Impact of High-Speed Railway Transportation on Economic Development in Zhengzhou City

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Abstract: China's high-speed rail is the leader in driving a new round of China's economy. Looking at it today, the scale of China's construction of high-speed rail is unprecedented. From improving the speed of operation, coastal travel, and extending from the Central Plains to the northwest, it has a huge impact on social and economic development. The rapid development of high-speed rail will create a new chapter in the history of the economy. Based on the data of some socio-economic and high-speed rail transportation in Zhengzhou City from 2007 to 2017, this paper analyses the relationship between high-speed rail transportation and social economy, and provides reference for the decision-making department to formulate transportation development planning. The study found that there is a strong correlation between high-speed rail transportation and economic development. The two influence each other and coordinate development. The direction of high-speed rail construction should be clarified to better realize the comprehensive development of regional economy.

1. Introduction
In March 2015, Premier Li Keqiang proposed a new concept of Made in China 2025 for industrial development, China’s high-speed rail going out as a Made in China 2025 war of a long-lasting battle. The construction of high-speed railway can greatly reduce the sense of distance between cities, and thus provide a good foundation for the exchange of freight and passenger transport. As China's economic development speeds up, its dependence on high-speed railways has gradually increased. In the context of the new era, the characteristics of high-speed railway will be further amplified. In addition, the improvement of the high-speed railway network will further deepen the economic cooperation and personnel exchanges in the region, not only providing a good circulation channel for freight transportation, but also playing an important role in the exchange of talents in the region.¹

The construction of high-speed rail in western developed countries started early and achieved remarkable achievements. It also provided valuable experience and technology for the construction of high-speed rail in other countries. Kiyoshi Kobayashi established a sophisticated high-speed rail system model that systematically demonstrates the dynamic relationship between capital and knowledge accumulation, wage levels, and land rent. A new perspective shows that high-speed rail construction plays a key role in the economic development of cities and regions along the line². David Ellis studied the impact of high-speed rail construction in Tennessee on the local economy, established an effective traffic demand model, and finally concluded that the high-speed rail developed the economic development of the US state of Naxi. It is a crucial role³. Nowadays, the development of
China's high-speed rail has been more than ten years, and the topic of high-speed rail has attracted the attention of more and more experts and scholars. Luo Renjian believes that the construction of high-speed rail has a great impact on the social and economic development of the areas along the line, and extends to other areas to promote the optimal allocation of social public resources\textsuperscript{[4]}. Zhao Qingguo pointed out that with the construction and operation of the city's high-speed rail, the city's form a vibrant commercial area centered on the high-speed railway station, a large number of resources will gather more and more. It is necessary to pay attention to the improvement of various infrastructures including roads in the city\textsuperscript{[5]}. Fu Mengxiang deeply studied the relationship between the construction of high-speed railway hubs and the rapid development of cities, and came to the conclusion that the construction of high-speed railway stations and economic development are not completely related to each other. Can the construction of high-speed railway hubs be Urban economic development provides a positive impetus, which mainly depends on the basic conditions of the city itself\textsuperscript{[6]}. Generally speaking, experts and scholars at home and abroad have studied the impact of high-speed rail on the overall economic situation of the region, while there are few studies on the economic impact of cities along the line.

2. Transport Development and Economic Development Status of Zhengzhou Railway
Zhengzhou, the capital of Henan Province, is an important central city in central China and an important transportation hub for the country. At the end of 2017, Zhengzhou completed a total production value of 913.02 billion yuan, an increase of 8.2% over the previous year; the per capita GDP was 93,143 yuan, an increase of 6.5% over the previous year.Zhengzhou High-speed Railway was officially put into operation in 2012. There are more than ten high-speed rail lines such as Xuzhou-Lanzhou High-speed Railway, Beijing-Guangzhou High-speed Railway, Zhengzhou-Hefei High-speed Railway, have formed a high-density high-speed railway network, which will further expand the economic development space of Zhengzhou City. Since the data of the high-speed rail is not public, it is assumed that the railway passenger and cargo turnover can reflect the situation of high-speed rail transportation to a certain extent, and the results are processed and analyzed. The GDP and railway passenger and cargo transportation data of Zhengzhou City in 2002-2017, the growth rate line chart of GDP and railway transportation are shown in Figure 1.

