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Application of Method for Fitting Trend in Analyzing Tourist

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ABSTRACT

The data of the income of tourism and the number of tourism of Si-ping city in the recently decade are investigated, the long term trends of the data are obtained by the method for fitting trend of non-stationary time series analysis based on SAS. Fitting models for the data are set. The estimated value of the model parameters are calculated by the method of conditional least squares. Finally, the regression equations and the model parameters are tested by F testing and T testing, respectively. The results show that the model we set and the model parameters are all prominent, these models can be used to analyze and predict the income of tourism and the number of tourism of Si ping city in the future.

1. Introduction

With the development of society and the improvement of people's living standard, the development momentum of tourism is strong in all provinces and cities (Naznin et al., 2018; Anna et al., 2019; Vishnu and Karthik, 2013). It has become one of the faster-growing industries in the national economy, and the income from tourism has promoted the development of the national economy (Jui-Chang Cheng, et al., 2016; Noel, 2005; Md and Sudharshan, 2016). Since the income of tourism and the number of tourism are the two important characters in the analysis of tourism (Ben, et al., 2019; Meng, et al., 2020).This paper takes the domestic income of tourism and the number of tourism of Siping city, Jilin Province from 2003 to 2017 as the research object. The trend fitting method in the nonstationary time series modeling method and SAS statistical software are adopted to extract the strong deterministic long-term trend from the data, establish a regression fitting model, and the estimated values of the model parameters are obtained by using the least square estimation method. Finally, F test (Paulo, et al., 2016; Huang and Su, 2009) and T test (Hwang and Sun, 2017; Hedberg, and Stephanie, 2015) are used to verify the validity of the model and the significance of the parameters. This model can be used to analyze and forecast the future trend of tourism revenue in Siping city. The conclusion of this paper can provide a useful model analysis method for some researches.

In recent years, relevant literatures have shown that non-stationary time series analysis method is applied in tourism, economy and other practical fields (Rebecca, et al., 2019; Cao, et al., 2019; Li, 2019) .

Above literature have not used the trend of the non-stationary time series model in siping tourist Numbers, and the application of tourism income data sequence, the number of domestic tourism in siping and tourism income data of time sequence model analysis also does not have appeared in the literature. So this article adopt the right trend fitting model to fit the number of domestic tourism and the income tourism data sequence of siping for more than ten years and establish proper regression model to forecast the future development trend of the domestic tourists and the number of tourism and the income of tourism. Results in this paper will provide the scientific theory basis and reference value for local economic construction.

2. Method for extracting trend terms of non-stationary time series

It is well known that there is a set of mature modeling and analysis methods for stationary time series. However, most of the economic and financial data encountered in practical application are not stable. Therefore, non-stationary time series analysis method is the mainstream method in the field of time series analysis. Non-stationary time series analysis methods are divided into deterministic analysis methods and stochastic analysis methods. Long-term trend is a major deterministic factor leading to non-stationary time series. The research on trend term of

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non-stationary time series is also a common content in statistical literature (Mininath and Ramchandra, 2019; Steven, et al., 2018; Xu, et al., 2019).

The common extraction methods of trend items mainly include trend fitting method and smoothing method. Therefore, the trend fitting method and its model checking method are briefly introduced below.

Definition 2.1 Taking time as independent variable and corresponding serial observed values as dependent variable, the method of establishing regression model of serial values changing with time is called trend fitting method.

When the long-term trend of time series $\{x_t\}$ is linear, the linear regression model

$$x_t = a + bt + I_t$$

is used to fit the sequence, where $\{I_t\}$ is random fluctuation which satisfy

$$E(I_t) = 0,\ Var(I_t) = \sigma^2 \ .$$

$T_t = a + bt$ is the long-term trend of the sequence after eliminating the effects of random fluctuations.

For model

$$\begin{cases} x_t = a + bt + I_t, t = 1,2,\cdots,n \\ E(I_t) = 0, Var(I_t) = \sigma^2 \end{cases},$$

the conditional least square method is used to estimate the value of the regression coefficient, that is, to obtain the least square estimation of the regression coefficient. The F test (also known as the analysis of variance) is used to check whether the regression equation is significantly true. When the p value of F test is less than the given significance level, the regression equation is significantly established, otherwise, the regression equation is not significantly established and the fitting model needs to be re-established. The T test is used to check whether the regression coefficient is significantly nonzero. When the p value of t-test is less than the given significance level, the regression coefficient is significantly non-zero, otherwise, the regression coefficient is not significantly non-zero, that is, significantly zero. At this time, the terms with significantly zero coefficient need to be eliminated to refit the model.

