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Master Thesis

The impact of high-speed railway on the economic development of cities along the HSR lines in China- -Taking Shaanxi Province as an example

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Abstract

As a revolutionary means of transport in the transportation industry, the successful operation of high-speed railways has not only changed the transportation landscape and ushered in a new era of transportation but has also profoundly affected the economic development of cities along high-speed railways, generating a huge economic effect. As the scale of high-speed railways in Shaanxi Province continues to expand rapidly, there is a great need to scientifically study the impact of high-speed railways on the economic development of cities along the lines in China, and to avoid the negative impact brought by high-speed railways, there is an urgent need for the regions along the lines to formulate reasonable industrial development strategies to guide the scientific development and reasonable layout of industries.

This thesis systematically analyses the mechanism of the impact of high-speed railways on the regional economy in terms of regional economic impact, accessibility, spatial structure, industrial structure and employment, and comprehensively analyses the path of the impact effect of high-speed railways. It is argued that high-speed railways mainly improve transport conditions as a prerequisite to influence the economic impact of urban development along the HSR lines, while the impact of high-speed railways on the economy of cities along the HSR lines is mainly reflected in catalytic effect, industrial agglomeration effect, industrial diffusion effect, integration effect, siphon effect and gradient effect.

The empirical part mainly uses the method of quantitative analysis to study the economic impact of cities along the high-speed railway in Shaanxi Province. Comparing and measuring the spatial interaction between cities before and after the opening of the high-speed railway, using the weighted travel time and economic potential model, to judge the accessibility changes of cities along the lines in Shaanxi with or without high-speed railway; select cities along the HSR lines in Shaanxi Province from 2010 to 2020 Regional GDP, output value and proportion of three industries, population and other data, summarize the development trend of high-speed railway regional economic aggregate, industrial structure, and employment population.

The main conclusions are: the opening of high-speed railways has significantly increased the level of accessibility between cities along the HSR lines in Shaanxi, with closer economic ties between towns and a significant increase in the intensity of the ties; the structure of industrial output value along the HSR lines has changed, and the changes vary from city to city along the lines; the beneficial impact of the opening of high-speed railways on the regional economy along the high-speed railways in Shaanxi mainly lies in enhancing the competitiveness of the secondary and tertiary industries; the formation of the Guanzhong Plain city cluster and the strengthening of the competitiveness of the city cluster; and the impact on labour force employment in the region.

Finally this thesis combines the development of cities along the HSR lines in Shaanxi Province to provide corresponding decision-making support for the development of relevant regional economic planning in cities along the lines.

Keywords: high-speed railway; regional economic impact; accessibility; Shaanxi Province

Chapter 1 Introduction

Throughout the history of human transportation, it is a history of continuous promotion of human development, social progress and economic development, and the development of transportation can, to a certain extent, promote economic and social development. This thesis is concerned with the study of the impact of high-speed railway on regional economic development, especially the economic development of cities along high-speed rail lines in China. Regional economic development and transport go hand in hand, and transport has always played an important role in the development of regional economies. Since the birth of the railway, it has become a popular mode of transport due to its better comfort, greater transport capacity and higher operating speed. The emergence of high-speed railways has not only brought the railway industry into a flourishing period, but also brought profound impact on the development of the regional economy, as its rapid development has facilitated people's travel while speeding up the transfer of traffic,

logistics, capital flow and information flow. Accelerate the flow of talent and industrial transfer. It can be said that the successful operation of high-speed railways has changed the pattern of transport, creating a new era of transport, and has been profoundly influencing the economic development of areas along the high-speed railways, producing a huge economic effect.

1.1 Background and purpose of the study

1.1.1 Background of the study

Transport is the lifeblood of the national economy and plays a vital role in its development. Its development provides the basic support for regional economic development, and the formation of a large-scale regional economy cannot be separated from the spatial expansion and accessibility provided by transport. In the past 20 to 30 years, China's regional economy has been upgraded through strategic planning, and a more reasonable regional division has gradually been formed.(Shi, 2019) However, as the regional economy continues to develop and upgrade, problems such as duplication of production and construction, trade barriers and flow costs are also constraining the economic development of the region. Only by deepening regional economic cooperation, increasing the exchange of regional economic factors and balancing the conflicts and contradictions arising from the geographical location of the regional economy can the development of the regional economy be coordinated, of which the development of transport is of paramount importance.

Through the continuous innovation and improvement of transport modes, the connection between regions is increased, the cost of regional development is reduced and the efficiency of regional communication is improved. The railway industry, the backbone of the transport industry, has been closely linked to social development and to the economic development of the regions over its 200 years of development. Despite the influence of increasingly developed airlines and motorways, rail transport continues to play a significant role in the overall transport sector. Under the influence of the oil crisis, high-speed railways were created, which do not use oil as an energy source and can meet the needs of high-speed operation, a product of the general trend of economic development, the construction and development of high-speed railways provide a huge stimulus for the economic development of all regions of the world.

In 1964, the world's first truly high-speed railway began operation in Japan, connecting Tokyo and Osaka, Japan's Tokaido, known as the Shinkansen or "bullet train", and the opening of the Tokaido Shinkansen also marked a new era in the development of high-speed rail around the world. Subsequently, the construction of high-speed rail in France, Italy, Germany and other developed countries, to the France TGV (Trains à grande Vitesse)[1] high-speed railway, Italy north-south high-speed railway, France to Germany high-speed railway as the representative, Japan and then

[1] It is a high-speed railway system designed and built by Alstom and the French national railway company and operated by the latter.

built the Sanyo Shinsen line[2] , the Tohoku Shinkansen[3] and so on. The opening of high-speed railways in France, Germany and Japan has accelerated the speed of population movement and material transfer in the regions along the HSR lines and promoted heavy industry in the cities along the lines to enhance economic efficiency. Along with the development of high-speed rail, the real estate sector in Japan and other countries has also flourished rapidly as a result of the opening of high-speed rail.

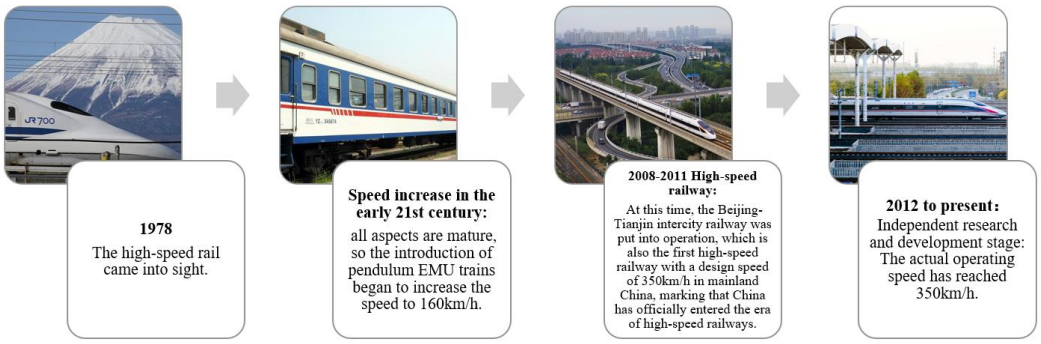
While China's high-speed railways started later than those of developed countries, the country's high-speed rail system has developed rapidly thanks to a prioritised development strategy over the past 15 years(Peng, 2010). China's vast territory and the large differences in economic development between some regions have led to the construction of infrastructure such as high-speed railways based on many factors such as geographical features, resource distribution and economic development, effectively shortening the spatial distance between China's territories, effectively improving the utilization of resources, and becoming an important support for regional economic development. China's high-speed rail service began operations in 2008, running at speeds from 250 km/h to 350 km/h from Beijing to Tianjin (117 km); in 2021, the total mileage of China's railway operations exceeded 150,000 km, with more than

[2] It is a high-speed railway that connects Shin-Osaka Station in Nishinakajima Gochome, Yodogawa-ku, Osaka City, Osaka Prefecture with Hakata Station in Hakata-ku, Hakata-eki Chuogai, Fukuoka City, Fukuoka Prefecture.

[3] It is a high-speed railway that connects Tokyo Station at Marunouchi Ichome, Chiyoda-ku, Tokyo, with Shin-Aomori Station at Oazaishi Ezaka, Aomori City, Aomori Prefecture.

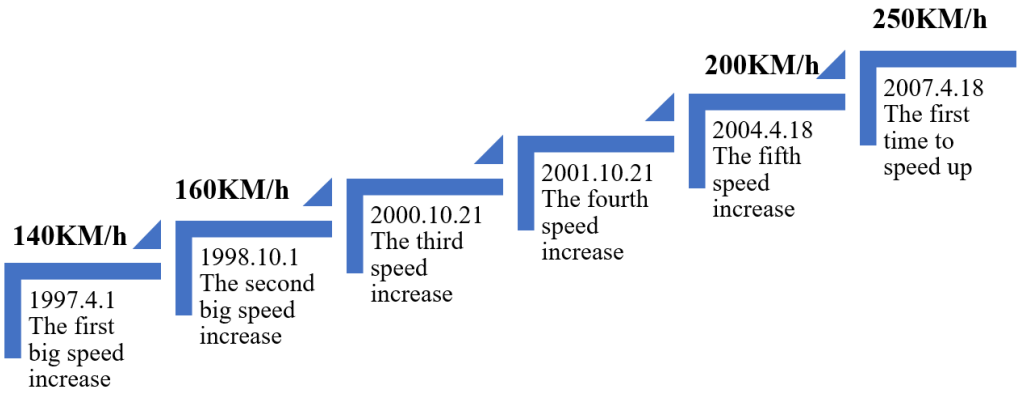
4,000 km of new railways operating nationwide, including about 2,150 km of high-speed rail; on 30 December 2021, the Beijing-Hong Kong's Anjiu (Anqing City, Anhui Province - Jiujiang City, Jiangxi Province) section of the high-speed railway will be opened for operation, so that the mileage of China's high-speed railway operation will exceed 40,000 km, which will far exceed the combined railway lines of other regions in the world in the long run. The sixth major speed-up of the railway and the large-scale construction of passenger lines marked the beginning of China's railway development into the era of "high-speed"(交通运输部, 2008). China's first medium and long-term planning outline for a comprehensive three-dimensional transport network-- <the National Comprehensive Three-dimensional Transport Network Planning Outline> states that by 2035, the total scale of the railway network will reach 200,000 km, of which high-speed railways will reach about 70,000 km, basically building a convenient and smooth, economic and efficient, green and intensive, intelligent, advanced, safe and reliable national comprehensive transport network(交通财会, 2021). The development history of China's high-speed railway and the six times of speed increase of the railway are shown in the figure (1-1, 1-2).

