



# A Study on the Impact of High-Speed Rail Opening on the Development of Tourism in Chengdu Based on the Gray Prediction Model

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**Abstract.** High-speed rail is an important catalyst for urban development and has a huge impact on the realization of urban tourism benefits and economic development. Through the establishment of regression analysis equation and grey prediction model, combined with the comparison with and without, this paper empirically analyzes the impact and contribution of high-speed rail to the economic growth of tourism in Chengdu. The empirical results show that in the first few years of the opening of the high-speed rail, the contribution to the economic aggregate and the optimization of the industrial structure is rapid and has a significant impact. In particular, the contribution of high-speed rail to Chengdu's tourism revenue is more significant, much higher than the contribution rate of other indicators.

**Keywords:** Coupling Coordination Degree · Tourism Industry · Regional Economy · Chengdu City

## 1 Introduction

Transportation is the necessary carrier to establish the connection between the tourist destination and the source of tourists, and it is a prerequisite for the realization of tourist activities [3]. The perfection, convenience and accessibility of traffic conditions will directly affect the source market, income level and service quality of regional tourism, and then affect the sustainable development of tourism. Facing the challenges and opportunities of the transportation market, China's railways have entered a new stage of development. With the official opening of the Beijing-Tianjin intercity high-speed railway in 2008, my country has entered the "high-speed railway era". As a new mode of transportation, high-speed rail has the advantages of high efficiency, speed, safety, reliability, and punctuality and comfort. It is an important catalyst for urban development. After its opening, it can greatly shorten the time and space distance between cities along the line, strengthen the connection between cities, and help the citizens. The realization of tourism benefits and economic development of the economy and node cities have a huge impact. At the same time, the "high-speed rail effect" produced by it is also significant, and its specific manifestations include the same-city effect, multiplier effect, aggregation effect, image effect and negative effect [1]. In economic reality, it is an indisputable

fact that the opening of high-speed rail has a positive impact on social and economic development. It is also of great significance in improving the efficiency of public travel and promoting the development of tourism. This paper takes Chengdu as an example to empirically study the impact of high-speed rail on regional economic growth and tourism development, focusing on how much the opening of high-speed rail contributes to the development of tourism in Chengdu.

## 2 Overview of the Study Area

Chengdu City is located in the southwestern region of China, the western part of the Sichuan Basin, and the hinterland of the Chengdu Plain. The transportation inside and outside Chengdu is very developed. The subway and bus lines in the city are widely laid out, and the shared bicycles are all over the city. In terms of transportation outside the city, there are four complete railway stations in the south, south and northwest, and there are many high-speed rail and train lines under it. It is the largest railway hub in the southwest. In addition, Chengdu has very rich tourism resources. It is one of the top ten ancient capitals in the country and the first batch of national historical and cultural cities. As of the end of 2020, there are 51 scenic spots above 4A level, 78 hotels above three-star level, and travel agencies. 729, received 200 million tourists, and achieved a total tourism income of 300.52 billion yuan [2].

## 3 Empirical Analysis

The opening of high-speed rail has a positive role in promoting regional economic development, urban function improvement and tourism activities. This paper will study the impact of high-speed rail on Chengdu's economic growth through empirical analysis. Through data collection, the relevant economic indicators of Chengdu from 2001 to 2009 were obtained, and the regression model was used to obtain the equation of Chengdu's railway passenger traffic and economic growth indicators without high-speed rail, and the grey prediction method was used to predict the absence of high-speed rail from 2010 to 2016 of railway passenger traffic. Compare the economic growth indicators without high-speed rail with the actual growth indicators after the opening of high-speed rail, and deeply explore the contribution of high-speed rail construction to Chengdu's economic growth [5].

### 3.1 Indicator Selection and Data Sources

High-speed rail belongs to the transportation industry. The opening of high-speed rail can effectively solve the contradiction between the passenger and cargo flow in the railway transportation industry. Therefore, this paper selects the railway passenger volume to reflect the high-speed rail index. Economic growth starts from two aspects of economic aggregate growth and structural growth, and selects regional GDP, tourism revenue and three major industry added value indicators for empirical analysis (see Table 1). The relevant data in this article come from "Chengdu Statistical Yearbook" (2002–2010) and "2001–2009 Chengdu Statistical Bulletin of National Economic and Social Development".