If the longterm trend of the time series presents a nonlinear characteristic , then the curve model can be used to fit the sequence. The common curve fitting models include

(a) quadratic form: $T_t = a + bt + ct^2$,

(b) exponential form: $T_t = ab^t$,

(c) Modified exponential form: $T_t = a + bc^t$,

(d) Compertz form：$T_t = e^{a+bc^t}$,

(e) Logistic form：$T_t = \dfrac{1}{a + bc^t}$ and so on.

In the above models, except the quadratic model and exponential model can be transformed into linear regression fitting model by appropriate transformation method, and then the estimated value of the model coefficient can be obtained by conditional least square method, the other curve models can only be estimated by iterative method.

The test method for the significant establishment of the regression model is still F test, and the test method for the significant non-zero regression coefficient is still T test.

3. Collation and display of domestic income of tourism and domestic number of tourism data series

The statistical yearbook of Jilin Province and the Statistical yearbook of Siping city are searched, the domestic income of tourism and the number of tourism data of Siping city from 2003 to 2017are onbtained, among them the data of 2010 and 2012 were missing.

Table 1 Domestic number of tourism original data of Siping city from 2003 to 2017

Year	Number of tourism (Thousands)	Year	Number of tourism (Thousands)
2003	46.55	2011	141.17
2004	52.19	2012	missing
2005	55.11	2013	195.02
2006	60.51	2014	228.47
2007	71.14	2015	263.70
2008	87.21	2016	343.54
2009	104.22	2017	414.40
2010	missing		

Table 2 Domestic income of tourism original data of Siping city from 2003 to 2017

Year	income of tourism 100 million	Year	income of tourism 100 million
2003	2.06	2011	15.68
2004	3.08	2012	missing
2005	3.45	2013	24.72
2006	3.92	2014	30.23
2007	5.44	2015	37.55
2008	7.5	2016	49.34
2009	9.73	2017	63.10
2010	missing		

The data of 2010 and 2012 need to be forecast and adjust and the moving average method is adopt ed to adjust them.

The moving average method is one of the simplest adaptive models and a practical method evolved from the arithmetic average. While the arithmetic mean can represent the average level of the data, it cannot show the future trend of the data. Although the original data may have a certain trend, its data is either fragmented or disorganized, so it cannot be analyzed directly. Moving average method can face the above disadvantages exactly.

The basic way it works as follow, first, a constant period N is we choosed, next, calculate the average of the data. As the period recurs downwards, the initial data is discarded and the next data is added, thus finishing all the data processing. In fact, the moving average method is to first calculate the average value of the first N data for a certain set of data. The weights of these N Numbers are the same, so are the weights of other data. The moving average method can eliminate abnormal factors in the data and play the role of logarithmic adjustment. The idea of the second moving average method is as follows. First, on the basis of the original data, a new set of data is obtained by moving average, then we conduct a moving average and get a new set of data Ⅱ on the basis of the data. Through two groups of data Ⅰ and Ⅱ, model has been established. The following table according to the known data is obtained by two moving average.

Table 3 Moving average of the number of tourism original data

Year	original data	The first Moving average	The second Moving average
2004	52.19		
2005	55.11	53.65	
2006	60.51	57.81	55.73
2007	71.14	65.825	61.8175
2008	87.21	79.175	72.5
2009	104.22	95.715	87.445

Table 4 Moving average of the incomer of tourism original data

Year	original data	The first Moving average	The second Moving average
2004	3.08		
2005	3.45	3.265	
2006	3.92	3.685	3.475
2007	5.44	4.68	4.1825
2008	7.5	6.47	5.575
2009	9.73	8.615	7.5425

On the basis of the quadratic moving average, a linear model can be established as follow

$$Y_{t+\lambda} = a_t + b_t \lambda ,$$

where λ is the forecast the number of lead periods.