Figure 1-1: Development history of China's high-speed railway



Source: The author draws

Figure 1-2: China's railways speed up six times



Source: The author draws

In 2006, China began to increase its budget for the construction of dedicated high-speed rail lines (from US$14 billion in 2004 to US$88 billion in 2009), and it can be said that since 2006, China's railway construction has been developing rapidly, ushering in a "golden year"(新华社, 2006). The majority of the new lines are based on existing trunk lines. Most of these new lines follow existing mainline routes and are for passenger traffic only, with China's national grid connecting cities that were not previously connected by rail and will carry both passengers and freight. High

speed trains can typically reach 300-350 km/h; on mixed-use high-speed lines, passenger train services can reach maximum speeds of 200-250 km/h.

Shaanxi Province (Figure 1-3) is an important province in the national medium and long-term railway network plan of the "eight vertical and eight horizontal" high-speed railway network(交通运输部, 2016). At the international level, the "One Belt, One Road" (Figure 1-4) construction will bring Shaanxi province, an inland province, into the core area of opening up to the west and a transit hub for integrating resources from the east to export China's international influence to the west; at the national level, the Guanzhong Plain City Cluster[4] has the important task of raising the level of inland reform and opening up and leading the Great Northwest; at the provincial level, the high-speed railway can effectively revitalise regional dynamics, mobilise economic autonomy and leapfrog Xi'an's ability to radiate and drive the Guanzhong Plain City Cluster; at the city level, Xi'an, as the ancient capital of 13 dynasties, is located in the Guanzhong Plain, which is basically in the centre of China, and Shaanxi Province shares borders with eight provincial administrative regions, namely Henan, Shanxi, Chongqing, Hubei, Sichuan, Ningxia, Gansu and Inner Mongolia, making it China's geographically largest neighbouring province. It is the province with the largest number of neighbouring provinces. This natural location advantage has determined

[4] The Guanzhong Plain City Cluster, with Xi'an as its centre, is an important birthplace of Chinese civilisation, the starting point of the ancient Silk Road, and carries the historical glory and heavy memories of the Chinese nation. The Guanzhong Plain City Cluster has a good foundation for development and a great potential for development, and it has a unique strategic position in the general situation of national modernisation and the all-round opening-up pattern.

that since ancient times Xi'an has been an important transportation hub on the road in China. In recent years, with the introduction of each five-year plan, investment in the construction of high speed railways in central and western China has gradually increased, and Shaanxi Province, as a large western province and the core transportation area in the northwest, the central area is bound to achieve greater development with the further promotion of the construction of high speed railways, and the importance of studying the effects of the construction of high speed railways in Shaanxi Province has been revealed.

Figure 1-3: Shaanxi province location

Source: https://www.vectorstock.com/royalty-free-vector/shanxi-province-map-china-map-vector-28774623

Figure 1-4: Schematic diagram of the "one Belt, one Road"

Source: https://www.dipublico.org/105952/chinas-one-belt-one-road-initiative-can-a-bilaterally-negotiated-globalization-2-0-internalize-human-rights-labor-and-environmental-standards/

The high capacity and fast speed of modern high-speed rail provides a new option for people to travel. High speed rail saves a lot of time for travel, promotes the development of tourism in the area where the high-speed rail is located, facilitates the exchange of talents, information, and resources in the areas along the HSR lines, and promotes the transformation of the industrial structure in the areas along the HSR lines. As the construction of the high-speed rail network is a costly economic investment project, its direct investment economic benefits can be measured from a development perspective, but indirectly the impact on the long-term economic development of the region is yet to be recognized and studied more, the construction of high-speed rail is not just a simple matter of changing travel but has already had an obvious impact on the economic and social development of the region along the line.

In recent years, China has made great efforts to develop high-speed railways, which have brought important opportunities for regional economic development, and the development of regional economies has also made significant progress with the commissioning of high-speed railways. The impact of high-speed railways on regional economic development has also become a subject of great interest to the academic community.

1.1.2 Purpose and significance of the study

High-speed railways have significantly reduced transport costs between regions, helping to break through the barriers that prevent market competition between regions, so it can be said that transport has entered the "high speed rail era", and so has the regional economy(Yao, 2010). The same can be said for the regional economy. As China's railway transport system continues to develop and improve, the impact of railways on the regional economy is gradually becoming more widely appreciated.

This thesis will systematically analyze the impact of high-speed railways on the economy of cities along railway lines and reveal the mechanism and impact effect of high-speed railways on the regional economy. Also on this basis, combined with the actual situation of high-speed railway operation in Shaanxi Province, the impact of high-speed railway on the economy of cities along the line will be empirically analyzed, and countermeasures for the economic development of cities along high-

speed railway will be proposed. The research objectives of this thesis mainly include.

（1）Systematic analysis of the impact paths and mechanisms of high-speed railways on regional economies, clarifying the links between high-speed railways and regional economic development, and exploring the mechanisms of the economic impact of high-speed railways on urban areas along the HSR lines.

（2）To measure the extent of the impact of high-speed railways on the regional economies of cities along the HSR lines, to analyze the role played by high-speed railways in regional economic development, to provide suggestions for the coordinated development of cities along high-speed railways in Shaanxi Province, and to promote the healthy economic development of cities along high-speed railways.

After decades of accumulation and exploration in theory and practice, China's high-speed railways have finally entered a phase of rapid development. The development of high-speed railways is a major economic and social development strategy issue for building and improving the main transport corridors between China's important economic zones and major cities, and it is therefore important to systematically evaluate the benefits and impacts of high-speed railways on regional economies and societies as follows.

Firstly, it is important to give fuller play to the huge transport capacity of high-speed railways, to improve the investment efficiency of high-speed railways, to integrate the construction of high-speed railways closely with the regional economy and to promote the economic and social development of cities along the HSR lines.

Furthermore, it provides a reference for the industrial and economic development of the urban areas along the high-speed railway. Finally, Shaanxi Province and China as a whole suffer from uneven regional economic development, with northern Shaanxi showing rapid economic development in recent years, central Guanzhong showing a steady rise in development, and southern Shaanxi lagging behind in economic development (Yan, Shuxi;Liu, 2020). This is not conducive to the coordinated and sustainable development of the economy. The construction and operation of high-speed railways brings opportunities for regional economic development, and also provides implications for regional economic strategic planning in other areas along high-speed rail lines.

1.2 Research content and research methodology

1.2.1 Study content

High-speed railways have a broad development prospect, so we must pay attention to them; at the same time, this kind of transportation system in China, in Shaanxi Province is in the stage of introduction, digestion, absorption and innovation, it is necessary to make some analysis, research, from both theoretical and empirical aspects to explore the impact of high-speed railways on the regional economy of cities along the HSR lines. Theoretically, the impact of high-speed railways on economic development in terms of accessibility, integration and strategy is analysed in the context of theories related to transport and regional economy, as well as in the context

of important aspects such as changes in industrial structure, population, urban construction and logistics, to form a comprehensive and detailed systemic analysis.

For empirical evidence, the main economic indicators of the study area are collected and counted, and the actual economic benefits brought by high-speed railways are analyzed and compared. Based on technical and economic analysis, we analyzed the feasibility and realism of high-speed railway development and conduct in-depth research on the relevant elements of high-speed railway on regional economic development, including the impact of regional industrial restructuring as well as productivity layout, urban economy, employment, etc.

The sections of this thesis that are the focus of the research are as follows.

（1） Introduction. Details of research background, research objectives, research content, research methods, thesis chapter structure and thesis writing ideas.

（2） Literature review and relevant theoretical foundations. The main focus is on the theories related to the impact of transport on regional economic development and the analysis and summary of the current research results of experts and scholars to provide a research basis and reference for the study of this thesis.

（3） History and current status of high-speed railway development. This chapter focuses on the important elements of high-speed railway construction in China and Shaanxi Province as well as the current stage of development.

（4） The impact of high-speed railways on regional development along the HSR lines. The impact of high-speed railways on the regional economy is studied and analysed in terms of regional economy, accessibility, spatial structure, industrial structure and labour force employment impact, revealing the mechanism of the impact of high-speed railways on the regional economy.

（5） The economic impact mechanism of high-speed railway on cities along the HSR lines. To clarify in detail the impact paths of high-speed railways on cities along the HSR lines and the high-speed rail effects manifested in them, and to establish a mechanism model for the economic impact of high-speed railways on cities along the HSR lines.

（6） An empirical analysis of the economic impact of high-speed railways on cities along the HSR lines within Shaanxi Province. Collecting and collating data using mathematical models and comparative analysis methods to empirically analyse the changes in relevant economic indicators of cities along the HSR lines after the opening and operation of high-speed railways, and to explore the quantitative and qualitative impact of high-speed railways on the economic development of cities along the HSR lines within Shaanxi Province.

