

Research on Quantitative Calculation of Tourism Development and Economic Benefit Enhancement by the Opening of High-Speed Railway in Ethnic Areas

Lili Liu¹, Jianliang Li¹, 

¹ Business School, Beijing Information Science and Technology University, Beijing, 100000, China

ABSTRACT

The construction and opening of high-speed railroads have brought new development opportunities to China's ethnic regions, which are economically backward but rich in tourism resources. From the perspective of the impact of high-speed rail on regional tourism, this paper briefly analyzes the homogenization effect and accessibility effect that the construction of high-speed rail brings to the corresponding region. Accordingly, it puts forward the relevant research hypotheses on the impact of high-speed rail on regional tourism and analyzes the current situation of tourism market development in China's A ethnic region. Under this premise, the model of high-speed railroad influence on tourism development level is designed and relevant research variables are selected. Based on the model, the empirical analysis of the impact of high-speed railroad on tourism in ethnic region A is launched. The study points out that the opening of high-speed railroad significantly promotes the total tourism income of ethnic region A at the 1% level, i.e., the opening of high-speed railroad has a positive positive effect on the tourism development of ethnic regions.

Keywords: high-speed railroad; tourism development level; accessibility effect; tourism income

1. Introduction

As an external embodiment of the comprehensive strength of the country in the new era, high-speed railroad can produce a huge time and space compression effect, which has a profound impact on the way of human production and life [1-2]. As an important symbol of transportation modernization, it supports the construction of a modern comprehensive transportation hub system, promotes the efficient flow of economic factors and large-scale movement of population between regions, city clusters and provinces, and becomes a new engine for the economic development of city clusters [3-6]. Among them, the vigorous construction of high-speed railways has the most tremendous impact on tourism [7]. With the transformation of China's basic contradiction, people's desire for a

 Corresponding author.

E-mail address: eloise912@126.com (J. Li).

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better life is growing, tourism as an important embodiment of the improvement of the quality of life, the number of tourists in the country is increasing day by day, and the demand for tourism transportation is more and more urgent [8-10]. High-speed rail has an important impact on regional accessibility and tourism spatial pattern due to its convenience, timeliness, safety and comfort [11-12]. At the same time, it has the characteristics of time and space compression, punctuality, and efficiency, so that the value experience and travel enthusiasm of tourists are improved, which in turn affects their travel behavior and increases the number of travelers' trips [13-15]. Therefore, the opening of high-speed railroad is conducive to driving the rapid development of tourism economy in the cities along the high-speed railway, which has a strong guiding effect on the regional tourism development and economic benefits [16-18].

The impact of high-speed rail on regional tourism and economy has become a hot topic. Li, M., and Chen, J. used the MGM(1,n) grey model to explore the impact of high-speed rail on tourism development and economic improvement in China's "1 8" urban tourism circle, and it was superficial that high-speed rail promoted the growth of the overall regional economy while increasing tourism revenue [19]. Wang, S. et al. found that high-speed rail is conducive to promoting the development of tourism economy through an empirical study based on the difference method, and that the driving effect of high-speed rail network on the tourism economy will have a more positive impact in the central city and the city with high abundance of tourism resources [20]. Yang, Z. and Li, T. showed that the attractiveness of high-speed rail service for inbound tourists is significantly higher than that of domestic tourists, and economic benefits are realized by promoting the rapid growth of inbound tourism revenue in the region [21]. Shu, H. et al. emphasize that the opening of high-speed rail lines has both positive and negative impacts on tourism efficiency; on the one hand, high-speed rail facilitates the optimization of the allocation of tourism resources between regions and thus contributes to the improvement of tourism efficiency, while on the other hand, it widens the technological differences between regions and thus leads to a slowdown in the growth of efficiency [22]. Li, L. S. et al. analyzed the relationship between high-speed rail and tourism with an urban-un perspective, where high-speed rail realizes the cross-regional flow of inbound tourists by connecting the core cities and promotes the rapid growth of economic benefits, while the regional cores suffer a certain degree of loss due to the accessibility of high-speed rail [23]. Jin, S. et al. quantitatively examined the relationship between urban accessibility and tourism economic development supported by high-speed rail from the perspective of transportation networks, destinations, and economic factors, and proposed a tourism-economic linkage model aimed at promoting the high-speed development of regional tourism [24]. Wang, Q. and Lu, S. conducted a dynamic assessment of the accessibility of cities and tourism scenarios in the high-speed rail network, while applying the difference method to measure the impact it has on the regional tourism economy, showing that the stable development of the economic benefits of urban tourism can be achieved by strengthening the mixed accessibility of the high-speed rail network [25]. Wang, D. G. et al. studied the characteristics of the spatial pattern of the urban hinterland before and after the high-speed rail network and its evolution, indicating that the high-speed rail network effectively strengthens the economic and spatial links between cities, and ultimately creates a spatial pattern of tourism that presents high-quality development [26]. Shi, K. et al. revealed the comparative advantages of tourism in different node cities under the influence of high-speed rail from the perspective of transfer of transportation advantages, node cities and non-node cities rely on the hotel industry and scenic area industry to obtain tourism economic development, respectively, in which the node cities have faster growth of tourism revenue [27]. Comprehensively, the above studies found that high-speed rail has positive effects on tourism development, and by improving the accessibility between tourist cities and increasing the attractiveness of tourists, it can achieve the value impact of promoting regional economic development. However, in the existing researches, the research object mainly focuses on the eastern coastal developed regions, and pays less attention to the western ethnic regions, and the

content mainly discusses the spatial structure and tourism economy caused by high-speed railroads, but does not analyze its action mechanism in depth.

Due to historical reasons, the economic development of ethnic regions in western China is relatively backward, but rich in tourism resources [28]. For many years, the backward transportation conditions have seriously constrained the development of tourism and economy in the western region, and the opening of high-speed railroads has brought about a turnaround [29-30]. The spatial and temporal compression effect of high-speed railroad reduces the psychological distance of tourists and lowers the risk of tourists' control of time, shortens the time distance between western ethnic areas and the main source of tourists, and becomes the first choice of transportation for tourists' short- and medium-distance trips [31-33]. Therefore, by quantitatively calculating the impact effect and mechanism of high-speed rail service on the development of tourism economy in ethnic areas, it can provide support for the high-quality development of tourism economy in ethnic areas [34-35].

