# Grey Correlation Analysis of Tourism, Economy and Environment in Hunan Province

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*Abstract—Using grey correlation analysis, quantitative analysis of the relationship between tourism, economy and environment of Hunan, the results show that: (1) tourism and economic have strong correlation, and they have a certain impact on the environment, which is the main factor to restrict the development of Hunan tourism, which is the main factor restricting the development of Hunan tourism.*

***Keywords— Tourism Economy Environment; Grey Correlation Analysis; Hunan Province***

## I. INTRODUCTION

Tourism, economy and environment are a huge and complex system, and it is difficult to use mathematical statistics method for accurate quantitative analysis, and grey theory just makes up for this shortcoming, which is suitable for some information is known, the "small sample", "poor information" is unknown, and the "information" is not deterministic system [1]. For example, these factors, such as tourism resources, tourism projects, tourism preference, passenger service quality, traffic conditions, regional economic development level, and so on, they have obvious gray to the development of tourism, the same as many other related factors for economic and environmental development also show some gray, so can use gray theory to tourism, economy and environment of these three systems.

Grey theory in tourism, economic and environmental aspects of the application is not much, and only based on both of them to study, such as the study of tourism and economic relations are: Yang of guangxi [2] (2010) by using grey correlation analysis method to analysis the inbound tourism demand influence factors and the relationship between the inbound tourism traffic and international tourist foreign exchange income, to chongqing as an example the rank correlation respectively, found that the biggest factors affecting inbound tourism demand in chongqing is travel related infrastructure level and the conditions of tourism resources, and puts forward increasing tourism infrastructure investment, improve the visibility of tourism resources such as conducive to accelerating the development of inbound tourism in chongqing fast advice; Zhang Haiguang and Sun Chunlan [3] (2012) study of cultural tourism industry in shandong province, in the construction of the index system affecting the development of tourism industry, using the method of grey correlation analysis reveals the dominant factor, the results found that passenger traffic, fiscal spending in education, change in gross regional product play an important role on the development of cultural tourism industry; WengGang minhe Li Lingyan [4] (2015) combined with "twelfth five-year" important strategic planning, influence on tourism. The main factors influencing the development of tourism economy in Hebei province were analyzed by using grey correlation analysis. The results showed that the highest degree of business mileage of Hebei Province, namely, the convenient and direct impact of the railway transportation, Fu Xiangyang and Huang Taozhen [5] (2015) used a regression analysis method to select Inner Mongolia tourism economic evaluation index, based on the gray correlation analysis method, and found that the economic support factor and residents living standard of Inner Mongolia tourism economic development. Study on economy and environment: Fu Peng [6] (2010) by using correlation method of Grey Relational Analysis on

Chang-Zhu-Tan industrial structure development and environmental quality of pollutants were analyzed, results showed that the third largest industry's

contribution to economic growth, and the development of related industries on the pollution of the environment can not be ignored; Qin Dongcheng, Zhou Yaozhi and Shi Qingdong [7] (2012) using grey relational analysis model, the correlation of Xinjiang's economic growth and environmental issues were analyzed, the results show that there is high correlation between economic growth and environmental issues; and Li Zuo Qing and Jiang Huiyun [8] (2013) in Zhejiang Province as an example, using the method of Grey Relational Analysis on the correlation between economic growth and environment the problem analysis, consistent with Qin dongcheng.

On the basis of the relevant index system, the main factors are the main factors, and the development strategies and suggestions are put forward. At present, the author has not found the grey theory in tourism and environment, and the main factors of different regions are different, therefore, this paper takes Hunan Province as an example, analyzes the relationship between tourism, economy and environment, and puts forward the relevant countermeasures and suggestions in Hunan province.

## II. GRAY CORRELATION ANALYSIS THEORY

The gray theory is proposed by Professor Deng Julong of Huazhong University of Science and Technology in 1980s. It is a part of the study of the information is known, and some of the information is unknown and the application of the phenomenon of uncertainty. It is through the "small sample" of known information generation, development to understand the reality of the world, to achieve the system's behavior and evolution of the law of the correct grasp and description. Since the publication of Control Problems of Grey System The, the gray theory has been applied widely in various disciplines, and has achieved good results.

### 2.1 Gray correlation analysis method

The gray correlation analysis method is as follows.