（7） Summary and recommendations. By studying the economic impact of high-speed railways on cities along the HSR lines, the basic conclusions of this thesis are distilled. It also provides suggestions for the development of regional economic construction, the coordinated development of cities along the high-speed railway in Shaanxi Province and promotes the sustainable

economic development of cities along the high-speed railway.

1.2.1 Research Methodology

This thesis adopts a research method that combines theoretical and empirical research, and qualitative and quantitative analysis. Theoretical research is conducted by reading the historical literature related to the topic and reviewing the latest research developments, so as to sort out and summarise the relevant theoretical research. By collecting statistical data on national economic and social development (with reference to statistical yearbooks), the context of socio-economic development was understood. From the theoretical research, the processing of the collected statistical data, analysis, generalization and calculation of the economic impact of high-speed rail on the cities along the HSR lines, exploring the use of quantitative methods to analyze the parts that are difficult to be precise in qualitative analysis. The empirical study uses statistical yearbook data and forecasts based on mathematical algorithms to explore the spatial and temporal impact of the opening of the HSR on the cities along the HSR lines. This is followed by a comparative approach based on the presence and absence of high-speed rail to measure how the relevant indicators of the cities have changed with and without high-speed rail, and to analyze the changes in the industrial structure and competitiveness of the cities along the high speed rail line in Shaanxi Province.

Chapter 2 Literature Review and Related Theories

2.1 Review of the literature

High-speed rail originated in Japan and has developed rapidly in Europe, so many European scholars have been exploring the theoretical and practical aspects of its construction, opening and operation on the economic development of the regions along its routes. The development of high-speed rail in China just started twenty years ago and is still in its infancy, leaving much more research to be done on the development of the region. As China continues to develop, the development of a region must rely on the creation and development of transport. Railways, on the other hand, are an important infrastructure and means of transport, especially the emergence and development of high-speed railways, which have become a prerequisite for regional development. According to the mechanism of the direct or indirect effect of high-speed railways on the economic development of the regions along the HSR lines, scholars worldwide have reviewed the regional economy, industrial structure, employment and other perspectives.

2.1.1 The impact of high-speed rail on the regional economy

Research by scholars in various countries around the world has demonstrated that the construction of high speed rail has an impact on regional economies. (Chen and Hall, 2011) analyzed the regional impact of inter-city high-speed rail in the United

Kingdom and concluded that the completion of high-speed rail would bring significant economic benefits and may promote face-to-face interaction among people, thus driving the economic development of the region. (Haynes, 1997) used the development of high-speed railroads as an entry point to study the interaction between human resources and regional transport in his article. His study found that the opening and operation of the railroad facilitated labor transfer between regions and increased employment opportunities. (Martin, 2002) evaluated the high-speed railroad project in terms of both social and regional development. It is shown that high-speed railroads not only improve the rational distribution of regional transportation resources, but also promote the development of the whole region. (Kamel, 2008) focused on the social effects of building high-speed rail hubs in three cities, including London, The Hague, and Ebbsfjord, and provided an in-depth analysis. (Kobayashi ;Okumura, 1997) established the theory of two-way transportation of high-speed railroads with labor and capital cum power-regional economic development model. In this theory, high-speed railroads create more information exchange between different urban manufacturing companies connected to them, thus promoting the development of different industries in the region. (Peter, 2003) suggests that the completion and improvement of high-speed railroads will have a significant impact on local economies, not only bringing economic vitality to areas in decline and transition, but also promoting the development of developed areas. (Donaldson, 2010) after an in-depth study of the huge railway network in the colonial areas of India, it was concluded that the construction of railways could effectively reduce the price

differences between regions, reducing transaction costs and thus increasing the level of economic development between regions. (David, 2010) explored the time and transportation advantages for localities during the operation of high-speed railroads by building an analytical model using the example of railroads in Tennessee, USA, and came to a positive conclusion.

In China, high-speed railroads have changed all aspects of people's lives, to a certain extent eliminating the barriers between two different neighboring cities in terms of time and space dimensions, and making transportation more diversified. (Xu, 2011) argued that at the same time, the development of metropolitan cities has accelerated the gathering of capital, talent, technology, innovation and other factors between regions, thus achieving regional integration and optimal distribution of resources. (Wang, 2010) pointed out that the construction and development of high-speed rail has greatly promoted the development of China's economy, and with its low-carbon and energy-saving features, high-speed rail has gradually become an important node and part of China's The construction and development of high-speed railroads have had a profound impact on China's economic development, and because of their low-carbon and energy-saving features, high-speed railroads have become the main transportation artery in China, while high-speed railways have played a huge role in promoting the crosstown effect, employment and industrial development. facing the pressure of large population, resource shortage and uneven economic development. (Zhou, 2010) argued that the completion of high-speed railways has greatly improved

China's transport resources, allowing for the rapid movement of factors of production across regions and creating opportunities for economic development between regions, bringing about new changes. (Fang, 2010) believed that the completion of railway passenger lines has contributed to the economic development of the regions by expanding the metropolitan areas of prefecture-level cities and strengthening the agglomeration and spillover effects. (Zhang, 2013) from the viewpoint of capacity, high-speed railroads can not only solve the current transportation pressure in the passenger market, but also increase the capacity and achieve the optimal capacity. He quantified the economic growth of the Beijing-Tianjin region using multivariate and gray forecasting methods and found that the Beijing-Tianjin intercity has contributed to the development of the region.

It is worth noting, however, that existing research remains controversial as to whether high-speed railways have boosted regional economic growth. The results of the (Wang, 2014) showed that in the short term, high-speed rail does not play a role in promoting regional economic growth in the context of the current slowdown in the Chinese economy as a whole. (Liang, 2008) focused on the changes in human, capital and logistics factors in the Beijing-Tianjin-Hebei[5] region, and concluded that the construction of the railway facilitated the flow of factors, while also creating an imbalance in economic development between the Beijing-Tianjin-Hebei region.

[5] It is China's 'Capital Economic Circle', a cluster of cities that includes the municipalities of Beijing and Tianjin, as well as Baoding, Tangshan, Langfang, Shijiazhuang, Qinhuangdao, Zhangjiakou, Chengde, Cangzhou, Hengshui, Xingtai, Handan in Hebei Province and Anyang in Henan Province.

(Sasakii, 1997) developed a supply-driven regional economic model based on the impact of high-speed railways on the regional economy, and the results showed that the Japanese Shinkansen transport system has a dispersal effect on economic activities and population in space. Therefore, whether or not the opening of a high-speed railway can drive regional economic growth depends on the magnitude of the 'spillover effects' and 'agglomeration' effects.

2.1.2 Impact of high-speed rail on regional accessibility

(Coto-Millán, Inglada and Rey, 2007) proposed that the introduction of high-speed rail has led to a significant reduction in the cost of transport by rail, not only in terms of money, but also in terms of time. In addition, the central regions of Europe have benefited from the increased accessibility. (Blum, Haynes and Karlsson, 1997) From the point of view of accessibility, it is argued that the high-speed rail linking the major cities along the HSR lines to form a new regional economic corridor with an extended function proves to a certain extent that the "point-to-point" connection of high-speed rail is an advantage, transforming the connected city belt into an extended functional area or economic corridor and increasing accessibility within the region. This increases accessibility within the region. (Kim, 2000) mainly from the perspective of the developments in Japan and Europe, found that high-speed railroads can improve regional transportation and promote regional economic development by influencing certain changes in the residence and living patterns of residents along the HSR lines.

(Chang, 2008) studied the access to high-speed rail in Korea and confirmed that the opening of high-speed rail will have a positive effect on the accessibility, especially in large metropolitan areas, and suggested that the construction of high-speed rail should be promoted vigorously to improve the accessibility of the region. (Jin *et al*, 2017) explored the mechanism of the development of high-speed trains in East Asia as an example and found that high-speed rail networks not only increased their accessibility but also expanded the core areas of economic development, forming a one-hour economic circle of Yangtze River Delta, Pearl River Delta, Tokyo, and Seoul, but also strengthened the unevenness of accessibility between parts of China. (Ureña, Menerault and Garmendia, 2009) At the national, regional and municipal levels, the completion of high-speed railways will disrupt the existing metropolitan system and its increased regional accessibility will have an even greater impact and impact on people's lives.

(Wu, 2009) Argued that the completion of inter-city high-speed railways has facilitated transportation in the Beijing-Tianjin region, which is conducive to promoting their economic development and enhancing the economic development of Beijing-Tianjin-Hebei. (Pol, 2003) argued that the development of high-speed railways will determine how each city responds in the face of opportunities. The completion of the high-speed railway has increased the region's accessibility and has led to development strategies to enhance the region's dominance accordingly. (Fang, 2014) argued that the completion of the Beijing-Guangzhou high-speed railway will

have a significant impact on the spatial pattern of China's cities, greatly improving accessibility, optimizing transportation and facilitating inter-regional economic interaction. (Zhao, 2010) pointed out that the construction of the high-speed railway has improved the accessibility of the region, while at the same time changing the intensity of its geographical location. (Tao, 2016) selected three indices of economic potential, travel time to Shanghai, and weighted average travel time were selected by et al. as measures of land accessibility in the Yangtze River Delta[6] region with or without high-speed rail access, and found that high-speed rail has an important impact on regions with low GDP per capita, particularly in terms of convenience to Shanghai, which facilitates Shanghai's economic radiation and pull on this category of regions and may make the Yangtze River Delta economic development model more parochial.

