Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 138 (2014) 767 – 775

Procedia
Social and Behavioral Sciences

The 9th International Conference on Traffic & Transportation Studies (ICTTS'2014)

Tourism Flows Prediction Based on an Improved Grey GM(1,1) Model

Xiangyun Liu, Hongqin Peng*, Yun Bai, Yujun Zhu, Lueling Liao

MOE Key Laboratory for Urban Transportation Complex Systems Theory Technology,Beijing Jiaotong University, Beijing 100044, China

Abstract

This study analyzes the factors affecting the tourist flow. These factors include tourism resources, traffic conditions and so on. In recent years, the grey forecasting model has achieved good prediction accuracy with limited data and has been widely used in various research fields. However, the grey forecasting model still have some potential problems that need to be improved, such as applicate range and prediction accuracy. It is found that original data and background value are main factors affecting the accuracy of the proposed model's application. To solve these problems, this study develops a optimization model for the GM(1,1) model problem which includes optimization of initial and background values. In order to reduce errors caused by back-ground values, the "new information prior using" principle is followed, and a liner function is dopted in the construe of background. Numerical examples verified that the simulation and prediction accuracy of the short-term forcasts is significantly increased. As a result, the newly improved model yields a high prediction capability.

Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).

Keywords: tourist flow; GM (1, 1); grey model forecast

1. Introduction

As the rapid economic development, China's tourism industry plays an increasingly important role in giving a great push to people's quality of life, obtaining employment, poverty alleviation, stimulating domestic demand and

* Corresponding author. Tel.: +861051684208; fax: +861051684208.
E-mail address: hqpeng@bjtu.edu.cn

Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).
doi:10.1016/j.sbspro.2014.07.256

industrial restructuring. As an infrastructure, the transportation's sophistication and construction has straightforward effects on the provincial tourist flow. In terms of tourism revenue, an important sector of tourism, transportation make up large gravity in the country's total tourism revenue. In addition, the construction of transportation networks needs invast large amounts money. Further more, to a extent, the government pay more attention to economically developed areas, which also contribute to the development of tourism(Lai, 2006). In 2008, China's tourism revenue has reached 1.14 brillion Yuan. According to the World Tourism Organization prediction, China will become the largest tourist destination in the world by 2020. In order to accelerate socio-economic progress, to enhance the management level of tourism, tourism demand forecasting is indispensable. As one of the indexes to measure tourism demand, tourists number is the fundamental to achieve analysis on composition of tourism economic, to make tourist destinations, country or region better know tourism demand products and changes of the tourism market.

Since the grey system theory was developed by a scholar, Professor Deng Julong in 1982, this theory has been widely applicated in industry, agriculture, transportation, tourist flow, etc. As for tourism, gray system theories are mainly applied in grey correlation analysis, gray prediction and improvement. Xu and Weng (2007) analyzed different factors of tourism demands and travel services; Liu (2009), Wang and Liu (2010), Shu and Dong (2011) predicted tourist flow in specific regions respectively. Xie and Liu (2006) discussed the influence of different fitting points and proposed optimization model fitting point contribute to the model. Yao puts forward sub-amendment modeling ideas, which enhance fitting effect of long sample sequences (Yao et al., 2010). Hu made some improvements on discrete gray model by researching the initial sensitivity problem and raw data preprocess problem of discreting gray model (Hu et al., 2009). However, the whole above predictions are mostly adopted in traditional GM(1,1) model. GM(1,1) model has numerous advantages, such as high precision, easy to use and so on. However, it has limitations. Researches indicated that the GM(1,1) model is generally applied in the original sequence data outside of the first data $x^{(0)}(k)$, $k = 2, 3,\cdots, n$, and has a certain low index trend. Namely, it is suitable to the development coefficient of $|a|<=0.5$ and relatively small fluctuations.

In order to improve the prediction accuracy and to reduce error further, this study develops a optimization model which include initial and background value to improve the GM (1,1) model.

