Construction of the Gravity Model of Tourism Demand on the Basis of the System Theory

WANG Yongqiang¹, YANG Guang²
1. College of Tourism, Hainan University, P.R.China, 570228
2. College of Foreign Languages, Hainan University, P.R.China, 570228

Abstract: This paper, based on the gravity model of tourism demand, studies the factors to the travel to the neighbor areas with the example of Hong Kong tourists to Macau, analyzing the drawing forces such as promotion activities of Macau’s Special Administrative Region government and the tourism industry, consumptions in Macau, especial events, and Macau’s tourism destination attractiveness, and the push powers such as Hong Kong’s GDP and the changes in Macau tourist market. On this basis, this paper revises the gravity model of tourism demand by re-considering the important factors affecting the tourist flow. The introduction of the explanatory variables of market structure makes the model closer to the reality. Moreover, by adding the space scale to the time sequence forecasting, this model analyzes the tourist flow from the whole perspective of time and space.

Keywords: tourism demand gravity, system theory, model construction

1. Introduction

1.1 Research Background

The industry of tourism and gambling refers to the mixture of the tourism industry and the lottery industry. It is the leading industry in Macau’s economic development. In 2008, the industry of tourism and gambling took the proportion of 37.2% in Macau’s GDP. 75% of the revenues of the SAR (Special Administrative Region) government is from this industry. It is undeniable that, to both the Portuguese government before regression and the SAR government at present, this industry has the significant role in Macau’s economy and society.

The most important factor to the industry of tourism and gambling is tourists; the number of tourists and their consumption level directly affect the growth of the fiscal revenue of Macau’s SAR government. The mainland China, Hong Kong and Taiwan are the three main tourist sources. Before the regression, due to the geopolitical relations and kinship, Hong Kong had long been the main source. After the regression, though the mainland became the largest tourist source, Hong Kong still ranks the second. According to the data from Macau’s Statistics and Census Service, in 2006 the number of Hong Kong visitors to Macau is 6.94 million, 31.6% of the total number of tourists to Macau; in 2007, it is 8.17 million, 30.3% of the total; in 2008, it is 7.06 million, 30.6% of the total; in 2009, it is 6.72 million, 30.9% of the total. Since Hong Kong tourists are so important to Macau, the study and promotion of HK tourists visiting Macau has become an important part of the strategy of Macau’s tourism development.

1.2 Research Target

Since Hong Kong tourists mean so much to Macau, how to attract HK tourists to Macau has become the important subject in the strategy of Macau’s economic development. But there is little research on Hong Kong tourists to Macau and less forecasting to the tourism demand, and even no relevant paper is found in the relevant literature retrieval (Kyung Kim, Mi - 2005; Yang LiXun, Yin Shulu, 2008). Therefore, the study of the factors influencing Hong Kong tourists visiting Macau is the key to forecasting the

¹WANG Yongqiang, (1970-), Doctor of Management and Associate Professor of College of Tourism, Hainan University (570228). Phone number: 13158945768, Email: yongqw@hotmail.com.
²YANG Guang(1978-), Lecturer of College of Foreign Languages, Hainan University (570228).
tourism demand of Hong Kong tourists to Macau; and because of the great similarity between Macau and Hong Kong, this study will fill the gaps in the theoretical studies in tourism forecasting. Based on the above reasons, this paper takes HK tourists as the example, adopts the gravity model of tourism demand, studies the factors to the travel of tourists to the neighbor areas, then tries to find out and summarize the new factors and set up the new forecasting model.

1.3 Research Purpose
The purpose of this study is to set up the factor model through the general literature analysis and theoretical researches. As to the basic question of how to attract HK tourists to Macau, this paper studies all the factors influencing HK tourists to Macau and finds out what are the key ones. As a result, this paper can offer the theoretical support for Macau to make the attracting strategy and offer the guidance to the actual operation of the strategy. Specifically, this study adopts the gravity model of tourism demand, considers the special conditions of Hong Kong and Macau, analyzes the drawing forces such as promotion of the government and the industry, consumptions in Macau, especial events, and Macau’s tourism destination attractiveness, and the push powers such as Hong Kong’s GDP and the changes in Macau tourist market.

1.4 Research Significance
Hong Kong is the second biggest tourist source of Macau. Since HK tourists are different from the mainland tourists who are greatly affected by the policy factors, HK source has the relative stability. Moreover, HK tourists in Macau have their own distinguishing characteristics. So the research in this aspect is of important theoretical and practical significance to Macau. The theoretical value of studying the factors to HK tourists to Macau is: 1) to find the new affecting factors and to establish a new study framework, so as to make groundbreaking research in the analysis of tourist behavior to neighboring areas and to provide reference to this kind of research and models; 2) with the new model, to explore the feasibility of structural forecasting in the smaller regions, so as to expand the field of tourism forecasting. This paper also has the realistic significance. By studying the characteristics of HK tourists, this paper establishes the accurate model of factors influencing HK visitors to Macau. The subsequent research can test the model through the questionnaire survey (delivering questionnaires while HK tourists arriving in and leaving Macau). Then the next empirical analysis will provide information to the macro decision-making, meso management and micro operation of the tourism destination.