It can be known from the parameter estimation formula of the polynomial model

$$a_t = 2M_t^{(1)} - M_t^{(2)} ,$$

$$b_t = \frac{2}{N-1}(M_t^{(1)} - M_t^{(2)}) ,$$

where $M_t^{(1)}$ and $M_t^{(2)}$ are the first and the second moving average value respectively.

For the data in Table 3, the 2009 data is used to forecast the data in 2010 and 2012. When N = 2, we have

$$a_{09} = 2M_{09}^{(1)} - M_{09}^{(2)}$$

$$= 2 \times 95.715 - 87.445 = 103.985 ,$$

$$b_{09} = \frac{2}{2-1}(M_{09}^{(1)} - M_{09}^{(2)})$$
$$= 2 \times (95.715 - 87.445) = 16.54 ,$$

and the prediction equation is

$$Y_{t+\lambda} = 103.985 + 16.54\lambda .$$

Then,

$$Y_{10} = 103.985 + 16.54 = 120.525 \approx 120.53 ,$$

$$Y_{12} = 103.985 + 16.54 \times 3 = 153.605 \approx 153.61 .$$

For the data in Table 4, the 2009 data is still use to forecast the data in 2010 and 2012. If $N = 2$, we have

$$a_{09} = 2M_{09}^{(1)} - M_{09}^{(2)}$$

$$= 2 \times 8.615 - 7.5425 = 9.6875 ,$$

$$b_{09} = \frac{2}{2-1}(M_{09}^{(1)} - M_{09}^{(2)})$$
$$= 2 \times (8.615 - 7.5425) = 2.145 ,$$

and the prediction equation is

$$Y_{t+\lambda} = 9.6875 + 2.145\lambda .$$

Then,

$$Y_{10} = 9.6875 + 2.145 = 11.8325 \approx 11.83 ,$$

$$Y_{12} = 9.6875 + 2.1425 \times 3 = 16.115 \approx 16.12 .$$

So we obtain the data by moving and leveling method, as shown in the following table 3 and table 4. In this way, we have two complete tourism data. We can see that the two data have the increasing trend from the data in these two tables. If we want to confirm the linear trend or the curved trend, we must study the fitting of data trends. This requires a time series trend fitting method. These are the content of the next section.

Table 5 Domestic number of tourism original data of Siping city from 2003

to 2017

Year	Number of tourism （Thousands）	Year	Number of tourism （Thousands）
2003	46.55	2011	141.17
2004	52.19	2012	153.61
2005	55.11	2013	195.02
2006	60.51	2014	228.47
2007	71.14	2015	263.70
2008	87.21	2016	343.54
2009	104.22	2017	414.40
2010	120.53		

Table 6 Domestic incom of tourism smoothing data of Siping city from 2003 to 2017

Year	tourism revenue 100 million	Year	tourism revenue 100 million
2003	2.06	2011	15.68
2004	3.08	2012	16.12
2005	3.45	2013	24.72
2006	3.92	2014	30.23
2007	5.44	2015	37.55
2008	7.5	2016	49.34
2009	9.73	2017	63.10
2010	11.83		

4. Results Analysis of trend items of number of tourism data series

From the statistical yearbook of Jilin Province and the Statistical yearbook of Siping City, the domestic tourism revenue data from 2003 to 2017 were searched and collected. The time sequence of the data is as follows:

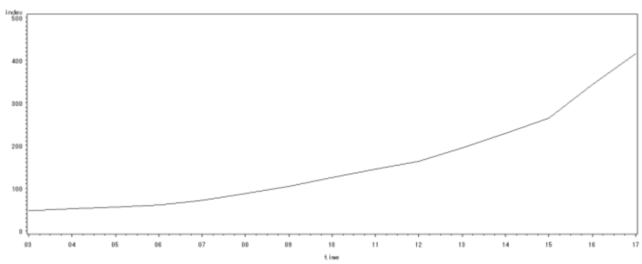


Fig. 1 Time series plot of Siping's domestic number of tourism from 2003 to 2017

It can be seen from the time sequence chart that the domestic tourism revenue data series of Siping from 2003 to 2017 has an obvious increasing trend, which is non-stationary, and its non-stationary is mainly caused by the long-term trend of the series.