2. Analysing of tourism flow influence factors

Tourism market refers to a variety of economic phenomena and economic relations produced by tourism products exchanging between tour operators and tourists. Analysis and prediction on the tourism market play a significant role in the compilation of tourism planning. Prediction of tourism flow has becoming more and more important in enhancing the competitiveness of the tourism industry and achieving sustainable development of tourism. The primary influencing factors mainly include tourism resources, traffic conditions, seasons and weather, competitor's conditions, disposable income of residents and etc.

(1)Tourism resources

Tourism resources mean all the natural and human elements that attract people to the tourist site. Attraction is the core feature of tourism resources, which is able to stimulate and satisfiy tourists demands of aesthetic, leisure, entertainment and other needs. It attract and make people aspire to go there from different places. Generally, the places where tourism resources are rich, where owns large species tourism resources will attract large tourist flows too.

(2)Tourism traffic

Tourist traffic is an integral part of the transportation. By tourist traffic, travelers can arrive to the destination. Moreover, tourist traffic is an important part of the tourism industry, as the development of tourism would not be so fast without well-developed modern transportation network. Therefore, tourism traffic can promote economic activities of tourism to a certain extent. The modernization of transportation, convenient means of transportation and the well-developed transport infrastructure are the prerequisite and foundation to promote the tourism industry development. By conducting the investigation of three corridors in Yunnan province, Duan get the result that most tourists are undertaken by railway and have high demands on security, comfort, affordability (Duan et al.,2011). In addition, traffic convenience and diversity make diverse types for travelers to select, which also encourage travelers to choose these destinations.

(3) Seasons and weather

Changes in tourism demand occurred in the time pattern reflecte a strong contrast. It is determined by the natural climatic conditions of tourist destination. Different seasons evoke diverse motivations of tourists, and the duration of the cozy climate affects tourists' flow directly. Moreover, tourists leisure time also affects tourist demand, such as China's traditional festivals, "May Day" and "October" Golden Week, Spring Festival, when people are more prone to have a vacation.

(4) Competitor status

Market competitiveness comes from the tourist satisfaction. To increase the competitiveness of tourism market, besides owning prosperous tourism resources, convenient transportation and other advantages, details mean more to it. Such as whether urban traffic is smooth; whether establish tourist information center; whether the signs of city logos are clear; whether the channel is smooth; whether the accomodation is safe and convenient, whether the price is reasonable, etc., which are also take an active part in tourists' increasing. Local government and service agents should do their best to meet tourists' expectations.

(5) Payment capacity of residents

Residents payment capacity represents people's absolute income with tax and basic costs deducted. Generally, available disposable income can be treated as a considered indicator. Disposable income is a material condition to judge whether a person has the potential to become a tourist. What's more, disposable income levels determine tourists' level of payment in tourist activities, consumers travelling expenditures increase with the disposable income. Tourists number are the rudimentary elements to determine the level of tourism revenue, in general, tourism revenue and reception of visitors are proportional relationship.

3. Grey model

3.1. Basic principles of grey model

Professor Deng Julong proposed gray system theory in 1982, as the system model of unclear and incomplete information to build a grey model for prediction and decision-making(Deng, J.L., 1982). GM(1,1) is the most commonly used grey forecasting model. In recent years, it has been widely applied in various research fields and has achieved good prediction accuracy. The basic idea of GM(1,1) model is to make original series accumulate and generate new series, weaken the randomness of the original series, reveal its regularity, make the new sequence reflecting the trend of the original series, to achieve the orderly sequence analysis, and meet the requirements of forecasting.

3.2. Steps of Grey model GM (1,1)

The procedures of traditional GM(1,1) are as follows:

(1)Data sequence smoothness test

Definition: Assume that $x^{(0)}$ is an original sequence, class ratio sequences $\sigma^{(0)}$, $X^{(0)}(k)=\{x^{(0)}(1), x^{(0)}(2),\cdots, x^{(0)}(n)\}$.