1.5 Research Methods
This study is on the basis of the research achievements of the domestic and overseas scholars and on the basis of the theories of tourism demand, tourist destination decision-making, and tourism demand forecasting model. This study aims at constructing a conceptual model of factors to HK tourists to Macau, in which the structure is relatively simple, the affecting factors are relatively complete and the relations among the factors are relatively clear. In this way, this paper, from a new perspective, reveals the factor mechanism affecting HK tourists to choose Macau. The subsequent activities of the study includes deducing the specific affecting factors, designing questionnaires according to the specific factors, converting the data of questionnaire survey into variables with SPSS software and conducting the statistical analysis. This paper adopts the following methods:

1.5.1 The forecasting technology of the gravity model of tourism demand
The forecasting technology of the gravity model of tourism demand is one of the structural forecasting methods. Due to the complex relationship between the independent variables and the dependent variables in Hong Kong-to-Macau travel, this study adopts this technology to predict the demand of HK tourists to Macau.

1.5.2 System Method
On account of the defects of the theory of the tourism demand gravity model and the practice of regional tourism system, this study also adopts the method of system theory. On the basis of system theory, this study sets up the attractiveness model.

2. Literature Review

2.1 Tourism Demand Forecasting

There is plenty of academic literature relating to tourism demand forecasting. The study of tourism demand began in the 1960s. Though 420 essays studying this object have been published from 1960 to 2002 (Li G, Song H, Witt S F., 2006), the real development occurs until the 1980s, because more than 90% of those 420 essays are published in the 1980s and after over 80 more essays have been published in the recent five years, from 2002 to 2007. The scholars, such as Crouch, Lim, Witt, Li and Song, etc, who clear up and observe the literatures just list the related literatures or study the recent ones. Among many tourism forecasting models, the generally used are the traditional quantitative and/or qualitative research methods, such as the Delphi method, the life cycle method, the econometric method, the space gravity model, and the time sequence method, etc. Since the 1980s, the comparative study of accuracy of different tourism demand forecasting models began to appear. The scholars, such as Martin and Witt, Gonza’lez and Moral, Kulendran and King, Kim and Song, Kulendran and Witt, compared the accuracies of these methods by analyzing the data of different countries. But none of the exiting models is intended for Hong Kong. In addition, the international tourism forecasting model currently used is the time sequence method. Though the time sequence is believed to be the most practical forecasting method of tourism, it can only predict the future growth or decrease of the tourist number and cannot interpret the causing factors. So the enterprises or the official tourism department cannot take the targeted measures to promote the growth of tourists.

Therefore, the structural forecasting method is needed to interpret the factors affecting the increase or decrease of tourists. The present structural forecasting method is not perfect and there are few successful cases. This study hopes, by analyzing the factors to HK tourists to Macau, to explore the feasibility of structural forecasting in relatively small areas and to open new vision to the research in this field.

2.2 Application of Gravity Model in Tourism Science

The gravity model, the autoregressive integrated moving average model (ARIMA) and the exponential smoothing model (ES) are the three most important forecasting models among the time sequence forecasting models.

Tourism demand gravity model is based on the gravity model of geography, which is developed from the gravity model of Newton's Universal Gravitation, namely the gravity between two objects is proportional to their qualities, and inversely proportional to the distance between them. In the humanities, the gravity model is mainly used for trade, so called Trade Gravity Model. The following is the basic model of trade gravity that is put forward by Bergsträ̈nd in 1989:

\[ M_{ij} = a_0 Y_i^n Y_j^n D_{ij}^n A_{ij}^n \]  \hspace{1cm} (1.1)

Here \( M_{ij} \) refers to the amount of imports of Country \( i \) from Country \( j \); \( Y_i \) is GDP of the importing country and \( Y_j \) is GDP of the exporting country; \( D_{ij} \) is the distance between the two countries; \( A_{ij} \) refers to other factors that promote or hinder the flow of trade between the two countries.