2.1.3 Impact of high-speed rail on regional spatial structure

(Vickerman, 1997) Examined the impact of high-speed rail on regional development in Europe, where the lack of an authentically networked, integrated transport organization may have concentrated regional development in metropolitan centers with network services. The advent of high-speed rail has greatly improved regional accessibility and has also greatly reduced urban space and spatiality, with the advent of high-speed rail changing perceptions of space and time. (Zhang, 2010) believed

[6] The Yangtze River Delta, or Yangtze River Delta for short; includes Shanghai, Jiangsu Province, Zhejiang Province and Anhui Province, with a total of 41 cities; is located in the lower reaches of the Yangtze River in China, bordering the Yellow Sea and the East China Sea, at the meeting point of the rivers and the sea, with many coastal ports along the river, and is an alluvial plain formed before the Yangtze River entered the sea.

that the rapid development of high-speed railways has promoted economic integration between regions, accelerating the process of co-location of major cities and increasing economic links between them. This is based on a number of theoretical and practical experiences in other countries, (T. Yu, 2012) discussed the role of high-speed railways in the development of peri-urban areas has also been explored. The theoretical analysis of the establishment of high-speed railway hubs points out the need for the construction of high-speed railway hubs, which will lead to changes in the traffic pattern of the surrounding areas and thus accelerate regional development.

2.1.4 Impact of high-speed rail on regional industrial structure

(Melibaeva *et al.*, 2010) argued that the increased connectivity and accessibility will lead to new economic development or reconfiguration of multiple metropolitan areas within the rail corridor, while the industrial structure will be spatially uneven. The completion of high speed rail will promote trade and commerce, creating more value-added space, which in turn will lead to the development of third sectors such as retail and services, accelerating the transformation of the industrial structure(Chen and Hall, 2011) . Vickerman.R (2017),(Vickerman, 2018) After an in-depth analyzed of HS1[7] , the first high-speed railway in the UK, analyzed its needs and argues that there should be no change in the railway transport infrastructure itself, but if it is intervened with other related policies, it will revolutionize the economic development of the regions

[7] The first dedicated high-speed rail line in the UK, bringing London and Paris within two hours of each other.

along the HSR lines by causing a huge change in the whole industry.

Studies by Chinese scholars in this area such as(Yi, 2013) Through the study of the example of the construction of the Harbin-Dalian high-speed railway[8] , the spatial and temporal superiority of the Eastern provinces[9] in development is explored from the perspective of time and space, and it is suggested that the location conditions of the high-speed railway can be used to integrate tourism resources, port resources and industrial resources, thus promoting the economic development of the northeast region. (He, 2011) then used the Wuhan-Guangzhou high-speed railway[10] as an example to make an empirical analysis of the development of Hengyang[11] area. He says that the completion of the Wuhan-Guangzhou high-speed railway has fully reflected Hengyang's geographical location and favorable conditions for the transfer of industries, promoting urbanization and tourism development. (Cai, 2012) believed that, as China enters the "high-speed railway era", the high-speed railway has had a huge impact on the tourism development of the West China Sea Region[12] , not only promoting the integration of tourism resources in the surrounding scenic areas of the

[8] It is a high-speed railway in China connecting Harbin, Heilongjiang Province with Dalian, Liaoning Province; the line runs north-south and is one of the main lines in northeast China.

[9] They are three provincial-level administrative regions in the northeast of China. The three northeastern provinces are divided into the provinces of Heilongjiang, Jilin and Liaoning.

[10] It is an important part of the Beijing-Hong Kong high-speed railway (Beijing to Hong Kong), which is one of the "eight vertical and eight horizontal" high-speed railways in China's Medium and Long-term Railway Network Plan, and is oriented in a north-south direction. It runs in a north-south direction.

[11] A prefecture-level city under the jurisdiction of Hunan Province and a provincial sub-centre, located in southern China, south-central Hunan Province.

[12] The Economic Zone on the West Coast of the Strait, as it is known, is an economic complex with Fujian as the main body, facing Taiwan, adjacent to Hong Kong and Macao, covering the west coast of the Taiwan Strait, including southern Zhejiang, eastern Guangdong and parts of Jiangxi, and dovetailing with the two economic zones of the Pearl River Delta and the Yangtze River Delta.

West China Sea Region, but also promoting the rational distribution of tourism resources within the region. The Beijing-Shanghai high-speed railway[13] is a new type of social transport(Hu, 1999) , which has played a positive role in reducing traffic pressure, promoting tourism development and increasing jobs. (Su, 2009) founded that the Beijing-Shanghai high-speed railway, when completed and opened to traffic, will promote closer economic ties between regions, thus promoting the rational distribution of resources in China and the division of labor and cooperation between regions, which will lead to the development of other industries such as the catering and information consulting industries. (Cui, 2014) Through the example of the Zhengxi high-speed railway[14] , the role generated by the development of urban tourism in the western Zhengzhou region is studied, and it is argued that the Zhengxi high-speed railway can effectively reduce the cost of regional transport and take advantage of the development of high-speed railways and the use of new media for marketing. (Yao, 2010) argued that the high-speed railway, with its focus on passengers, has the greatest impact on industrial development, particularly in industries like tourism which require high traffic volumes, and that the high-speed railway can contribute to the continued development of a third sector.(Yu, 2012) used case studies, systematic analysis and questionnaires, et al. discussed the development

[13] The Beijing-Shanghai High Speed Railway, also known as the Beijing-Shanghai Passenger Dedicated Line, is a high-speed railway connecting Beijing and Shanghai, and is one of the "eight vertical and eight horizontal" high-speed railway main corridors in the Medium and Long-term Railway Network Plan revised in 2016.

[14] It is a high-speed railway linking Zhengzhou City in Henan Province and Xi'an City in Shaanxi Province, and is an important part of the "Land Bridge Channel", one of the main channels of the "Eight Vertical and Eight Horizontal" high-speed railway in the Medium and Long-term Railway Network Planning (2016 version).

opportunities and problems that high-speed railways bring to the development of short- and medium-haul tourism in the Yangtze River Delta region, and propose corresponding countermeasures. (Zhang, 2017) used the with and without comparison method to establish a gray forecast and multiple linear regression model for Wuhan city, through which he conducted an empirical study and found that the development of high-speed railroads has a significant pull effect, and its overall contribution shows a trend of increasing before decreasing, and also promotes the transformation and optimization of regional industries.

2.1.5 The impact of high-speed rail on regional employment

(Kingsley, 1997) Starting with the dynamics of high-speed railways, and looking at specific examples, combined with relevant local regulations, it is suggested that the construction and operation of high-speed railways can effectively reduce the workload of workers, thus significantly improving the employment situation in the region. The study result of (David, 2010) showed that due to the construction of the high-speed railway, the residents in the surrounding areas have gradually gathered in the surrounding areas, thus leading to a significant increase in the surrounding property prices. Thus, the construction of high-speed railways will lead to a large concentration of people, which will lead to an increase in house prices and jobs in the corresponding industries in the surrounding area. (Chen and Silva, 2014) developed a SEM[15]model

[15] Structural Equation Modeling (SEM)

using the economic development status across Spain as an exogenous factor and used it as an exogenous variable to study the effect of high-speed rail on economic development and GDP in each region, and found that the construction of high-speed rail boosts GDP and provides more room for emerging companies to grow and develop, and further promotes population mobility and boosts local employment in Spain.

Chinese scholars(Ping, 2001) By examining the new railway network in Japan, and based on the special situation of high-speed railways in China, it is proposed that the development of high-speed railways will bring great changes to the city, and also cause far-reaching changes to the transportation and residential environment of the city. (Gu, 2008) Through quantitative analysis of the spatial distribution of employment in the secondary and tertiary industries of transport and the employment population living in the city, it is found that there is a serious disconnect between the employment and residential geographies in Shanghai, which leads to rising employment costs, increased commuting distances and traffic congestion.(Yin, 2010) Used the promotional effect of high-speed railways on the development of the real estate industry as an entry point, et al. provide a more detailed analysis of the practical application of the Beijing-Tianjin Intercity Railway in urban construction, sales and management.

To sum up, high-speed rail is a new form of economy with its own characteristics and

special superiority, which plays a huge role in promoting economic development between regions. Theories on high-speed rail have been discussed by academics in various countries from the following perspectives: firstly, the development of the region by high-speed rail; secondly, the role of regional access and accessibility, the spatial layout of cities, regional industry, and regional employment. Theoretically, the integration, agglomeration and extension effects of high-speed railways are empirically studied, yielding either positive or negative economic impacts. In the empirical analysis, the impact of high-speed railways on the regional economy is mainly verified by measuring data, and the results show that high-speed railways have an important impact on the transportation and industrial structure of the regions along the HSR liness. In conclusion, the current study of the impact of high-speed railways on the region has made great progress, but there are still some shortcomings and deficiencies: more qualitative research, less analysis of the mechanism and path of high-speed railways on the regional economic impact, the analysis of the regional economic benefits of high-speed railways is also not comprehensive. The quantitative research focuses more on engineering and the impact of high-speed railways on the economy of larger regions, but there is a lack of research that specifically analyses the impact of high-speed railways on the economic development of cities along the HSR lines, and does not highlight the differences in the impact of high-speed railways on different regions along the HSR lines. This thesis will provide an in-depth analysis of the impact mechanisms of high-speed railways on the economic development of urban areas along the HSR liness, and rationalise the different pathways and their

interrelationships.