4.1 Establishing the regression model

According to the curve growth characteristic of the sequence shown in the sequence diagram, the following quadratic trend model

$$\begin{cases} x_t = a + bt + ct^2 + I_t,\ t = 1,2,\cdots,15, \\ E(I_t) = 0,\ Var(I_t) = \sigma^2 \end{cases}$$

is attempted to be established for the series. Then we transform this model into a linear trend fitting model, let

$$t_2 = t^2,$$

we have

$$T_t = a + bt + ct_2,$$

so the above quadratic trend fitting model is transformed into linear trend fitting model

$$\begin{cases} x_t = a + bt + ct_2 + I_t, t = 1,2,\cdots,15 \\ E(I_t) = 0, Var(I_t) = \sigma^2 \end{cases}.$$

4.2 Estimation method of regression model parameters

This section we use the conditional least squares estimation method to calculate the estimate of the parameter the above model

$$x_t = a + bt + ct_2 + I_t, t = 1,2,\cdots,15.$$

Running by SAS statistical software, the results are as follows:

$$\hat{a} = 68.61769,\quad \hat{b} = -11.80576,\quad \hat{c} = 2.21113.$$

The estimates of each parameter in the model are listed in Table 5.

Table 5 Parameter estimation of regression equation and parameter T test

Variable	DF	Parameter estimation	Standard error	The value of the t statistic	p values
Intercept	1	68.61769	12.41160	5.53	0.0001
t	1	-11.80576	3.56961	-3.31	0.0063
t_2	1	2.21113	0.21695	10.19	< 0.0001

4.3 Significance test for regression equation

In this section, the significance of the model

$$x_t = a + bt + ct_2 + I_t, t = 1,2,\cdots,15$$

is tested by using F test, namely analysis of variance. The test results are listed in Table 6.

Table 6 F test of regression equation

Element	DF	Sum of squares	mean square value	Value of the F statistic	p values
Model	2	175751	87876	452.59	< 0.0001

According to the results in Table 6, the p value of The F test is significantly less than that of the *p* value discrimination method of the hypothesis test in mathematical statistics. It can be seen that the above regression equation is obviously established, that is, it is effective to extract the strong growth trend.

The test of significant non-zero regression coefficient in the regression model is t test. the corresponding data are listed in Table 5. It can be seen from Table 5 that the p value of the T test of the three coefficients is significantly less than that of the other three coefficients, so all the three coefficients are significantly non-zero.

Then the final fitting model is obtained as follow

$$x_t = 68.61769 - 11.80576t + 2.21113t^2 + I_t, t = 1,2,\cdots,15.$$

The fitting effect is shown in Figure 2.

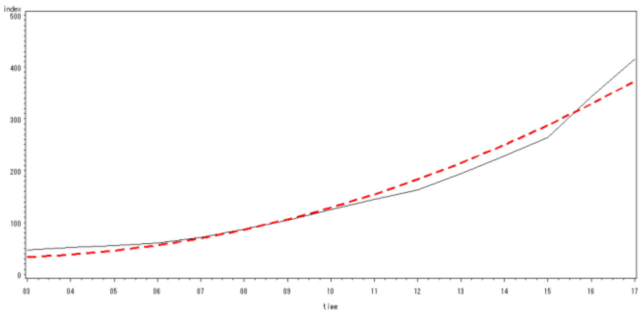
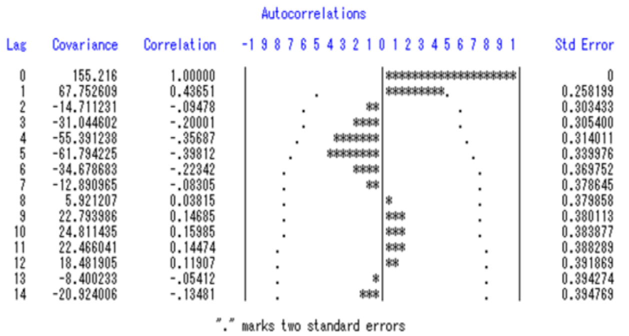


Fig. 2 The effect diagram of siping's domestic income of tourism series from 2003 to 2017

The dashed line in Figure 2 is the fitting curve, and the solid line is the timing diagram of the digital sequence. It can be seen from the fitting effect diagram that the final fitting model well fits the domestic number of tourism data series of Siping from 2003 to 2017.