Since tourism in essence is a trade activity, many scholars revised the trade gravity model to construct the gravity model of tourism demand for tourism analysis. Tourism demand gravity model first appeared in the 1940s and was developed in the 1960s and 70s. It is the main research object in this paper. Since the end of the 1940s, foreign scholars started the research on the gravity model of tourist destination. G. K. Zipf and J. Q. Stewart put forward their primitive tourism gravity models respectively in 1946 and 1948 and their models are similar. G. K. Zipf’s model is the following

\[ M_{ij} = \frac{a_0 Y_i^n Y_j^n D_{ij}^n}{1 + D_{ij}^n} \]  \hspace{1cm} (1.2)
\[ I = \frac{P_i P_j}{D} \] (1.2)

Here \( I \) is the attractiveness index; \( P_i \) and \( P_j \) refer respectively the populations of the two cities; and \( D \) is the distance between the two cities. Model 1.2 is in imitation of Newton’s Gravity Model. But Model 1.2 has great limitation in the research of tourist attractiveness, for compared with the diversity and complexity of the tourist activities, the variable factors in this model are too simple to explain the actual conditions completely.

Therefore, the subsequent scholars made continuous improvement of Model 1.2 and the more typical model was put forward by Crampon L. J. in 1966;

\[ T_{ij} = G \frac{P_i A_j}{D_{ij}^b} \] (1.3)

In this model, \( T \) refers to the number of travels between the guest source area \( i \) and the destination \( j \) in a certain period; \( P_i \) the measuring unit of the population, wealth or travel tendency of the tourist source area; \( A_j \) is the measuring unit of the attractiveness or capacity of the destination; \( D_{ij} \) is the distance between the source area and the destination; \( G \) and \( b \) are the empirical parameters. But Model 1.3 has two defects: 1) it has no constraint, that is, the tourist flow in the model is not limited but in fact the capacity of one destination is limited; 2) it is too sensitive to the distance, overestimating the number of excursions and underestimating the number of long-distance travels. Therefore, it is necessary to improve it, and one of the solutions is to develop a model with definite upper limits and to revise the distance variables. To overcome the defects mentioned above, the subsequent scholars have made unremitting efforts, and one of the main research directions is to revise the distance variables. For example, Wolfe (Wolfe, 1972) introduced a distance function on the basis of Model 1.3

\[ T_{ij} = G \frac{P_i A_j}{D_{ij}^b} D^{[\log D_{ij}/m]/n} \] (1.4)

Here \( m \) and \( n \) are the empirical estimation coefficients, and the others are the same as those in Model 1.3.

Smith (1992) discovered one important characteristic of the gravity model that its basic form is unchanged and it can be applied to different problems if the definitions of parameters and variables are properly changed.

The gravity model with the maximum entropy put forward by Wilson (1962) overcomes the linear limitation of the general gravity model:

\[ T_{ij} = P_i A_j \exp\left(-\lambda c_{ij}\right) \] (1.5)

Here \( T_{ij} \) is the intensity of regional spatial interaction; \( P_i \) and \( A_j \) are the intensity indexes of economy in Region \( i \) and \( j \) respectively and refer respectively to demand and supply; \( \lambda \) is the attenuation factor, determining the decaying rate of the regional interacting force; \( c_{ij} \) is the distance between Region \( i \) and \( j \) in the broad sense. At the same time, the more accurate prediction of tourism gravity can be obtained with the distance function of Edwards. S. L and Dennis S. J. (1976), which uses the fee to show the distance.

\[ C_{ij} = \left[ \frac{X_1 X_2 X_3 + X_4}{X_5} \right] X_6 \] (1.6)

\( X_1 \) is the price of petrol per litre; \( X_2 \) is the consumption of petrol per kilometer; \( X_3 \) is the average mileage per hour; \( X_4 \) is the travelling time opportunity cost, as \( 1/4 \) of the wage per hour; \( X_5 \) is the number of passengers of each car; \( X_6 \) is the travelling time. Edwards and Dennis used this distance function in the empirical research in southwest England and found it was effective.
South Africa’s scholar, Ferrario (1979) put forward the market gravity model that is greatly different from the above gravity models. In his model, the factors of supply and demand are used to work out the tourism potential index, and the distance factor is included in the supply factors as the accessible sub-factor. His model is like:

\[ I = \frac{A + B}{2} \quad (1.7) \]

\( I \) is the measuring unit of the tourism potential; \( A \) is the measuring unit of tourism demand; \( B \) is the measuring unit of tourism supply. Considering the difference in the levels of tourism destinations, Ferrario introduced the weighting coefficient to embody the difference and made the model closer to the reality. With the weighting coefficient, Model 1.7 can be rewritten as:

\[ I = \frac{\sqrt{AG} + B}{2} \quad (1.8) \]

The biggest characteristic of Model 1.8 is that the distance variable is no longer used as the independent factor but is included in the tourism supply variable. Ferrario applied this model in the empirical research and the result was identical with the actual situation of South Africa.

The domestic scholars also tried to set up the gravity model of tourism destination. Zhang Lingyun (1986) took Japan as the example and constructed one tourism gravity model on the basis of the mechanism of tourism attraction.

\[ E = K\left(\frac{PQ}{r^2}\right) \quad (1.9) \]

\( P \) is the abundance index of tourism resource; \( Q \) is the abundance index of tourists; \( r \) is the distance function and \( K \) is the medium coefficient.

