

ANALYSIS ON THE SPATIAL VARIATION OF THE CENTER OF GRAVITY OF INBOUND TOURISM IN CHINA

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Abstract: This paper examines CoG movement of the chief indicators of inbound tourism in China from 2000-2010. Three themes guide the analysis. First, the changing CoG of China inbound tourism is calculated and mapped. Second, the changing inbound tourism size distribution of the 31 provinces is examined. Third, the provinces are ranked according to their growth rate, and analyse the changing spatial concentration of inbound tourism. Some generalizations regarding spatial variation are given and future trends for the balanced development of inbound tourism are briefly discussed.

1 INTRODUCTION

Since the reform and opening up, inbound tourism in China has been experiencing a rapid development, and foreign exchange reserve due to international tourism has been growing at a high speed. The number of inbound tourists to China of 2010 exceeds 264 millions, and the industry income brought by inbound tourism reached 51.96 billions for the same year, being 144 and 224 times respectively the numbers of 1978, 7.62 and 21.4 times those of 1990, 1.17 and 1.1 times those of 2000. From the beginning of the 21st century, impacted by SARS, international financial crisis, China's exchange reform and various natural disasters, the growth rate of inbound tourism in China shrunk, and a negative growth even appeared. Under the accumulated influences of policies like File 41 and its implementations, assignment instructions released by the State Council in 2009, inbound tourism gained a strengthened position in the regional economy development. Witnessing the building of high-speed mass transit system, the establishment of International travelling island of Hainan and Touristic reform experiment area of Guilin, the constructing of local style tourist destination by the autonomous region of Ningxia, international interests sites by the region of Xizang and the like by the region of Xinjiang, inevitable questions arise: What is the current situation of the

spatial distribution of inbound tourism in China? How to enhance development the regional tourism for a more balanced spatial distribution of the inbound tourism in China? It is based on these questions that this paper attempts to illustrate the spatial diversity and diachronic dynamic variation of the inbound tourism in China.

The center of gravity (CoG) is a concept developed by Carl Von Clausewitz, a Prussian military theorist, in his work *On War* (Carl Von Clausewitz, 2009). In its military sense, the CoG is usually seen as the "source of strength"; in its geometric sense, it is the point in or near a body upon which gravity can be thought of as acting. Recently, the CoG was applied to social and economic research, it was seen as the point of greatest importance, interest, or activity. Scholars employ the CoG model to do analysis on metropolis demographic gravity center movement and demographic spatial convergence (L. N. Tellier, 1995; G. F. Mulligan, 2005). Lucia Falzon (2006) brought Bayesian Network algorithm into the research of military planning gravity center (Y. H. Bao, 1998). Research involving CoG in China came about comparatively late, with the subjects varying from demography gravity center at the primary stage to spatial gravity center concerning society, economy and natural resources. Some researchers analysed the arable land gravity center coal resource (Y. H. Bao, 1998; J. H. Wang, 2006). Some

researchers focused on the analysis of the demographic and economic gravity center and did some comparative study on the results (Fan C, 2003; Y. J. Yu, 2005; Z.X.Feng, 2005; Z.X.Feng, 2006). In recent years, there has been a shift of attention to industrial gravity center among domestic scholars (G. Z. Cao, 2007; J. J. Zhang, 2009; S. M. Wu, 2010; Wen M, 2004).

The subjects of the current research concentrate at the macro-economic level, and are limited to the primary and secondary sector of economy. The researches revolving economic development and industry spatial distribution is not seen with obvious progress, and those on tourism economic gravity center are very rare. This paper sees each province (autonomous area, municipality) as the basic physical unit, calculate and work out CoG movement of the chief indicators of inbound tourism in China, in the aim to look inside the spatial variation and characteristics of the inbound tourism from an overall perspective, with the help of which the geographical developing planning and related policies formulation of the industry of tourism can be better done.

2 METHODOLOGY

2.1 Data

In the measurement of the gravity centers for inbound tourism, the coordinates of the capital city in each province are taken as the economic gravity center (the capital cities remain geographically static during the time of research). The fact is more than a few provinces govern at least two chief touristic cities, such as Guilin and Nanning in Guangxin Province, Qingdao and Jinan in Shandong Province, Suzhou and Nanjing in Jiangsu Province, etc., but it's quite difficult to acquire data of sub-provincial areas, and the inbound touristic gravity center tend to be physically close to the capital city in most cases. Therefore, it's feasible and necessary to set the coordinates of the capital city as the economic CoG and to do explorative research on the topic. As to the indicator selecting, consulting the statistics from 2000 to 2009 from "China Tourism Statistics Yearbook", this paper chooses inbound tourism foreign exchange income as the total amount indicator. Based on the indicator chosen, inbound tourism economic center is worked out. Please note that the calculation is within the Chinese mainland,

Hong Kong, Chinese Taipei and Macaw are not included.