The model can be used to predict the general trend of number of tourism in Siping in the next few years in the case that there is no big change in the comprehensive influence (i.e., no big change in the random factors).



Autocorrelations

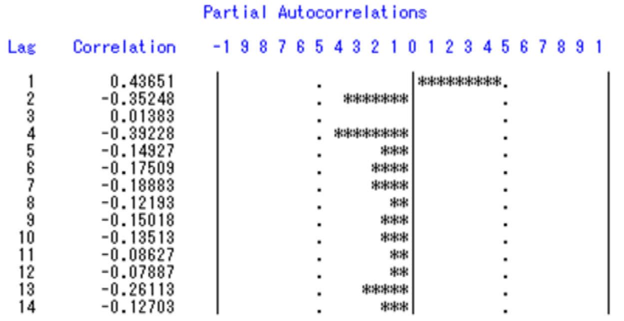
Lag	Covariance	Correlation	Std Error
0	155.216	1.00000	0
1	67.752609	0.43651	0.258199
2	-14.711231	-.09478	0.303433
3	-31.044602	-.20001	0.305400
4	-55.391238	-.35687	0.314011
5	-61.794225	-.39812	0.339976
6	-34.678683	-.22342	0.369752
7	-12.890965	-.08305	0.378645
8	5.921207	0.03815	0.379858
9	22.793986	0.14685	0.380113
10	24.811435	0.15985	0.383877
11	22.466041	0.14474	0.388289
12	18.481905	0.11907	0.391869
13	-8.400233	-.05412	0.394274
14	-20.924006	-.13481	0.394769

"." marks two standard errors

Fig. 3 Autocorrelation figure of residuals of the number of tourism in Siping city from 2003 to 2017

4.4 Correlation test for residuals of the number of tourism

By sorting out the data, the residual series of the number of domestic tourists in Siping from 2003 to 2017 can be obtained. SAS software is used to make a graphic analysis of the residual. The simulation results are shown in the figure below.



Partial Autocorrelations

Lag	Correlation
1	0.43651
2	-0.35248
3	0.01383
4	-0.39228
5	-0.14927
6	-0.17509
7	-0.18883
8	-0.12193
9	-0.15018
10	-0.13513
11	-0.08627
12	-0.07887
13	-0.26113
14	-0.12703

Fig. 4 Partial autocorrelation figure of of the number of tourism in Siping city from 2003 to 2017

We can see that the first-order autocorrelation coefficient falls within the range of 2 times standard deviation, and the fluctuation range is small from the autocorrelation diagram and partial autocorrelation diagram. It can be seen that the correlation of residuals is weak and the residuals can be considered as white noise. The p value of by the significance tested of the quadratic model is less than the given significance level, this again indicates that the residuals are not correlated, so it is unnecessary to choose the model to fit the residuals. The model we have chosen is valid .

5. Results Analysis of trend items of income of tourism data series

From the statistical yearbook of Jilin Province and the Statistical yearbook of Siping City, the domestic tourism revenue data from 2003 to 2017 are searched and collected. The time sequence of the data is as follows.

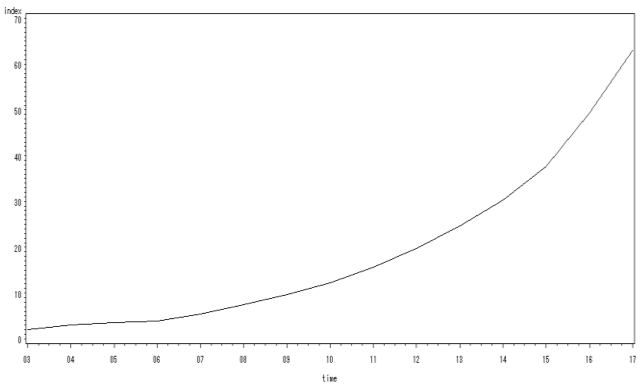


Fig. 5 Time series plot of Siping's domestic income of tourism from 2003 to 2017

It can be seen from the time sequence chart that the domestic tourism revenue data series of Siping from 2003 to 2017 has an obvious increasing trend, which is non-stationary, and its non-stationary is mainly caused by the long-term trend of the series.