In addition, Bao Jigang (1986), with the data of domestic tourists sampling survey conducted by Beijing Municipal Policy Research Organization, chose space, economic development level, and educational level as factors to set up the forecasting gravity model of tourists form different provinces, municipalities and autonomous regions to Beijing. Zhang Jie (1999) thinks that one of the basic functions of the gravity model is tourism forecasting and he makes the simple prediction of tourist volume of Jiuzhaigou. Guo Yajun (2000) applies the gravity model to the construction of tourism attraction system, and he argues the model analysis is helpful to improve the regional tourism competitiveness from different aspects according to the importance of each factor. Wang Haihong (2003) points out that the tourist attraction is only one aspect of the tourism supply capacity and the other is the integral attraction. Zhang Youlan (2005) revises the gravity model and forecasts the American tourist flow to Henan Province. Li Zhigang and Su Yanhui (2006) apply the scenery index to the gravity model in the example of American tourists to Guilin City. Guo Wei (2007) elaborates in detail the application of the trade gravity model in tourism and makes the empirical research on the inbound tourist market of China. Sun Ruijuan (2007), on the basis of the gravity model and with the example of Nanjing, constructs the model suitable for analyzing the factors to regional tourism.

Unfortunately, Hong Kong and Macau are not taken into consideration either as the destination or as the tourist source, which does not correspond to their status as the important tourism destination and tourist source. Taking the development of tourism market of Hong Kong and Macau to test the forecasting effect of the forecasting models is not only of theoretical importance to the choice and improvement of the forecasting technology of tourism demand but also of practical significance to the exploration of China’s inbound tourism market.

2.3 Tourism System

From the perspective of System Theory, the tourism system is a complex and open system. First, tourism consists of the subsystems of tourism subject, tourism object, tourist media and tourism environment, and each subsystem can be decomposed into multiple subordinate subsystems. In the narrow sense, tourism system refers to the system of tourism industry, a complex system made up of
supply, demand and the relevant supporting industries and including the recreational system, the support system, the industry system, the management system and the network system, etc. These subsystems interrelate and interact with each other and constitute the giant and complex tourism system.

3. Research Hypotheses and Model Construction

3.1 Research hypotheses

There are many factors that affect the tourism market, and among them the main five are the political, economic, social and cultural and industrial factors. This paper summarizes previous literature and, according to the real conditions of Macau’s tourism industry, chooses the important factors from those affecting Hong Kong tourists to Macau as the metrics. The metrics include Hong Kong’s GDP, Macau tourism destination attractiveness (food, new facilities including new casinos), the measures of Macau’s SAR government to promote tourism, the consumption index of HK tourists in Macau (Macau’s CPI /Hong Kong’s CPI), special events, the market structure of HK tourists to Macau.

This paper puts forward ten hypotheses as the following:

1. **H\(_0\)**: the number of Hong Kong tourists to Macau \([Y]\) has no relation with the per capita GDP in Hong Kong.

**H\(_1\)**: the number of Hong Kong tourists to Macau \([Y]\) has relation with the per capita GDP in Hong Kong.

Assumption: Hong Kong’s per capita GDP is one important factor to the travel of HK tourists to Macau. The income of Hong Kong tourists may affect their travel to Macau, but how much the change of the income affects and how it affects, positively or negatively, has not been studied so far. In this hypothesis, the number of Hong Kong tourists to Macau is related to the per capita GDP in Hong Kong. Statistical analysis can tell their positive or negative relativity, so that it will clear whether Macau is the bargain or the substitute of long-term travel for Hong Kong tourists.

2. **H\(_0\)**: The number of Hong Kong tourists to Macau \([Y]\) has no relation with the tourism destination attractiveness of Macau \([X_2]\) (food, new facilities including new casinos, shopping, scenery, shows, and bars, etc).

**H\(_1\)**: The number of Hong Kong tourists to Macau \([Y]\) has relation with the tourism destination attractiveness of Macau \([X_2]\) (food, new facilities including new casinos, shopping, scenery, shows, and bars, etc).

Assumption: Macau’s food is an important factor to HK tourists.

Assumption: Macau’s new casinos will attract more HK tourists. Besides food and new facilities (new casinos), this paper increases the new metrics such as shopping, scenery, show and bar, etc. In recent years, the shopping environment in Macau has got great improvement. With the opening of some international famous casinos, Macau has drawn two-thirds of top luxury brands in the world and shopping has become one of Macau’s appeals. Scenery here is defined as “static views”, referring to the static theme parks or the large buildings with scenic value. All new casinos in Macau adopt the casino-and-hotel mode and their appearance, internal decoration and facilities have the distinguishing and attractive features, drawing many tourists who want to enjoy sightseeing and seek novelty. Show here is defined as “dynamic views”, referring to various attractive performances. Performance in recent years has become another distinctive feature of Macau. The casino hotels, in order to attract tourists, always make large investments to put on the grand performances, such as the Fly Dragon Performance of Hard Rock and the Fountain Performance of Wynn Macau Resort. Bar is one of the most important facilities to attract the adult males and the youth.