This paper theoretically discusses the tourism impact effect brought by high-speed railway construction, puts forward the research hypothesis of the role of high-speed railway opening on the tourism impact of the region where it is located, and analyzes the current development status of the tourism market in China's ethnic areas. Then it proposes a model of high-speed railroad affecting tourism development level, designs model variables and carries out descriptive statistical analysis of variables. Subsequently, based on the panel data of China's ethnic region A, the model variables are modified and determined, and the baseline regression analysis and path analysis are carried out to verify the research hypothesis that the opening of high-speed railways has an impact on the tourism of the region in which it is located. Finally, the appropriateness of the model is tested by parallel trend test. The reliability of the empirical analysis results is verified by the placebo test.

2. Analysis of the impact of high-speed rail on regional tourism

This chapter is the basic chapter of this paper. This chapter describes the main tourism impact effects brought by high-speed rail, accordingly puts forward the research hypothesis of high-speed rail and regional tourism impact paths, and finally briefly summarizes the current development status of China's ethnic areas tourism market in terms of the number of tourists and tourism income.

2.1. *Tourism Impact Effects of the High Speed Railway*

2.1.1. Co-location effect. The so-called co-location effect refers to the blurring of administrative boundaries between neighbouring cities as a result of improved transport conditions and the compression of temporal and spatial distances, and the gradual integration and coordinated development of individual cities. Co-citizenization is not the original scale expansion, but presents the region with certain radiation intensity and competitiveness. Co-citizenship can also be understood as the flow and spread of various resource elements in a wider range of cities, forming a common prosperity of the regional group.

The upgrading and improvement of transportation facilities provide a basic guarantee for the development of co-citizenship. The tourism elements between cities tend to flow more frequently with the improvement of transportation conditions. Inter-city tourism cooperation is therefore easier, and regional tourism clusters are gradually born. High-speed railway has the advantages of speed and high frequency of departure, which improves the efficiency of inter-city tourism. The development of high-speed rail tends to be in the mode of "public transportation", which eliminates the obstacles of inter-city connection and creates conditions for tourism co-location. For example, after the opening of Beijing-Shanghai high-speed railway, Jinan-Qufu can be reached in 30 minutes, and Qufu is influenced by Beijing-Shanghai high-speed railway, which promotes the effect of tourism co-location with key cities in the province.

2.1.2. *Accessibility effects.* Both globally and in terms of China's national conditions, tourism transportation is playing an increasing role in modern life and its status has been significantly enhanced. The development of tourism requires certain transportation conditions as support. Tourists need to realize the problem of spatial movement from their residence to tourist attractions when they generate tourism demand. Tourists usually work outside the leisure time is relatively small, if the completion of the spatial movement of the time spent beyond the expected goal of the tourists, the tourists will be adjusted accordingly as well as re-selected tourist destinations, or even give up the travel plan. Therefore, the type of transportation and the amount of experience required are issues that need to be addressed in advance.

2.2. *Formulation of research hypotheses*

First of all, the development of tourism economy is not only dependent on the unique tourism resources, but also subject to the constraints of tourism accessibility, the opening of high-speed rail can provide transportation convenience at the same time, so that tourists travel to increase the scope of travel, tourists to save the cost of time, will inevitably have more play and sightseeing time, resulting in an increase in the consumption expenditure of the residents, the market tourism revenue increases. Tourism income is the standard for assessing and defining the economic efficiency and development of tourism in a region, and is the financial income that the tourism market obtains by selling tourism products to tourists and providing quality services for tourists. In this paper, we set the average tourism revenue of A national region, which is expressed by the ratio of all tourism revenue in a region in a certain period of time to the resident population of the region, and because of the different sizes of each city within the A national region, the use of the average tourism revenue is more reflective of the overall level of economic development of tourism in a region.

Based on this, hypothesis 1 is proposed: the opening of high-speed rail is conducive to enhancing the accessibility of tourist places in ethnic regions and promoting the development of tourism economy.

Secondly, high-speed rail transportation and road transportation are both forms of residents' going out, and according to the big data statistics, it is known that road transportation is still the most chosen mode of residents' travel, and the total number of road passengers accounts for the highest proportion of the total number of the whole passenger transportation. According to the research, it is found that if a region has a higher level of highway development, then its overall transportation operation capacity will be stronger, and the effect of the construction and operation of high-speed rail on the transportation framework of the whole region will be more obvious, and the marginal contribution will be smaller.

Based on this, hypothesis 2 is proposed: the development level of highway transportation in ethnic areas has a negative impact on the opening of high-speed rail on the regional tourism economy.

2.3. *Current Situation of China's Ethnic Area Tourism Market Development*

The current status of the development of China's A-ethnic regions in China's tourism market revenue from 2005 to 2020 is shown in Figure 1.

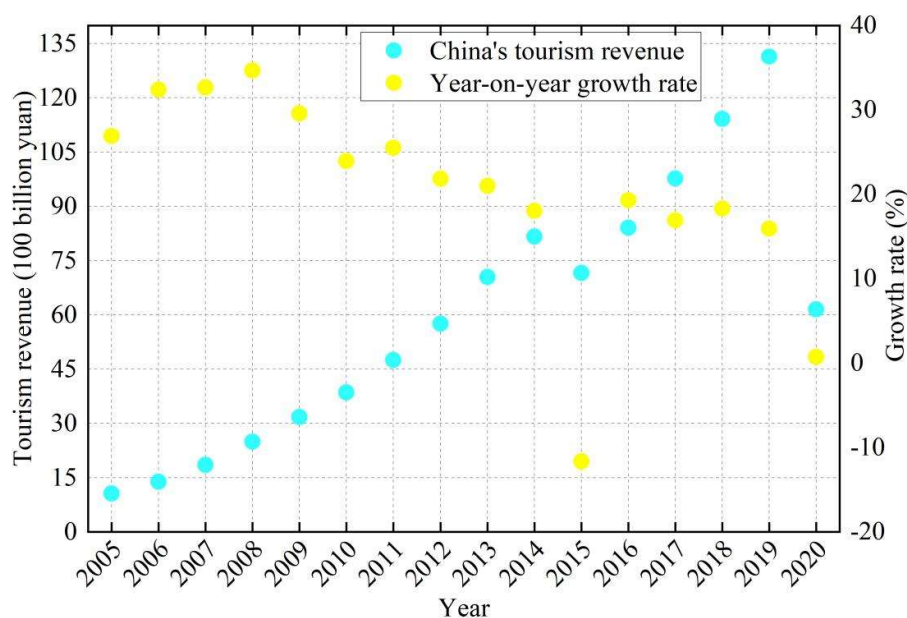


Fig. 1. Development status of tourism revenue from 2005 to 2020

From Figure 1, it can be seen that the number of Chinese tourists in China's ethnic region A from 2005 to 2020 has been maintaining a growth trend, indicating that the tourism industry in China's ethnic region A has been maintaining a stable development, in which the year-on-year growth of the number of tourists in 2008 was the largest. The number of tourists grew from 1.386 billion in 2005 to 13.141 billion in 2019, an increase of about 9.48 times. The year-on-year growth rate of the number of tourists per year has largely stabilized and has been at a positive growth rate.

