An Empirical Study with DID Model for the Impact of Lanzhou-Xinjiang HSR on Regional Economic Growth

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ABSTRACT
By using Difference-in-differences (DID) model, this study empirically analyses the economic data of all cities in Gansu and Qinghai provinces of China from 2011-2018 to verify the impact of the opening of the Lanzhou-Xinjiang high-speed railway (Lan-Xin HSR) on the economic growth of cities along the line. Further regression is conducted to analysis the specific impact mechanism around the urbanization rate, industrial structure and urban-rural gap. The key finding is that the opening of the Lan-Xin HSR has heterogeneous impacts in Gansu and Qinghai Provinces: It promotes the economic growth of Qinghai province, while it has a negative impact in Gansu province. Mechanism analysis reveals that 1) the opening of Lan-Xin HSR has promoted urbanization level in both Gansu and Qinghai provinces; 2) it has promoted the development of secondary industry in Gansu province, while the promotion of tertiary industry in Qinghai province is more obvious; 3) it has narrowed the urban-rural gap within Qinghai province, but it has increased that within Gansu province to some extent. This paper makes up for the lack of study on the HSRs in less developed areas such as western regions in China and provides references for relevant policy adjustments.

Keywords: *Difference-in-differences model (DID), High-speed railway (HSR), Regional economic growth (REG)*

1. INTRODUCTION

As an important symbol of the rapid development of China today, high-speed rail (HSR) has become the most effective way to solve the problem of long-distance rapid transportation [2]. As the key nodes and hubs of time-space interaction between different cities in the region, HSR stations coordinate the flow of regional economic factors and have a great impact on the regional economic growth of the stations [4] [7]. The Lanzhou-Xinjiang high-speed railway (Lan-Xin HSR) is the longest HSR built at one time in the world. It is a key project of Chinese "Medium and Long-Term Railway Network Planning" and an important part of the railway passage of the Eurasian Continental Bridge [5]. The Lan-Xin HSR has a total length of 1786km. It starts from Lanzhou in Gansu Province and reaches Urumqi in Xinjiang Uygur Autonomous Region, passing through Gansu, Qinghai, and Xinjiang. As an important transportation line on the Silk Road Economic Belt, the Lan-Xin HSR plays an important role in the economic development of the northwest region in China.

By using Difference-in-differences (DID) model, this study empirically analyses the impact of the opening of Lan-Xin HSR on the economic growth of cities along the line and the specific mechanism. This study makes up for the lack of previous literature on the HSRs in western China [8].

Section 2 provides the methodology, Section 3 presents the empirical results, conclusion and implications are shown in Section 4.

2. METHODOLOGY

According to the New Economic Geography Theory, the interconnection of regional HSRs constructions enables both core areas and peripheral areas to enjoy the dividends, and the time compression effect produced by HSRs will affect the strength of agglomeration and dispersion between core areas and peripheral areas. The HSR will lead to changes in the regional economy and industrial layout by affecting the role of the two forces above [3].

2.1 Model Specification

According to the important positioning of Lan-Xin HSR in the passenger transportation system in Northwest

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China and the analysis of economic development changes before and after its opening, this study proposes the following hypotheses:

Hypothesis 1 (H1): The opening of the Lan-Xin HSR has promoted the economic growth of the areas along the line.

Hypothesis 2 (H2): The opening of the Lan-Xin HSR promotes the urbanization rate and industrial development in the areas along the line, and increases the gap between urban and rural areas [1].

To construct the DID model, basing on the fact that the Lan-Xin HSR was opened in 2014, this study divides the time period into two phases. The first phase is before the opening, that is, from 2011 to 2014; the other phase is from 2015 to 2018 after the opening. At the same time, the sample are divided into the "treated" and the "controlled" groups, where the "treated" refers to the cities with station of the Lan-Xin HSR, and the "controlled" refers to the other cities in two provinces.

