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What are the Factors that Determine the Number of People Coming to China?

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Abstract This paper studies the factors that affect people coming to China. We select the spending of United States and South Korea, GDP, railway transportation capacity of China as observations. Based on the data from 1988 to 2015, we use the ordinary least squares analysis regression model and present a most reasonable regression equation. It is found that South Korea's spending is negative to the number of visitors, whereas the spending of US is positive. On comparing the effect of other variables, the growth of railway transportation capacity and the overseas travel expenses of South Korea or United States, have almost no significant impact on the number of people coming to China. However, as China economic growth increasing rapidly, more and more people are willing to come.

Keywords Least squares analysis, regression, correlation coefficient.

MSC(2010) 62M10, 91B82.

1. Introduction

China attract countless visitors all over the world every year. The factors that determine the number of people coming the China draws considerable attention from the government and the general public [3, 4]. On the one hand, knowing the specific amount of decision can help us to control the number of people coming to China to a certain extent. For example, if GDP of is positively related to the number of foreigners in China, government will boost GDP in order to gain bigger benefit from tourism [10]. In this way, this also makes a great contribution to China's GDP, resulting in a virtuous circle. On the other hand, it is useful to predict and analyze the future after knowing the parameters of the impact. Commercial firms can advertise precisely. Not only that, but government is able to have political propaganda as well.

Understanding the effect of factors control numbers of visitors traveling to China is curial for at least three reasons. The rise of tourism will bring many benefits. First of all, as an important emerging labor-intensive industry, tourism can provide an important role in solving the employment problem of labor force [12]. The types of talents required for tourism are diverse, and most of the practitioners have lower

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technical requirements and it is easier to master the training. Therefore, it is possible to provide more jobs for some unemployed people with lower education levels and make due contributions to the stability of society. What is more, tourism can bring huge economic income to the country and society, get rid of regional poverty, promote commercial consumption, and accelerate economic growth [13]. Reasonable and optimized the industrial structure sector, as a non-productive industry, led other related industries; the rapid development of cross-border tourism has also played a positive role in the country's foreign exchange earnings. In addition, preserving and promoting the unique culture of the region, tourism developed local culture, promoted cultural exchanges in various regions learned from each other, and achieved common progress [14]. Because these remarkable reasons, finding the factors affect number coming to China is vital for us.

There are a number of studies that have done related to our topic. Chu etc [1] study the effects of GDP on visiting numbers of China. Mejia etc [2] look at the effects of visitors from China to US, apparently, we do the opposite. They find no statistically significant effect of numbers of people arrived China between GDP (China) and other factors.

This paper looks at the effect of not limited to GDP of China and parameters, including spending cost of travel, railway transportation capacity. Apart from that, this paper chooses two symbolized countries: South Korea, which is the country with the largest number of tourists visiting China in Asia; United State, with the world's largest economy. We chose these factors for two reasons: it is somewhat easier to calculate, and its magnitude is easier to interpret.

2. Data

The data on visiting reasons was constructed in the following way. From Bloomberg database, we collected US and South Korea international travel spending data from 1998 to 2015. We summed the total spending of US and South Korea international travel respectively. Whether it is South Korea or the United States, the increase in the number of tourists traveling abroad will inevitably have some connection with the number of tourists coming to China. At present, we are unable to determine the specific degree of impact and related directions, but the introduction of data can make our research more intuitive.

Additionally, we measured China's real GDP per capita and railway transportation capacity(million passenger-km), which were collected from World Bank database*. The transportation capacity of the railway reflects the degree of perfection of the infrastructure, which is related to the tourist traffic of foreign tourists to China. We do not take GDP data directly but logarithmically. Furthermore, it is seen by the scatter graph that there is a u-type trend, so a quadratic term is added to the regression. The abbreviations used in this paper are list in Table 1, the fluctuation of the logarithm of the obtained variables from 1998 to 2015 are shown in Figure 1.

*https://data.worldbank.org/indicator/IS.RRS.PASG.KM

Table 1. The abbreviations in this paper.