The current status of the development of the revenue of China's A ethnic regions in China's inbound tourism market from 2005 to 2020 is shown in Figure 2.

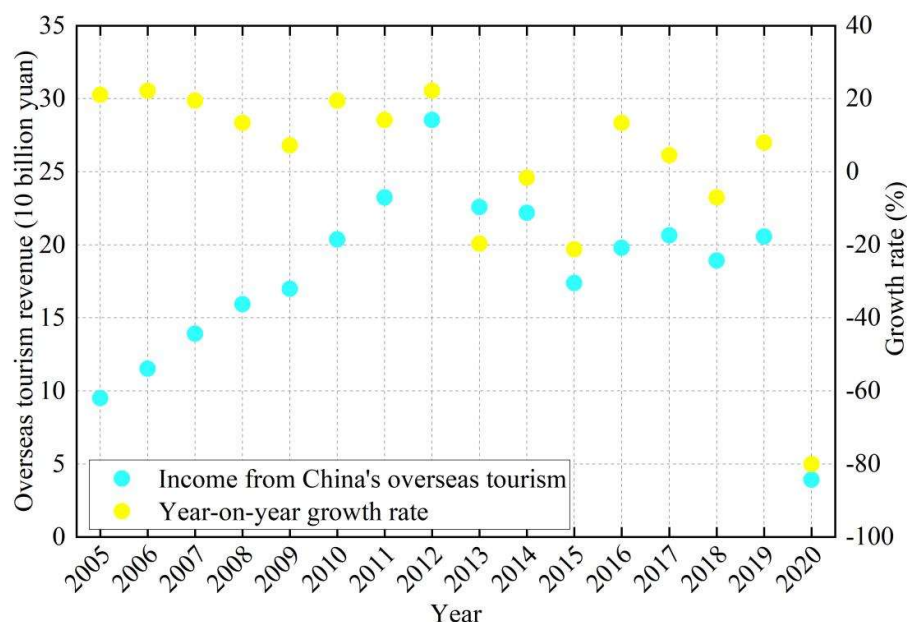


Fig. 2. Development status of overseas tourism revenue in China from 2005 to 2020

From Figure 2, it can be seen that the inbound tourism revenue from 2005 to 2020 also shows a steady growth year by year, and the year-on-year growth rate of the inbound tourism revenue of China's A-nationality regions between 2005 and 2020 decreases from 21.06% in 2005 to -80.05% in

2020, which is the most obvious change. The inbound tourism revenue of China's A ethnic region grew from 9.50 tens of billions of yuan in 2005 to 20.56 tens of billions of yuan in 2019, an increase of about two times. However, in 2020, both the number of inbound tourists and inbound tourism revenue in China's A ethnic region showed a downward trend compared with 2019, and the inbound tourism revenue decreased from 20.56 tens of billions of yuan in 2019 to 3.93 tens of billions of yuan in 2020, which may be caused by the emergence of the New Crown Epidemic.

3. Modeling of the level of tourism development affected by high-speed railroads

On the basis of the above theoretical foundation and phenomenon analysis, we design the tourism development level model, accessibility model and intermediary effect model from the three aspects of tourism development level measurement, tourism accessibility and intermediary effect test, and synthesize the three to form a model of high-speed railroad affecting the tourism development level and design the model variables.

3.1. Construction of the model

3.1.1. Modeling the level of tourism development. At present, the measurement of the level of regional tourism development mostly adopts the number of tourists and tourism revenue, but it is difficult for a single indicator to truly express the comprehensive development level of tourism, so the level of regional tourism development is measured by the comprehensive evaluation method with four indicators, namely, domestic tourism revenue, foreign exchange income from tourism, the number of domestic tourists and the number of inbound tourists, and the formula is shown in equation (1):

$$TP_{\theta i} = \sum_{j=1}^n (w_j x'_{\theta ij}) \quad (1)$$

Where: $TP_{\theta i}$ is the tourism development level of θ region in the i th year. w_j is the weight of the j th indicator, which is determined by entropy method. $x'_{\theta ij}$ is the normalized value of the j th indicator in the i th year of the θ region.

3.1.2. Accessibility model. There are more ways to measure the accessibility, this paper uses the weighted average travel time to construct the accessibility model to measure the regional tourism accessibility as in equation (2):

$$A_i = \frac{\sum_{j=1}^n (T_{ij} \times M_j)}{\sum_{j=1}^n M_j} \quad (2)$$

Where: A_i is the tourism accessibility of region i , the smaller the value, the better the accessibility. T_{ij} is the shortest time for region i to reach region j , and M_j is the GDP of region j .

3.1.3. Mediated effects model. High-speed railroads change the tourism accessibility of the region, and whether tourism accessibility can further influence the level of tourism development in ethnic regions, i.e., whether the mediating effect of tourism accessibility exists has not been demonstrated. The mediating effect model is constructed to test as equation (3):

$$TP_{it} = \alpha_0 + \alpha_1 HSR_{it} + \sum_{i=1}^N \delta_j X_{it} + \xi_{it} \quad (3)$$

Where: TP_{it} is the comprehensive level of tourism development, measured by the measured level of tourism development. HSR_{it} is a dummy variable for the opening status of high-speed railroads in i regions in period t . α_i is the marginal contribution of high-speed railroad opening to the aggregate level of tourism development. X_{it} is a set of variables that affect the aggregate level of tourism development in addition to the opening of high-speed railroads. δ_j is the partial regression coefficient of each control variable. ξ_{it} is the random disturbance term. α_0 is the constant term.