2.2 Method

The gravity center model being the basis, this paper analyses the regular patterns of the spatial variation of the inbound tourism and industrial distribution in China over the past decade. More specific description would be: establish a resource data base, the inbound tourism economic indicators of each province for the years from 2000 to 2010 included, then the gravity center model is used to calculate the gravity center coordinates of inbound tourism for each year; draw out a scatter diagram and a gravity center moving line; conclude the reasons for the inbound tourism gravity centers referring to their longitudes and latitudes.

2.2.1 CoG Model

Assume that a region consists of n sub-regions (particle), the longitude and latitude of central city in the number i sub-region are set as X_i , Y_i , and T_i represents the quantity of certain feature of the number i sub-region. Certain feature and coordinates of provinces (autonomous regions, municipalities) are used to help calculate the CoG of certain feature. Formula for calculating the CoG coordinates is

$$X = \frac{\sum X_i * T_i}{\sum T_i} \quad (1)$$

$$Y = \frac{\sum Y_i * T_i}{\sum T_i} \quad (2)$$

From the algorithm point of view, there are two determinants of CoG: geographical location and feature variation in each area. Now that the geographical location of each area is assumed to be same, the CoG variation can reflect the change of corresponding feature. Due to an uneven developing level and speed of inbound tourism and related touristic industries throughout different regions in China and a huge annual gap, the inbound tourism economic and industrial gravity centers stay in a continuously changing state.

2.2.2 Moving Direction of CoG

The CoG moving direction points out the physical structure variation direction. The CoG of the years i and $i+1$ are represented as $A (X_i, Y_i)$, $B (X_{i+1}, Y_{i+1})$. The year i is the starting year, and θ stands for the shifting angle away from the starting year when it comes to year $i+1$. The east is

considered 0° in this paper. The following formula is used to calculate the angle between two sequential years:

$$\theta = \arctg \left| \frac{Y_{i+1} - Y_i}{X_{i+1} - X_i} \right| \quad (3)$$

θ stands for the shifting angel of the gravity center ($0^\circ < \theta < 180^\circ$), with the east being 0° , counter-clockwise movement means a positive variation, and clockwise negative. When $\theta = 0^\circ$ or $\theta = \pm 180^\circ$, the gravity center moves horizontally, to the east or the west; when $\theta = \pm 90^\circ$, it moves vertically, to the north or the south; when $0^\circ < \theta < 90^\circ$, the gravity center moves to the north-east direction; when $90^\circ < \theta < 180^\circ$, it moves to the north-west; when $-90^\circ < \theta < 0^\circ$, the gravity center moves to the south-east direction; and to the south-west when $0^\circ < \theta < 90^\circ$.

2.2.3 Geographical Shifting Distance of CoG

Formula (4) is used to calculate the gravity center geographical shifting distance of two sequential years:

$$D = C * \sqrt{(X_{i+1} - X_i)^2 + (Y_{i+1} - Y_i)^2} \quad (4)$$

$C=111.111$, the ratio between the physical coordinates (degree) and the graphic distance (kilometer), $X_{i+1} - X_i$, $Y_{i+1} - Y_i$ represent the variation of the gravity center coordinates from the year i to the year $i+1$, $C*(X_{i+1} - X_i)$, $C*(Y_{i+1} - Y_i)$ respectively stand for the actual shifting distances along the longitude and the latitude, thus $\frac{C*(Y_{i+1} - Y_i)}{C*(X_{i+1} - X_i)}$

stands for the ratio between the variation speed along the two directions.

When $\left| \frac{Y_{i+1} - Y_i}{X_{i+1} - X_i} \right| < 1$, the gravity center shifting angel is within the range of $(-45^\circ, 45^\circ)$, $(135^\circ, 180^\circ)$, $(-135^\circ, -180^\circ)$, indicating that the variation speed along the longitude is faster than along the latitude;

When $\left| \frac{Y_{i+1} - Y_i}{X_{i+1} - X_i} \right| > 1$, the gravity center shifting angel is within the range of $(45^\circ, 135^\circ)$, $(-45^\circ, -135^\circ)$, indicating that the variation speed along the latitude is faster than along the longitude;

When $\left| \frac{Y_{i+1} - Y_i}{X_{i+1} - X_i} \right| = 1$, the gravity center shifting

angel straddles the diagonal of 45° and 135° , indicating that the variation speeds at both directions are the same;

If the shifting direction coincides with the axis, the gravity center moves along the longitude or the latitude.