(1) Determining the analysis sequence

If there is a m reference sequence, remember to $A_1$、$A_2 \cdots A_m$; there are n sequences, remember to $B_1$、$B_2 \cdots B_n$ put these sequences together, forming the following matrix

$$\begin{pmatrix} A_{11} & A_{12} & \cdots & A_{1k} \\ A_{21} & A_{22} & \cdots & A_{2k} \\ \cdots & & \cdots & \\ A_{m1} & A_{m2} & \cdots & A_{mk} \\ B_{11} & B_{12} & \cdots & B_{1k} \\ B_{21} & B_{22} & \cdots & B_{2k} \\ \cdots & & \cdots & \\ B_{n1} & B_{n2} & \cdots & B_{nk} \end{pmatrix}_{(m+n)\times k}$$

For ease of description, Write it down to $x_{ij}$ ,Among them the i= (m+n), j=k , expressed as I row and column J

(2) Sequence non dimensional treatment

Because of the difference of the measurement units of the data, the standard treatment is carried out in the front of the correlation analysis. In this paper, the standard data method is as follows: set up the first I (i=1,2,... (m+n) the average value of the sample is the standard data for:

$$X_{ij} = \frac{x_{ij} - \overline{x}_i}{rms_i}$$

The root mean square of the I index is $rms_i$, calculated as:

$$rms_i = \sqrt{\frac{\sum_{j=1}^{k} x_{ij}^2}{k}}$$

Transformation form is as follows:

$$\begin{pmatrix} X_{11} & X_{12} & \cdots & X_{1k} \\ X_{21} & X_{22} & \cdots & X_{2k} \\ \cdots & & \cdots & \\ X_{m1} & X_{m2} & \cdots & X_{mk} \\ X_{(m+1)1} & X_{(m+1)2} & \cdots & X_{(m+1)k} \\ X_{(m+2)1} & X_{(m+2)2} & \cdots & X_{(m+2)k} \\ \cdots & & \cdots & \\ X_{(m+n)1} & X_{(m+n)2} & \cdots & X_{(m+n)k} \end{pmatrix}_{(m+n)\times k}$$

(3) The gray correlation coefficient matrix

①For the two grade: $\Delta_{i(k)} = \left| X_{m(k)} - X_{m+i(k)} \right|$;

②Calculation of extreme value from $\Delta_{i(k)}$ :

$$\max_i \max_k \left| X_{m(k)} - X_{m+i(k)} \right|;$$

$$\min_i \min_k \left| X_{m(k)} - X_{m+i(k)} \right|;$$

③Set resolution factor: This paper takes 0.5;

④Find the correlation coefficient: let the above values into the formula

$$\delta_{ij} = \frac{\Delta \min + \rho \Delta \max}{\Delta_{ij} + \rho \Delta \max};$$

⑤Seek the degree of correlation: $r_i = \frac{1}{n}\sum_{k=1}^{n} \zeta_i(k)$。

(4) result analysis

After getting the gray correlation matrix, the numerical value of the correlation degree of each index is compared, and the influence degree of the index is obtained.

## III. GRAY CORRELATION ANALYSIS OF TOURISM AND ECONOMY AND ENVIRONMENT IN HUNAN PROVINCE

### 3.1 Index selection

The purpose of this paper is to study the relationship between tourism, economy and environment of the three. According to the existing research results, combined with the current situation of Hunan province's tourism economy, based on the reliability and availability of data, this paper selects the data indicators and the corresponding description as shown in Figure 1.