By subtracting the difference between the change in the controlled group and the change in the treated group after the HSR opening, the difference between the two before the opening of the HSR can be eliminated, and the effect of the HSR opening on the regional economy can be reasonably estimated [10]. The basic equation of the model is as follows:

$$Y_{it} = \beta_0 + \beta_1 time_{it} + \beta_2 area_{it} + \beta_3 time_{it} area_{it} + X_{it} + \varepsilon_{it} \quad (1)$$

where Y denotes the dependent variable, including lnGDP, URZ, Industry and Gap. They respectively denote the log of GDP, urbanization rate, industrial structure and urban-rural gap of the cities. time is a dummy variable of time, which is assigned a value of 1 after the opening of the HSR, that is, in 2015 and later, and 0 before that. β_1 represents the changes of the four explained variables in the cities during the study period; area is a regional dummy variable, the cities along the HSR are assigned a value of 1, and the others are 0. β_2 represents regional factors unrelated to the opening of Lan-Xin HSR; time×area is a dummy variable of HSR, which is also an estimator of DID. β_3 represents the impact of the opening of Lan-Xin HSR on the regional economy. X denotes control variables that have been proven to affect economic growth in previous studies, including industry, investment, employment and expenditure [6]. They respectively denote the ratio of the output of the secondary and tertiary industries, the total social fixed asset investment, the number of nonprivate enterprises in urban areas and the fiscal expenditure of each district after logarithmic processing [9]. ε represents the random disturbance term. The subscripts i and t respectively present area and time.

2.2 Data Source

The sample includes 14 cities in Gansu Province and 8 cities in Qinghai Province, and the time period is from 2011 to 2018. Data for the dependent and control variables were obtained from the statistical yearbooks of these two provinces from 2012 to 2019. The control variables were selected by referring to existing practices in the literature.

3. EMPIRICAL RESULTS

Using stata14, the data from Gansu and Qinghai provinces were regressed separately. The empirical results are shown in Tables 1 and 2, respectively.

3.1 Results of Gansu Province

For time and area factors: the coefficients for both time and area are significantly positive at the 1% level. This indicates that after controlling for other factors, the economy of Gansu Province is growing gradually over time, and cities with HSR have higher GDP than other cities.

Table 1: Results of the impacts of HSR on economic growth in Gansu Province.

Variable	lnGDP	URZ	Industry	Gap
time	0.314*** (0.047)	17.369*** (1.643)	0.342** (0.135)	6178.514*** (582.911)
area	0.532*** (0.073)	14.417*** (3.965)	0.503*** (0.143)	-2937.721*** (694.285)
Diff	-0.156** (0.077)	0.489 (4.075)	-0.128 (0.201)	839.741 (1059.711)
lnEpt	0.613*** (0.07)	31.324*** (2.991)	-0.785*** (0.195)	3573.698*** (846.391)
lnExpen	0.262*** (0.089)	-33.841*** (3.421)	1.608*** (0.166)	-2830.928*** (926.903)

lnInv	0.121** (0.051)	-2.275 (2.445)	-0.636*** (0.132)	244.711 (698.512)
Industry	-0.296*** (0.034)	1.039 (1.401)		-553 (486.172)
N	112	112	112	112
R^2	0.9215	0.8450	0.6255	0.6274

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

For HSR factor: the coefficient of the interaction term is negative, and the significance level reaches 5%, indicating that after the opening of the Lan-Xin HSR, the GDP growth of Gansu Province has been weakened. It is likely to be manifested as the "siphon effect" of the HSR, which points out the direction for our further analysis.

For control variables: the coefficient of Industry is significantly negative at 1% level, indicating that the improvement of the secondary industry can promote the development of Gansu's economy more than the tertiary industry; the regression results of other control variables show that increasing the employment, investment and expenditure will promote the GDP growth in Gansu Province.

Overall, R^2 is 0.9215, indicating that the overall model is highly significant, and the regression has a strong explanatory power.

Further regression is conducted to analysis the specific impact mechanism.

1) Urbanization rate

For time and area factors: Both coefficients are significantly positive. It shows that after controlling for other factors, the urbanization rate of Gansu Province is gradually growing over time; in addition, the urbanization level of cities along the Lan-Xin HSR is higher than that of other cities in the province.

For HSR factor: the coefficient of the interaction term is positive but not significant.

For control variables: The coefficient of employment is significantly positive, indicating that with the improvement of employment, urbanization construction will be accelerated; the coefficient of expenditure is significantly negative, which is contrary to common sense, but it may be that the results due to increased expenditure have not yet occurred considering the comprehensive development of Gansu Province.

Overall, R^2 is 0.8450, indicating that the model has strong significance, and the regression has a strong explanatory power.

2) Industrial structure

For time and area factors: Both coefficients are significantly positive. It shows that after controlling for other factors, the industrial development of Gansu Province is gradually growing over time; the level of the tertiary industry in the cities along the HSR is higher than that of other cities in the province.

For HSR factor: the coefficient of the interaction term is negative but not significant, indicating that the opening of the Lan-Xin HSR has no significant impact on the upgrading of the industrial structure in Gansu Province. Although the opening of the HSR will theoretically increase the total level of the tertiary industry, it has not been significantly manifested in Gansu Province for the time being.