$thoupeotc\_n$:	the number of overseas Chinese;
$gdppc$:	the real GDP per capita;
$lrgdppc$:	the logarithm of $gdppc$;
$ultx$:	means squared $lrgdppc$;
$skspending$:	the international travel spending of South Korea;
$usspending$:	the international travel spending of US;
$railcarmpkm$:	the railway transportation capacity;
$lthoupeotc\_n$:	the logarithm of $thoupeotc\_n$;
lsk:	the logarithm of $skspending$;
lus:	the logarithm of $usspending$;
$lrail$:	the logarithm of $railcarmpkm$;
$corr$:	the correlation coefficient.

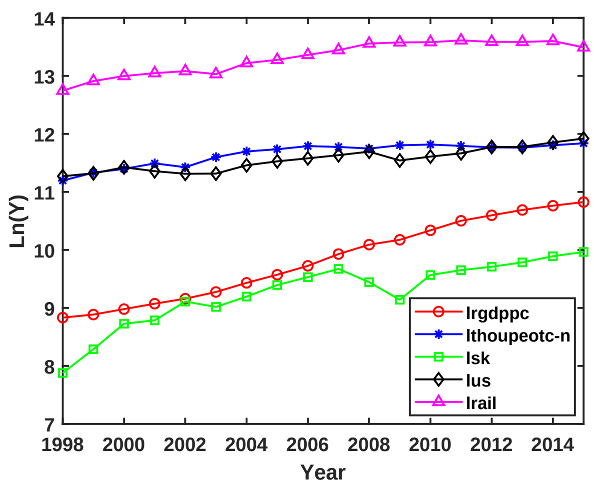

Figure 1. The fluctuation of the logarithm of variables from 1998 to 2015.

3. Regression analysis and empirical Result

We organize the collected data and use the MATLAB and/or STATA software to make the regression, where we use variables: $thoupeotc\_n$, representing the number of overseas Chinese, the unit is thousands; $lrgdppc$ is the logarithm of real GDP per capita; $ultx$ means squared $lrgdppc$; $skspending$ is international travel spending of South Korea; $usspending$ is international travel spending of US and $railcarmpkm$ representing Railway transportation capacity.

3.1. One-dimensional regression analysis

The variable, *thoupeotc_n*, as a function of other variables, is approximated by the regression equation. The one-dimensional regression analysis and the computation of corresponding regression coefficients are proceeding by MATLAB software.

After observing the distributions of the corresponding variables, the one dimensional regression model is assumed in form of: $y = p_1x^2 + p_2x + p_3$, where y represents the variable *thoupeotc_n*, and x represents another variable; p_1, p_2, and p_3 are the corresponding regression coefficients. The regression model can be wrote in matrix form,

$$\begin{pmatrix} y(1) \\ y(2) \\ \vdots \\ y(N) \end{pmatrix} = p_1 \begin{pmatrix} x^2(1) \\ x^2(2) \\ \vdots \\ x^2(N) \end{pmatrix} + p_2 \begin{pmatrix} x(1) \\ x(2) \\ \vdots \\ x(N) \end{pmatrix} + p_3 \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix}. \tag{3.1}$$

i.e., $Y = XP$, where,

$$Y = \begin{pmatrix} y(1) \\ y(2) \\ \vdots \\ y(N) \end{pmatrix}, X = \begin{pmatrix} x^2(1) & x(1) & \cdots & 1 \\ x^2(2) & x(2) & \cdots & 1 \\ \vdots & \vdots & & \vdots \\ x^2(N) & x(N) & \cdots & 1 \end{pmatrix}, P = \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix}.$$

Then, we can get $P = (X^TX)^{-1}X^TY$. It should be noted that, X^T means the transposition of matrix X, $(X^TX)^{-1}$ means the inverse matrix of X^TX, and $(X^TX)^{-1}$ will take the pseudo inverse if the matrix X^TX is degenerate. The regressions are shown in Figure 2, and the corresponding coefficients are list in Table 2.