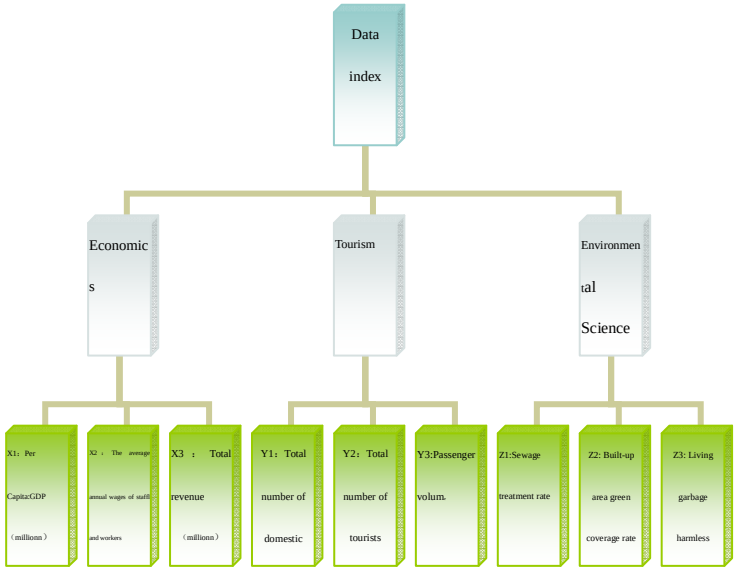


*Fig. 1: Tourism - Economy - Environment Indicator*

Collected from the "2008~2013 Hunan Province Statistical Yearbook" to the relevant raw data, after finishing the visible table 1,

*Table 1 related sequence index raw data*

| year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| X1 | 18147 | 20428 | 24719 | 29880 | 33480 | 36763 |
| X2 | 23082 | 26008 | 29275 | 35520 | 40028 | 43893 |
| X3 | 1314.3 | 1507.2 | 1878.7 | 2523.5 | 2938 | 3315 |
| Y1 | 808.8 | 1053.5 | 1365.5 | 1718.2 | 2175.5 | 2630.9 |
| Y2 | 12830 | 16065 | 20398 | 25328.3 | 30506.3 | 36058.1 |
| Y3 | 131442 | 131442 | 131442 | 131442 | 131442 | 131442 |
| Z1 | 52.1 | 59.2 | 75 | 82.8 | 85.8 | 88.4 |
| Z2 | 35.8 | 36.6 | 36.6 | 36.8 | 37 | 37.6 |
| Z3 | 59.5 | 66.6 | 79 | 86.4 | 95.7 | 96 |

### 3.2 Calculating the gray correlation degree

In this paper, we use R language to calculate the gray relational degree, to get the gray relational matrix, the

original data is used as a comparison sequence, the original data as the reference sequence, the above data will be standardized and then use gray correlation analysis method to calculate the gray correlation degree, the results are as follows.

*Table 2 Grey Incidence Matrix of the Index*

| Comparison Reference | X1 | X2 | X3 | y1 | y2 | y3 |
|---|---|---|---|---|---|---|
| X1 | 1 | 0.96 | 0.96 | 0.92 | 0.94 | 0.97 |
| X2 | 0.96 | 1 | 0.98 | 0.93 | 0.95 | 0.95 |
| X3 | 0.96 | 0.98 | 1 | 0.92 | 0.93 | 0.95 |
| y1 | 0.92 | 0.94 | 0.92 | 1 | 0.98 | 0.92 |
| y2 | 0.94 | 0.95 | 0.93 | 0.97 | 1 | 0.94 |
| y3 | 0.97 | 0.95 | 0.95 | 0.92 | 0.94 | 1 |
| z1 | 0.85 | 0.82 | 0.83 | 0.81 | 0.82 | 0.85 |
| z2 | 0.8 | 0.8 | 0.79 | 0.85 | 0.84 | 0.82 |

By the gray correlation matrix can be the index for the reference sequence of gray correlation degree of order, in which the numerical value of the black box in the system, the gray correlation degree of gray correlation, the sort of results table 3.

*Table 3 Gray Relational Degree of Each Index*

| Comparison Reference | X1 | X2 | X3 | Y1 | Y2 | Y3 | Z1 | Z2 | Z3 |
|---|---|---|---|---|---|---|---|---|---|
| X1 | 1 | 4 | 3 | 6 | 5 | 2 | 8 | 9 | 7 |
| X2 | 3 | 1 | 2 | 6 | 5 | 4 | 8 | 9 | 7 |
| X3 | 3 | 2 | 1 | 6 | 5 | 4 | 8 | 9 | 7 |
| Y1 | 6 | 3 | 4 | 1 | 2 | 5 | 9 | 7 | 8 |
| Y2 | 5 | 3 | 6 | 2 | 1 | 4 | 9 | 8 | 7 |
| Y3 | 2 | 3 | 4 | 6 | 5 | 1 | 8 | 9 | 7 |
| Z1 | 4 | 6 | 5 | 8 | 7 | 3 | 1 | 9 | 2 |
| Z2 | 5 | 6 | 7 | 2 | 3 | 4 | 9 | 1 | 8 |
| Z3 | 3 | 6 | 5 | 8 | 7 | 4 | 2 | 9 | 1 |

As can be seen from the table 3, the system internal (black box) the size of the respective table gray relational order Z2 other than the basic front, indicating the rationality and the scientific nature of the selected indicators. The following is an analysis of the results.

