



# Cruise Tourism Prosperity Index Based on Principal Component Analysis

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**Abstract.** This paper proposes to establish a more robust and flexible framework to formulate the cruise tourism prosperity index (CTPI), which can predict the supply and demand of the cruise industry. However, the use of indicators and cycle selection solves this challenge by incorporating indicators into predictive models. In this paper, CTPI in China from 2010 to 2018 is constructed and evaluated by principal component analysis. Then future development is predicted. Finally, the prediction results show consistency between projected results and actual developments.

**Keywords:** Cruise tourism prosperity index · Principal component analysis

## 1 Introduction

The development of the “Belt and Road” development strategy has brought many opportunities to the development of the tourism industry, especially the cruise industry [1]. Port cities have also seized this opportunity to promote port development and accelerate their integration into the “21st Century Maritime Silk Road” [2]. According to the requirements of the National Coastal Cruise Port Layout Plan [3], by 2030, a national port layout will be formed with 2 to 3 cruise home ports as the lead, the departure port as the main body, and the visiting port as the supplement. In 2018, the global economic growth rate has been significantly improved, providing a good foundation for the development of the cruise industry, with nearly 26.9 million passengers taking cruises [4]. The cruise industry is not only a high-growth industry but also a highly volatile industry. The cruise home port economy plays a central and central role in the regional economy and even the world cruise economy [5]. The unhealthy development of the cruise home port economy or large-scale and large fluctuations will have a greater impact on the regional cruise economy [6]. Therefore, it is very important and necessary to use scientific and rigorous methods to analyze, evaluate and calculate the economic operation of my country’s cruise home port economy.

Under this background, this paper takes the cruise home port economy as the research object, starting from the construction of the evaluation system of the prosperity index, and exploring the cultivation mechanism of the cruise home port prosperity index.

The organization of this paper is as follows: Sect. 2 explains related research progress, Sect. 3 weight indexes and introduces the principal component analysis method, Sect. 4 describes the data and presents the results of preliminary data analysis. Finally, Sect. 5 examines the findings and draws conclusions.

## 2 Relate Works

### 2.1 Economic Measurement Method of Cruise Home Port

From the perspective of qualitative assessment of cruise economy, industrial cluster theory, competitive advantage theory, game theory combined with gray correlation analysis method and SWOT analysis method can be used to analyze the advantages and modes of China's cruise economic development [7]. From the perspective of quantitative measurement of cruise economy, using neural network theory to study the degree of impact of cruise home ports and ports of call on regional economy, it is found that cruise tourism has a greater impact on the economy of home ports. The impact of the local economy is relatively limited. The IMPLAN input-output model prospectively evaluates the impact of the cruise industry on the local economy [8], reflecting that the industry rate of return of the cruise economy is closely related to the complexity of the local economic system. The cruise economic prosperity evaluation index system constructed by Cao Shuang analyzed the prosperity of China's cruise tourism market [9].

For the cruise industry, foreign countries pay more attention to the overall impact of the tourism industry on the region. Most domestic research results are qualitative descriptions. Overall, although scholars have theoretically demonstrated the development value of the cruise economy to the regional economy, and have also proposed a cruise economy prosperity evaluation system, it rarely involves the integration of the cruise economy from a two-dimensional interactive perspective of the "cruise home port-hinterland city" attributes, in-depth exploration of the path and mechanism of the comprehensive effect of various prosperity factors on the cruise home port economy, which makes it difficult for the existing research results to effectively solve the practical problems of cruise home port prosperity evaluation and planning.

### 2.2 Tourism Industry Prosperity Index

Economic prosperity refers to the overall economic operation and development trend, and is an economic concept used to describe and analyze the degree of economic activity. The prosperity index is a quantitative expression of prosperity. It can not only describe the running status of the economy, indicate the expansion and contraction of the economy, but also predict the future development trend of the economy. Foreign scholars' analysis and research on the tourism industry's prosperity focused on empirical research. Wong predicted the number of international tourists through a business cycle and explained various methods of tourism prediction [10]. On the basis of Wong, Turner introduced

indicators such as exchange rate and per capita income of the source country, and used the composite index method to predict the future development of the Australian tourism industry [11]. Regarding the research on the tourism industry prosperity index, domestic scholars mainly focused on: Ni Xiaoning first determined the index weights based on the principal component analysis method, and then used the synthetic index method to calculate the Chinese tourism market prosperity index [12]. Dai Bin used the coefficient of variation method to weight indicators, established a travel agency prosperity index system, and calculated the Chinese travel agency industry prosperity index [13]. Wang Xinfeng established a tourism boom measurement method and measurement model based on the idea of variable weight [14]. Tang Chengcai established a synthetic model for tourism measurement of heritage sites, and conducted a comparative study of the three tourism heritage sites of Huangshan, Zhangjiajie and Chengde [15].