Where

$$\sigma^{(0)}(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)} \tag{1}$$

Then:

$$\sigma^{(0)} = (\sigma^{(0)}(2), \sigma^{(0)}(3), \cdots, \sigma^{(0)}(n)) = \left[\frac{x^{(0)}(1)}{x^{(0)}(2)}, \frac{x^{(0)}(2)}{x^{(0)}(3)}, \cdots, \frac{x^{(0)}(n-1)}{x^{(0)}(n)}\right] \tag{2}$$

Let φ be a measure, then $\varphi[min\ \sigma^{(0}(a), max\ \sigma^{(0}(b)]=|max\ \sigma^{(0}(b)- min\ \sigma^{(0}(a)|$. When $k>3$, $\sigma<0.5$, the sequence is smooth, it can be modeled directly; if not, we need to select an appropriate pretreatment to meet the conditions and then use the inverse operation to decrease the predicted values.

(2)Accumulated generating

Let $X^{(0)}(k)=\{x^{(0)}(1), x^{(0)}(2),\cdots, x^{(0)}(n)\}$, k=1, 2,⋯, n be the raw data sequence, generate the first-order accumulated generating operation (AGO) sequence $x^{(1)}$

$$X^{(1)}(\mathrm{k}) = \{x^{(1)}(1), x^{(1)}(2), \cdots, x^{(1)}(n)\} \tag{3}$$

Where

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i),\ k = 1, 2, \cdots, n \tag{4}$$

(3)Setting up model

Accumulated generating series $x^{(1)}(k)$ reflects obvious exponentially, the first-order differential equation of GM(1,1) model is obtained as follows:

$$\frac{dx^{(1)}(t)}{dt} + ax^{(1)}(t) = b \tag{5}$$

Where t denotes the independent variables in the system, a represents the developed coefficient, b is a grey controlled variable, a and b denote the model parameters requiring determination. By using the least square method, parameters a and b can be obtained as

$$\hat{u} = \begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T y_n \tag{6}$$

Furthermore, accumulated matrix B is

$$B = \begin{bmatrix} -1/2[x^{(1)}(1) + x^{(1)}(2)] & 1 \\ -1/2[x^{(1)}(2) + x^{(1)}(3)] & 1 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots & \cdots \\ -1/2[x^{(1)}(n-1) + x^{(1)}(n)] & 1 \end{bmatrix} \tag{7}$$

Meanwhile, the constant vector y_n is

$$y_n = [x^{(0)}(2), x^{(0)}(3), \cdots, x^{(0)}(n)]^T \tag{8}$$

The solution of the GM(1,1) model can be obtained from the following equations

$$\hat{x}^{(1)}(k+1) = \left(x^{(0)}(1) - \frac{u}{a}\right)e^{-ak} + \frac{u}{a} \tag{9}$$

The recovered data $x^{(0)}(k+1)$ can be retrieved by the inverse accumulated generating operation

$$\begin{cases} \hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k) \\ \hat{x}^{(0)}(1) = x^{(1)}(1) \end{cases} \tag{10}$$

3.3. The applied range of GM(1,1) model

Studies found that GM(1,1) model is to make an index based on least squares fitting except the first point of the original sequence essentially, fitting with pure exponential sequence, which cannot fully achieve satisfactory fitting results, tends to produce some deviations, and indicates that tradition GM(1,1) model is just an approximat model. GM(1,1) model's accuracy depends on the size of the development coefficient and structure of background equations, when the GM(1,1) model's original data meet certain trends and less volatile index case has the following conclusions(Liu & Deng, 2000):

- When $0 \leq -a \leq 0.3$, GM(1,1) model is suitable for long-term forecasts;
- When $0.3 \leq -a \leq 0.5$, GM(1,1) model is only suitable for short-term forecasts;
- When $0.5 \leq -a \leq 0.8$, we should be very cautious with GM(1,1) model for short-term prodictions;
- When $0.8 \leq -a \leq 1$, adopt residuals to ament GM(1,1) model;
- When $-a > 1$, GM(1,1) model is not suitable for forecasts.

Therefore, GM(1,1) model is generally applied in the original sequence data outside of the first data $x^{(0)}(k)$, $k = 2, 3, \cdots, n$ and has a certain low index trends, namely, the development coefficient $|a| \le 0.5$, and relatively small fluctuations in the case.