2.2 Related theories

2.2.1 Growth Pole Theory

The theory of uneven regional development, developed by French economist François Perroux in the early 20th century, has had a significant impact on regional economic development and regional planning, particularly in developing countries such as China and Pakistan(Peng, 1998). The theory suggests that there is no balanced development in every region of a country, and that economic growth is generally spread by one or more 'growth centers' to other regions through different channels and means. Therefore, it is often necessary to select the right geographical space as a growth pole to drive the growth of the regional economic level. Later, the French economist J.bB Boudeville introduced this theory into regional economic theory, and later the American economists John Friedman, A.O. Hischman and the Swedish economist Gunnar Myrdal further analyzed and extended this theory from different perspectives, making the theory of regional growth poles the mainstream of regional economic development work in various countries. The theory of regional growth poles has become the dominant theory in the work of regional economic development in various countries. In layman's terms, a positive factor can be a growth pole if it drives economic growth, such as a policy innovation point or a consumption hotspot. Many countries and regions use the growth pole theory to address issues related to

uneven internal development. The extent to which growth poles affect the regional economy is very close, and the transport system of a region is also crucial to the economic impact of the region. The more robust a region's transport system is, the faster the factors affecting regional economic growth flow to the growth poles, and the greater the probability that growth poles will be formed, and the more significant the impact on regional economic development. The opening and operation of high speed rail in a region can benefit its industrial growth poles, thus promoting the development of the regional economy.

2.2.2 Economic radiation theory

Economic radiation refers to the flow and transfer of capital, talents, technology, markets and other factors between regions with relatively developed levels of economic development and modernization and regions with less developed economies, as well as the spread of ideas, ways of thinking and habits of life, replacing the forces of old habits that are contrary to modernization with modern ideas, ways of thinking and habits of life, thus further improving the allocation of economic resources The efficiency of economic resources allocation. The characteristics of economic radiation are as follows: firstly, the premise of economic radiation is established in the open space of the free market; the role of radiation is also a pulling effect, radiation is both an influence and a connection, by extending the dynamic range of the source of economic radiation, pulling the surrounding economic

regions to the corresponding range, thus forming an economic linkage. Secondly, radiation is a two-way communication, interchangeable, such as talking about underdeveloped regions providing economic and economic development factors such as talents, resources and labour force to developed regions, while developed regions pass on advanced science and technology, management experience, ideas and so on. This interaction gradually brings the two regions closer together, resulting in integrated development. Finally, the speed and extent of radiation is related to the distance and the relationship. The closer the economically developed country (region or city) is to the lagging country (region or city), the better the relationship, the fuller and faster the radiation, and the higher the degree of radiation; and vice versa. The medium of economic radiation is mainly transportation network, information network, relationship network, etc., that means economic radiation is carried out through transportation, information and various relationships. Economic radiation has both positive and negative effects. The main forms of economic radiation are point radiation, line radiation and surface radiation(Hu, 2003). The main types of economic radiation are point radiation, line radiation and surface radiation.

The mainstream of economic radiation theory includes growth pole theory, point-axis development theory, grid development theory, circular cumulative causality theory and centre-periphery theory, which encompasses industrial agglomeration and diffusion, gradient transfer and so on. The French historian Golo Mann pointed out that the central city radiates and drives the development of the surrounding satellite

cities, making them the core of the region and generating huge economic momentum and influence, sometimes even worldwide. When there are a considerable number of cities of different nature, type and scale in a certain region, and there is more than one mega-city as the core, relying on certain natural environmental conditions, with the help of accessible transport and information networks, the cities will form a relatively close economic, social and ecological links between each other, together forming a relatively complete urban aggregate, so that the whole regional economy shows a strong growth momentum(Cui, 2010), the region's economy is growing strongly.

2.2.3 New economic geography theory

In 1990, the American economist Paul Krugman and others first proposed a new theory of economic geography, which is based on the theory of increasing returns and has often been used to explore and study issues related to the agglomeration of economic growth. (Fujita and Thisse, 2009) believed that economic geography is considered to be the study of the evolution of industrial structure and layout, and the "analysis of trade patterns and the location of economic activity". This theory is very different from the previously existing economic geography theories, in that the new theory is no longer influenced by space, but explains well the causes of agglomeration effects(Fujita and Mori, 2005) , in terms of transport costs, factor mobility and so on. The main reason for selecting the new economic geography as the theoretical basis for this thesis is that it is closely related to the economic radiation theory and the growth

pole theory, precisely because the traditional economic geography cannot do an effective job of explaining the agglomeration effect of regional economic development on the premise that further explanation arises from the development axis and the radiation theory itself verifies the content of uneven competition. The current state of regional economic development in China and even in Shaanxi Province is itself characterized by unbalanced and imperfect competition.

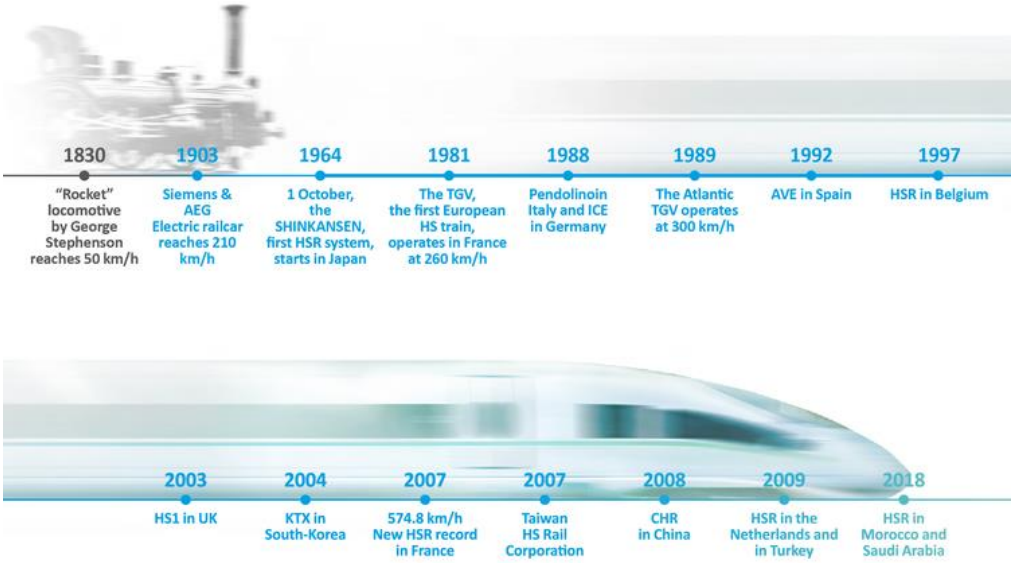
Chapter 3 Overview of high-speed rail development

To some extent, the evolution of transport modes can be understood as the evolution of the speed of each mode of transport. From horse-drawn carriages and ships to steam trains and automobiles to today's airlines, highways and high-speed trains, all modes of transport, by land, sea and air, have sought to develop themselves and to meet the needs of transport with better services. In the mid-20th century, railways lost their edge in the transport market due to the impact of airlines and motorways, until 1964 when the Shinkansen line opened in Japan and high-speed railways were successfully operated for the first time commercially, achieving a historical breakthrough in transport speed, setting a new model for rail transport and creating a new dimension in railway development. This chapter will sort out an overview of the development of high-speed railways in the world, China, and Shaanxi Province at different scales.

3.1 Overview of high-speed rail development worldwide

The development of high-speed rail worldwide has been divided into four main phases, and the timeline for the development of high-speed rail is shown in Figure 3-1.

Figure 3-1: Timeline of high-speed rail development



Source: Union Internationale des Chemins de fer (UIC)

https://uic.org/passenger/highspeed/article/high-speed-rail-history

19th-20th centuries: the birth of the railway to high-speed rail

As the railway mode is a guided, low-grip transport system, the history of railways can also be called the history of speed.

Since the origins of railways in Europe, during the industrial revolution of the early 19th century, the speed of passenger trains has been key to competing with other modes of transport and other railway companies. 50 km/h achieved by George Stephenson's impressive "Rocket" locomotive in 1829 was understandably regarded

as high speed at the time, followed by 100 km/h in 1850, 130 km/h in 1854 and even 200 km/h in the early 20th century. It was followed by 100 km/h in 1850, 130 km/h in 1854 and even 200 km/h in the early 20th century. In the 1930s, the maximum and average speeds between two cities using steam, electricity or diesel power were 180 km/h and 135 km/h respectively. However, the advent of other modes of transport, such as aviation and motorways, spurred the railways to take further steps to keep up with the competition.

1964: The birth of the Shinkansen

Following a succession of railway speed records in European countries such as Germany, Italy, the UK and France, Japan National Railways began operating a brand-new Shinkansen railway line on 1 October 1964. The line was designed to provide transport capacity for the transport system commensurate with Japan's rapid economic growth. JR[16] promoted not only the concept of the new line but also the new transport system, which was later expanded to other parts of Japan and became an important pillar of transport passenger traffic in Japan afterwards. The Shinkansen was designed to operate at a speed of 210 km/h and featured advanced technological innovations such as larger loading capacity, 24KV AC powered motor units, Automatic Train Control (ATC) and Centralized Traffic Control (CTC). Thus, the high-speed railway was officially born.

[16] JAPAN RAILWAYS is short for Japan Railways.

1964-1981: The advent of the TGV

Following the great technical and commercial success of the Shinkansen in Japan, several European countries, notably France, Germany and Italy, despite their uncertain future (the introduction of Concorde, political opposition, the first oil crisis of 1973, etc.), new technologies and innovations designed to overcome the decline in rail market share, the French national railway company SNCF began operating on 27 September 1981 the Paris and The first high-speed line between Paris and Lyon, with a maximum speed of 260 km/h. Thanks to its interoperability with the existing rail network, the new European high-speed railways rapidly spread and expanded their services.

1981-2018: High-speed rail services around the world

The operational success of high-speed rail in Japan and France has encouraged a number of European countries to start looking at establishing a new generation of competitive medium and long-distance passenger rail services, either by developing their own technology or by importing it. Italy and Germany in 1988, Spain in 1992, Belgium in 1997, the UK in 2003 and the Netherlands in 2009 have all joined the club of countries providing high-speed rail services in Europe. At the same time, other countries such as China in 2003, South Korea in 2004 and Turkey in 2009 have actively pursued the development of high-speed rail and following the opening of the Beijing-Tianjin high-speed railway in August 2008, China has significantly increased its strategic position for high-speed rail, eventually becoming the global leader in

high-speed rail. Many new high-speed rail systems are being developed, built or have just started operating (as shown in Table 3-1), demonstrating that high-speed rail can operate globally, regardless of geography, population, climate, economic and political circumstances and the culture of the country.