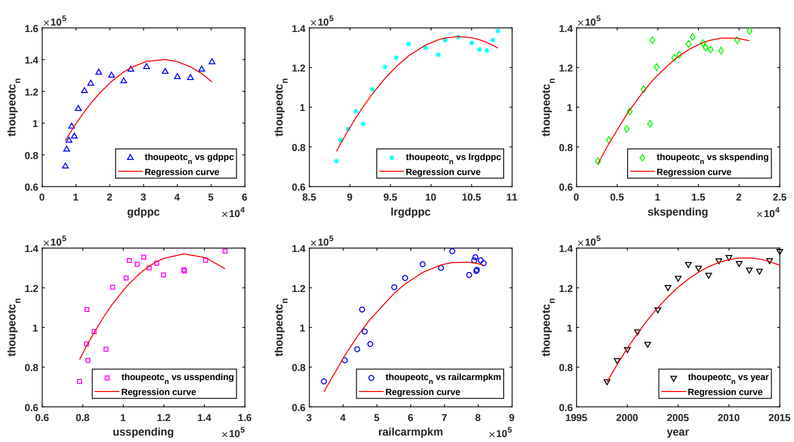

Figure 2. One-dimensional regression model: $y = p_1x^2 + p_2x + p_3$, where, variable y represents *thoupeotc_n*, variable x represents *gdppc*, *lrgdppc*, *skspending*, *usspending*, *railcarmpkm*, and *year*, respectively.

Table 2. Parameters corresponding to the regression model, $y = p_1x^2 + p_2x + p_3$.

x \ P	p_1	p_2	p_3
gdppc	6.3281e-05	4.4672	6.1291e+04
lrgdppc	-2.5333e+04	5.2414e+05	-2.5754e+06
skspending	-2.4433e-04	9.1642	4.9111e+04
usspending	-1.9523e-05	5.1013	-1.9616e+05
railcarmpkm	-3.9218e-07	0.5895	-8.8479e+04
year	-336.1285	1.3523e+06	-1.3601e+09

From this one dimensional regression, we can see that it is better to choose *lrgdppc* rather than *gdppc* as the parameter in regression analysis. Furthermore, it is reasonable to use the multivariate regression analysis in the study. Thus, we regress the relationship between *thoupeotc_n* and other variables by multivariate regression analysis.

3.2. Multivariate regression analysis

We first investigate the regression corresponding to the variable *railcarmpkm* and *year*. The regression model (Model 1) is set as, $y = p_1x_1 + p_2x_2 + p_3$, where y represents *thoupeotc_n*, x_1 represents the variable *railcarmpkm*, x_2 represents the variable *year*. p_1, p_2, and p_3 are the corresponding regression coefficients. The ordinary least squares method is used to solve these coefficients. Rewrite the regression model into matrix form,

$$\begin{pmatrix} y(1) \\ y(2) \\ \vdots \\ y(N) \end{pmatrix} = p_1 \begin{pmatrix} x_1(1) \\ x_1(2) \\ \vdots \\ x_1(N) \end{pmatrix} + p_2 \begin{pmatrix} x_2(1) \\ x_2(2) \\ \vdots \\ x_2(N) \end{pmatrix} + p_3 \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix}. \tag{3.2}$$

i.e., $Y = XP$, where,

$$Y = \begin{pmatrix} y(1) \\ y(2) \\ \vdots \\ y(N) \end{pmatrix}, X = \begin{pmatrix} x_1(1) & x_2(1) & \cdots & 1 \\ x_1(2) & x_2(2) & \cdots & 1 \\ \vdots & \vdots & & \vdots \\ x_1(N) & x_2(N) & \cdots & 1 \end{pmatrix}, P = \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix}.$$

Then, $P = (X^TX)^{-1}X^TY$, where, $(X^TX)^{-1}$ is the inverse or pseudo inverse of matrix X^TX. The regression results by STATA software are shown in Figure 3.

reg thoupeotc_n railcarmpkm year

Source	SS	df	MS			
				Number of obs	=	18
				F(2, 15)	=	37.57
Model	6.1403e+09	2	3.0701e+09	Prob > F	=	0.0000
Residual	1.2257e+09	15	81711909.2	R-squared	=	0.8336
				Adj R-squared	=	0.8114
Total	7.3659e+09	17	433290953	Root MSE	=	9039.5

thoupeotc_n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
railcarmpkm	.0769426	.0370813	2.07	0.056	-.0020943	.1559794
year	1240.864	1144.033	1.08	0.295	-1197.584	3679.313
_cons	-2421090	2273722	-1.06	0.304	-7267414	2425235

Figure 3. Regression results by STATA software for the Model 1: $y = p_1x_1 + p_2x_2 + p_3$. Where y represents *thoupeotc_n*, x_1 represents the variable *railcarmpkm*, and x_2 represents the variable *year*. p_1, p_2, and p_3 are the corresponding regression coefficients.