For control variables: The coefficient of employment is significantly negative, indicating that a large influx of labour force has increased employment in the secondary industry after the opening of the HSR; the coefficient of expenditure is significantly positive, indicating that Gansu Province is increasing investment in the tertiary industry in recent years; The coefficient of investment is significantly positive, indicating that its increase promoted the upgrading of the industrial structure.

Overall, R^2 is 0.6255, indicating that the model has strong significance, and the regression has a certain explanatory power.

3) Urban-rural gap

For time and area factors: The coefficient of time is significantly positive, indicating that the urban-rural gap in Gansu Province has increased over time; the coefficient of area is significantly negative, indicating that the urban-rural gap in HSR cities is not greater than the other cities.

For HSR factor: The coefficient of the interaction term is positive, indicating that the opening of the Lan-Xin HSR can increase the urban-rural gap to a certain extent, but the impact is not significant.

For control variables: The coefficient of employment is significantly positive, indicating that the increase in the number of laborers can promote urbanization construction, and the urban-rural gap become larger. The coefficient of expenditure is significantly negative, indicating that under the rural revitalization strategy, the increase in expenditure has narrowed the urban-rural gap in Gansu Province.

Overall, R^2 is 0.6274, indicating that the model has strong significance, and the regression has a certain explanatory power.

3.2 Results of Qinghai Province

For time and area factors: Both coefficients are positive. It shows that after controlling for other factors, Qinghai's economy is gradually growing over time, and the GDP of cities with HSR is higher than that of the other cities.

Table 2: Results of the impacts of HSR on economic growth in Qinghai Province.

Variable	lnGDP	URZ	Industry	Gap
time	0.04 (0.065)	-1.264 (3.195)	0.115 (0.108)	3380.813*** (620.817)
area	0.046 (0.075)	-17.768*** (4.267)	0.232** (0.11)	-1265.981** (562.145)
Diff	0.099 (0.085)	8.208* (4.683)	0.162 (0.178)	-1843.435** (726.601)
lnEpt	0.549*** (0.031)	15.167*** (1.22)	-0.071 (0.044)	-1135.994*** (231.288)
lnExpen	0.533*** (0.107)	-7.789** (3.001)	0.027 (0.153)	3638.341*** (685.414)
lnInv	-0.017*** (0.006)	-0.192 (0.27)	-0.041*** (0.015)	-195.288*** (58.123)
Industry	-0.327*** (0.062)	-1.613 (2.817)		2529.469*** (527.472)
N	64	64	64	64
R^2	0.9810	0.8371	0.4315	0.8592

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

For HSR factor: The coefficient of the interaction term is positive, indicating that the GDP of the cities with HSR grows faster than other cities, which proves that the opening of the Lan-Xin HSR has promoted the regional economic growth of the cities along the line in Qinghai Province.

For control variables: The coefficients of employment and expenditure are significantly positive at the 1% level, indicating that the increase in employment and expenditure will promote the development of the regional economy. The coefficient of industry is significantly negative at the 1% level, improving the tertiary industry can promote the economic development of Qinghai Province more than the secondary industry.

Overall, R^2 is 0.9810, indicating that the model has strong significance, and the regression has a strong explanatory power.

Mechanism analysis.

1) Urbanization rate

For time and area factors: The coefficient of time is negative, indicating that after controlling for other factors, the urbanization level of Qinghai Province is gradually declining over time, which may be caused by resources being invested in the countryside under the rural revitalization strategy in recent years. The coefficient of area is significantly negative, which may be the influence of the "siphon effect" of the HSR.

For HSR factor: The coefficient is positive, indicating that after the opening of the HSR, the urbanization level of the cities along the line develops faster than the cities not along the line, which proves that the opening of the Lan-Xin HSR can promote the development of the urbanization level in Qinghai Province.

For control variables: The coefficient of employment is significantly positive, and the coefficient of expenditure is significantly negative, which is the same as the results of Gansu Province.

Overall, R^2 is 0.8371, indicating that the model has strong significance and the regression has a strong explanatory power.

2) Industrial structure

For time and area factors: Both coefficients are positive. It shows that after controlling for other factors, the industrial structure of Gansu Province is gradually

upgrading over time; in addition, the industrial structure of cities with HSR is better than that of cities without HSR.

For HSR factor: The coefficient of the interaction term is positive, indicating that after the opening of the HSR, the total level of the tertiary industry in the cities along the line in Qinghai Province has increased, which proves that the opening of the Lan-Xin HSR has a certain impact on the upgrading of the industrial structure, but the impact is not significant.