Table 3-1: High Speed lines in the World

HIGH SPEED LINES IN THE WORLD (Summary)

Updated 1st June 2021

Status
1. In operation: It is now operating on High Speed.
2. Under construction: It is now constructing of High Speed lines.
3. Planned: It is approved but not start constructing.
4. Long-term planning: It is not approved. Just planned.

Area	Country/Region	Length(km)				
		1. In operation	2. Under construction	3. Planned	4. Long-term planning	Total
AFRICA	EGYPT	-	-	1,370	300	1,670
AFRICA	MOROCCO	186	-	640	-	826
AFRICA	SOUTH AFRICA	-	-	-	2,390	2,390
ASIA-PACIFIC	CHINA (+ CHINESE TAIPEI)	38,283	14,925	4,361	7,134	64,703
ASIA-PACIFIC	INDIA	-	508	-	7,479	7,987
ASIA-PACIFIC	INDONESIA	-	142	570	-	712
ASIA-PACIFIC	JAPAN (SHINKANSEN SYSTEM)	3,041	688	346	-	4,075
ASIA-PACIFIC	KAZAKHSTAN	-	-	-	-	1,011
ASIA-PACIFIC	MALAYSIA and SINGAPORE	-	-	-	-	-
ASIA-PACIFIC	SOUTH KOREA	893	-	49	-	942
ASIA-PACIFIC	CHINA - CHINESE TAIPEI	-	-	-	-	-
ASIA-PACIFIC	THAILAND	-	253	431	1,958	2,642
ASIA-PACIFIC	VIETNAM	-	-	1,600	-	1,600
ASIA-PACIFIC	AUSTRALIA	-	-	-	1,749	1,749
EUROPE	AUSTRIA	254	281	71	-	606
EUROPE	BELGIUM	209	-	-	-	209
EUROPE	CZECH REPUBLIC	-	-	666	339	1,005
EUROPE	DENMARK	56	-	-	-	56
EUROPE	ESTONIA, LATVIA, LITHUANIA (Rail Baltica)	-	-	870	-	870
EUROPE	FINLAND	1,120	-	-	-	1,120
EUROPE	FRANCE	2,735	-	-	1,725	4,460
EUROPE	GERMANY	1,571	147	81	210	2,009
EUROPE	ITALY	921	327	-	-	1,248
EUROPE	NORWAY	-	-	-	333	333
EUROPE	POLAND	224	-	805	875	1,904
EUROPE	PORTUGAL	-	-	-	-	314
EUROPE	RUSSIA	-	-	1,080	-	1,080
EUROPE	SERBIA	-	76	204	-	280
EUROPE	SPAIN	3,487	1,135	943	-	5,565
EUROPE	SWEDEN	860	214	338	-	1,412
EUROPE	SWITZERLAND	178	-	-	-	178
EUROPE	THE NETHERLANDS	90	-	-	-	90
EUROPE	UNITED KINGDOM	113	225	341	-	679
LATIN AMERICA	BRAZIL	-	-	-	511	511
LATIN AMERICA	CHILE	-	-	-	127	127
MIDDLE EAST	BAHRAIN and QATAR	-	-	-	180	180
MIDDLE EAST	IRAN	-	1,336	117	1,651	3,104
MIDDLE EAST	ISRAEL	-	-	85	-	85
MIDDLE EAST	SAUDI ARABIA	449	-	-	-	449
MIDDLE EAST	TURKEY	724	1,743	1,944	-	4,411
NORTH AMERICA	CANADA	-	-	-	1,523	1,523
NORTH AMERICA	MEXICO	-	-	210	-	210
NORTH AMERICA	USA	735	563	1,659	4,521	7,478
AFRICA(3)		186	-	2,010	2,690	4,886
ASIA PACIFIC(0)		42,217	16,515	7,357	18,320	86,235
EUROPE(19)		11,819	2,405	5,399	3,482	23,241
LATIN AMERICA(2)		-	-	-	638	180
MIDDLE-EAST(1)		1,173	3,079	2,146	1,831	9,572
NORTH AMERICA(3)		735	563	1,869	6,044	7,688
TOTAL(44)		56,129	22,562	18,781	33,005	131,803

Source: UIC Passenger Department

3.2 Overview of high-speed railway development in China

It has been more than 120 years since the first railway appeared in China in 1876. Railways have always been a major force in China's transportation, with passenger and freight turnover far higher than other modes of transport. However, as the national economy continues to develop at a rapid pace, the huge demand for transport is no longer being met and railways are gradually becoming a "bottleneck" industry. With the complex and changing economic situation in the world today and China's ongoing industrialization and urbanization, the role of railways as the backbone of transport is becoming increasingly apparent.

Since 2011, China's railway mileage has grown steadily and the mileage of high-speed railways has climbed rapidly, with railway mileage increasing from 93,200 km in 2011 to 153,000 km in 2020, and the mileage of high speed railways increasing from 0.66 million km in 2011 to 38,000 km in 2020, with the market share of high speed railways in railways exceeding 60% in ten years.

In the early stages of China's high-speed rail development, critics in China and abroad questioned the need for an expensive high-speed rail system in a developing country, arguing that the majority of the working class could not afford the extra cost of faster travel. In response, the Chinese government argued that China's high-speed rail was a

matter of core interest(Xue, 2012) :

- To provide a fast, reliable and comfortable way of moving large numbers of passengers over long distances in densely populated countries, and to improve economic productivity and competitiveness in the long term by connecting labor markets and freeing up old railways for the movement of goods.
- During the recession of 2008-2009, the economy was stimulated in the short term by creating construction jobs and helping to drive demand for construction, steel and cement.
- Promotes cross-city economic integration and facilitates the development of smaller cities by linking them to larger cities.
- Supports energy independence and environmental sustainability as electric trains use less energy on a per unit basis to transport people and goods.
- Fostering an indigenous high-speed rail technology and components industry; Chinese train equipment manufacturers have been quick to absorb foreign technology (e.g. Japan's Shinkansen system), localize their production processes and begin to compete with foreign suppliers in the export market.

The development of high-speed rail in China has forced domestic airlines to cut fares, cancel feeder flights, especially those under 500 km, and terminate some shorter intercity routes altogether. since October 2013, China's high-speed rail has carried more than twice as many passengers per month as domestic airlines(Wikipedia, 2014)

The operating mileage, passenger traffic and passenger turnover of China's high-speed railways and their share of the total have increased year on year from 2016 to 2020 (Table 3-2), and high-speed rail passenger transport has become the main mode of railway passenger transport. This section will sort out the current status of China's high-speed railway development and collate the high-speed railway lines that have been opened.

Table 3-2: Operating mileage, passenger traffic and passenger turnover of high-speed railways in China and their share, 2016-2020

YEARS	Operating mileage (km)	Proportion of railway operating mileage (%)	Passenger volume (ten thousand people)	Proportion of railway passenger traffic (%)	Passenger turnover (100 million person-kilometers)	Proportion of railway passenger turnover (%)
2016	22980	18.5	122128	43.4	4641	36.9
2017	25164	19.8	175216	56.8	5875.6	43.7
2018	29904	22.7	205430	60.9	6871.9	48.6
2019	35388	25.3	235833	64.4	7746.7	52.7
2020	37929	25.9	155707	70.7	4844.9	58.6

Source: Compiled by View Research World Data Centre

https://www.chinabaogao.com/data/202204/589604.html

3.2.1 "Four horizontal and four vertical" passenger dedicated lines

On 1 August 2008, the Beijing-Tianjin Intercity Railway was opened with an operating speed of 350km/h. It is the first high-speed railway of high standard in mainland China. In October of the same year, the Chinese government adjusted the Medium- and Long-Term Railway Network Plan, resulting in the Medium- and Long-Term Railway Network Plan (2008 Adjustment). In the 2008 Adjusted Medium- and

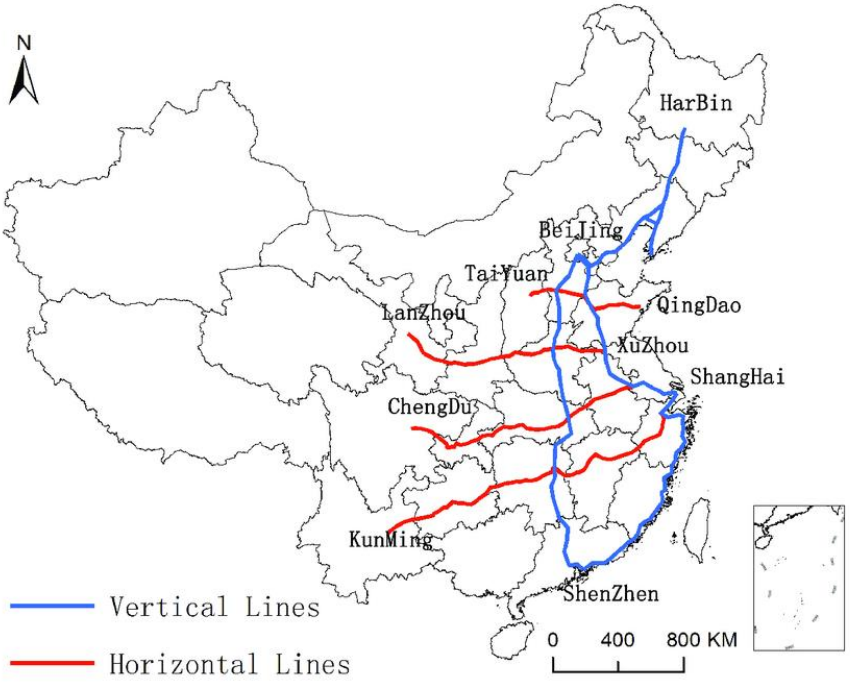
Long-Term Railway Network Plan, the focus was on the construction of "four longitudinal and four horizontal" passenger lines and intercity rapid passenger transport systems. "The names of the "four vertical and four horizontal" passenger lines and the specific names of the high-speed railway lines are shown in Table 3-3 and Figure 3-2, and the "four vertical and four horizontal" passenger lines were basically completed by the end of 2016.