There is equation (4):

$$A_{it} = \beta_0 + \beta_1 HSR_{it} + \sum_{i=1}^N \phi_j X_{it} + \xi_{it} \quad (4)$$

Where: A_{it} is the tourism accessibility of region i at time t , based on the regional accessibility measured by equation (2). β_1 is the degree of impact of the opening of the high-speed railroad on regional tourism accessibility. β_0 is a constant term. ϕ_j is the partial regression coefficient of each control variable. ξ_{it} is the random perturbation term.

There is equation (5):

$$TP_{it} = \lambda_0 + \lambda_1 HSR_{it} + \lambda_2 A_{it} + \sum_{i=1}^N \gamma_j X_{it} + \xi_{it} \quad (5)$$

Where: λ_1 is the direct impact of the opening of high-speed railroad on the level of regional tourism development. λ_2 is the effect of regional tourism accessibility on the level of tourism development. λ_0 is the constant term. γ_j is the partial regression coefficient of each control variable. ξ_{it} is the random perturbation term.

There is a mediation effect if the coefficients α_1 are significant, β_1, λ_2 are significant. And if λ_1 is not significant, there is a full mediation effect, and if λ_1 is significant there is a partial mediation effect. If at least one of the coefficients β_1, λ_2 is not significant, a further Sobel test is required.

3.2. Variable design

The explanatory variable of the study is the comprehensive tourism development level of each prefecture-level city in China's ethnic regions, measured by equation (1) and denoted as TP_{it} . The core explanatory variable is HSR_{it} , which indicates whether i region opens high-speed railroad in t year, and is 1 if high-speed railroad has been opened, and 0 otherwise. The mediating variable is tourism accessibility, which is measured by the tourism accessibility model measured by the tourism accessibility value of each region before the opening of regional high-speed railroad (2013) and after the opening of high-speed railroad (2019), and is denoted as A_{it} . In order to accurately measure the impact of the opening of the high-speed railroad on the level of regional tourism development, other major factors that will have an impact on the level of regional tourism development are introduced as control variables, including population density (PEG), investment level (IVS), resource endowment (ATI is based on the number of scenic spots of grade 3A and above, and calculates the level of regional resource endowment based on the scoring standard of grade A scenic spots) and industrial status (TRG). The preliminary design variables and descriptive statistics analysis based on Chinese regions are shown in Table 1, where μ refers to the mean and σ^2 is the variance.

Table. 1 Meaning and descriptive statistical analysis of variable

Variable		Variable meaning	μ	σ^2	Mi n	M ax
Tourism development level	TP_{it}	Tourism development level index model	0.1322	0.1378	0.0067	0.7781
State of opening of high-speed railway	HSR_{it}	The dummy variable (0,1) is 1 when the high-speed railway is opened in region i in year t, otherwise it is 0	0.3334	0.4745	0.0000	1.0000
Tourism accessibility	A_{it}	Accessibility model calculation	0.5872	0.1965	0.3034	1.0000
Density of population	PEG	The ratio of permanent resident population to land area at the end of the year	0.0187	0.0131	0.0016	0.0618
Investment level	IVS	Proportion of regional fixed asset investment to GDP	0.9828	0.3626	0.3572	2.7204
Resource endowment	ATI	$5A*0.95+4A*0.85+3A*0.75$	15.1038	17.3234	0.0000	99.4501
Industrial status	TRG	The ratio of regional tourism revenue to GDP	0.3698	0.2117	0.0479	1.1200

As can be seen from Table 1, the mean value of the current high-speed railroad opening status (HSR_{it}) is only 0.3334, while the variance of the resource endowment variable in the Chinese region is as high as 17.3234, which indicates that the coverage of high-speed railroads in the Chinese region is uneven, with a dense railroad network in economically developed regions and a sparse railroad network in economically underdeveloped regions. However, the nationalities in the economically underdeveloped regions have richer tourism resources than the economically developed regional cities, which provides favorable research comparison conditions for the empirical analysis of the high-speed railroad on the tourism development of the nationalities in the following.

4. Empirical analysis of the impact of high-speed railroads on tourism in ethnic areas

Based on the theoretical foundation of the second chapter, the model of high-speed railroad affecting tourism development level proposed in the third chapter is used as a research tool, and based on the panel data of prefecture-level cities in China's ethnic region A from 2005 to 2020, they are grouped according to whether or not high-speed railroads are available, among which the regions with high-speed railroads are the experimental group, and the rest of the regions without high-speed railroads constitute the control group. Taking into account the development characteristics of ethnic

region A in China, appropriate research variables are identified in this chapter, and the hypotheses 1 and 2 proposed in the previous section are verified through baseline regression analysis and path analysis to complete the empirical analysis of the impact of the opening of high-speed railroads on the tourism and economic development of ethnic regions. Finally, the reliability of the empirical results is tested by using the placebo test.

4.1. Data sources

The data of GDP, resident population, fixed asset investment, total tourism revenue and tourist trips come from the statistical database of Chinese provinces and cities in the EPS database, and the missing data are made up through the statistical yearbook of each city (state) and the bulletin of national economic development.

4.2. Descriptive statistical analysis of variables

On the basis of the variables set in Chapter 3, considering the characteristics of rich tourism resources and low level of economic development in China's Ethnic Area A, the explanatory variables in this section are set as follows: the number of tourists (DP) and tourism income (DC). The original variable HSRit is modified to HSR in the core explanatory variables with the same meaning. The mediator variable and subordinate variable tourism accessibility (Ait) were deleted. In the control variables, population density (PEG) is modified to population size (pop), resource endowment (ATI) is deleted, and new variables are added, such as economic development level (eco), openness to the outside world (open), urbanization level (urban), and road mileage (road). At the same time, the original control variable of industrial status (TRG) is modified to industrial structure (ind), and the original control variable of investment level (IVS) is modified to fiscal expenditure level (exp), which together with the variables of passenger flow (pas) and labor force level (hum) form the other variables.

Table 2 shows the final model variables as well as the descriptive statistics based on the 2005-2020 period in China's Ethnic Area A. The number of tourists, tourism revenue, road mileage, highway passenger traffic, the number of employees in the tertiary industry, and fiscal expenditure are logarithmically processed to reduce the heteroskedasticity among the variables.