3. **H\(_0\)**: the number of Hong Kong tourists to Macau \([Y]\) has no relation with the promotional spending.

**H\(_1\)**: the number of Hong Kong tourists to Macau \([Y]\) has relation with the promotional spending.

Assumption: the promotional spending of Macau’s SAR government and the lottery industry will increase the number of HK tourists.

According to the statistics of Macau’s casinos, every year the gaming enterprises attract HK tourists by making great sales promotion and paying large commission to the agents. Each gaming enterprise
launches special offers to HK tourists, such as returns tickets, free hotel accommodations, meal tickets, lucky draws, etc. All the promotional activities are attractive to HK tourists.

4. \( H_0 \): the number of Hong Kong tourists to Macau \([Y]\) has no relation with the consumption index of HK tourists in Macau.
\( H_1 \): the number of Hong Kong tourists to Macau \([Y]\) has relation with the consumption index of HK tourists in Macau.

Assumption: the consumption index of HK tourists in Macau is proportional to the number of Hong Kong tourists to Macau.

5. \( H_0 \): the number of Hong Kong tourists to Macau \([Y]\) has no relation with the special events.
\( H_1 \): the number of Hong Kong tourists to Macau \([Y]\) has relation with the special events.

Assumption: special events will affect the number of HK tourist to Macau.

Special events refer to the big events that can influence the tourism demand of Macau. Jones Calviny and Mundy Max (2004) analyzed the impact of tourism expenditures on the regional economy in the two major events of Rugby World Cup 1999 and Jazz Festival 2000. Macau regularly every year holds the international events such as Macau International Fireworks Display Contest, Macau International Music Festival, Macau Grand Prix, Macau Food Festival, Macau International Trade and Investment Fair. This paper supposes the special events will affect the number of HK tourist to Macau.

6. \( H_0 \): the number of Hong Kong tourists to Macau \([Y]\) has no relation with the market structure of HK tourists visiting Macau.
\( H_1 \): the number of Hong Kong tourists to Macau \([Y]\) has relation with the market structure of HK tourists visiting Macau.

Assumption: the market structure of HK tourists visiting Macau will affect the numbers of HK tourists to Macau.

The market structure is introduced quantitatively in the tourism gravity model as an explanatory variable and this is one important innovation of this paper. In the process of research, this study plans to use the Shift-share Method (SSM). This method is put forward in succession in the 1960s by American scholars, Dunn, Perloff, Lampard, Muth etc., and in the early 1980s Dunn made the summary and set the form used commonly at present. SSM has been widely adopted by foreign scholars in the analysis of regional economic structure. In the 1990s, this method begins to be widely used in China. But it is mostly confined to the research of the traditional industry structure (i.e. the classification system of the primary, secondary and tertiary industries) and the analysis of industry competitiveness, and seldom is used in the analysis of the internal structure of single industry. In recent years, domestic tourism scholars begin to pay attention of SSM and have made some attempts in the empirical research. But most of the researches are on the structure of tourism industry and few on the market structure of tourist source areas. Chen Chao (2007), by using the grey system theory, constructs the gravity model to predict the market trend of tourist sources to Fujian Province and concludes that the tourist flows from Taiwan to Fujian are getting centralized and the regional distribution of tourists is unbalanced. Xiamen, Quanzhou, Fuzhou, and Wuyi Mountain have become the concentration areas of Taiwan tourists, and the share of the rest areas is shrinking. Landing visa for Taiwan compatriots brings much convenience to the individual travelers, raising the scale of individual tourists from Taiwan. The increase of exchanges of science and technology, culture, trade between both sides of the Taiwan straits bring much more young Taiwan tourists, and the traveling purpose is changing from traditional family-visiting and sight-seeing to culture, commerce and trade, and conference. The tendency of tourism consumption is that the tourism consumption capacity of family-visiting and sightseeing is declining and the consumption capacity of culture, commerce and trade, and conference is ascending. The change in the market structure affects the numbers of Taiwan tourists to Fujian.