For control variables: The coefficients are consistent with the results of Gansu Province, in which the impact of investment is significant.

Overall, R^2 is 0.4315, indicating that the significance of the model is weak, and the explanatory power of the regression is not strong.

3) Urban-rural gap

For time and area factors: The coefficients are consistent with the results of Gansu Province.

For HSR factor: The coefficient is significantly negative, indicating that the opening of the Lan-Xin HSR can narrow the urban-rural gap in Qinghai Province to a certain extent and promote coordinated regional development. The opening of HSR will promote the flow of people, so that people can have more and better employment options, and rural residents can choose to work in cities to increase their income, thus narrowing the urban-rural gap.

For control variables: The coefficients of the four control variables are all opposite to those of Gansu Province. The coefficients of employment and investment are significantly negative, indicating that the increase of the two has narrowed the urban-rural gap in Qinghai Province; the coefficients of expenditure and industrial structure are significantly positive, indicating that the increase of the two has increased the urban-rural gap in Qinghai Province.

Overall, R^2 is 0.8592, indicating that the model has strong significance and the regression has a strong explanatory power.

3.3 Parallel Trend Test

An important prerequisite for the DID model is that the "treated" and "controlled" groups must satisfy the common trend assumption, i.e., if there is no such a policy as HSR opening, there is no systematic difference in the trend of economic growth between cities with and without HSR. The two figures show the trend of GDP of the "treated" cities with HSR opening and "controlled" cities without HSR opening. It can be found that the change trend of the "treated" and the "controlled" areas basically the same, so it satisfies the parallel trend test.

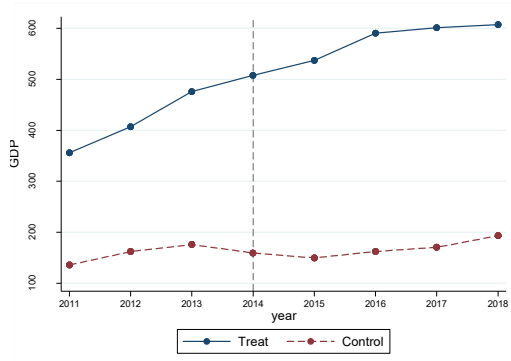

Figure 1: Parallel trend test of Gansu Province.

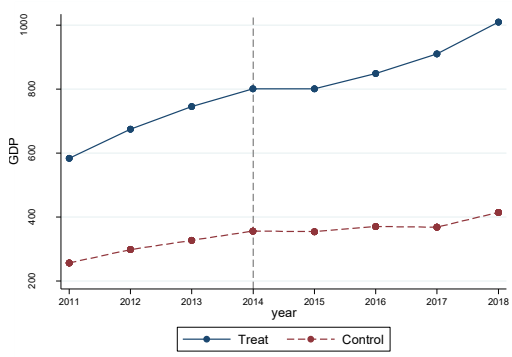

Figure 2: Parallel trend test of Qinghai Province.

4. CONCLUSIONS

This study uses the DID model to empirically analyse the impact of the opening of Lan-Xin HSR on the economic growth of the regions along the line, and studied the specific impact mechanism around urbanization rate, industrial structure, and urban-rural gap. The key finding is that the opening of the Lan-Xin HSR has heterogeneous impacts on the GDP of Gansu and Qinghai provinces: it has promoted the economic growth of Qinghai province, while it has a negative impact in Gansu province. Mechanism analysis reveals that 1) The opening of the Lan-Xin HSR has promoted the development of urbanization in Gansu and Qinghai provinces; 2) The impact on the industrial structure of the two provinces is different. The opening of HSR has more obviously promoted the development of the secondary industry in Gansu Province, while the promotion of the tertiary industry in Qinghai Province is more obvious; 3) There is also heterogeneity in the impact on the urban-rural gap within the two provinces. The opening of Lan-Xin HSR has narrowed the urban-rural gap in Qinghai Province and promoted coordinated regional development, but it has increased the urban-rural gap in Gansu Province to a certain extent.

This study can help policy makers understand the role of HSRs in promoting economic growth and provide a reference for the planning of future HSRs construction. The impact of the opening of HSRs on the economic growth, industrial structure improvement and

coordinated regional economic development of a region depends mainly on the regional economic development status and regional economic base. According to the results of the study, the less developed cities should take full account of their local endowment conditions and plan their HSRs networks rationally.

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