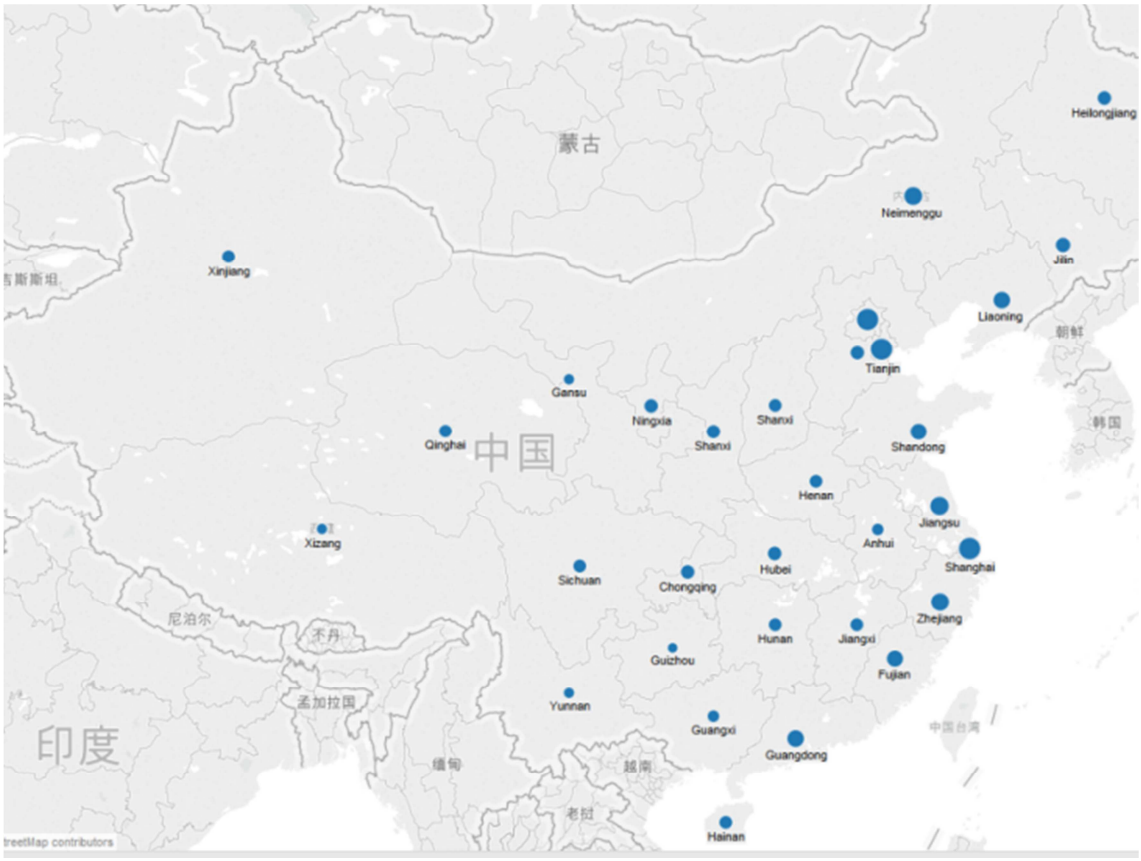

Figure 5. *The map of average value of Per Capita GDP. In this map, all areas are marked by bubbles. The size of bubble is proportional to the value scale of average value of Per Capita GDP at the corresponding area.*

The Moran's I coefficient are defined as

$$I=\frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}}\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-\frac{\sum x_i}{n})(x-\frac{\sum_{j=1}^{n}x_j}{n})}{\sum_{i=1}^{n}(x_i-\frac{\sum_{i=1}^{n}x_i}{n})^2},$$

and the Geary's c coefficient are calculated as

$$C=\frac{(n-1)\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-x_j)^2}{2\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}\sum_{i=1}^{n}(x_i-\bar{x})^2}.$$

In statistics, Moran's I is a measure of spatial

autocorrelation developed by Patrick A.P. Moran. Like autocorrelation, spatial autocorrelation means that adjacent observations of the same phenomenon are correlated. Negative (positive) values indicate negative (positive) spatial autocorrelation. Moran's IValues range from − 1 (indicating perfect dispersion) to + 1 (perfect correlation). A zero values indicates a random spatial pattern. For statistical hypothesis testing, Moran's I values can be transformed to Z-scores in which values greater than 1.96 or smaller than − 1.96 indicate spatial autocorrelation that is significant at the 5% level. The Z-scores transformation can be easily written as

$$Z = \frac{I - E(I)}{\sqrt{VAR(I)}}.$$

Geary's C is also a measure of spatial autocorrelation or an attempt to determine if adjacent observations of the same phenomenon are correlated. Geary's C is inversely related to Moran's I, but it is not identical. Moran's I is a measure of global spatial autocorrelation, while Geary's C is more sensitive to local spatial autocorrelation.Geary's C is also known as Geary's contiguity ratio or simply Geary's ratio.The value of Geary's C lies between 0 and 2. 1 means no spatial autocorrelation. Values lower than 1 demonstrate increasing positive spatial autocorrelation, whilst values higher than 1 illustrate increasing negative spatial autocorrelation.

The Moran's I coefficient and Geary's c coefficient are calculated and shown in table 2. It can be seen that average area Per Capita GDP in China are displayed positive autocorrelation both from Moran's I coefficient and Geary's c coefficient, which means the per capita GDP data in the nearby areas are tended to be similar. However, at the same time it is also noticed that only weak positive autocorrelation are found in the data, as the Moran's I coefficient are close to 0, and Geary's c coefficient are close to 1.The p-value of the spatial autocorrelation test are 0.0078 and 0.1311 for Moran's I coefficient and Geary's c coefficients respectively, thus spatial autocorrelations of area Per Capita GDP value are accepted by Moran's I coefficient but rejected by Geary's c coefficients test. Recalling that Moran's I is a measure of global spatial autocorrelation, while Geary's C is more sensitive to local spatial autocorrelation, it can be seen from Figure 5 that spatial autocorrelation can be found overall but cannot be found in many local areas, for example, the parts away from coastline.

Table 2. *The Moran's I coefficient and Geary's c coefficient computed onarea Per Capita GDP data in China.*

Spatial autocorrelation coefficients			
Assumption	**Coefficient**	**Observed**	**Pr > |Z|**
Randomization	Moran's I	0.196	0.0078
Randomization	Geary's C	0.773	0.1311

4. Conclusion

This paper firstly make a descriptive study on area level per capita GDP data in China. A growth trend on per capita GDP can be found in all areas in China. However, the disequilibrium is also noticed in different areas. It is also pointed out that areas with higher Per Capita GDP have relative lower growth rate on Per Capita GDP. Then, Moran's I coefficients and Geary's C coefficients are used to measure the Spatial autocorrelation in the Per capita GDP data. Weak positive autocorrelation are found both from Moran's I and Geary's c coefficients. Moreover, from the results of Moran's I coefficient and Geary's c coefficients test, global spatial autocorrelation are accepted, while local spatial autocorrelation are rejected.

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