3 GEOGRAPHICAL DISPARITY AND VARIATION ROUTE OF THE INBOUND TOURISM IN CHINA

3.1 Characteristics of Variation of the In-bound Tourism Spatial Distribution

3.1.1 Moving Direction

From the perspective of the moving direction, starting from 2000, 60% of the movements of the inbound tourism economic gravity center are clockwise (negative, as assumed above), the other 40% being counter-clockwise, and no apparent regular pattern can be found. There is an obvious eastward tendency in the shifting of inbound tourism economic gravity center (fig.1, tab.1), as is shown in Fig1 and Tab1 that the gravity center moves within the north latitudes of 30.7° and 30.9° , with the years of 2003 and 2008 being exceptions. The distinct situation of these two years might reflect the fact that inbound tourism is substantially influenced by the exterior environment.

To look at the issue in details, during the period between 2000 and 2003, the inbound tourism gravity center shifts clockwise, revealing a tendency of moving toward the southeast. The Western Development Campaign started from October 2000 didn't alleviate the economic disparity between the eastern and the western tourism, and the tourism industry got seriously influenced by the SARS breakout. The Yangtze River Delta region was an area that enjoyed a high speed development in inbound tourism during that period of time (tab2). The economic gravity center varies within 115.87° - 115.92° of the east longitude, 30.86° - 30.92° of the north latitude during 2004-2007, and annual distinctions of this period are slight. The movements

between 2007 and 2010 remains eastward, with the direction of the one of 2008 being apparently north by east, resulting from the influences of the Sichuan earthquake and Beijing Olympics. In 2009, « Instructions on the implementation of Hainan International Travel Island Building and Development » was released by the State Council and the development project of the island has been upgraded to a state strategy, a sign of a larger gap between the east and the west, a smaller one between the north and the south though.

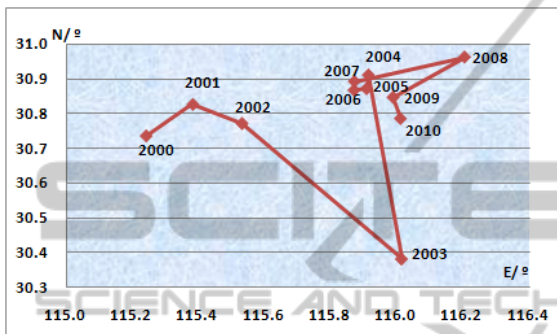


Figure 1: China inbound tourism gravity center movement from 2000-2010.

3.1.2 Shifting Distance

From the perspective of the shifting distance, the shortest distance of gravity center shifting corresponds to the year of 2007, moving by 2.79km, 85.43° to the north by east, and the longest corresponds to the 2003, moving by 68.98km, 38.92° to the south by east. Shifting distances in 4 respective years are longer than 20km, reaching 194km, 78% of the total shifting distance, indicating that the overall gravity center movement slows down, but the external environment influences are prominent to inbound tourism in China.

During the studied period of time, the angel of the gravity center shifting is within the range of (45°, 135°) or (-45°, -135°), stating that the situation of $|\frac{Y_{i+1}-Y_i}{X_{i+1}-X_i}| < 1$ happened in 6 respective years (60%), indicating a higher variation speed along the longitude than the latitude from an overall view, and a fiercer dynamic comparison between the east and the west than between the north and the south.

Table 1: Direction and distance of China inbound tourism gravity center movement from 2000-2010.

Year	E/°	N/°	Moving Direction		Distance /km
			Direction	Degree/°	
2000	115.24	30.735			
2001	115.382	30.826	North East	32.65	18.74
2002	115.531	30.771	South East	-20.26	17.65
2003	116.014	30.381	South East	-38.92	68.98
2004	115.914	30.911	North West	100.68	59.93
2005	115.908	30.871	South West	-98.53	4.49
2006	115.87	30.867	South West	-173.99	4.25
2007	115.872	30.892	North East	85.43	2.79
2008	116.205	30.963	North East	12.04	37.83
2009	115.989	30.847	South West	-151.76	27.24
2010	116.0109	30.78547	South East	-70.41	7.26

3.2 Inter-province Comparison of In-bound Tourism Spatial Distribution

3.2.1 Comparison of the Inbound Tourism Scale

The list of Top 10 provinces (autonomous region or municipality) in inbound tourism income experiences slight changes during 2000-2003, yet it stays comparatively stable from 2004, with only a small number of provinces switching the ranking positions. Starting from the year of 2004, the international tourism income of Tianjin has been ranked top 10 countrywide, yet Shanxi and Guangxi, former top 10 seat-takers, were pushed out of the top 10 circle in the same year. During the studied decade, the provinces among the top 10 in the international tourism income that bear an obvious growing proportion are Zhejiang, Jiangsu, Liaoning, Shandong and Tianjin (fig.2), this might be an apparent cause for the eastward tendency of the movement of the inbound tourism gravity center.

