

Research on the impact of high-speed railway opening on regional economy and environment - evidence based on Henan Province

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Abstract: The opening of high-speed rail has a great role in promoting regional economy. Many scholars have used prefecture-level cities across the country as samples to prove that the opening of high-speed rail can stimulate economic growth and reduce environmental pollution. However, the heterogeneity between regions may make the result no longer significant in a particular region. Therefore, this article uses the data of 17 prefecture-level cities in Henan Province as an example to explore the economic and environmental effects of the opening of high-speed rail in Henan Province, and study one of the mechanisms by which high-speed rail acts on the environment. The results prove that the opening of high-speed rail has a significant positive effect on the economic and environmental quality of cities in Henan Province. In addition, high-speed rail can also improve the environment by adjusting the industrial structure, reducing pollutant emissions, and improving environmental quality.

1 Introduction

In July 2016, the National Development and Reform Commission, in conjunction with the China Railway Corporation and the Ministry of Transport, proposed the "Eight Vertical and Eight Horizontal" high-speed railway network plan for the new period, focusing on optimizing the layout of the road network in the east and west. It can be seen that the impact of transportation on society has always been the focus of national government's attention and scholars' research focus. Berechman (2006) found early on that the development of transportation infrastructure can significantly increase local economic growth. Zhu Wentao and Gu Naihua (2020) included spatial effects in their research and found that the spillover effect of high-speed rail in non-central cities has a positive impact on the agglomeration of manufacturing industries. Li Jianming and Luo Nengsheng (2020) found that the opening of high-speed rail lines can reduce smog and improve air quality in cities along the line; Ran Qiying and Zhang Jinning (2020) also showed that the opening of high-speed rail lines can improve the green development of cities through innovation and structural effects. Some scholars have also found that the opening of high-speed rail can improve the level of green innovation technology in cities along the route, and thus play a positive role in promoting environmental governance.

Henan Province is an important part of the Central Plains region. High-speed rail plays a pivotal role in its industrial development and economic growth. However, Henan Province has yet to realize high-speed rail connections between cities and cities, and due to its large

population base, its per capita high-speed rail mileage is relatively small. The density is still very small. Therefore, this article will take Henan Province as an example to discuss the impact of the opening of high-speed rail on the regional economy and environment.

The main significance of this article is to explore the economic and environmental effects of the opening of high-speed rail based on the micro-level of Henan Province. The results show that the economic and environmental improvement effects of high-speed rail are still applicable in Henan Province. In addition, the opening of high-speed rail can optimize the industrial structure, increase the proportion of secondary and tertiary industries, reduce high-polluting industries and improve environmental quality by optimizing industrial structure.

2 Research design

2.1. Hypothesis

In recent years, studies on the impact of the opening of high-speed rail mainly include the agglomeration effect, siphon effect, synergy, and diffusion caused by high-speed rail. The opening of high-speed rail can not only save people's time and the cost of goods circulation, but also promote tourism and services in areas along the route. The development of the industry has stimulated the growth of local GDP. In addition, the high-speed rail has a certain positive effect on environmental governance, and to a certain extent can reduce the emission of pollutants and promote the green development of cities.

On the one hand, the opening of high-speed rail can promote investment and capital transfer, promote foreign

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direct investment and social investment, improve resource utilization efficiency, and reduce unnecessary costs, such as partial transaction costs in the supply chain and unnecessary storage costs. As a populous province, Henan is rich in labor resources. Some companies may choose Henan Province as their production location in order to narrow the distance from the market and save production costs, so as to create more jobs for Henan Province and prosper the industry. development of. This kind of directional agglomeration with labor resources as the initial motivation will attract more upstream and downstream industries to invest here as a link becomes larger and larger, which will also trigger agglomeration of economic contacts and ultimately drive the growth of per capita GDP. Bring economic growth and efficiency improvements to cities. On the other hand, the opening of high-speed rail has improved the accessibility between cities, the circulation of various resource elements has become less restricted, and the speed of information circulation will also increase, which increases the value of time. Some scholars have proved that there is a positive correlation between human capital and innovation. The flow of human resources will also bring about changes in the allocation of innovative elements, attracting innovative elements and resources from areas without high-speed rail to the cities that have already opened, that is, Faber. The proposed "siphon effect" stimulates innovation vitality in various regions, and innovation diversity will further stimulate economic growth. In addition, the improved accessibility will enable the development of many previously unsupported industries, such as the fresh food industry, which will also enrich the industrial clusters in areas where high-speed rail is opened and bring greater economic effects to cities. Accordingly, this article puts forward the first hypothesis:

Hypothesis 1: The opening of high-speed rail can promote local economic growth.