Table 2. Descriptive statistical analysis of variables

Variable	Observed number	μ	σ	Min	Max
DP	615	8.89	1.39	5.25	11.55
DC	615	8.48	1.77	2.21	12.28
HSR	615	0.33	0.48	0	1
open	615	0.16	0.26	0.002	3.65
pop	615	1.98	1.32	0.19	7.06
urban	615	0.59	0.15	0.26	0.89
road	615	0.87	0.69	5.52	10.18
eco	615	3.54	2.41	0.37	14.79
exp	615	0.18	0.12	0.04	0.69
pas	615	7.82	0.88	5.24	10.28
hum	615	2.64	0.68	1.25	4.54
ind	615	39.64	9.23	11.06	70

As can be seen from Table 2, the mean value of HSR in Ethnic Area A is 0.33, which indicates that the percentage of cities with HSR during 2005-2020 is 33%. The maximum value of the number of tourists after taking the logarithm is 11.55, the minimum value is 5.25, the mean value is 8.89, and the standard deviation is 1.39. The maximum value of the tourism income after taking the logarithm

is 12.28, the minimum value is 2.21, the mean value is 8.48, and the standard deviation is 1.77. This shows that there are large differences in the level of tourism development among the prefecture-level cities in China's ethnic region A. The data for the remaining variables also vary widely, and thus the impact on tourism development varies widely, and the reason for the differences may be the uneven development among the prefecture-level cities in addition to the time factor.

4.3. Benchmark regression analysis

In general, the opening of high-speed railroads boosts the tourism economy. Table 3 reports the effects of the opening of HSR on the number of tourists in the cities of Ethnic Area A, including the logarithm of the total number of tourists, the logarithm of the number of Chinese domestic tourists, and the logarithm of the number of inbound tourists. From the regression results, it can be seen that the opening of high-speed rail significantly boosts the number of tourists in Ethnic Area A at the 1% level and has a more pronounced effect on the increase in the number of Chinese domestic tourists, with the opening of high-speed rail, on average, increasing the number of total tourists by 17.78%, increasing the number of Chinese domestic tourists by an average of 18.82%, and boosting the number of inbound tourists by an average of 13.47%. The goodness of fit of the regression on overall tourism numbers will be better than the goodness of fit of the regression on Chinese domestic tourism numbers and inbound tourism numbers separately.

Table 3. The baseline return of the impact of CHSR opening on tourist numbers

	(1) Total number of tourists lntourist	(2) Number of domestic tourists lndtourist	(3) Number of overseas tourists lnftourist
HSR	0.1778*** (9.2398)	0.1882*** (9.8268)	0.1347*** (3.2617)
eco	0.8321*** (26.4264)	0.8263*** (25.9428)	0.3644*** (6.0338)
exp	0.2004*** (11.2272)	0.2199*** (12.0539)	0.0417 (1.3414)
road	0.0924*** (10.1825)	0.0892*** (9.8571)	0.1906*** (10.4824)
Individual effect	Yes	Yes	Yes
Time effect	Yes	Yes	Yes
N	3570	3625	3620
F	118883.9657	12241.8279	1243.8206
r2_w	0.8798	0.8784	0.4042

*p<0.1, **p<0.05, ***p<0.01, the same below.

From the estimated coefficients of the control variables, the GDP per capita of cities in Ethnic Area A is positively related to the total number of tourists, the number of domestic tourists in China and the number of inbound tourists, i.e., cities with a high GDP per capita have a better standard of living, which gives tourists the expectation that the city is well-developed and worthwhile for tourism. Local financial expenditure has a significant positive impact on the total number of tourists and the number of domestic tourists, this is because more local financial expenditure, the more money will be used to invest in infrastructure construction, tourism transportation is more developed, to a certain extent, will promote the development of the tourism industry, and inbound tourists by the transportation infrastructure of the limitations of the smaller, the number of inbound tourists does not have a significant impact on the number of inbound tourists. Railroad mileage has a significant

positive effect on the total number of tourists, the number of Chinese domestic tourists and the number of inbound tourists.

Table 4 reports the impact of the opening of high-speed rail on the income of urban tourists, including the logarithm of total tourism income, the logarithm of Chinese domestic tourism income and the logarithm of inbound tourism income. From the regression results, it can be seen that the opening of high-speed rail significantly contributes to the total tourism revenue and China's domestic tourism revenue and inbound tourism revenue at the 1% level, and the addition of a high-speed rail station city can increase the total tourism revenue, domestic tourism revenue by 20.45%, domestic tourism revenue by 20.93%, and inbound tourism revenue by 11.83% on average. The goodness of fit of the regression on overall tourism revenue would be better than the regression on China's domestic tourism revenue and inbound tourism revenue respectively.

Table 4. Baseline regression of the impact of CHSR opening on tourism revenue

	(1) Total number of tourists Intourist	(2) Number of domestic tourists Indtourist	(3) Number of overseas tourists Inftourist
HSR	0.2045*** (6.3677)	0.2093*** (6.1097)	0.1183*** (2.6533)
eco	1.2835*** (32.1443)	1.3154*** (31.1119)	0.4353*** (6.5848)
exp	0.0548*** (3.2105)	0.0568*** (3.1908)	0.0992*** (2.8728)
road	0.1084*** (9.1191)	0.1036*** (8.2411)	0.2391** (12.1518)
Individual effect	Yes	Yes	Yes
Time effect	Yes	Yes	Yes
N	3570	3625	3620
F	6203.1119	5627.6201	1438.2816
r ² _w	0.7928	0.7714	0.4498

In terms of control variables, the city's GDP per capita has a significant contribution to all three incomes at the 1% level, and the higher the GDP per capita of a city, the higher the price level will be, and thus the higher the tourism income created relative to other cities. The higher the local financial expenditure, the better the construction of tourist attractions, and the more tourism income will be created.

To summarize, the opening of high-speed railways promotes the development of the local tourism economy by improving the accessibility of the tourist places in the cities of Ethnic Area A and promoting the increase of the number of tourists and income, which is consistent with the research hypothesis 1. In addition, the opening of high-speed railways has a higher increase in the tourism economy of Ethnic A region, which side by side reflects that the infrastructure construction of Ethnic A region in China is yet to be perfected and the construction of highway transportation is lacking, which is in line with the characteristics of the region, and verifies the research hypothesis 2.

4.4. Path of action analysis

This part makes a brief analysis of the role path of high-speed rail affecting tourism in ethnic areas, using the number of urban population and the proportion of urban tertiary industry to GDP in ethnic area A as research variables to verify the role effect of high-speed rail opening, and constructing a path test model. Where Y denotes the total number of tourists and tourism income, X denotes the

core explanatory variables: HSR is the dummy variable of high-speed rail opening, and the control variables include: gross domestic product per capita, government expenditures, and railroad mileage. M denotes the path term population size and the share of tertiary sector in GDP.