So far, no literature research in the field of tourist source forecasting has detailed the study of tourism market structure to the impact of internal changes in the source market on the tourism destination. This study plans to adopt the following SSM mathematical modeling:

Assume in any area, after the time \([0, t]\), the structure and total number of tourists will change. The total...
number of tourists in the base year is \( b_{i,0} \), and \( b_{i,t} \) in the end year. All tourists from the main sources are divided into \( n \) parts according to the market structure of those sources. \( b_{j,0} \) and \( b_{j,t} \) \((j=1, 2, \ldots, n)\) show the tourists flows from the source market segments \( j \) in the base and end year. \( B_0 \) and \( B_t \) are the total number of tourists from the market segment \( j \) of all sources to the destination in the corresponding base and end year. \( B_{i,0} \) and \( B_{i,t} \) are the total number of tourists from the market segment \( j \) of the main sources to the source market and the important regions related to the destination in the base and end year. Then:

1. the changing rate of tourist flow from the market segment \( j \) of the main sources to the destination in the time \([0, t]\):
   \[
   r_j = \frac{(b_{j,t} - b_{j,0})}{b_{j,0}} \quad \text{(j=1, 2, \ldots, n, the same below)};
   \]
2. the changing rate of tourist flow from the market segment \( j \) of the main sources to the source market and the important regions related to the destination in the time \([0, t]\):
   \[
   R_j = \frac{(B_{j,t} - B_{j,0})}{B_{j,0}};
   \]
3. taking the share of the tourist flow to the source market and the important regions related to the destination as the criterion and standardizing the tourist flow in the market segment \( j \) of the main sources with the following formula, we can get:
   \[
   b_j' = b_{j,0} \cdot B_{j,0} / B_0.
   \]

Then, \( G_j \), the growth of tourist flow from the market segment \( j \) of the main sources to the destination in the time \([0, t]\) will be resolved into \( N_j \), the portion component, \( P_j \), the structure transfer component and \( D_j \), the competitiveness transfer component.

1. \( G_j = b_{j,t} - b_{j,0} = N_j + P_j + D_j \);
2. \( N_j = b_j' \cdot R_j \);
3. \( P_j = (b_{j,0} - b_j) \cdot R_j \);
4. \( D_j = b_{j,0} \cdot (r_j - R_j) \);
5. \( PD_j = P_j + D_j \);
6. \( N_j \) — the portion component, or the average tourist growth effect in the related regions. It refers to the change in the scale of the market segment \( j \) in the destination \( i \) with the proportional distribution of the total amount of all related regions in the market segment of the main guest source. In other words, it means the change of the tourist flow in the regionally standardized market segment of the main tourist source according to the average growth rate of all related regions.

\( P_j \) — the structure transfer component, or the structure effect of the source market. It refers to the deviation of the growth of the market segment \( j \) in the destination \( i \) from the standard of all related regions. This deviation is caused by the difference between the proportion of the market segment in the source and the proportion of the corresponding markets in all related regions. It reflects the effect and contribution of the market structure of the source to the growth without considering the difference between the growth rate of the destination and the average growth rate of all related regions. So the
higher its value is, the more contribution the source market makes to the growth of the total tourist number.

$D_{ij}$ — the competitiveness transfer component, or the regional share effect. It refers to the deviation caused by the difference between the growth rate of the market segment $j$ in the destination $i$ and the average growth rate of the corresponding markets in the related regions. It reflects the relative competitiveness of the market segment $j$ in the destination. So the higher its value is, the more effect the competitiveness of the segment $j$ in the destination on the growth of the total tourist number.

$PD_{ij}$ is the general deviatoric component, reflecting the general growth advantage of the market segment $j$ in the destination $i$.

So $G_i$, the general increment of tourist flow in the destination $i$, $N_i$, the general share component, $P_i$, the general structural transfer component, and $D_i$, the general competitiveness transfer component will be:

\begin{align*}
G_i &= b_{ij,t} - b_{ij,0} = N_i + P_i + D_i, \\
N_i &= \sum b_{ij,t} \cdot R_j, \\
P_i &= \sum (b_{ij,0} - b_{ij,t}) \cdot R_j, \\
D_i &= \sum b_{ij,0} \cdot (r_j - R_j).
\end{align*}

The relative growth rate of the regional tourist flow of the destination relative to all the related regions is

\[ L = \frac{b_{ij,t}}{b_{ij,0}} \cdot \frac{B_i}{B_0}. \]

Then $K_{j,0} = b_{ij,0} / B_{j,0}$ and $K_{j,t} = b_{ij,t} / B_{j,t}$ refer to, respectively in the base year and the end year, the proportions of the tourist flow from the market segment $j$ of the main source in the tourist flow from all the corresponding market segments in all sources in the same period.

$L$ can be divided into $w$, the structural effect index, and $u$, the competitiveness effect index.

\begin{align*}
W &= \frac{\sum K_{j,0} \cdot B_{j,t}}{\sum K_{j,0} \cdot B_{j,0} \cdot \sum B_{j,t}}, \\
u &= \frac{\sum K_{j,t} \cdot B_{j,t}}{\sum K_{j,0} \cdot B_{j,t}}.
\end{align*}

Then, if $G_i$ is getting greater and $L$ is greater than 1, the number of tourists in the destination increases more rapidly than those in all related regions.