However, some scholars have found that the economic growth brought about by the opening of the high-speed rail will attract more attention to all aspects of the region. The environment is one of them, and the government and society will also increase their supervision. This has also led the government to choose to sacrifice the economy in exchange for the improvement of environmental quality in order to avoid unnecessary punishment. In other words, while high-speed rail brings economic growth, it will also restrain economic growth due to the government's environmental protection motives. However, the agglomeration effect brought by the high-speed rail allows different companies to share advanced environmental governance methods and technologies, and at the same time promote the efficiency of local green development by improving the level of innovation. Ran Qiying (2020) research shows that the effect of innovation on green development is 0.0129, That is, enterprises can complete environmental governance at a lower cost, realize the coordinated development of economy and environment, and promote the balanced development of the region. As a convenient, safe and fast means of transportation, the high-speed rail can replace private cars and other tools to reduce pollutant emissions. The opening of the high-speed

rail can also accelerate the transformation of local industries and increase the proportion of the tertiary industry. Studies have shown that the tertiary industry is relatively Compared with the primary and secondary industries, the pollution is smaller and the output is greater. Therefore, the opening of the high-speed rail can improve the environmental quality. In other words, the opening of high-speed rail can not only directly reduce pollution, but also increase investment in environmental protection industries by adjusting the industrial structure, reduce high-polluting industries, and improve the environment. Accordingly, the following hypotheses are proposed:

Hypothesis 2: The opening of the high-speed rail can improve the local environmental quality,

Hypothesis 3: The opening of high-speed rail can reduce environmental pollution by optimizing the industrial structure.

2.2. Model construction

This article first considers the economic impact of the opening of the high-speed rail on the cities of Henan Province. Because the GDP of each region is not balanced, this article uses the logarithm of GDP as the explained variable to eliminate heteroscedasticity, and whether the high-speed rail is opened as a two-valued dummy variable. To verify Hypothesis 1, build the following model:

$$\ln GDP = \beta_0 + \beta_1 HSR_{it} + \alpha X_{it} + \mu_i + \rho_t + \varepsilon_{it} \quad (1)$$

Where X_{it} is the control variable, μ_i is the individual fixed effect, ρ_t is the individual's time effect, ε_{it} is the random error term, i is the i -th city, and t is the time.

In order to verify Hypothesis 2, this paper selects industrial wastewater discharge and industrial sulfur dioxide discharge as the explained variables, and still uses whether to open the high-speed rail as the core explanatory variable. The framework model is as follows:

$$Pollution = \beta_0 + \gamma_1 HSR_{it} + \theta K_{it} + \mu_i + \rho_t + \varepsilon_{it} \quad (2)$$

In order to verify the intermediary mechanism of the impact of high-speed rail on environmental quality-industrial structure, the following model is constructed:

$$SIJS = \beta_0 + \delta_1 HSR_{it} + \vartheta K_{it} + \mu_i + \rho_t + \varepsilon_{it} \quad (3)$$

$$Pollution = \beta_0 + \omega_1 HSR_{it} + \omega_2 SIJS_{it} + \varphi K_{it} + \mu_i + \rho_t + \varepsilon_{it} \quad (4)$$

Among them, SIJS (industrial structure level) is based on Xu Deyun's (2008) definition and expression of industrial structure, and is determined by the weighted value of the added value of each industry, namely:

$$SIJS = \sum_{i=1}^3 Y_i * i = Y_1 * 1 + Y_2 * 2 + Y_3 * 3$$

This article strictly follows the test mechanism of the intermediate variable. First, the model (2) is used to test

the impact of the opening of high-speed rail on the environment. If the coefficient is significant, it means that the opening of the high-speed rail does have an impact on the environment; then the model (3) is tested, if the coefficient is significant, then It shows that the opening of the high-speed rail has an impact on the industrial structure of the opened area; finally, the industrial structure variables are included in the model (2), that is, the test model (4). If the result shows that the coefficient is still significant, it means that the opening of the high-speed rail can be affected by affecting the local industrial structure level. The quality of the environment.