### 3.2 Regression Model Building

In May 2010, Chengdu entered the “high-speed rail era”, using its relevant data from 2001 to 2009 to establish the relationship between railway passenger traffic and GDP, tourism revenue, added value of the primary industry, added value of the secondary industry and the third industry without high-speed rail. The regression equation of the value-added relationship of the tertiary industry.

The linear regression model equation is obtained from Table 1.

$$Y_{n,t} = \alpha + \beta X_t (n = 1, 2, 3, 4, 5; t = 2001, \dots 2009)$$

Among them,  $\alpha$ ,  $\beta$ : parameters to be estimated;  $X_t$ : railway passenger traffic in year  $t$  (10,000 people);  $Y_{n,t}$ : the value of the  $n$ th economic indicator in year  $t$ , where  $Y_1$  represents the regional gross domestic product (GDP) (100 million yuan),  $Y_2$  represents tourism revenue (100 million yuan),  $Y_3$  represents the added value of the primary industry (100 million yuan),  $Y_4$  represents the added value of the secondary industry (100 million yuan), and  $Y_5$  represents the added value of the tertiary industry (100 million yuan). The regression results are shown in Table 2.

It can be seen from Table 2 that the values in the five regression equations are all close to 1, indicating that  $X$  has a greater interpretation of  $Y$ , and the regression equations are well fitted. At the same time, the coefficient test  $P$  values in the above five models are all less than the significance level, indicating that  $X$  has a significant impact on  $Y$ . Therefore, it can be reflected that the railway passenger volume has a significant impact on GDP, tourism revenue and the added value of the three major industries.

**Table 1.** Relevant economic indicators of Chengdu in 2001–2009

year	railway passenger traffic /10,000 people	GDP/billion	tourism revenue /billion	value added of the primary industry/billion	value added of the secondary industry/billion	value added of the tertiary industry/billion
2001	2925	1490.86	142.0	132.54	676.13	682.19
2002	2896	1663.22	163.0	140.19	758.08	764.95
2003	2601	1870.80	174.1	153.18	859.07	858.55
2004	3048	2185.73	216.8	168.01	1021.99	995.73
2005	7931	2371.01	272.5	182.29	1107.67	1181.05
2006	8837	2750.48	324.1	195.13	1211.61	1343.74
2007	10125	3324.40	415.2	235.52	1504.01	1573.40
2008	10983	3900.98	375.4	270.15	1816.66	1814.17
2009	11101	4502.60	501.3	267.77	2001.80	2233.04

**Table 2.** Regression equations of railway passenger volume and various economic indicators without high-speed rail

equation	fit regression equation	R <sup>2</sup>	P
Equation 1 GDP	$Y_{1,t} = 987.680 + 0.251X_t$	0.831	0.000
Equation 2 tourism revenue	$Y_{2,t} = 78.093 + 0.031X_t$	0.881	0.000
Equation 3 value added of the primary industry	$Y_{3,t} = 106.963 + 0.013X_t$	0.866	0.000
Equation 4 value added of the secondary industry	$Y_{4,t} = 464.335 + 0.112X_t$	0.827	0.000
Equation 5 value added of the tertiary industry	$Y_{5,t} = 421.380 + 0.127X_t$	0.844	0.000

**Table 3.** Railway passenger traffic in Chengdu from 2001 to 2009

	(Unit: 10,000 people)								
year	2001	2002	2003	2004	2005	2006	2007	2008	2009
serial number	1	2	3	4	5	6	7	8	9
$X^{(0)}$	2925	2896	2601	3048	7931	8837	10125	10983	11101

**3.3 The Establishment of Grey Forecasting Model**

Based on the accumulated data of railway passenger traffic in Chengdu from 2001 to 2009 (see Table 3), a grey prediction model is established to predict the railway passenger traffic in Chengdu without high-speed rail from 2010 to 2016.