Next, we define the regression error as, $Error(y, y^*) = |y - y^*|/y$, where, y is the real value of *thoupeotc_n*, and y^* is the value of regressive function. The smaller Error indicates better regression. Moreover, we introduce the correlation coefficient between y and y^* as an index to characterize the regression. The closer to 1 of the correlation coefficient, the better regression of the model. The correlation coefficient between the variable y and y^* is defined as,

$$corr(y, y^*) = \frac{Cov(y, y^*)}{\sqrt{Var(y)Var(y^*)}}$$

where, $Cov(y, y^*)$ is the covariance between y and y^*, $Var(y)$ is the variance of y, and $Var(y^*)$ is the variance of y^*.

We add another variable (*lrgdppc*) to make a new regression (Model 2), $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4$. Where y represents *thoupeotc_n*, x_1 represents the variable *lrgdppc*, x_2 represents the variable *railcarmpkm*, and x_3 represents the variable *year*. p_1, p_2, p_3 and p_4 are the corresponding regression coefficients. The regressive results of Model 2 is shown in Figure 4. The comparison of the above two models are shown in Figure 5, and the correlation coefficients of these two models are listed in Table 4.

reg thoupeotc_n lrgdppc railcarmpkm year

Source	SS	df	MS			
				Number of obs	=	18
				F(3, 14)	=	44.02
Model	6.6599e+09	3	2.2200e+09	Prob > F	=	0.0000
Residual	706000016	14	50428572.6	R-squared	=	0.9042
				Adj R-squared	=	0.8836
Total	7.3659e+09	17	433290953	Root MSE	=	7101.3

thoupeotc_n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lrgdppc	-104909.1	32680.16	-3.21	0.006	-175001.1	-34817.15
railcarmpkm	.1488027	.0367381	4.05	0.001	.0700073	.2275981
year	12809.1	3713.995	3.45	0.004	4843.375	20774.83
_cons	-2.46e+07	7150373	-3.45	0.004	-4.00e+07	-9311293

Figure 4. Regression results by STATA software for the Model 2: $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4$. Where y represents *thoupeotc_n*, x_1 represents the variable *lrgdppc*, x_2 represents the variable *railcarmpkm*, and x_3 represents the variable *year*. p_1, p_2, p_3 and p_4 are the corresponding regression coefficients.

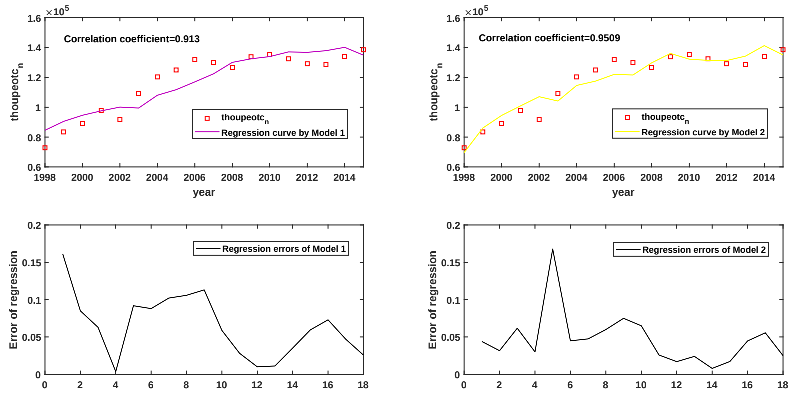

Figure 5. The regression and regression error of Model 1 and Model 2.

Obviously, we can see that due to the large p-value, China's railway carrying capacity has significant impact on the number of people in China. This also means that the quality of China's infrastructure is a necessary condition for foreign tourists to come to China.