It can be seen from Figure 1 that the GDP and high-tech industrial value of Zhengzhou City are increasing year by year, and the passenger turnover is slowly increasing, but the cargo turnover is generally declining; as can be seen from Figure 2, GDP The growth rate was large, and the value of high-tech industry increased sharply in 2010. The subsequent growth rate showed a slow trend year by year, but it was always very high. The growth rate of passenger turnover was generally on the rise, while the cargo turnover was presented in 2014 and 2015. The negative growth trend had eased in 2016 and 2017.
3. Analysis of the Correlation between Railway Transportation and Social Economic Development

3.1. Correlation Analysis of Passenger Turnover, Cargo Turnover and Zhengzhou Gross Domestic Product (GDP).

For the two elements \( x \) and \( y \), if their sample values are \( x_i \) and \( y_i \) \((i = 1, 2, ..., n)\), then the correlation coefficient between them is:

\[
 r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2} \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}
\]  

(3.1)

In Equation 3.1, \( \bar{x} \) and \( \bar{y} \) represent the average of the two sample values, \( \bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \), \( \bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i \).

By calculating the average passenger turnover of Zhengzhou City, the average value of cargo turnover, and the average of 11 years of GDP, use Equation 3.1 to determine the degree of correlation between the two, and the passenger turnover and goods of Zhengzhou City during 2007-2017. Correlation analysis is carried out on the data of three variables of turnover and GDP\(^7\), the results are shown in Table 1.

It can be seen from Table 1 that, with a confidence level of 95\%, the correlation coefficients of passenger traffic, freight volume and gross domestic product (GDP) in Zhengzhou are: 0.995 and 0.342, respectively, when the correlation coefficient is greater than the confidence level of 0.95, indicating a strong correlation between the two. Therefore, it shows that Zhengzhou City passenger transport and Zhengzhou City's GDP have a highly dependent relationship, but there is basically no correlation between Zhengzhou City's cargo transportation and Zhengzhou's GDP. Since the high-speed rail only provides passenger transportation services, it has little impact on cargo transportation. Therefore, the impact of passenger turnover on Zhengzhou's GDP can be considered to be largely due to the impact of high-speed rail.
Table 1. Correlation coefficient between passenger turnover, cargo turnover and GDP

|                      | Passenger turnover (100 million people) | Cargo turnover (100 million tons) | GDP (Billion) |
|----------------------|-----------------------------------------|-----------------------------------|---------------|
| Passenger turnover   | 1                                       | -                                 | -             |
| Cargo turnover       | -0.380                                  | 1                                 | -             |
| GDP                  | 0.995                                   | -0.342                            | 1             |

3.2. Correlation Analysis of Passenger Turnover, Cargo Turnover and High-tech Industry Value

By calculating the average value of passenger turnover in Zhengzhou City, the average value of cargo turnover, and the average value of 11 years of high-tech industry value, the correlation degree between the two groups is determined by using Equation 2.1, respectively, for Zhengzhou City passengers from 2007 to 2017. Correlation analysis was carried out on the data of three variables: turnover volume, cargo turnover and high-tech industry value[7]. The results are shown in Table 2.

Table 2 Correlation coefficient between passenger turnover, cargo turnover and high-tech industry value

|                      | Passenger turnover (100 million km) | Cargo turnover (100 million tons) | High-tech industry value (100 million yuan) |
|----------------------|-------------------------------------|-----------------------------------|---------------------------------------------|
| Passenger turnover   | 1                                   | -                                 | -                                           |
| Cargo turnover       | -0.380                              | 1                                 | -                                           |
| High-tech industry value | 0.961                                | -0.989                            | 1                                           |

It can be seen from Table 2 that the correlation coefficient between Zhengzhou City's passenger turnover, cargo turnover and high-tech industry value is 0.961 and 0.989, respectively, when the confidence level is 95%. When the correlation coefficient is greater than the confidence level of 0.95, it shows that there is a strong correlation between the two. Therefore, it shows that the high-speed railway opening of Zhengzhou City has a strong correlation with the high-tech industry value. High-tech industries have promoted the development of high-speed rail, and the rapid development of high-speed rail has also provided guarantee for high-tech industries.

3.3. Analysis on the Economic Development and Changes of Zhengzhou before and after the Opening of the High-speed Railway

China's high-speed rail develops rapidly, and the most direct impact of high-speed rail opening on cities along the line is the economic benefits brought about by the substantial increase in accessibility between cities. With the improvement of traffic accessibility, the economic ties between cities have also been greatly improved. The total economic and economic links between the provinces and municipalities before and after the high-speed rail are shown in Table 3. From the growth rate of the total foreign economic relations of various cities after the high-speed rail in Table 4, it can be seen that the economic linkage intensity of each city has increased significantly after the construction of high-speed rail. The overall economic linkages of various cities have averaged 588,000 from 2009. By 2014, it increased to 2.591 million, and the average growth rate reached 340.8%. Among them, Zhengzhou's total foreign economic relations increased from 2.097 million to 13.255 million, an increase of more than five times, reflecting Zhengzhou's economic growth in other cities in the province has been significantly enhanced.
Table 3 Total foreign economic relations between provinces and cities in the province before and after high-speed rail