According to relevant literature research on the tourism industry prosperity index at home and abroad, it can be seen that on the one hand, foreign research on the tourism industry prosperity index should take precedence over my country, and my country's research is based on the experience of foreign research. On the other hand, Chinese scholars have weak research on relevant theories and rich empirical research results, which has laid a good practical foundation for the study of China's tourism prosperity index. However, in the selection of indicators, there are indicators dependent on the domestic research results. Logical confusion; in determining the weights, even if some more complicated evaluation methods are adopted in the evaluation, there is a lack of effective integration of multiple methods.

### 3 Methodology

#### 3.1 CTPI System

The CTPI (Cruise Tourism Prosperity Index) system explores 3 groups of indicators, i.e., leading coincident and lagging indexes. Leading index refers to peak or valley indicators appearing in advance before economic indicators get to peak or valley, which reflects income and consumption level of the cruise tourist market of the year; coincident indicator is those whose peak or valley time and economic cycle fluctuation is approximately similar to the benchmark time, which indicates the prosperity of the cruise tourist market of the year; lagging indicator is defined as those turning points appear later than the benchmark turning points of economic cycle fluctuations, which reveals the investment heat of the cruise tourist market of the year. Referring to China macro-economic prosperity index developed by National Information Center Economic Prosperity Analysis Research Group, this paper constructs a composite index that consists of leading, coincident and lagging indicators. To demonstrate the tourism prosperity, this paper utilizes consists of leading, coincident and lagging indicators to constructs a composite index.

First, we selected 49 primary indicators from statistical data of cruise tourism development. Then we exclude some relevant indicators by correlation analysis. Finally, we obtained 4 leading indicators, 10 coincident indicators and 3 lagging indicators, as listed in Table 1.

**Table 1.** The index system and weight of CTPI in China

Classification	Index	Weight
Leading indicator	Home prot city GDP	0.5014
	PGP of local residents in home prot city	0.4986
	Total number of tourists	0.4913
	Economic growth rate	0.5001
Coincident indicator	Total number of cruise ships received	0.4327
	Total number of cruises from home port received	0.4021
	Total number of cruise tourists	0.4123
	Total number of home port cruise tourists	0.4287
	Average consumption of inbound cruise tourists	0.4105
	Average consumption of onbound cruise tourists	0.3964
	Number of cruises in home port	0.3512
	Average tonnage of cruise ships in home ports	0.3796
	Total number of cruise companies	0.3903
	Number of berths at the cruise terminal	0.4489
	Lagging indicator	Number of tourists staying overnight in the home port city
Tourists spend the amount in the home port city		0.4920
Number of people employed onshore in cruise home port		0.4568

### 3.2 Tourism Prosperity Composite Index

The internationally agreed prosperity indexes associate with Diffusion Index (DI) and Composite Index(CI). DI is a measure of the move in any of the business cycle indicators, showing how many of an indicator components are moving together with the overall indicator index, it lacks essential ability to describe the extent. Hence, CI is used to forecast prosperity index [9]. These steps can be described as follows.

Step 1: Symmetrical Change Rate and Standard of Single Index

Calculating the formula of symmetrical change rate:

$$C_{it} = \frac{d_{it} - d_{it-1}}{(d_{it} + d_{it-1})/2} \times 100 \tag{1}$$

$$A_i = \sum_{t=2}^N \frac{|C_{it}|}{N - 1} \tag{2}$$

$$S_{it} = C_{it} - A_i \tag{3}$$

where,  $C_{it}$  is the symmetric change rate of the  $i_{th}$  indictor in the  $t_{th}$  year;  $d_{it}$  is the actual indicator value of the  $i_{th}$  indictor in the  $t_{th}$  year;  $A_i$  is ordinal average of  $C_{it}$  sequence and

N is the standardized number of period;  $S_{it}$  is the standardized value of the  $i_{th}$  indicator's  $C_{it}$  in the  $t_{th}$  year.

Step 2: Determining weighted average of standardized multi-index symmetric change rate

$$R_t = \sum_{i=1}^k S_{it} * \left( \frac{W_i}{\sum_{j=1}^k W_j} \right) \tag{4}$$

where,  $R_t$  is the value of the composite average symmetrical change rate of the leading indicator or lagging indicator in the  $t_{th}$  period;  $W_i$  is the weight of the  $i_{th}$  indicator,  $i = 1, 2, \dots, k$  refers to the number of indicators.