What is more, the number of visitors come to China and the number of overseas tourists in South Korea and the United States is another area we should discuss. Regression model (Model 3) is defined as, $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4$, where y represents *thoupeotc_n*, x_1 represents the variable *skspending*, x_2 represents the variable *usspending*, and x_3 represents the variable *year*. p_1, p_2, p_3, and p_4 are the corresponding regression coefficients. Also addition of the variable *lrgdppc* is considered in Model 4. The regression results by STATA software of Model 3 and Model 4 are shown in Figure 6 and Figure 7, respectively. The regression curve and regression error of these two models are shown in Figure 8.

reg thoupeotc_n skspending usspending year

Source	SS	df	MS			
				Number of obs	=	18
				F(3, 14)	=	22.51
Model	6.1012e+09	3	2.0337e+09	Prob > F	=	0.0000
Residual	1.2648e+09	14	90341049.7	R-squared	=	0.8283
				Adj R-squared	=	0.7915
Total	7.3659e+09	17	433290953	Root MSE	=	9504.8

thoupeotc_n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
skspending	2.097688	1.46288	1.43	0.174	−1.039876	5.235253
usspending	−.6160433	.3598073	−1.71	0.109	−1.387753	.1556665
year	3819.698	1494.424	2.56	0.023	614.4776	7024.919
_cons	−7506512	2970981	−2.53	0.024	−1.39e+07	−1134390

Figure 6. Regression results by STATA software for the Model 3: $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4$. Where y represents *thoupeotc_n*, x_1 represents the variable *skspending*, x_2 represents the variable *usspending*, and x_3 represents the variable *year*. p_1, p_2, p_3, and p_4 are the corresponding regression coefficients.

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reg thoupeotc_n lrgdppc skspending usspending year
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Source	SS	df	MS			
				Number of obs	=	18
				F(4, 13)	=	15.68
Model	6.1012e+09	4	1.5253e+09	Prob > F	=	0.0001
Residual	1.2647e+09	13	97288402.2	R-squared	=	0.8283
				Adj R-squared	=	0.7755
Total	7.3659e+09	17	433290953	Root MSE	=	9863.5

thoupeotc_n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lrgdppc	-654.2213	40435.78	-0.02	0.987	-88010.41	86701.97
skspending	2.085135	1.704879	1.22	0.243	-1.598032	5.768302
usspending	-.6144603	.385993	-1.59	0.135	-1.448348	.219427
year	3910.58	5827.351	0.67	0.514	-8678.647	16499.81
_cons	-7682458	1.13e+07	-0.68	0.509	-3.21e+07	1.67e+07

Figure 7. Regression results by STATA software for the Model 4: $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4x_4 + p_5$. Where y represents $thoupeotc\_n$, x_1 represents the variable $lrgdppc$, x_2 represents the variable $skspending$, x_3 represents the variable $usspending$, and x_4 represents the variable $year$. p_1, p_2, p_3, p_4, and p_5 are the corresponding regression coefficients.

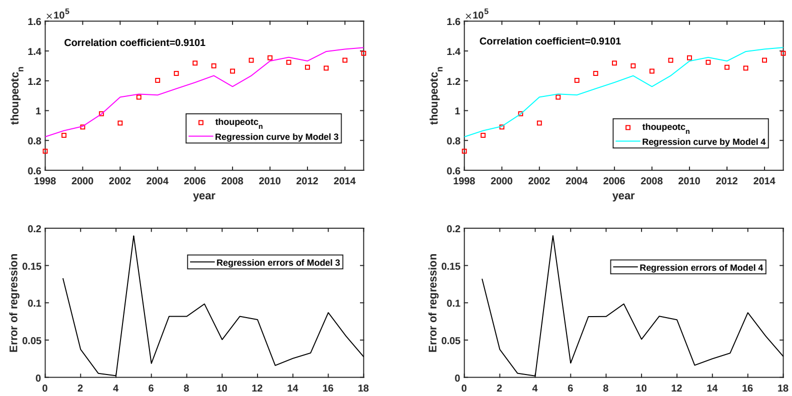

Figure 8. The regression and regression error of Model 3 and Model 4.