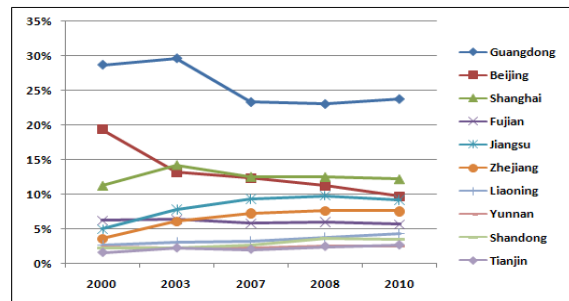


Figure 2: Proportion of Top 10 Provinces in international tourism income from 2000-2010.

The cumulative proportion of top 10 provinces in international tourism income declined during 2000-2010 (fig.3). The percentage is 85.34% in 2000, and climbed to 87.68% in 2003, it decreased to 81.98% in 2007, which is the lowest one during the past 11 years. The decline of the cumulative proportion of the Top 10 provinces in international tourism income reveals that the geographic concentration of inbound tourism is on the downside. There are some new and emerging destinations (as Xizang, Hainan, etc.) coming up because of transportation development, government supporting policies and other reasons. Accordingly, the rapid growth rate of this rising destinations in the west and central region of China are changing the CoG of inbound tourism to the southeast slightly in recent years (fig.1, fig.3, tab.2).

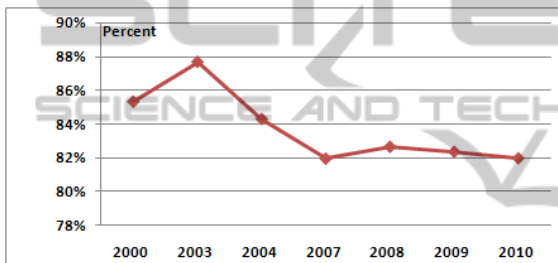


Figure 3: Cumulative proportion of top 10 provinces from 2000-2010.

3.2.2 Comparison of Inbound Tourism Growth Rate

The annual average growth rates are measured on a four-period-division basis, the 10 regions with the highest growth rates in each period are shown in Tab 2 along with the specific figures. The growth rates are high and uneven, and those during 2004-2007 are the highest. The rates of Sichuan and Hainan during the same four years are higher than 50%. From 2007 to 2010, due to the influences of the financial crisis, growth rates of all areas slow down, with the one of a western region, Ningxia, being the highest as over 30%. To compare seeing the country as a whole, from 2000 to 2010, Shanxi, Anhui, Zhejiang, Shandong and Jiangsu's annual average rates are higher than 20% and are the five highest in the country.

In the past decade, Gansu province is the only one holding a negative growth rate of -12.26%, and the annual average growth rate of Beijing is the second lowest as 6.19%, while Shanghai and

Guangdong, functioning as the “power sources” for the tourism industry of the Yangtze River Delta and the Pearl River Delta, retain annual average growth rates of 14.67% and 11.65%.

Table 2: Top 10 provinces in international tourism income growth rate.

No.	Province ^a	2000-2004 ^a Annual growth rate ^a	Province ^a	2004-2007 ^a Annual growth rate ^a	Province ^a	2007-2010 ^a Annual growth rate ^a	Province ^a	2000-2010 ^a Annual growth rate ^a
1 ^b	Zhejiang ^a	26.12% ^a	Xizang ^a	54.62% ^a	Ningxia ^a	31.91% ^a	Shanxi ^a	24.99% ^a
2 ^b	Jiangsu ^a	24.93% ^a	Hainan ^a	54.61% ^a	Shanxi ^a	27.97% ^a	Anhui ^a	23.45% ^a
3 ^b	Sichuan ^a	24.08% ^a	Shanxi ^a	39.75% ^a	Anhui ^a	27.26% ^a	Zhejiang ^a	22.56% ^a
4 ^b	Inner Mongolia ^a	18.97% ^a	Jiangxi ^a	34.84% ^a	Liaoning ^a	22.54% ^a	Shandong ^a	21.20% ^a
5 ^b	Shanghai ^a	17.19% ^a	Anhui ^a	34.72% ^a	Chongqing ^a	22.52% ^a	Jiangsu ^a	20.78% ^a
6 ^b	Shandong ^a	15.79% ^a	Shandong ^a	33.63% ^a	Tianjin ^a	22.16% ^a	Tianjin ^a	19.87% ^a
7 ^b	Tianjin ^a	15.51% ^a	Inner Mongolia ^a	29.09% ^a	Hubei ^a	22.10% ^a	Liaoning ^a	19.43% ^a
8 ^b	Jilin ^a	13.41% ^a	Hubei ^a	28.96% ^a	Jiangxi ^a	20.96% ^a	Jiangxi ^a	18.70% ^a
9 ^b	Anhui ^a	13.03% ^a	Heilongjiang ^a	28.61% ^a	Jilin ^a	19.36% ^a	Jilin ^a	18.04% ^a
10 ^b	Shanxi ^a	12.95% ^a	Zhejiang ^a	27.70% ^a	Shanxi ^a	18.40% ^a	Hubei ^a	17.82% ^a