The path test model is shown in equations (6)-(8):

$$Y = cX + e_1 \quad (6)$$

$$M = aX + e_2 \quad (7)$$

$$Y = c'X + bM + e_3 \quad (8)$$

Where equation (6) is the benchmark regression model of this thesis, equation (7) is the core and control variables do regression on the path variables, and equation (8) is the benchmark regression model add the path variables, do regression on the tourism economy, if c , a , b in the model are all significant, then it shows that the opening of the high-speed railroad can lead to the development of the tourism economy through the influence variables.

Table 5 shows the results of the role path analysis.

Table 5. Action path analysis

	(1) Path variable	(2) Total number of tourists	(3) Gross tourism income
	lnpop	Intourist	lnftourincome
HSR	0.0516***	0.1707***	0.1152***
	(22.5768)	(8.9378)	(2.6761)
lnpop		0.2076***	0.0917***
		(6.1857)	(2.6243)
N	4012	3692	3762
chi1	744.7802	12153.7891	1438.1527
chi2	744.7802	12153.7891	1438.1527
R2_w	0.2905	0.8801	0.4499
	ind	Intourist	lnftourincome
HSR	0.0618***	0.1021***	0.1204**
	(32.3866)	(5.3879)	(2.5546)
ind		0.8274***	0.4718***
		(27.1857)	(7.3266)
N	3970	3690	3760
chi2	1179.6777	13965.9949	1420.8599
R2_w	0.3979	0.8921	0.4486

As can be seen from Table 5, with the addition of control variables, the opening of high-speed rail can increase the population of ethnic areas by 5.16% at the 1% significance level, the opening of high-speed rail can promote the growth of the population in the station area, and the opening of high-speed rail promotes the movement of rural population and neighboring cities towards the cities of high-speed rail stations, and promotes the number of tourists and the increase of tourism income. At the same time, the opening of high-speed rail increases the proportion of tertiary industry in GDP by 6.18%, and the development of tertiary industry, compared with primary and secondary industry, requires more flow of capital, talents and other factors. Relying on the opening of high-speed rail, it can gather elemental resources and drive the economic development of catering and lodging and entertainment industry to promote the development of tertiary industry, and at the same time, it promotes the optimization of tourism facilities, improves the tourism hospitality service, and promotes the tourism economic development.

4.5. Parallel Trend Test

In order to test the appropriateness of the model, this section puts forward the common trend hypothesis: before the point in time when the high-speed railway opens, the tourism economies of the experimental group region and the control group region are with parallel development trends and do not have large systematic differences. Therefore, this paper successively uses trend comparison and event analysis to test the common trend of the tourism economy of the experimental group and the control group.

4.5.1. Trend mapping. Comparison of the development trends of the experimental group and the control group in the total number of domestic and foreign tourist arrivals in China, the total revenue of domestic and foreign tourist arrivals in China, the number of domestic tourist arrivals in China, the revenue of domestic tourist arrivals in China, the number of inbound tourist arrivals in China, and the revenue of international tourist arrivals in China from 2005 to 2019 are plotted separately to illustrate the changes after the opening of the high-speed rail. The trend of China's total tourism arrivals from 2005 to 2019 is shown in Figure 3, and the trend of China's total tourism revenue from 2005 to 2019 is shown in Figure 4.