5.1 Establishing the regression model

According to the curve growth characteristic of the sequence shown in the sequence diagram, the following quadratic trend model

$$\begin{cases} x_t = a + bt + ct^2 + I_t, t = 1,2,\cdots,15 \\ E(I_t) = 0, Var(I_t) = \sigma^2 \end{cases}$$

is attempted to be established for the series. Then we transform this model into a linear trend fitting model, let $t_2 = t^2$,we have $T_t = a + bt + ct_2$, so the above quadratic trend fitting model is transformed into linear trend fitting model

$$\begin{cases} x_t = a + bt + ct_2 + I_t, t = 1,2,\cdots,15 \\ E(I_t) = 0, Var(I_t) = \sigma^2 \end{cases}.$$

5.2 Estimation method of regression model parameters

This section we use the conditional least squares estimation method to calculate the estimate of the parameter the above model

$$x_t = a + bt + ct_2 + I_t, t = 1,2,\cdots,15.$$

Running by SAS statistical software, the results are as follows:

$$\hat{a} = 69.35701, \quad \hat{b} = -12.18760, \quad \hat{c} = 2.23485.$$

The estimates of each parameter in the model are listed in Table 7.

Table 7 Parameter estimation of regression equation and parameter T test

Variable	DF	Parameter estimation	Standard error	The value of the t statistic	p values
Intercept	1	69.35701	12.21845	5.68	0.0001
t	1	-12.18760	3.51406	-3.47	0.0046
t_2	1	2.23485	0.21357	10.46	< 0.0001

5.3 Significance test of regression equation

In this section, the significance of the model

$$x_t = a + bt + ct_2 + I_t, t = 1,2,\cdots,15$$

is tested by using F test, namely analysis of variance. The test results are listed in Table 8.

Table 8 F test of regression equation

Element	DF	Sum of squares	mean square value	Value of the F statistic	p values
Model	2	176157	88079	468.10	< 0.0001

According to the results in Table 8, the p value of The F test is significantly less than that of the P value discrimination method of the hypothesis test in mathematical statistics. It can be seen that the above regression equation is obviously established, that is, it is effective to extract the strong growth trend.

The test of significant non-zero regression coefficient in the regression model is t test. The corresponding data are listed in Table 7. It can be seen from Table 7 that the p value of the t test of the three coefficients is significantly less than that of the other three coefficients, so all the three coefficients are significantly non-zero.

Then the final fitting model is obtained as follow

$$x_t = 69.35701 - 12.18760t + 2.23485t^2 + I_t, t = 1,2,\cdots,15.$$

The fitting effect is shown in Figure 6.

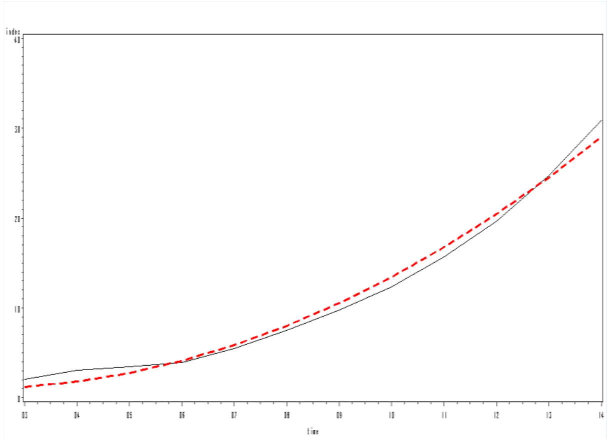


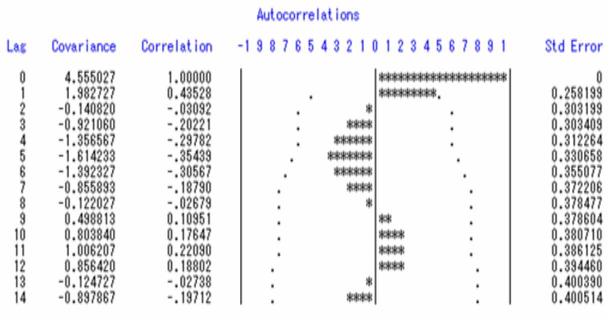
Fig.6 The effect diagram of siping's domestic income of tourism series from 2003 to 2017

The dashed line in Figure 6 is the fitting curve, and the solid line is the timing diagram of the digital sequence. It can be seen from the fitting effect diagram that the final fitting model well fits the domestic tourism revenue data series of Siping from 2003 to 2017.