Accumulate the original sequence data  $x^{(0)}$  in Table 3 to generate a new data sequence:

$$X^{(1)} = [2925, 5821, 8422, 11470, 19401, 28238, 38363, 49346, 60447]$$

Set up a first-order differential equation for  $X^{(1)}(k)$ :

$$\frac{dX^{(1)}(k)}{dk} + aX^{(1)} = b$$

Among them, a and b represent undetermined coefficients. Using MATLAB7 to calculate, get the estimated parameter values  $\hat{a} = -0.0486$ ,  $\hat{b} = 22829.0572$ , then the time response equation of railway passenger volume is:

$$\hat{x}^{(1)}(k + 1) = 472658.6872e^{0.486k} - 469733.6872$$

Substituting into this equation, the predicted value of railway passenger volume in the absence of high-speed rail from 2010 to 2016 is  $X = [14146, 15955, 17855, 19849, 21942, 24140, 26446]$ . After model testing, the posterior variance ratio  $C = 0.1002 < 0.35$ , the small error probability  $P = 1.000$ . Therefore, the model fitting accuracy is good, and the predicted railway passenger volume data is valid without high-speed rail.

### 3.4 Empirical Results and Analysis

Substitute the predicted value of railway passenger traffic without high-speed rail from 2010 to 2016 into the linear regression model equation in Table 1, and obtain five economic indicators without high-speed rail. The contribution rate of high-speed rail to economic growth indicators (%) = (with high-speed rail indicators - no high-speed rail indicators)/no high-speed rail indicators  $\times$  100%, the results are shown in Table 4.

## 4 Analysis of the Connection Between High-Speed Rail and Chengdu's Tourism Industry

### 4.1 Economic Growth Analysis

From Table 4, it can be seen that the GDP value of Chengdu with high-speed rail from 2010 to 2016 is much higher than that without high-speed rail, indicating that the opening of high-speed rail has a significant effect on regional economic growth. Driven by the high-speed rail effect, Chengdu's GDP exceeded one trillion in 2014, however, there is still a big gap between the GDP value and the trillion mark without high-speed rail. The contribution rate of high-speed rail to GDP in the seven years since its opening and operation has shown an upward-downward-upward trend, of which the decline rate is small, and the overall trend is still rising and relatively stable. In general, the impact of high-speed rail on economic growth has increased significantly in the first few years, and the momentum has been rapid, especially in driving the economic growth of urban tourism. The data in the table shows that the contribution rate of high-speed rail to Chengdu's tourism revenue has grown rapidly and is significantly higher than the contribution rate of other indicators. 178.69%. In May 2010, Chengdu ushered in the "high-speed rail era". According to statistics, during the National Day of the same year, the cumulative number of travel agencies received 2,643, an increase of 7.00% over the previous year. From 2011 to 2014, travel agencies have The growth rates of the cumulative number of groups received were 69.96%, 30.50%, 21.75%, and 16.88%, respectively. It can be seen from this that the high-speed rail had a huge stimulating effect on the tourism market when it first opened. In December 2014, the Chengmian-Leshan high-speed railway was opened to traffic, with Chengdu as the center, passing Deyang and Mianyang to the north, and Meishan and Leshan to the south. It is the most economically developed, densely populated and most touristic economy in Sichuan Province Vibrant region [4]. In 2015, Chengdu's tourism revenue reached 204.002 billion yuan with high-speed rail, which is 2.47 times that without high-speed rail. As an important central city in the western region, Chengdu actively responds to the central government's "Western Development" strategy and drives the realization of tourism benefits in the region. Develop the local tourism business economy and realize the rapid development of the regional economy.