| City   | Year 2009 (Ten thousand) | Year 2014 (Ten thousand) | Growth     | City   | Year 2009 (Ten thousand) | Year 2014 (Ten thousand) | Growth     |
|--------|--------------------------|--------------------------|------------|--------|--------------------------|--------------------------|------------|
| Zhengzhou | 209.7                   | 1325.53                  | 532.10%    | Zhoukou | 25.44                    | 77.48                    | 301.45%    |
| Kaifeng  | 46.86                    | 315.95                   | 574.28%    | Luohe   | 86.48                    | 347.19                    | 301.45%    |
| Xuchang  | 49.91                    | 199.69                   | 300.08%    | Zhumadian | 29.28                 | 185.1                    | 332.25%    |
| Xinxian  | 71.77                    | 351.22                   | 389.39%    | Xinyang  | 25.76                    | 154.95                    | 301.60%    |
| Jiaozuo  | 67.47                    | 204.06                   | 202.43%    | Nanyang  | 42.45                    | 93.09                    | 119.29%    |
| Anyang   | 52.01                    | 228.56                   | 339.43%    | Luoyang  | 94.82                    | 416.25                    | 338.98%    |
| Hebi     | 49.44                    | 225.44                   | 356.01%    | Pingdingshan | 78.18               | 176.41                    | 125.64%    |
| Puyang   | 29.7                     | 90.35                    | 204.17%    | Sanmenxia | 6.49                   | 50.53                    | 678.83%    |
| Shangqiu  | 26.57                    | 65.82                    | 147.22%    | Jiyuan   | 65.57                    | 155.39                    | 136.99%    |

The improvement of regional accessibility will significantly increase the intensity of economic linkages between cities, and the opening of high-speed rail is closely linked with traffic accessibility. Therefore, the opening of high-speed rail will also promote the economic linkage between cities. In 2009 (before the construction of high-speed railway), the urban economic linkage pattern in the province formed a radial structure centered on Zhengzhou and extended with the Beijing-Guangzhou and Longhai Railways. On the whole, the intensity of economic linkages between cities is generally low. Only Zhengzhou has strong economic links with neighboring cities such as Xinxiang, Luoyang, Kaifeng and Jiaozuo, all of which are between 200,000 and 300,000. Zhengzhou is located at the intersection of the main railway lines of Beijing-Guangzhou and Bohai. It has a superior traffic location and is also the economic center of the province. Therefore, Zhengzhou has strong economic ties with other cities in the province, thus giving play to the provincial economy. Development dominates and radiates the way.

In 2014 (after the construction of the high-speed railway), the spatial structure of the radial economic connection centered on Zhengzhou was strengthened, and at the same time, the economic linkage strength of the cities along the Shiwu high-speed railway in the north-south direction is the most obvious, followed by Zhengxi high-speed rail section and Zhengkai inter-city line. Before and after the opening of the high-speed railway, the intensity of economic linkages changed significantly, especially the economic linkages between Xinyang and Sanmenxia as the center. From the perspective of the growth of foreign economic relations between Xinyang and Sanmenxia, Zhengzhou and Kaifeng were among the top two cities. The places are followed by cities along the high-speed railway. The cities ranked behind are non-high-speed rail cities such as Nanyang, Pingdingshan and Shangqiu. It can be seen that the opening of high-speed rail can significantly improve the strength of foreign economic relations along the cities along the line; for Zhengzhou, the high-speed railway strengthens the status of Zhengzhou's economic center, making the ability of radiation to drive other cities to develop stronger, and presents Zhengzhou as the center. The radial spatial connection pattern.

4. Conclusion
Firstly, through the above correlation analysis, it can be seen that there is a high correlation between Zhengzhou's gross domestic product (GDP) and passenger turnover and high-tech industrial value and passenger turnover and cargo turnover. Zhengzhou's economic development and there is a strong correlation between the opening of high-speed rail. Among them, the total production value, high-tech industry value and passenger turnover were positively correlated, the correlation coefficients were 0.995 and 0.961 respectively; the high-tech industrial value and cargo turnover were negatively correlated, and the correlation coefficient was 0.989. It can be seen that the increase in the gross domestic product and high-tech industrial value depends to a large extent on the rapid development of high-speed rail passenger transport services, and the development of high-speed rail passenger
transport services can promote economic improvement. This shows that economic growth can promote the development of high-speed rail transportation, and the development of high-speed rail can also promote economic progress.

In short, the GDP of Zhengzhou City is closely related to the development of high-speed rail transportation, and they promote each other and influence each other. The improvement of the level of high-speed rail transportation and the increase in the gross domestic product and the value of high-tech industries reflect each other and develop together.

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