If $P_i$ gets greater and $w$ is greater than 1, the proportion of new and rapidly-increasing segment of the tourist market is getting larger and the structure of the general tourist market is getting perfect.

If $D_i$ is getting greater and $u$ is greater than 1, then the market segment has great potential and competitiveness.

7. $H_0$: the number of Hong Kong tourists to Macau [$Y$] has no relation with the attitude of HK tourists.

$H_1$: the number of Hong Kong tourists to Macau [$Y$] has relation with the attitude of HK tourists.

Assumption: the attitude of HK tourists can affect the number of HK tourists to Macau.

8. $H_0$: the number of Hong Kong tourists to Macau [$Y$] has no relation with the perceived distance between Hong Kong and Macau.
H1: the number of Hong Kong tourists to Macau [Y] has relation with the perceived distance between Hong Kong and Macau.
Assumption: the perceived distance between Hong Kong and Macau can affect the number of HK tourists to Macau.

9. H0: the number of Hong Kong tourists to Macau [Y] has no relation with the number of hotel rooms in Macau.
H1: the number of Hong Kong tourists to Macau [Y] has relation with the number of hotel rooms in Macau.
Assumption: the number of hotel rooms in Macau can affect the number of HK tourists to Macau.

10. H0: the number of Hong Kong tourists to Macau [Y] has no relation with the number of Hong Kong’s outbound tourists.
H1: the number of Hong Kong tourists to Macau [Y] has relation with the number of Hong Kong’s outbound tourists.
Assumption: the number of Hong Kong’s outbound tourists can affect the number of HK tourists to Macau.

3.2 Research hypothesis
In this hypothesis the main assumed variables are: [Y], the number of HK tourists to Macau; [X1], Hong Kong’s GDP; [X2], Macau tourism destination attractiveness (food, new facilities including new casinos, shopping, scenery, shows and bars, etc.); [X3], the measures of Macau’s SAR government and the gaming enterprises to promote tourism; [X4], the consumption index of HK tourists in Macau (Macau’s CPI/Hong Kong’s CPI); [X5], special events; [X6], the market structure of HK tourists visiting Macau; [X7], the attitude of HK tourists to Macau; [X8], the perceived distance between Hong Kong and Macau, [X9], the number of hotel rooms in Macau; [X10], the number of HK outbound tourists.
According to the assumption and further quantization, this paper tries to set up the model of tourism attractiveness:

\[ T_{ij} = g_i \left( y_{it} z_{it} m_{it} r_{it} a_{it} L_{it} K_{ij} \right) \]

In the formula, \( i \) is Hong Kong people; \( t \) is the year; \( T_{it} \) is the tourist flow of Hong Kong people to Macau in the year of \( t \); \( y_{it} \) is the population of Hong Kong; \( z_{it} \) is Hong Kong’s per capita GDP; \( m_{it} \) is the number of HK outbound tourists; \( r_{it} \) is the number of hotel rooms in Macau; \( a_{it} \) is the promotional spending of Macau; \( a_{it} \) is the abundance of tourist attractions in Macau; \( u_{it} \) is the fee of round trips; \( c_{it} \) is the per capita tourist consumption; \( d_{it} \) is the perceived distance between Hong Kong and Macau; \( e_{it} \) is the effect of special events; \( L \) is the relative growth rate of the regional tourist flow of the destination relative to all the related regions, reflecting the effect of the market structure; \( K \) is the attitude of HK tourists to Macau; \( g_i, \alpha, \beta, \rho, \theta, \phi, \psi, \gamma, \varphi, \delta, \tau_i \) are the empirical parameters; \( \varepsilon \) is the disturbance. So Figure 2-1 is the research model of factors to Hong Kong tourists to Macau. Table 2-1 is the cross-reference of assumed parameters and the model parameters.
Figure 3-1: Research Model of Factors to Hong Kong Tourists to Macau

![Research Model Diagram]