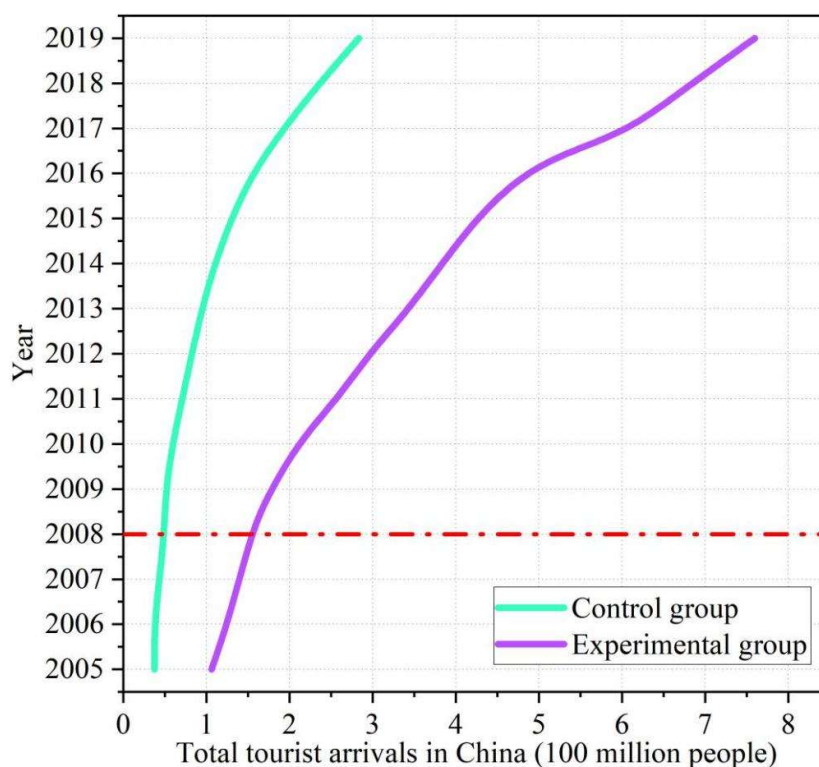


Fig. 3. Trends of total tourist arrivals in China from 2005 to 2019

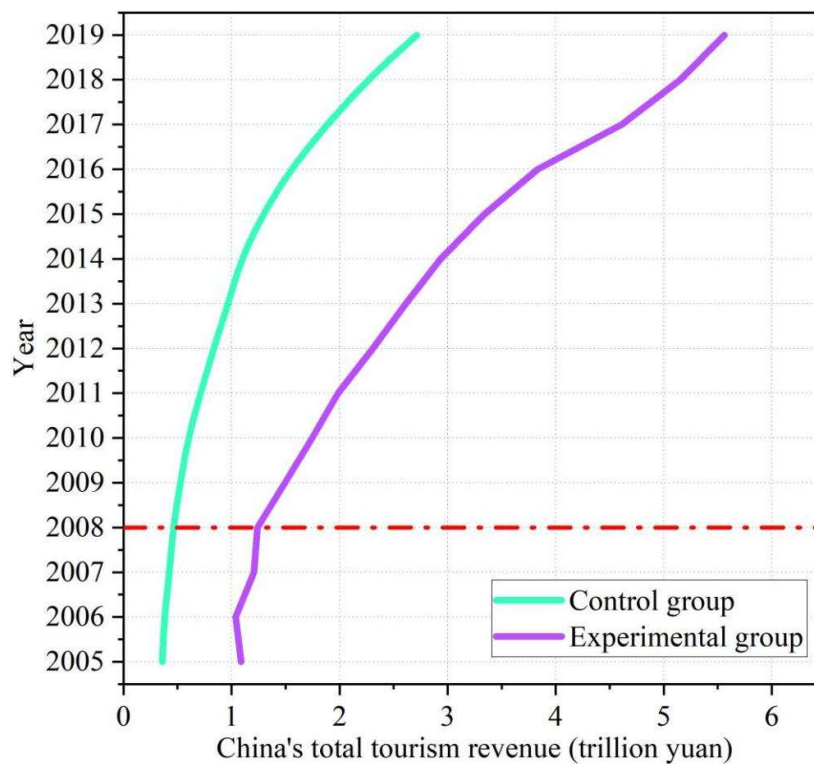


Fig. 4. Trends of total tourism revenue in China from 2005 to 2019

There is variability in the opening of high-speed rail stations in different prefecture-level cities within the ethnic areas, but from the information combing of high-speed rail construction history, 2008 is a key time point for the large-scale construction of China's high-speed railways and putting them into use. Therefore, taking 2008 as the demarcation point, it can be seen from the trend graphs that: firstly, as far as the individual indicators are concerned, the cities with high-speed rail and those without high-speed rail were basically parallel before 2008. Secondly, except for the inbound tourism income, the experimental group and the control group of all other variables show a trend of gradually increasing tourism economic differences after 2008, which intuitively indicates that there is an influential effect of high-speed rail on tourism economic development. Finally, the tourism economic development of the control group shows a gradual and steady upward trend, which indicates that the opening of the high-speed rail has no obvious negative impact on the tourism economy of the control group area.

4.5.2. Event analysis. The test model is set as in equation (9):

$$\begin{aligned} Tour_{it} = & \alpha + \sum \beta_n Before_{it}^n \times HSR_{it} + \sum \beta_m After_{it}^m \times HSR_{it} \\ & + \lambda \sum_n Controls_{it} + \eta_t + \mu_i + \varepsilon_{it} \end{aligned} \quad (9)$$

Where $Tour$ denotes the indicators of regional tourism economy. $Before_{it}^n$ and $After_{it}^m$ are dummy variables. A value of 1 indicates that city i is in year t is the n th year before the opening of the HSR ($n \geq 1$), otherwise it is 0. A value of 1 indicates that city i is in year t is the m th year after the opening of the HSR ($m \geq 0$), otherwise it is 0. To better present the results, the maximum value of period values n and m is taken as 8 here. The test results mainly focus on the parameter β_n and β_m , which can simultaneously test the common trend hypothesis and the dynamic effect of the opening of high-speed railways affecting the tourism economy.

The results of the test of the difference between the total tourist trips in China's ethnic area A before and after the opening of the high-speed rail are shown in Fig. 5, and the results of the test of

the difference between the total tourist income in China's ethnic area A before and after the opening of the high-speed rail are shown in Fig. 6.

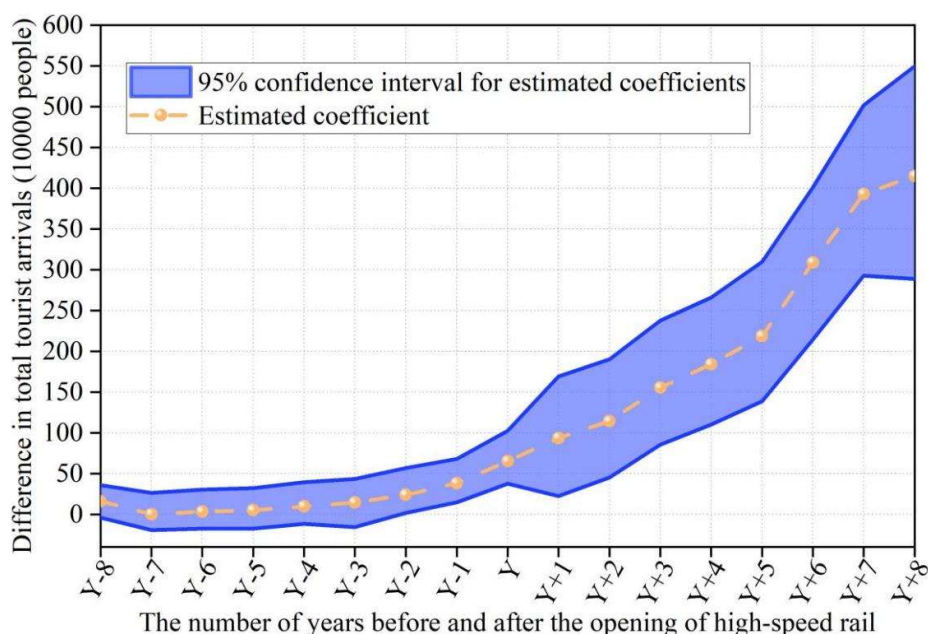


Fig. 5. The difference of tourists number of before and after the opening of CHSR