The model can be used to predict the general trend of tourism revenue in Siping in the next few years in the case that there is no big change in the comprehensive influence (i.e., no big change in the random factors) (Tan,2018; Zhang, et al., 2019). By sorting out the data, the residual series of the number of domestic tourists in Siping from 2003 to 2017 can be obtained. SAS software is used to make a graphic analysis of the residual. The simulation results are shown in the figure below.

5.4 Correlation test for residuals of the income of tourism

By sorting out the data, the residual series of the number of domestic tourists in Siping from 2003 to 2017 can be obtained. SAS software is used to make a graphic analysis of the residual. The simulation results are shown in the figure below:



Autocorrelations

Lag	Covariance	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1	Std Error
0	4.555027	1.00000	********************	0
1	1.982727	0.43528	*********.	0.258199
2	-0.140820	-.03092	*	0.303199
3	-0.921060	-.20221	****	0.303409
4	-1.356567	-.29782	******	0.312264
5	-1.614233	-.35439	*******	0.330658
6	-1.392327	-.30567	******	0.355077
7	-0.855893	-.18790	****	0.372206
8	-0.122027	-.02679	*	0.378477
9	0.498813	0.10951	**	0.378604
10	0.803840	0.17647	****	0.380710
11	1.006207	0.22090	****	0.386125
12	0.856420	0.18802	****	0.394460
13	-0.124727	-.02738	*	0.400390
14	-0.897867	-.19712	****	0.400514

Fig. 7 Autocorrelation figure of tourism residuals of income of tourism in Siping city from 2003 to 2017

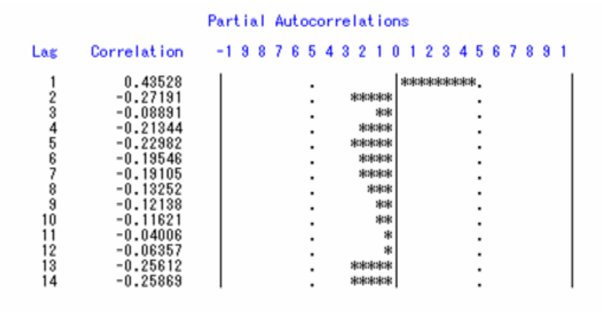


Fig. 8 Partial autocorrelation figure of residuals of income of tourism in Siping city from 2003 to 2017

We can see that the first-order autocorrelation coefficient falls within the range of 2 times standard deviation, and the fluctuation range is small from the autocorrelation diagram and partial autocorrelation diagram. It can be seen that the correlation of residuals is weak and the residuals can be considered as white noise. The p value of by the significance tested of the quadratic model is less than the given significance level, this again indicates that the residuals are not correlated, so it is unnecessary to choose the model to fit the residuals. The model we have chosen is valid.

6. Conclusion

Time series analysis is a very practical data modeling method, all kinds of economic data often take time as variable and are usually non-stationary, which is a kind of common time series data. Therefore, time series analysis is often used in the study of economic data such as tourism income. The trend fitting method in nonstationary time series analysis is applied in this paper, a quadratic trend fitting model is established for domestic tourism revenue data. The data started in 2004 because the SARS outbreak in 2003 had a great impact on the tourism industry. The fitting model established in this paper is obviously established, and the parameters are also significantly non-zero. It is a reasonable model that can be used to predict and further analyze the data. As is known to all, the data is natural, model is artificial, neither fitting model is right and wrong, only the difference between the good and bad, there is the fitting precision is high and low respectively, any model based on concerns of prediction of the trend of future development, not one hundred percent correct, any prediction precision, small error model can be used.

Acknowledgement

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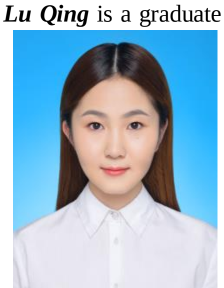

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