2.3. Variable description and data source

In the text, $\ln GDP$ represents the logarithm of GDP per capita in a certain city. HSR_{it} is a two-valued dummy variable, which indicates whether high-speed rail is available in this area. Due to the time lag effect of the high-speed rail opening effect, this article takes June 30 of the current year as the dividing point. If the high-speed rail is opened before June 30 of the current year, it is considered that the high-speed rail was opened in the same year, and the value is 1; otherwise, it is considered secondary. The high-speed rail will be opened every year, and the value is 0. As an environmental variable, Pollution uses two indicators: industrial wastewater discharge and industrial sulfur dioxide discharge. SIJS is used to measure the industrial structure of a city. Y_1 , Y_2 , and Y_3 represent the added value of the city's first, second, and tertiary industries, respectively. i represents the i -th city, which is 1 to 17, representing 17 prefecture-level cities in Henan Province. t represents time, spanning a total of 14 years from 2005 to 2018.

In order to ensure the reliability of the results, this paper draws on the research results of Ran Qiying and other scholars, and uses the following variables as control variables, which is X_{it} in the model: Foreign investment (FDI), measured by the proportion of direct foreign investment in GDP; The degree of government intervention (GOV) is measured by the proportion of government fiscal expenditures in GDP; the degree of informatization (INTERNET) is expressed by the logarithm of mobile phone users at the end of the year; scientific research investment (SINPUT) is measured by the percentage of the area's scientific research expenditures in general expenditures Proportion measurement; population (PERSON), expressed by the logarithm of the population at the end of the year; fixed asset investment (FIX), expressed as the proportion of annual fixed asset investment in GDP; population density (HUM), divided by the total number of people at the end of the year The total area of each city is determined; the level of education (POP) is based on the logarithm of the number of college students who graduated that year; the per capita GDP (PGDP) is expressed by the logarithm of the per capita GDP.

In this paper, the high-speed rail opening data are taken from the Ministry of Transport and Henan Provincial Transportation Bureau, and the other data are taken from the EPS data platform, with a total of 238 observations.

Since the fixed asset investment of each city in Henan Province in 2018 has not been announced for the time being, the article returns the fixed asset investment of each city from 2005 to 2017 against the year, and estimates the fixed asset investment of each city in 2018 based on this.

3 Empirical results

3.1. Descriptive Statistics

This article first conducts descriptive statistics on the explained variables and explanatory variables. The results show that the maximum standard deviation of each variable is 1.134845 and the minimum is 0.0000223. The standard deviations of the remaining variables are all near 0, indicating that the overall data is stable.

3.2. Main inspection result

First, this paper verifies the impact of the opening of high-speed rail on the economy. The results are shown in Table 1. From the results, it can be seen that the coefficient of car HSP is significantly positive and consistent with expectations, indicating that the opening of high-speed rail can promote local economic growth. hypothesis 1 is correct. From the point of view of the coefficients of the control variables, the government intervention coefficient is significantly positive, indicating that government support can promote GDP growth. Although the coefficient of foreign investment is not significant, its standard error is 0.102, which is close to 10%. After adding foreign investment, the overall R2 of the model has increased, and the F value of the model is 674.96, which is highly significant. It can be said that foreign investment, as a part of social investment, also has a certain effect on GDP growth.

Table 1 Test results of the economic impact

Explanatory variables	Model 1	Model 2	Model 3
HSP	0.7778423*** (0.0544147)	0.1646403*** (0.0214643)	0.1564178*** (0.0219601)
GOV		4.371927*** (0.5381147)	4.356277*** (0.5360959)
FDI			5.976482 (3.643329)
Control	No	YES	YES
Constant	16.12644*** (0.0284021)	9.777285*** (1.18723)	9.785037*** (1.182599)
R ²	0.2271	0.7213	0.7242
Obs	238	238	238