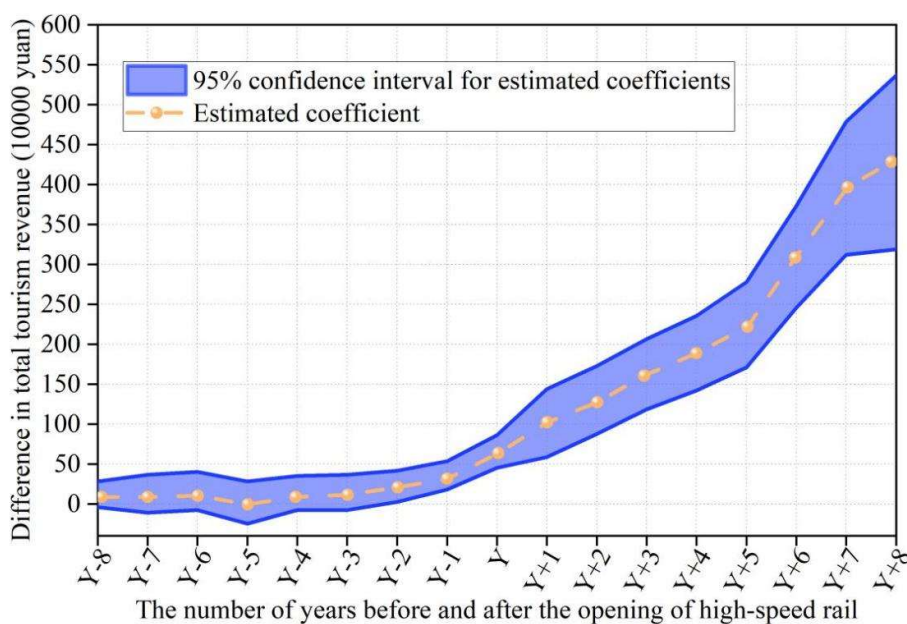


Fig. 6. The difference of tourism income before and after the opening of CHSR

The estimated values and 95% confidence intervals of the parameters β_n and β_m of the impacts on the total number of Chinese tourism trips, the total revenue of Chinese tourism, the number of domestic tourism trips, the revenue of domestic tourism, the number of inbound tourism trips, and the revenue of international tourism for 8 years before and after the opening of the high-speed rail are presented in the figure respectively, in which the horizontal coordinates indicate the number of years, e.g. Y denotes the year of opening, Y-3 denotes the 3rd year before the opening of the XRL, and Y+3 denotes the 3rd year after the opening of the XRL. As can be seen from the respective trend graphs, before and after the opening of the HSR shows roughly the same trend of impact on the total

number of domestic and international tourism trips and total revenue in China, the number of domestic tourism trips and revenue in China, and the number of inbound tourism trips and revenue in the region of Ethnicity Area A.

Regarding the common trend hypothesis test, before the opening of the high-speed rail, the estimated coefficients β_n of each tourism economic indicator are basically insignificant, while after the opening of the estimated coefficients β_m all become significant. It indicates that before the opening of the high-speed rail, the difference in the development of various tourism economic indicators between the experimental group of regions and the control group of regions can not reject the original hypothesis of zero, that is, there is no difference in the development of the tourism economy of the cities before the opening of the high-speed rail, and passes the test of the hypothesis of the common trend. Thus, combined with the research results of the mapping method, it can be comprehensively proved that the model of this paper satisfies the common trend hypothesis, indicating that the model used in the research is applicable and the regression results are unbiased.

With regard to the dynamic effect test, it can be seen that in the year when the high-speed railway opened, the development level of tourism economy in ethnic region A was significantly increased, and the upward growth trend has been maintained in the following years. It indicates that the opening of high-speed rail has a sustained promotion effect on the tourism economy of ethnic regions, and with the prolongation of high-speed rail operation time, this positive impetus will be more and more powerful.

4.6. *Placebo test*

In the process of studying the impact of the opening of high-speed rail on the tourism economy of ethnic region A, there may be omitted variables, and then the model needs to be tested for robustness. The test of random sampling is commonly used to verify the robustness of the baseline regression. Here, by allowing the shock of high-speed rail opening to a specific area to be randomized, a year in the year variable is randomly selected as the point in time when the high-speed rail opens in that city within each city group based on city grouping, and the test is repeated 500 times. Figure 7 exhibits the distribution of the estimates, which are centered around 0, indicating that the unobserved variables hardly affect the estimates, suggesting that the previous estimates are robust.

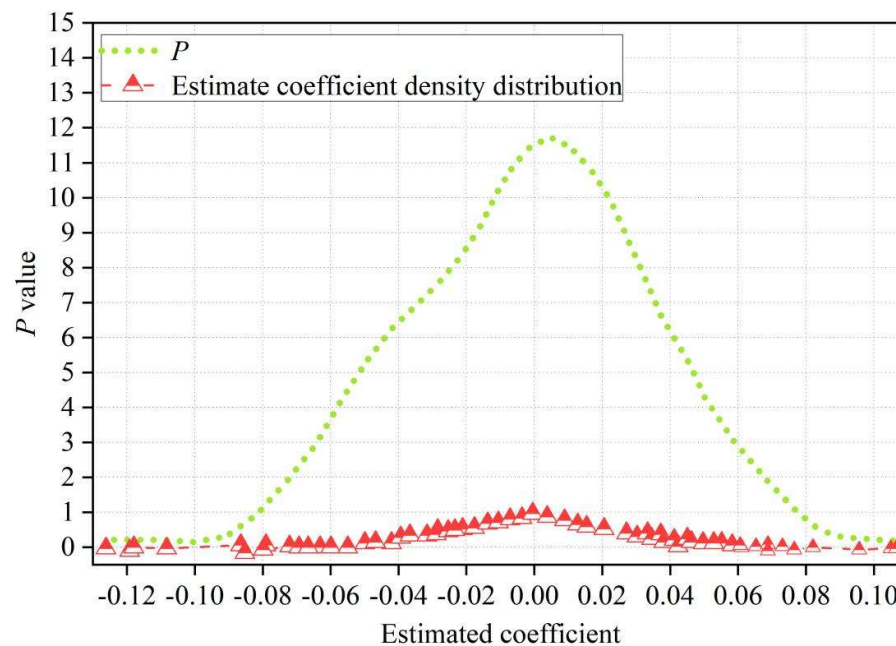


Fig. 7. Placebo test

5. Conclusion

This paper develops an empirical analysis of the impact of high-speed railroads on tourism in ethnic areas by constructing a model of high-speed railroads affecting the level of tourism development. The regression results of the model are unbiased, the estimation results are robust, and the analysis results are consistent with the research hypotheses, which is an effective research attempt to quantify the economic benefits of high-speed railway opening on tourism.

The model of high-speed railroad affecting tourism development level points out that the opening of high-speed railway can positively promote the tourism economic development of China's ethnic regions, and the opening of high-speed railway significantly promotes the increase of tourism number and tourism income in ethnic region A at the 1% level. Among them, the total number of tourists is enhanced by 13.47% and the total tourism income is enhanced by 20.45%, and the distribution of the model estimation is concentrated around 0.

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