4. Grey optimization GM(1,1) model

GM(1,1) model is the simplest and most common gray forecasting model. To some extent, it is a comparitive and quantitative description of the system development. Most scholars have improved it just from the following aspects(Zhang et al., 2007): i)background value; ii)initial value selection; iii)gray differential equation. In order to further improve the prediction accuracy, many scholars just optimized GM(1,1) model from the one aspect (background value, origial value, for example). Few people enhance the predict accurcy from multiple aspects. Therefore, this study develops a optimization model for predicting tourism tourists which refer to the initial and background value to improve GM(1,1) model.

4.1. Initial value selecting

Traditional GM(1,1) model initial conditions is $x^{(0)}(1)$, according to the "new information prior using" principle (New information on the role of cognitive over the old), comparied with original GM(1,1) model, the information closer to the predicted time means more on characteristics of the system. The initial conditions of traditional GM(1,1) model $x^{(0)}(1)$, which can't comply with the principle of new information priority, thus, the process of the prediction error is higer(Zhang, J., 2008); based on it, this study chooses the accumulated generating data $x^{(1)}(n)$ as initial conditions of the model, compared to original model, which in line with the principle of new information priority, thus obtain a better predictive accuracy than the original GM(1,1) model.

4.2. Construct of background value

Research shows that GM(1,1) model's prediction accuracy is caused by parameter development coefficients a and gray control variable b, a and b depend on the construct of the background value. The time response formula of albino differential equations

$$\frac{dx^{(1)}(t)}{dt} + ax^{(1)}(t) = b \tag{11}$$

Which is a non-homogeneous type exponential function, the traditional model $x^{(1)}(t)$ is a trapezoidal integration in the interval of $[t,t\text{-}1]$. In order to reduce the original GM(1,1) model in the form of trapezoidal integration errors caused by background values tectonic, assuming $x^{(1)}(t)$ is a liner function, set up $x^{(1)}(t)=x_1e^{x_2t}+x_3$, where x_1, x_2, x_3 are undetermined parameters, substitute into the background value formula $z^{(1)}(k)= \int_{k-1}^{k} x^{(1)}(t)$, after simplifying the calculations, new background values is constructed(Wu, Z.H., 2012):

$$z^{(1)}(k) = x^{(1)}(k) + \frac{x^{(0)}(k)}{\ln x^{(0)}(k) - \ln x^{(0)}(k-1)} - \frac{[x^{(0)}(k)]^2}{[x^{(0)}(k) - x^{(0)}(k-1)]} \tag{12}$$

According to:

$$Y = \left[x^{(0)}(2), x^{(0)}(3), \cdots, x^{(0)}(n)\right]^T, \ B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \cdots\cdots\cdots & \cdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \tag{13}$$

Then the least square estimate sequence of the grey differential satisfies

$$\hat{u} = \begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T y_n \tag{14}$$

and then obtain the model.

According to the specific values of a and b, get a time response formula of improved model

$$x^{(0)}(k) + az^{(1)}(k) = b \quad (15)$$

$$\hat{x}^{(1)}(k+1) = \left(x^{(1)}(n) - \frac{b}{a}\right)e^{-a(k-n)} + \frac{b}{a}, k = 0, 1, \cdots, n-1 \quad (16)$$

After a regressive reduction:

$$\hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}, k = 0, 1, \cdots, n-1 \quad (17)$$

5. Numerical example

Zhejiang province lies besides the East China Sea. Its terrain is mainly hilly and mountainous, coastal twists and turns, owning many bays and islands, with a mild and humid climate. Zhejiang owns both a long cultural history and an unique natural environmental conditions; besides, Zhejiang includes almost all types of ecological features except for sand (gravel) landscape, modern glaciers, grasslands and court buildings. It also has large numbers of tourist attractions, owning 12 national scenic attractions, 42 provincial-level scenic spots, 28 national key cultural relics protection units, 323 provincial cultural relics protection units, 16 national forest parks, 41 provincial-level forest parks, 5 national Nature Reserve and 6 provincial-level nature reserves(Ma, L.Q., & Mao, Z.Q., 2004). In recent years, the tourism industry in Zhejiang province develops fast, tourism indicators higher, domestic tourist numbers and tourism revenue have been largely increased. Tourism has increasingly becomes a pillar industry of Zhejiang Province, which plays a crucial role in promoting its economic development. The data of domestic tourists are listed in Table 1.