Source: This paper

Table 3-1: cross-reference of assumed parameters and the model parameters

<table>
<thead>
<tr>
<th>Assumed Parameters</th>
<th>Model Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>$T_{it}$: the tourist flow of Hong Kong people to Macau in the year of t</td>
</tr>
<tr>
<td>X1</td>
<td>$z_{it}$: Hong Kong’s per capita GDP</td>
</tr>
<tr>
<td>X2</td>
<td>$a_{it}$: the abundance of tourist attractions in Macau</td>
</tr>
<tr>
<td>X3</td>
<td>$p_{it}$: the promotional spending of Macau</td>
</tr>
<tr>
<td>X4</td>
<td>$w_{it}$: the per capita tourist consumption</td>
</tr>
<tr>
<td>X5</td>
<td>$e_{it}$: the effect of special events</td>
</tr>
<tr>
<td>X6</td>
<td>$L$: the effect of the market structure</td>
</tr>
<tr>
<td>X7</td>
<td>$K$: the attitude of HK tourists to Macau</td>
</tr>
<tr>
<td>X8</td>
<td>$d_{it}$: the perceived distance between Hong Kong and Macau</td>
</tr>
<tr>
<td>X9</td>
<td>$r_{it}$: the number of hotel rooms in Macau</td>
</tr>
<tr>
<td>X10</td>
<td>$m_{it}$: the number of HK outbound tourists</td>
</tr>
</tbody>
</table>

Source: this paper
4. Possible Conclusion and Innovation

4.1 Possible Conclusion
4.1.1 Revision of important factors to tourism forecasting
This paper develops the previous models of tourism gravity forecasting and revises the important factors to the tourist flow. Its introduction and study of explanatory variables in the market structure makes the model closer to the reality.

4.1.2 Discovery of the forecasting model more fit in with the nature of tourism
This study on the basis of the theory of tourism system develops the forecasting model of tourism gravity, in which the important factors meet the requirement of tourism system, so this model is more fit in with the nature of tourism. Meanwhile, by adding the factor of space to the time sequence factor, this model analyzes the tourist flow from the whole perspective of time and space.

4.2 Innovation
4.2.1 New model of tourism destination attractiveness from the perspective of tourism
Most researches on tourism attractiveness in tourism science are from the perspective of geography. The model is put forward by Crampon in 1966 and it includes the main variables such as the destination resources, capacity, the distance between the destination and the source area. Bao Jigang, the domestic scholar, forecasted the number of tourists that the destination entertained with the model in 1988. It has certain difference from the trade gravity model. Previous researches focus on the revision of definitions of parameters and variables in the gravity model, but the basic form of the model remains unchanged. All the models are based on the assumption that the three factors, source, destination and distance, are relatively independent. They also use the assumptions of single destination and minimum cost route. According to the literature review, the domestic scholars have made much progress in the industry analysis by applying the gravity model. But most focus on the empirical research and few make the deep theoretical exploration (Luo Xupei, 2003). As the main means for tourism market forecasting, the gravity model of tourism demand, on the basis of the systematical evaluation of the destination, can define the gravity scope of the destination system, estimate the impact coefficients of the factors, and forecast the tourist flow in the future year. The means has gained wide concern from the field of tourism in the world, but obviously its theoretical base is not strong enough.

This paper, on the basis of previous foreign and domestic researches on the tourism gravity model, tries to setup a completely new model of tourism destination attractiveness from the perspective of tourism. At the same time, by taking the tourism market of Hong Kong people to Macau, it makes an approach to the gravity model of factors to the regional tourism between Hong Kong and Macau. The explanatory variables are constructed according to the previous researches and the conditions of Hong Kong and Macau. Distinctively, the explanatory variable of market structure is introduced in the model. Moreover, the empirical research is conducted to test whether the explanatory variables can explain the factors to HK-Macau regional tourism.

4.2.2 Innovation in methodology: application of the structural forecasting method to the system scale of small space.
In the world, tourism forecasting usually adopts the time sequence method and there are many successful precedents. For example, Margarida De Mello (2001) used the model of integrated vector autoregression (AIDS) to analyze the long-term demand of British tourists and forecasted the shares of the destination market. But the time sequence method has one defect of neglecting other interference factors to tourism demand. So it cannot make the demand analysis to deeper levels and cannot offer more reference and suggestion to the decision makers. Even though the structural forecasting method is less used, it has its own advantage. It can help to discover the affecting mechanism behind the economic phenomena and get clear analysis and prediction of economic activities. The gravity model is one of the important methods of structural forecasting. So far there is no special research on Hong Kong tourists to Macau and nobody adopts the structural forecasting method to predict HK tourists to Macau. All of this
leaves much space of exploration for this paper.

Achievement of the current stage for the research on the Forecasting System for the Development of Macau’s Industry of Tourism and Gambling (Software) (Number: 020/2006/A), project of Macau’s Science and Technology Development Fund.

Acknowledgements:
Achievement of the current stage for the research on the Forecasting System for the Development of Macau’s Industry of Tourism and Gambling (Software) (Number: 020/2006/A), project of Macau’s Science and Technology Development Fund.

WANG Yongqiang , (1970-), Doctor of Management and Associate Professor of College of Tourism, Hainan University (570228), Phone number: 13158945768, Email: yongqw@hotmail.com.

YANG Guang, (1978-), Lecturer of College of Foreign Languages, Hainan University (570228).

References