3.2.3 Comparison between Regions

Bohai Sea area, Yangtze Delta area and Pearl River Delta region are the three main region of China inbound tourism, which has the core city of Beijing, Shanghai and Guangzhou respectively. In the beginning of reform and opening up of China, these areas have seen the fast growth rate of inbound tourism, but in recent decade, the growth patterns are different among these regions. Shanghai surpassed Beijing in 2003 to be the municipality (province) with the second highest inbound tourism income countrywide, and three out of the top ten locate in the Yangtze Delta area, the center of which is Shanghai, accounting for 30% of the national inbound tourism income. The proportion of the foreign exchange income generated by tourism of Beijing in the national total has been declining since 2000, from 19.32% of 2000 to 9.71% of 2010. Though the four members (Beijing, Tianjin, Liaoning and Shandong) from the Bohai Sea area that surrounds Beijing and Tianjin are among the top ten list, a gap exists when compared to the Yangtze Delta area in terms of the growth rate and the total volume (fig.2, tab.2). The Pearl River Delta region with Guangdong province as the core area, as a whole consistently tops the inbound tourism foreign income chart in the country. The figure of this region goes down during the period of 2000-2007, yet its national proportion stays around 23% in recent years.

4 CONCLUSIONS

Base on the previous analysis, in the past decade, in terms of the shifting direction the inbound tourism gravity center moves toward the north by east before 2008, and toward the south by west later on; in terms of the shifting distance, the periods around 2003 and 2008 are when evident movement happens; in terms of the shifting angel, the variation speed along the longitude is faster than along the latitude, a reflection of the situation that the east-west tourism variation is fiercer than the south-north variation. Since the gravity center represents a state that takes the strength coming from all the spots into account, the gravity center variation mirrors the redistribution of the strength. Hence in reality it mirrors the redistribution and variation characteristics of the tourism and related industries of China. Although a feature of the CoG of inbound tourism started to move to the south and the west in the development of the tourism industry in recent years, disparity between the eastern and western regions is becoming more and more notable, and the south-eastern coast clustering overall structure of the inbound tourism industry stays unchanged.

Having been through more than 30 years of fast growth, the inbound tourism of the south-eastern coast area is bound to be engaged in an industry upgrade. Industry transfer is an important way of industry upgrade, along with which physical redistribution of the inbound tourism industry will come along. Accelerating the inbound tourism shifting toward the middle and western regions and the underdeveloped areas in the north means a lot to enhancing the coordinated development, reducing the regional development disparity and improving the industry upgrade in the eastern region. To realize an even development among the inbound tourism area and to realize an efficient industry transfer between regions, **first of all**, with the high-speed mass transit network construction in China since 2008, the transportation infrastructure system requires improvement and expansion in the west and central region of China, especially the lines between the international port cities and the central and western cities, fully bringing out the radiating and linking effects of the core cities to accelerate the Chinese tourism industrial development; **secondly**, the investment environment of the middle and western regions and the underdeveloped areas in the north should be more elaborately established, the tourism information and service network should be

further enhanced, achieving the paralleling of the industrial distribution and tourism destination planning, in the aim of orderly propelling the tourism industry development in places like Shangri-La, Ancient Silk Road, Three Gorges, the Qinghai-Tibet Railroad adjacent areas, the North-eastern Old Industrial Base, the Bohai Sea area, the Yangtze River Delta area, the middle region, the Pearl River Delta area, the coast west to the Taiwan Strait, Beibu Gulf and the international travelling island of Hainan; and **finally**, by means of upgrading the tourism products realized by encouraging the middle and western regions to develop eco-tourism and business conference products, the inbound tourism is able to develop at a higher speed and gain a stronger risk-resisting ability.

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