Table 3-3: "Four horizontal and four vertical" passenger lines

Four vertical	High-speed rail line	Four horizontal	High-speed rail line
1. Beijing-Shanghai Passenger Line	Beijing-Shanghai high-speed railway, Hefei-Bengbu passenger line	1. Xuzhou-Lanzhou Passenger Dedicated Line	Zhengzhou-Xuzhou Passenger Dedicated Line, Zhengzhou-Xi'an Passenger Dedicated Line, Xi'an-Baoji Passenger Dedicated Line, Baoji-Lanzhou Passenger Dedicated Line
2. Beijing-Hong Kong Passenger Dedicated Line	Beijing-Shijiazhuang Passenger Dedicated Line, Shijiazhuang-Wuhan Passenger Dedicated Line, Wuhan-Guangzhou Passenger Dedicated Line, Guangzhou-Shenzhen-Hong Kong High Speed Rail	2. Shanghai-Kunming Passenger Line	Shanghai-Hangzhou Intercity High-speed Railway, Hangzhou-Changsha Passenger Dedicated Line, Changsha-Kunming Passenger Dedicated Line
3. Beijing-Harbin Passenger Dedicated Line	Beijing-Shenyang Passenger Dedicated Line, Harbin-Dalian Passenger Dedicated Line, Panying Passenger Dedicated Line	3. Qingdao-Taiyuan Passenger Line	Jiaozhou-Jinan Passenger Dedicated Line, Shijiazhuang-Jinan Passenger Dedicated Line, Shijiazhuang-Taiyuan Passenger Dedicated Line,
4. Hangzhou-Fuzhou-Shenzhen Passenger Line	Hangzhou-Ningbo Passenger Dedicated Line, Ningbo-Taizhou-Wenzhou Railway, Wenzhou-Fuzhou Railway, Fuzhou-Xiamen Railway, Xiamen-Shenzhen Railway	4. Shanghai-Wuhan-Chengdu Passenger Dedicated Line	Shanghai-Nanjing High-speed Railway, Hefei-Ningbo Passenger Dedicated Line, Hefei-Wuhan Passenger Dedicated Line, Wuhan-Yichang High-speed Railway, etc.

Source: Drawn by the author based on the Medium and Long Term Railway Network Plan (2008 Adjustment)

Figure 3-2: Schematic diagram of "four horizontal and four vertical"



Source: Chong, Z., Qin, C. and Chen, Z. (2019) 'Estimating the economic benefits of high-speed rail in China: a new perspective from the connectivity improvement", Journal of Transport and Land Use, 12(1)

The construction of the "Four Longitudinal and Four Horizontal" passenger lines is a milestone in the development of China's national railway trunk and arteries. The "Four Longitudinal and Four Horizontal" passenger lines are the primary state of China's high-speed rail network, which can effectively improve the connectivity between cities along the lines and become an effective driving force for economic development. Although the lines were fully completed in 2016, the density of the high-speed railway network is still sparse, with the central and western regions and the northeast of China having less coverage.

Figure 3-3: China's medium to long-term high-speed railway network plan

Source: Medium- and Long-Term Railway Network Planning (2008 Adjustment)

3.2.2 "Eight vertical and eight horizontal" high-speed railway network

In 2016, China issued the "Medium and Long-term Railway Network Planning (2016-2030)", planning the time period from 2016 to 2025 and looking forward to 2030, planning to reach 150,000 km of railway business mileage in 2020, 30,000 km of high-speed railway business mileage, 175,000 km of railway business mileage in 2025, 38,000 km of high-speed railway business mileage. 38,000 km and proposed the development and construction of "eight vertical and eight horizontal" high-speed railway networks on the basis of "four vertical and four horizontal" passenger lines, as shown in Table 3-4 and Figure 3-4.

Table 3-4. "Eight vertical and eight horizontal" high-speed railway network

Eight vertical	Route introduction, city station	Eight horizontal	Route introduction, city station
1. **Coastal Passageway**	a high-speed rail corridor passing along the eastern coast of China, starting from Dalian in the north to Fangchenggang in the south and passing through the cities of Qinhuangdao, Tianjin, Dongying, Weifang, Qingdao, Lianyungang, Yancheng, Nantong, Shanghai, Ningbo. Fuzhou, Xiamen, Shenzhen, and Zhanjiang.	1. **Suifenhe–Manzhouli Passageway**	, a high-speed rail located in the northeast of China stretching from Suifenhe in Heilongjiang to Manzhouli in Inner Mongolia, passing through cities of Mudan River, Harbin, Tsitsihar and Hailar.
2. **Beijing–Shanghai Passageway**	a high-speed rail line connects China's capital, Beijing and its metropolis, Shanghai, passing through cities of Beijing, Tianjing, Dongying, Weifang, Linyi, Yangzhou, Nantong and Shanghai. It connects the city agglomerations in north and east China as well as in the Beijing-Tianjin-Hebei region and Yangtze river delta.	2. **Beijing–Lanzhou Passageway**	a high-speed rail connects north and northwest China, running from Beijing through Hohhot and Yinchuan to Lanzhou.
3. **Beijing–Hong Kong (Taipei) Passageway**	a high-speed rail line including two branches. One branch passes through cities of Beijing, Xiong'an, Hengshui, Heze, Shangqiu, Fuyang, Hefei, Jiujiang, Nanchang, Ganzhou, Shenzhen and finnally ends in Hongkong. The other branch splits at Hefei station, passing through Hefei, Fuzhou and then stops in Taipei.	3. **Qingdao–Yinchuan Passageway**	a high-speed rail line starts from Qingdao in the coastal province of Shandong to Yinchuan in Ningxia.
4. **Harbin–Hong Kong (Macau) Passageway**	a high-speed rail links Harbin in Heilongjiang Province and other major inland cities with Hong Kong and Macau via Beijing. It runs through cities of Harbin, Changchun, Shenyang, Beijing, Shijiangzhuang, Zhengzhou, Wuhan, Changsha, Guangzhou, Shenzhen and Hong Kong. One branch splits at Guangzhou station and stretches to Zhuhai and Macau.	4. **Eurasia Continental Bridge Passageway**	a high-speed rail connects Lianyungang in Jiangsu Province to Urumqi in Xinjiang Province. The route passes through the cities of Xuzhou, Zhengzhou, Xi'an, Lanzhou, and Xining
5. **Hohhot–Nanning Passageway**	a high-speed rail connects north China, central plains, central China and southern China. It runs from Hohhot in Inner Mongolia to Nanning in Guangxi, passing through cities of Datong, Taiyuan, Zhengzhou, Xiangyang, Changde, Yiyang, Shaoyang, Yongzhou, Guilin.	5. **Yangtze River Passageway**	a high-speed rail that will run in an east-west direction largely parallel to the Yangtze River, connecting the cities of Shanghai, Nanjing, Hefei, Wuhan, Chongqing and Chengdu.
6. **Beijing–Kunming Passageway**	a high-speed rail starts from Beijing to Kunming. The main route passes through cities of Xiong'an, Baoding, Xinzhou, Taiyuan, Xi'an, Chengdu and Chongqing. Apart from the main route, a branch line runs from Beijing to Taiyuan through Zhangjiakou and Datong, and a spur line from Chongqing connects to Kunming.	6. **Shanghai–Kunming Passageway**	a high-speed railway line built in stages and completed on 28 December 2016, beginning in Shanghai and ending in Kunming, passing through cities of Hangzhou, Nanchang, Changsha, and Guiyang.
7. **Baotou (Yinchuan)–Hainan Passageway**	a high-speed rail stretches from Baotou to Haikou(Sanya), passing through cities of Yan'an, Xi'an, Chongqing, Guiyang, Nanning, Zhanjiang. This passageway includes the line from Yinchuan to Xi'an and the high-speed railway around Hainan island.	7. **Xiamen–Chongqing Passageway**	a high-speed rail connects the west coast of the Taiwan Straits, South-central and south-western regions in China, stretching from Xiamen to Chongqing, passing through cities of Longyan, Ganzhou, Changsha, Changde, Zhangjiajie and Qianjiang.
8. **Lanzhou (Xining)–Guangzhou Passageway**	a high-speed rail connects northwest, southwest and south China, passing through cities of Lanzhou(Xining), Chengdu (Chongqing), Guiyang and Guangzhou. The passageway has two termini at Lanzhou and Xining which meet at Chengdu in Sichuan Province. From Chengdu, the corridor passes through Guiyang before ending at Guangzhou.	8. **Guangzhou–Kunming Passageway**	a high-speed passage passes through cities of Guangzhou, Nanning and Kunming. It is made up of the existing Nanning–Guangzhou high-speed railway and Nanning–Kunming high-speed railway lines. It has been fully operational on 28 December 2016

Source: Drawing compiled by the author based on the Medium and Long Term Railway Network Plan (2016-2030)