According to this regression results, the coefficient of South Korea's international tourism spending is positive. This means that in South Korea, the greater the cost of international tourism, the more tourists there are in China. Conversely, the coefficient of US international travel spending is negative. We can analyze that, perhaps relative to Americans, traveling to China is less than spending money in countries such as Northern Europe. This also explains the reason why the coefficient is negative. However, we cannot ignore that each p value is small. This also means that the international tourism spending of the two countries has a very small effect on the number of people coming to China.

Moreover, it is reasonable to consider the combination of all the variables to make the regression. The model can be assumed as: $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4x_4 + p_5x_5 + p_6x_6 + p_7$, where y represents $thoupeotc\_n$, x_1 represents the variable $lrgdppc$, x_2 represents the variable $ultx$, x_3 represents the variable $skspending$, x_4 represents the variable $usspending$, x_5 represents the variable railcarmpkm, and x_6 represents the variable year. $p_1 \sim p_7$ are the corresponding regression coefficients. The regression results by STATA software are shown in Figure 9.

Considering the effect of other variables, the overseas travel expenses of South Korea and the United States have almost no significant impact on the number of people coming to China. The same as for the China's infrastructure. Under other conditions. However, the number of people coming to China is increasing according to the year.

```
reg thoupeotc_n lrgdppc ultx skspending usspending railcarmpkm year

      Source |       SS           df       MS      Number of obs   =        18
-------------+----------------------------------   F(6, 11)        =     60.51
       Model |  7.1493e+09         6  1.1916e+09   Prob > F        =    0.0000
    Residual |   216617624        11  19692511.3   R-squared       =    0.9706
-------------+----------------------------------   Adj R-squared   =    0.9546
       Total |  7.3659e+09        17   433290953   Root MSE        =    4437.6

------------------------------------------------------------------------------
 thoupeotc_n |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lrgdppc |   615665.9   154155.9     3.99   0.002       276371    954960.8
        ultx |  -31419.91   6813.924    -4.61   0.001    -46417.25   -16422.56
  skspending |  -.6095876   .8954458    -0.68   0.510     -2.58045    1.361275
  usspending |   .2255244   .2086999     1.08   0.303     -.233821    .6848698
 railcarmpkm |  -.0377632   .0469802    -0.80   0.439     -.141166    .0656395
        year |   4509.436   3042.326     1.48   0.166    -2186.678    11205.55
       _cons |  -1.19e+07    5645648    -2.11   0.058    -2.44e+07    500496.7
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Figure 9. Regression results by STATA software for the Model 5: $y = p_1x_1 + p_2x_2 + p_3x_3 + p_4x_4 + p_5x_5 + p_6x_6 + p_7$, where y represents *thoupeotc_n*, x_1 represents the variable *lrgdppc*, x_2 represents the variable *ultx*, x_3 represents the variable *skspending*, x_4 represents the variable *usspending*, x_5 represents the variable railcarmpkm, and x_6 represents the variable year. $p_1 \sim p_7$ are the corresponding regression coefficients.

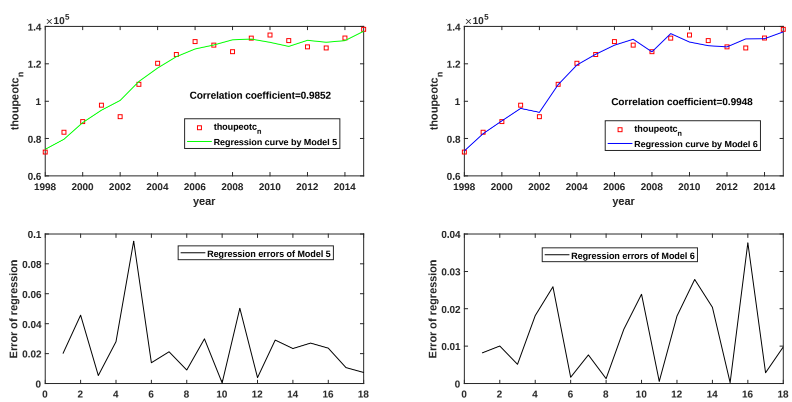

Figure 10. The regression and regression error of Model 5 and Model 6.

From the one-dimensional regression analysis, we can see the distributions of *thoupeotc_n* versus another variable is approximate quadratic polynomial distribution. Thus, the quadratic term of each variable including *lrgdppc*, *skspending*, *usspending*, *railcarmpkm*, and *year*, should be considered. The new regression model (Model 6) can be defined as, $y = p_1x_1^2 + p_2x_2 + p_3x_2^2 + p_4x_2 + p_5x_3^2 + p_6x_3 + p_7x_4^2 + p_8x_4 + p_9x_5^2 + p_{10}x_5 + p_{11}$, where, y represents *thoupeotc_n*, x_1 represents the variable *lrgdppc*, x_2 represents the variable *skspending*, x_3 represents the variable *usspending*, x_4 represents the variable *railcarmpkm*, x_5 represents the variable *year*, and $p_1 \sim p_{11}$ are the regression coefficients.