Table 1. 2007-2012 Zhejiang domestic tourists (unit: 10,000).

Years	2007	2008	2009	2010	2011	2012
Tourists	19100	20900	24410	29500	34295	39123.8

5.1. Simulation of the model

(1)Data sequence smoothness test

Take Zhejiang 2007-2012 data:

$X^{(0)}$=(19100, 20900, 24410, 29500, 34295, 39123.8)

According to equation (2) , class ratio sequences $\sigma^{(0)}$=(0.913876, 0.856206, 0.827458, 0.860184, 0.876576). Seen by the $\varphi[min\ \sigma^{(0)}(a), max\ \sigma^{(0)}(b)]=|max\ \sigma^{(0)}(b)-min\ \sigma^{(0)}(a)|$=0.086. When k>3, σ <0.5, then the sequence is smooth.

(2)Accumulated generating

According to equation (3), the AGO series $x^{(1)}(k)$ can be obtained

$X^{(1)}(k)$=(19100, 40000, 64410, 93910, 128205, 167328.8)

(3)Calculate a

Constructing a data matrix B and data vector y_n, according to the formulas (7) and (8), substitute the data:

$$Y = [20900, 24410, 29500, 34295, 39123.8], \quad B = \begin{bmatrix} -29393.1653 & 1 \\ -51889.3352 & 1 \\ -78694.6762 & 1 \\ -110627.2338 & 1 \\ -147337.5381 & 1 \end{bmatrix}$$

and then by equation(6), the development coefficient and grey input we obtained are a=-0.1564, b=16568.9651 respectively.

(4)Establish the model

Substituting the specific values of a and b into equation (16), we can get the time response equation of improved model:

$$\hat{x}^{(1)}(k+1) = 273239.54739e^{0.1564(k-5)} - 105910.74739 \tag{18}$$

According to formula (17), (18), the sequence $\hat{x}^{(0)}$ can be obtained as the output of the predictive value of Zhejiang's tourism demand for 2007-2012. $\hat{x}^{(0)}(1)$=19100, $\hat{x}^{(0)}(2)$=21164.20, $\hat{x}^{(0)}(3)$=24748.22, $\hat{x}^{(0)}(4)$=28939.18, $\hat{x}^{(0)}(5)$=33839.85, $\hat{x}^{(0)}(6)$=39570.41.

5.2. Model evaluation

There are generally three methods to test the gray model: residual test, correlation test and posterior error test, this study mainly adopts residual test and posterior error test.

(1)residual test

Calculating residuals and get residual sequence:

$$\begin{cases} E = (e(1), e(2), \cdots e(n)) = x^{(0)} - \hat{x}^{(0)} \\ e(i) = x^{(0)}(i) - \hat{x}^{(0)}(i), i = 1, 2, \cdots, n \end{cases} \tag{19}$$

$\delta(i)$ reprents the relative error between actual value $x^{(0)}(i)$ and model values $\hat{x}^{(0)}(i)$.

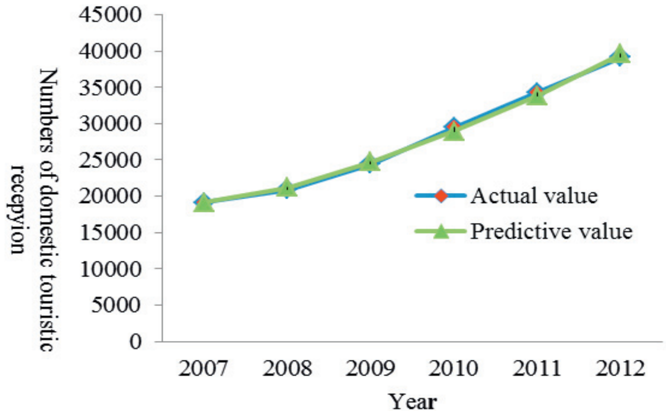

Fig.1. Zhejiang domestic tourism curve between actual and predicted values

$$\delta(i) = \frac{x^{(0)}(i) - \hat{x}^{(0)}(i)}{x^{(0)}(i)} \times 100\% \tag{20}$$

$\delta(i)$ is believed qualified residuals that less than 10%.