Step 3: Standardizing the average change rate by the synchronization index

The standardization factor F can be obtained as follows:

$$F = \left[ \sum_{t=2}^N \frac{|R_t|}{N-1} \right] / \left[ \sum_{t=2}^N \frac{|P_t|}{N-1} \right] \tag{5}$$

$$r_t = \frac{R_t}{F} \tag{6}$$

where  $P_t$  is the value of the composite average symmetrical change rate of the coincident indicator in the  $t_{th}$  period of the time sequence;  $r_t$  is the average change rate of the synchronic index standardization  $t = 2, 3, \dots, N$  refers to the number of period.

Step 4: calculating the CI

First, calculating the original chain index. with  $I_1 = 100$ , the calculation formula is:

$$I_t = \frac{I_{t-1} * (200 + r_t)}{200 - r_t} \tag{7}$$

$$CI_t = \frac{I_t}{I_0} * 100 \tag{8}$$

where,  $I_0$  is the average value of the chosen benchmark year and  $CI_t$  is the CI.

## 4 Result

According to the CI construction method, the statistical software, MATLAB R2018, is employed. The benchmark year is 2010. The cruise tourism prosperity index of three indicators of the tourism industry in China shows a trend of sustained growth on the whole. The cruise tourism prosperity index of the composite indicator rose from 100 in 2010 to 102.15 in 2018, with an annual growth rate of 1.10% (Fig. 1).

The composite prosperity index of cruise tourism industry pointed out that from 2010 to 2018, the composite prosperity index of China cruise tourism prosperity index of the composite indicator tourism industry had maintained a stable development tendency. Not until 2018 did it drop slightly.

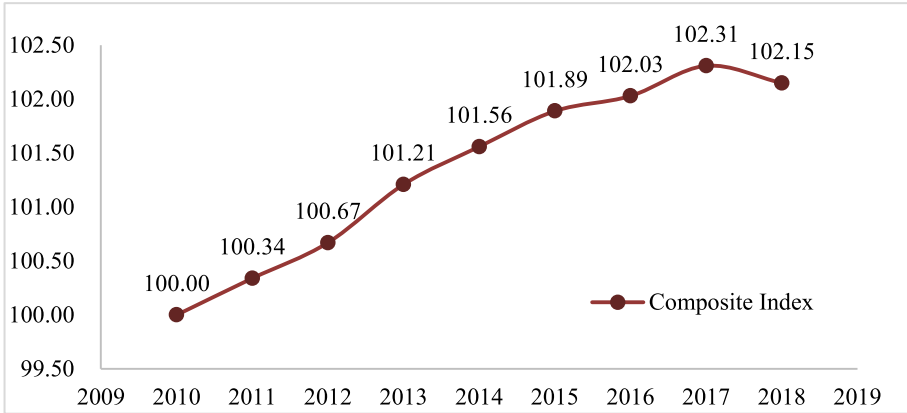


Fig. 1. Composite prosperity index (2010–2018)

In 2006, Costa’s “Elan Gona” made its maiden voyage in China, marking the beginning of my country’s cruise industry from scratch. For more than ten years, the development of China’s cruise industry is second only to that of the United States, and its international market share has increased from 0.5% in 2006 to 9.6%, a nearly 20-fold increase in ten years. The attractive market also attracts the influx of international capital. However, the fierce competition and the slowdown of the industry have brought downhill routes.

The overall decline in the cruise market in 2018 is due to the decline in the capacity of the cruise market in 2018. The slowdown in the growth of the cruise market has already appeared. From the second half of 2017, the cruise market began to show signs of fatigue. Faced with the trough in the Chinese cruise market, some foreign cruise giants have chosen to speed up adjustments or even “flee”. In addition to departure, some international cruise companies have chosen to adjust routes to cope with the current fierce market competition.

## 5 Conclusion

This article takes the cruise home port economy as the research object, starting from the construction of the evaluation system of the prosperity index, and explores the cultivation mechanism of the cruise home port prosperity index. From a theoretical point of view, it is helpful to provide an effective tool for the scientific measurement of the economy of the home port of cruise ships, and to deepen the understanding of the complex changes in the economy of the home port of cruise ships. The concept of the cruise home port prosperity index constructed by this project helps to solve the dilemma that the economic attributes of cruise home ports under the traditional single dimension are difficult to be fully understood. The multi-disciplinary fusion research paradigm is used to construct a cruise home port prosperity evaluation index system to quantify its comprehensive impact and provide a theoretical reference for accurately grasping the complex relationship of cruise home port economic fluctuations. In terms of practical value, it is helpful to

provide practical guidance for the economic construction of cruise home ports. The introduction of a prosperity index to monitor the economic operation of the cruise home port is of great significance for verifying and evaluating the effects of the implementation of cruise economic construction. This research will help improve the healthy operation of the cruise home port economy, enrich the construction practices of the cruise home port economy, and cultivate the cultural confidence of China's unique cruise culture.

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