The results of corresponding regression coefficient are calculated by MATLAB software, the values of coefficient are listed in Table 3. The comparison of the regression and regression error of Model 5 and Model 6 are shown in Figure 10.

Table 3. The regression coefficients of the regression Model 6.

Parameter	*Value*	*Parameter*	*Value*
p_1	-1.2520e+04	p_2	2.0785e+05
p_3	4.1546e-04	p_4	-10.9013
p_5	-1.6887e-05	p_6	3.7617
p_7	-7.4573e-08	p_8	0.0474
p_9	-415.7505	p_{10}	1.6788e+06
p_{11}	-1.6956e+09		

Table 4. Correlation coefficient between the real values of $thoupeotc\_n$ and the regressive function values in various models.

	Model 1	*Model* 2	*Model* 3	*Model* 4	*Model* 5	*Model* 6
Correlation coefficient	0.9130	0.9509	0.9101	0.9101	0.9852	0.9948

On comparing the regression error and the correlation coefficients of the above 6 models, we find Model 5 and Model 6 are the relative optimal regression model (the correlation coefficient of each model is shown in Table 4). As we have analyzed before, GDP will affect the number of people in China to a certain extent. However, slower development in China is likely to cause US interest in China. When China develops rapidly and rises rapidly, it will cause the United States to panic in China. In addition, in model 5 the coefficient of South Korea's international tourism spending changes to negative and the coefficient of US international travel spending changes to positive, both the values are small and near to zero. In model 6, regression coefficients of the quadratic term (except *ultx*) are near to zero. Thus, only the quadratic term of *lrgdppc*, i.e., *ultx*, that needs to be considered in the regression. Although, the accuracy of Model 6 is better than Model 5, regression Model is the compatible one without complex calculations.

Therefore, we think the Model 5 as the appropriate regression:

$$\begin{aligned}(thoupeotc) = &- 2920148 + 615665(lrgdppc) - 31419.91(ultx)\\ &- 0.6095876(skspending) + 0.2255244(usspending)\\ &- 0.0377632(railcarmpkm) + 4509.436(year). \end{aligned} \tag{3.3}$$

Remark. We can also analyze the criticality of each variable by percolation theory according to the Reference [7], and characterise the dynamic behaviors base on bifurcation Theory according to Reference [6, 9, 11]. Moreover, it is still an open problem to build ODE/PDE model to character the variations of each variable from the system. PDEs with fixed or free boundary conditions [5, 8, 15] can be used to investigate the diffusion of tourists among regions.

4. Conclusion

Overall, we can conclude that with the economic growth, China are becoming a more attracting country. The economics plays a significant role in the attraction to the foreign people. A higher GDP help improving the quality of China's infrastructure. Moreover, the rising of high-speed railway not only make the residents enjoyed the more convenient tour experience, but also give an extra reason for those visitors who are confused in deciding which country they should go and set China as their destination. In addition, we suggest that the government should take the international tourism sector in a higher place. Especially for the Asian area, as a conventional and predetermined spread center of culture, China has been returning to the place she always to be in the history. Attracting more Asian traveler to China is beneficial to cultivate the image of herself in a steady multilateral economic and trade circumstance.

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