***, **, * indicate significant at the level of 1%, 5%, and 10% respectively, and standard errors in parentheses.

In order to verify hypothesis 2, this paper uses the logarithmic value of industrial sulfur dioxide and industrial wastewater as the explanatory variable, and still takes the opening of the high-speed rail as the core explanatory variable. Because pollution is inseparable from human behavior and economic growth, economic growth sometimes comes at the expense of the environment. The government generally takes measures to

rectify companies and behaviors that pollute the environment. Therefore, this article selects per capita GDP (divide the actual GDP by the total population at the end of the year PGDP1) and government intervention as control variables. In addition, the quality of the labor force also has a certain impact on the environment. The higher the quality of the labor force, the stronger the awareness of environmental protection and the more inclined to choose to engage in work that does not damage the environment. Therefore, the control variable of this article will also add the number of college students who graduated that year as a variable to measure the quality of the work group into the model. Hausman test found that the P value is less than 0.01, that is, it is better to choose a fixed-effect model. Based on this, this paper uses a fixed-effects regression model for regression, and the specific results are shown in Table 2.

Table 2 Test results of the economic impact

Explained variable	ln So2	ln Waste
HSP	-0.2735468 [*] (0.1447796)	-0.3078191 ^{***} (0.0926565)
Control	YES	YES
CONSTANT	12.71734 ^{***} (0.2910369)	9.653893 ^{***} (0.1862586)
R ²	0.2221	0.3165
Obs	238	238

***, **, * indicate significant at the level of 1%, 5%, and 10% respectively, and standard errors in parentheses.

It can be seen from the table that the coefficient of HSP is significantly negative, which verifies the second hypothesis. When the explained variable is wastewater, the high-speed rail opening coefficient is always highly significant at the 1% level; when the explained variable is sulfur dioxide, the P value corresponding to the coefficient of the high-speed rail opening variable is not very small, but at 10% The level is still significant, showing that the opening of the high-speed rail has a significant effect on the improvement of environmental quality. This is generally mainly because the exhaust of vehicles such as cars contains a lot of suspended solids, sulfur dioxide, carbon monoxide and other harmful substances. After the opening of the high-speed rail, the use of these vehicles can be reduced, thereby reducing the emission of harmful substances and improving environmental quality.

In order to further Hypothesis 3, this article first takes the industrial structure level as the explained variable, and the opening of high-speed rail is still used as the core explanatory variable. Then, the industrial structure level is added to the regression model of hypothesis 2, still using the fixed effect regression. The results are shown in Table 3. It can be seen from the table that the coefficient of HSP in model (1) is positive, and the opening of high-speed rail can increase the proportion of secondary and tertiary industries and optimize the industrial structure; in models

(2), (3), the coefficient of HSP is negative, that is, the opening of high-speed rail has a negative adjustment effect on environmental pollution; the data in the table also shows that high-speed rail can reduce environmental pollution SO₂ by optimizing the industrial structure, but for wastewater, the adjustment effect of industrial structure is not obvious.

Table 3 Industrial structure mechanism inspection

	(1) structure	(2) ln So2	(3) ln Waste
HSP	1434.583 ^{***} (287.6891)	-0.2442045 [*] (0.1454139)	-0.3041378 ^{***} (0.0935936)
STRUCTURE		0.0000765 [*] (0.0000477)	9.59e-06 (0.0000307)
Control	YES	YES	YES
CONSTANT	-2147.433 ^{***} (509.8676)	12.91741 ^{***} (0.3156869)	9.678994 ^{***} (0.2031873)
R ²	0.1413	0.2149	0.3111
Obs	238	238	238

***, **, * indicate significant at the level of 1%, 5%, and 10% respectively, and standard errors in parentheses.

3.3. Robustness test

In order to enhance the robustness of the empirical results, this paper also makes the following tests. For Hypothesis 1, this article replaces variables and uses the logarithm of per capita GDP as the explained variable to perform regression. Before regression, the logarithm of per capita GDP in 2005 is used as the base period data, and the logarithm of per capita GDP in each period is divided by the base period data. The regression results show that the effect of high-speed rail on per capita GDP is highly significant at the level of 1%, and the explanatory power reaches 0.6233, indicating that the conclusion of Hypothesis 1 is robust. For Hypothesis 2, this article considers that the impact of high-speed rail on the environment may have a lag effect, so the value of the variable of high-speed rail opening is delayed by one period to obtain HSP1, and then the regression is carried out. The result shows that all are at the 1% level except for the POP coefficient. The POP coefficient is highly significant at the 5% level; for Hypothesis 3, this article adopts the approach of substitution variables, using the weighted number of people engaged in different industries as the measurement value of the industrial structure level, and then performing regression, the result is still significant. Show that the conclusions reached are reliable. In addition, after replacing the weights of the industrial structure with the weights of the number of people engaged in different industries, when hypothesis 3 is tested, the adjustment effect of the industrial structure on the impact of high-speed rail opening on wastewater is significant.