(2)Posterior error test

Actual data sequence $X^{(0)}$, Variance S_1^2, Residuals sequence e, Variance S_2^2, then:

$$S_1^2 = \frac{1}{n}\sum_{i=1}^{n}(x^{(0)}(i) - \bar{x}^{(0)})^2 \tag{21}$$

$$\text{Where} \quad \begin{cases} \bar{x}^{(0)} = \frac{1}{n}\sum_{i=1}^{n} x^{(0)}(i) \\ S_2^2 = \frac{1}{n}\sum_{i=1}^{n}(e(i) - \bar{e})^2 \\ \bar{e} = \frac{1}{n}\sum_{i=1}^{n}(e(i) - \bar{e})^2 \end{cases} \tag{22}$$

Calculated posterior error ratio is: $C=S_2/S_1$.

Calculated small error: $p=p\{|e(i)-\bar{e}|<0.6745S_1\}$, then get the process of this model; the result is in Table 2.

Table 2. The process of this model

Year	Real data	Simulated data	Discrepancy	Relative error
2007	19100	19100	0	0
2008	20900	21164.20	-264.20	-0.01264
2009	24410	24748.22	-338.22	-0.01386
2010	29500	28939.18	560.82	0.01901
2011	34295	33839.85	455.15	0.01327
2012	39123.8	39570.41	-446.61	-0.01141

From the Table 2, we get the result that $\delta(i)$ is less than 10%, which is treated as a qualified residuals. Based on the formula of $C=S_2 / S_1$, and then get a value of 0.054206479. Where $p=p\{|e(i)-\bar{e}|<0.6745S_1\}=\{|e(i)-\bar{e}|<4832.993454\}=1$, therefore, $C\leq0.35$, $P>0.95$, the model has an excellent accuracy.

In summary, the consequences were tested and verified satisfactory by the residuals and posterior error test. Therefore, this model can be applied in domestic tourism tourists prediction of Zhejiang domestic tourism.

5.3. Forecast of tourism passengers in Zhejiang Province

According to equations (16) and (17), we get the 2013-2017 of prediction value of the sequencex $\hat{x}^{(0)}$ in the next five years: $\hat{x}^{(0)}(7)=46271.42$, $\hat{x}^{(0)}(8)=54107.19$, $\hat{x}^{(0)}(9)=54107.19$, $\hat{x}^{(0)}(10)=73984.27$, $\hat{x}^{(0)}(11)=86513.05$.

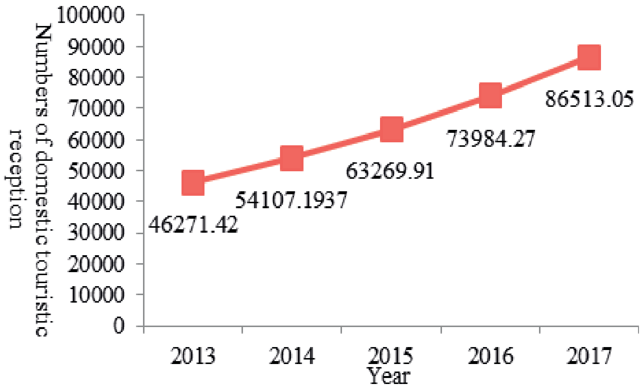

Fig.2. Forecast results (2013-2017) are based on the improving grey model

Fig.2. shows that the tourism tourists of Zhejiang province in 2013-2017 is on a gradual upward tendency.