**3.3 Result Analysis**

From the overall point of view, the gray relational degree of each index in the gray relational matrix has reached 0.8, which has a high degree of correlation. Combined with the gray correlation degree, the results can be compared with the results of the reference sequences:

(1) The size of the sort of the grey related degree between the per capita GDP of Hunan Province and each index: passenger volume > financial total income > on-the-job workers in the average wage > reception Travel total number > domestic travel total number > living garbage harmless treatment rate > sewage treatment rate > built-up area green coverage rate. Hunan province showed that the per capita GDP and passenger traffic volume of the largest, ranked second, the three is the economic indicators, followed by the reception of the total number of tourists and the total number of domestic tourism, and the relative environmental indicators.

(2) Remove the inter economic indicators ranking, respectively to post year of average wage (x2) and total fiscal revenue (x3) for the sort of reference sequence of gray correlation degree the same: passenger volume > reception Travel total number > domestic travel total number > living garbage harmless treatment rate > sewage treatment rate > built-up area green coverage rate. Combined (1) analysis shows that the index of the gray correlation degree of the economic indicators of the index position of tourism in the first and the environmental indicators, and therefore, the impact of tourism indicators on the economic indicators is more.

(3) The index of domestic tourism revenue in Hunan Province between the grey correlation degree of ordering: reception Travel total number > on-the-job worker year of average wage > financial total income > passenger

volume > per capita GDP> built area green coverage rate > living garbage harmless treatment rate of sewage treatment rate >. The total number of tourists and the total number of tourists and the gray correlation degree between the size of the sort, in these sort of economic indicators and environmental indicators, and therefore the economic indicators and environmental indicators of the larger relevance.

(4) The index of Hunan Province passenger traffic between grey correlation degree size sorting: per capita GDP> on-the-job workers in average annual salary > fiscal revenue > reception Travel total number > domestic travel total number > living garbage harmless treatment rate > sewage treatment rate > built-up area green coverage rate. In this sort of economic indicators, the top three, and the correlation is the largest of the GDP, combined with (2) analysis shows that tourism and the economy has a strong correlation, and the economic impact of tourism more.

(5) Hunan Province sewage treatment rate between the index and the grey correlation degree of size sorting: garbage harmless treatment rate > passenger volume > per capita GDP> financial total income > on-the-job workers in the average wage > reception Travel total number > domestic tourism revenue > built-up area green coverage rate. Hunan sewage treatment rate and garbage harmless treatment rate is the largest, followed by passenger traffic volume and per capita GDP, which is related to the degree of gray correlation between the number of life garbage harmless treatment rate and the gray degree of correlation between the indicators, the ranking of the per capita GDP.

(6) Built-up area green coverage rate between the index and the grey correlation degree of size sorting: domestic tourism revenue > reception Travel total number > passenger volume > per capita GDP> on-the-job worker year average wage > financial total income > garbage harmless of processing rate > sewage treatment rate. This sort of tourism targets in the top three, with the largest correlation is the total domestic tourism revenue, combined with (5) analysis shows that tourism and the economy has a certain degree of relevance, in which the impact of tourism on the environment more.

## IV. CONCLUSIONS AND RECOMMENDATIONS

Through grey correlation analysis, the relationship between tourism and economy has a strong correlation, and both of them have a certain impact on the environment. In the development of the economy, the development of the tourism industry will increase rapidly, while the development of the tourism industry can promote the economic growth, but in the process of economic and tourism development, tourism development has a greater impact on the environment.

In order to meet the development of tourism, the main factors that restrict the development of Hunan's tourism development are the main factors that restrict the development of Hunan's tourism development. As the increase of passenger traffic, the traffic system should be improved to meet the needs of people. In addition, the gray correlation degree between 0.7-0.9, which is a high degree of correlation, shows that the coordination of the three is not enough, and the effect of tourism and economic development is still not negligible.

Grey relational analysis can objectively reflect the actual relationship among the factors in the system. This paper analyzes the relationship between the three parties in Hunan tourism, economy and environment by calculating the grey relational degree, and provides the relevant theoretical guidance for the industry, which has some practical significance.

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