4 Conclusions and recommendations

4.1. Conclusions

In summary, this article draws the following conclusions: the opening of the high-speed rail has promoted the economic development of cities along Henan Province, and can significantly increase the overall GDP and per capita GDP; at the same time, it has also promoted the improvement of the environmental quality of various cities in Henan Province; in addition, this article uses the industrial structure As an intermediary variable, the research results show that the opening of the high-speed rail optimizes the local industrial structure, increases the proportion of secondary and tertiary industries, reduces high-polluting enterprises, and reduces the discharge of sulfur dioxide and industrial wastewater. In other words, high-speed rail can reduce environmental pollution and improve environmental quality by optimizing the local industrial structure.

4.2. Recommendations

However, from a national perspective, although Henan Province is located in the central plains and is an important transportation hub, it is not a province with high-speed rail connections between cities and cities. According to data from the Ministry of Transportation, Anhui Province, Fujian Province, Jiangxi Province, Hebei Province and Jiangsu Province have all realized high-speed rail interoperability among prefecture-level cities. Based on this, this article puts forward the following suggestions:

① The Henan Provincial Government should pay attention to the construction of high-speed railways in Pingdingshan, Puyang, Nanyang, and Zhoukou, and realize the high-speed rail connection between all prefecture-level cities in the province as soon as possible, so as to enjoy the economy brought by high-speed rail. And environmental welfare; ② The opening of high-speed rail has promoted the flow of resources and personnel between cities, and has enriched the industrial content. Each prefecture-level city in Henan Province should maximize the convenience and time-saving features of high-speed rail and vigorously develop the tertiary industry, To reduce the number of high-polluting industries.

Since this article only analyzes the data of Henan Province, but there are big differences among various regions of the country, there are still some shortcomings in the general applicability of the conclusions. In the future, we can relax the sample scope and analyze the data of various provinces across the country to explore high-speed rail The effect of opening in different regions, especially on how high-speed rail can adjust and improve the environment through the industrial structure.

References

1. Berechman J, Dilruba O, Kaan O. (2006) Empirical analysis of transportation investment and economic development at state, county and municipality levels

[J]. Transportation, 33: 537–551.

2. YJ Chen, P Li, Y Lu. (2018) Career Concerns and Multitasking Local Bureaucrats : Evidence of a Target-based Performance Evaluation System in China[J]. Journal of Development Economics. 133, 84–101.
3. Shijin Wang,Huiying Zhou,Guihong Hua,Felix Chan. (2020) Is the High-Speed Rail Opening Environmentally Friendly? Taking the Difference-in-Differences Test in Jiangsu, China[J]. Complexity
4. Feng Li,Yang Su, Jiaping Xie,Weijun Zhu,Yahua Wang. The Impact of High-Speed Rail Opening on City Economics along the Silk Road Economic Belt[J]. Sustainability,2020,12(8).
5. Thompson, J.N. (1984) Insect Diversity and the Trophic Structure of Communities. In: Ecological Entomology. New York. pp. 165-178.
6. Tong Shilong,Zhao Shouguo,Wang Han. (2021) The opening of high-speed rail and the inflow of foreign venture capital: Based on the panel data of Chinese cities[J].China Soft Science, (01):32-43.
7. Zhu Wentao,Gu Naihua. (2020) High-speed rail accessibility, spatial spillover effects and manufacturing agglomeration[J].Capital Economy Li Jinkai,Zhong Changbiao.The opening of high-speed rail, urban accessibility and employment opportunities[J].Soft Science, 34:21-26.
8. Ran Qiyong,Zhang Jinning,Yang Xiaodong. (2020) Does the opening of high-speed rail improve the efficiency of urban green development—An empirical test based on the double difference model[J].Journal of Guizhou University of Finance and Economics, (05):100-110.
9. Shijin Wang,Huiying Zhou,Guihong Hua, (2020) Felix Chan. Is the High-Speed Rail Opening Environmentally Friendly? Taking the Difference-in-Differences Test in Jiangsu, China[J]. Complexity.