6. Conclusions

GM(1,1) model has many advantages, such as simple principle, high calculation precision. It has been applied in kinds of fields. GM(1,1) model is generally used for the short-term sequence predictingnd. In order to obtain a forecast model that has more accurate forecasting with limited data, this study develops a optimization model for the GM(1,1) model problem which includes optimization of initial and background values. The empirical results show that the improved model can significantly improve the prediction accuracy of the grey forecast. We can also clearly see that Zhejiang province's tourism has entered a rapid progressive stage and owned a more stable source markets. In the coming years, the number of domestic tourist will continue to increase.

Acknowledgements

This work is supported by the National Basic Research Program of China (2012CB725406) and the National Natural Science Foundation of China (No.71131001 and No.71231001).

References

Deng, J.L. (1982). Grey Controlling System. *Central Institute of Technology, 10*, 9-18.

Duan, L.Z., He, M., He, B.H., & Zhang, L.L. (2011). Competition between Road and Railway of Tour and Public Transportation Corridors. *Journal of Transportation Systems Engineering and Information Technology, 11*, 194-197. doi:10.3969/j.issn.1009-6744.2011.02.030

Hu, R., Zhuang, Q. J., Zhu, L., & Fu, Y. (2009). Application of improved discrete grey model in medium-long term power load forecasting. *Journal of Electric Power Science and Technology*, *24,* 50-53. doi: 10.3969/j.issn.1673-9140.2009.04.010

Lai, F.B.(2006). Perspectives on the impact of transport on travel and Development Strategies. *Railway Transport and Economy, 28*, 85-86. doi:10.3969/j.issn.1003-1421.2006.11.033

Liu, Q.L., & Li, B.(2010). The Grey Forecasting Model of the International Tourist of Henan. *Henan Sciences, 28*, 113-115. doi:10.3969/j.issn.1004-3918.2010.01.030

Liu, S.F., & Deng, J.L.(2000). The Range Suitable for GM (1, 1). *Systems Engineering Theory & Practice, 20*, 21-124. doi:10.3321/j.issn:1000-6788.2000.05.023

Ma, L.Q., & Mao, Z.Q.(2004). Zhejiang tourism status and integration into the Yangtze River Delta tourism circle strategy. *Business Economics and Management, 9*, 52-54. doi: 10.3969/j.issn.1000-2154.2004.09.013

Shu, L.J., & Dong, W.(2011). Forecast on Jin Cheng Shan Tourism Passenger Based on the GM(1, 1) Model. *GanSuNongYe, 249*, 9-20. doi:10.3969/j.issn.1673-9019.2011.01.009

Wang, Z.C., & LIU, L.(2010). Comparison and Demonstration Studies on Tourism Passenger Forecast Models—take Huang Shan as an example. *Journal of Anhui Normal University Natural Science, 33*, 287-290. doi:10.3969/j.issn.1001-2443.2010.03.019

Wu, Z.H.(2012). The improved Prediction Control based on the grey dynamic model. Master. Thesis, Zhejiang Sci-Tech University, Zhejiang. doi: 10.7666/d.y2051284

Xie, N.M., & Liu, S.F.(2006). Research on discrete grey model and its predicative result. *Journal of Systems Engineering, 21,* 520-523. doi:10.3969/j.issn.1000-5781.2006.05.012

Xu, X.N., & Weng, G.M.(2007). Grey Relational Analysis on Influence Factors of Difference in Tourism Demand among Urban Residents. *Resource Development & Market, 23*, 21-24. doi:10.3969/j.issn.1005-8141.2007.01.007

Yao, T.X., Liu, S.F., & Xie, N.M.(2010). Study on the properties of new information discrete GM (1, 1) model. *Journal of Systems Engineering, 25*, 165-170.

Zhang, J. (2008). Improvement of Grey Forecasting Model and its Application. Master. Thesis, Xian University of Technology, Shan xi. doi: 10.7666/d.y1380759

Zhang, Y., Wei, Y., & Xiong, C.W.(2007). One New Optimized Method of GM(1,1) Model. *Systems Engineering Theory& Practice, 27*, 141-146. doi:10.3321/j.issn:1000-6788.2007.04.021