### 4.2 Economic Structure Growth Analysis

In 2010, the contribution rates of high-speed rail to the added value of the primary, secondary and tertiary industries were 1.98%, 21.10%, and 25.58%, respectively. It can

**Table 4.** Comparison of economic growth indicators of Chengdu with and without high-speed rail from 2010 to 2016

economic indicators	before and after the opening of the high-speed rail	year 2010	year 2011	year 2012	year 2013	year 2014	year 2015	year 2016
GDP	high-speed rail	5551.33	6950.58	8138.94	9108.89	10056.59	10801.16	12170.23
	no high-speed rail	4538.33	4992.39	5469.28	5969.78	6495.12	7046.82	7625.63
	contribution rate/%	22.32	39.22	48.81	52.58	54.83	53.28	59.60
tourism revenue	high-speed rail	603.90	805.01	1050.78	1330.66	1663.37	2040.02	2502.45
	no high-speed rail	516.62	572.70	631.60	693.41	758.30	826.43	897.92
	contribution rate/%	16.89	40.56	66.37	91.90	119.36	146.85	178.69
value added of the primary industry	high-speed rail	285.09	327.34	348.10	353.17	357.07	373.15	474.94
	no high-speed rail	290.86	314.38	339.08	365.00	392.21	420.78	450.76
	contribution rate/%	-1.98	4.12	2.66	-3.24	-8.96	-11.32	5.36
value added of the secondary industry	high-speed rail	2480.96	3143.82	3765.62	4181.49	4508.53	4723.49	5201.99
	no high-speed rail	2048.69	2251.30	2464.10	2687.42	2921.84	3168.02	3426.29
	contribution rate/%	21.10	39.64	52.82	55.59	54.30	49.10	51.83
value added of the tertiary industry	high-speed rail	2785.34	3479.42	4025.22	4574.23	5190.9	5704.52	6493.30
	no high-speed rail	2217.92	2447.67	2688.97	2942.21	3208.01	3487.16	3780.02
	contribution rate/%	25.58	42.15	49.69	55.47	61.81	63.59	71.78

be seen that the first year of the high-speed rail had a negative effect on the growth of the primary industry, and had a negative impact on the growth of the secondary industry, the growth of the three industries has a positive effect, and the contribution rate of high-speed rail to the added value of the three industries is quite different. It can be seen from Table 4 that the contribution rate of the high-speed rail to the added value of the primary industry for 7 years is negative for 4 years, and the highest contribution rate for the remaining three years is only 5.36%, and the contribution rate of the high-speed rail to the secondary and tertiary industries. Significantly larger than the primary industry. The contribution rate of high-speed rail to the added value of the secondary industry shows an upward-downward-rising trend, and the contribution rate to the added value of the tertiary industry has been on an upward trend and is generally higher than that of the secondary industry. After the opening of the high-speed railway, it will bring opportunities to urban transportation, tourism, social services and other industries with its advantages of high efficiency and convenience, thereby driving the rapid development of the urban tertiary industry. It can be seen from the above analysis that the opening of the high-speed rail has had a significant impact on the adjustment of Chengdu's industrial structure and economic transformation and upgrading.

## 5 Conclusions

As a systematic project that has a comprehensive driving effect on the development of the national economy, high-speed railway plays an important role in the development of tourism. After its completion and opening to traffic, it has changed the regional economic model, greatly shortened the time and space distance between cities, and promoted short-distance tourism. Form a high-speed rail tourism circle. This paper empirically analyzes the impact and contribution of high-speed rail to the economic growth of Chengdu's tourism industry by establishing regression analysis equations and grey prediction models, combining with and without comparison. The empirical results show that in the first few years of high-speed rail operation, the contribution to the optimization of the economic aggregate and industrial structure has been rapid. In particular, the contribution of high-speed rail to Chengdu's tourism revenue is very significant, much higher than the contribution rate of other indicators. For Chengdu, the tourism industry has now entered a mature stage, and the tourism market structure is relatively stable. However, in order to meet the diversified travel needs and tourism purposes of tourists, Chengdu should seize the "high-speed rail opportunity" in time, build a tourism brand, and improve comprehensive strength, to achieve effective docking with the ever-expanding tourism market demand, thereby promoting the higher and faster development of the urban economy.

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