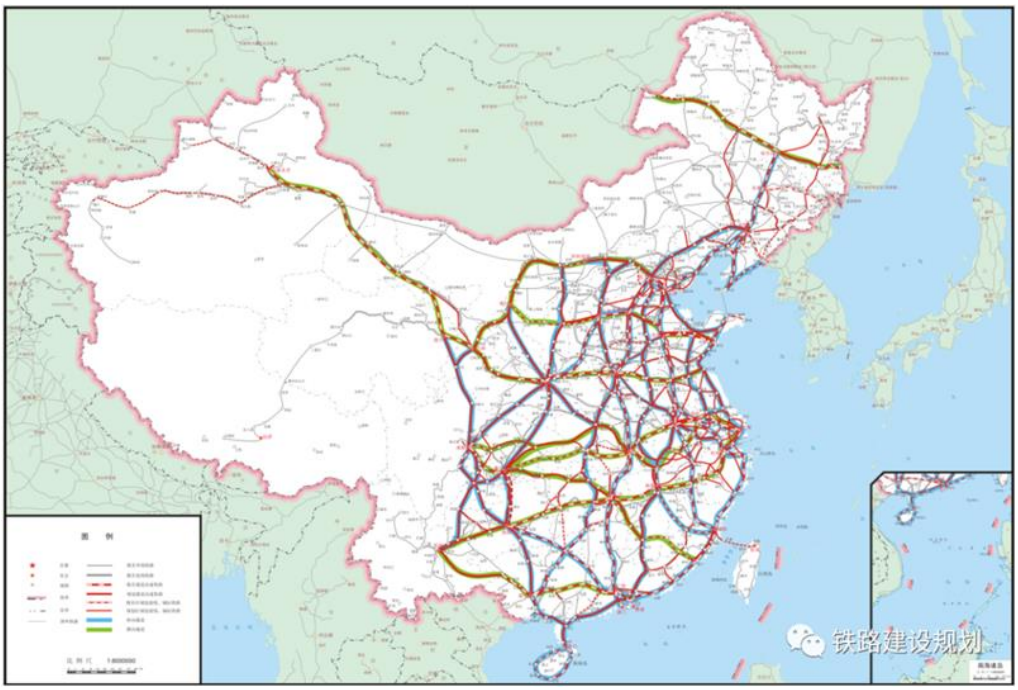
Figure 3-4. Schematic diagram of the "eight vertical and eight horizontal" high-speed railway network

Source: WANG, Yuxiang & Liu, Xueli & Wang, Feng. (2018). Economic Impact of the High-Speed Railway on Housing Prices in China. sustainability. 10. 4799. 10.3390/su10124799.

This is shown in Figure 3-5. The green highlighted lines are the horizontal lines of the eight vertical and eight horizontal lines, while the blue highlighted lines are the vertical lines of the eight vertical and eight horizontal lines. As can be seen by the extent of line coverage, the network is more comprehensive than the "four vertical and four horizontal" layout, covering a large area in the central region, extending westwards to Urumqi, and establishing a high-speed rail network between major cities in the north-east. However the layout is still focused on the relatively economically developed eastern coastal region, so the 2016-2030 version of the HSR route plan tends to be more 'efficient' in terms of measuring 'efficiency' and 'equity' in the

process of economic and social development. The 2016-2030 version of the HSR route plan tends to be more 'efficient' in terms of measuring 'efficiency' and 'equity'. China's high-speed rail network is thus taking shape. Neighboring provincial capitals will form a one- to two-hour traffic circle, and provincial capitals will form a half- to one-hour traffic circle with neighboring cities. The majority of provincial capitals in China will be within 8 hours of Beijing.

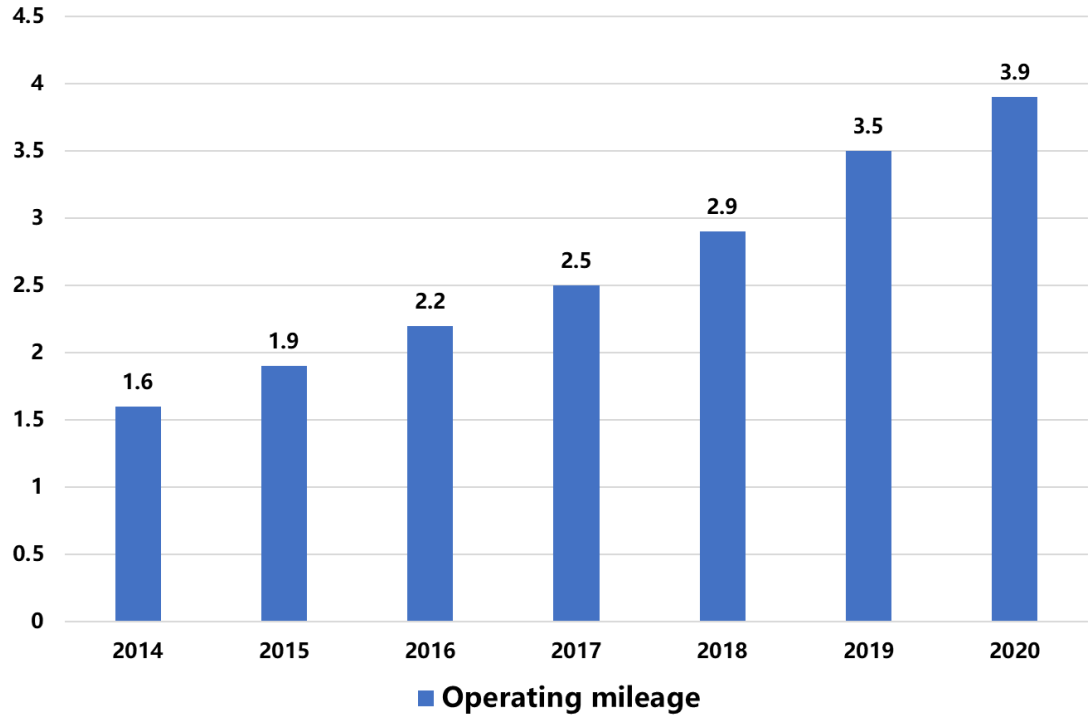
Figure 3-5: China's medium and long-term high-speed railway network plan (2016-2030)



Source: Medium- and Long-Term Railway Network Plan (2016-2030)

As the data in Table 3-5 shows, by the end of December 2020, China had 39,000 kilometers of high-speed rail, covering 95% of cities with a population of 1 million or more, with a steady increase in operational mileage.

Table 3-5: China's high-speed rail operating history, 2014-2020 (unit: 10,000 km)



Source: drawn by the author

3.2.3 Regional Distribution of High-Speed Rail

By 2021, according to the report ATLAS High-Speed Rail 2021 (Figure 3-6) China has basically achieved full coverage of high-speed rail in cities in the eastern region, and the number of cities in the central region that have opened high-speed rail has also increased significantly, but there is still a need for continued improvement, with cities in the Inner Mongolia Autonomous Region opening high-speed rail to accelerate the northeast, central and western regions between cities in the interconnections. Overall, more and more cities have opened high-speed railways, and by the end of 2021, 93% of China's cities with a population of 500,000 or more will be covered by high-speed railways(中国政府网, 2022). The number of cities with high-speed rail is

increasing, with 93% of the country's cities with a population of 500,000 or more connected by the end of 2021. The only regions currently without railways operating at speeds above 200 km/h are those without high speed rail plans for the time being Macao Special Administrative Region and the Tibet Autonomous Region.

Figure 3-6: Map of China's high speed rail lines

Source: ATLAS High-Speed Rail, International Union of Railways

3.3 Overview of high-speed railway development in Shaanxi Province

Shaanxi Province (Figure 3-7) is located in the inland hinterland of western China, in the middle reaches of the Yellow River, between 105°29′-111°15′ E and 31°42′-39°35′

N, with a total area of about 205,600 km2. The shape of the province is mainly north-south, spanning 7°54′ latitude and a maximum distance of 863 km. There are many neighbouring provinces, including Shanxi Province to the east across the Yellow River, Ningxia Hui Autonomous Region and Gansu Province to the west, Sichuan Province and Chongqing City to the south with the main ridge of the Micang Mountains and Daba Mountains, Inner Mongolia Autonomous Region to the north, and Hubei Province and Henan Province to the southeast, making it the province with the largest number of neighboring provinces in China. Shaanxi Province has 10 prefecture-level cities under its jurisdiction. Xi'an, the capital of the province, is the only national center city in the northwest, with the third largest economic output in the west, and as the ancient capital of the 13th dynasty, has a rich history and an important international status and world-class influence. The province is conveniently connected by main lines such as the Zhengxi Passenger Line, the Xibao Passenger Line[17] , the Xicheng Passenger Line[18] , the Daxi Passenger Line[19] , the Baolan

[17] It is a high-speed railway connecting Xi'an in Shaanxi Province and Baoji in Shaanxi Province, and is an important part of the "Land Bridge Channel", one of the main channels of the "Eight Vertical and Eight Horizontal" high-speed railway in the Medium and Long-term Railway Network Planning (2016 version).
[18] It is a high-speed railway linking Xi'an in Shaanxi Province and Chengdu in Sichuan Province, and is one of the main channels of the "eight vertical and eight horizontal" high-speed railways in the Medium and Long-term Railway Network Plan revised in 2016, and is the first high-speed railway in China to cross the Qinling Mountains.
[19] It is a high-speed railway connecting Datong and Xi'an, an important part of the Beijing-Kunming High-speed Railway of China's Medium and Long-term Railway Network Planning (2016 version), and a key project of railway construction in western China.

Passenger Line[20] , the Baocheng Railway[21] , the Longhai Railway[22] , etc. It is an important hub connecting the eastern and central regions of China with the northwest and southwest.

Figure 3-7: Geographical location of Shaanxi Province

Source: Wikipedia https://en.wikipedia.org/wiki/Shaanxi

[20] It is a high-speed railway connecting Lanzhou City in Gansu Province and Baoji City in Shaanxi Province, and is an important part of the "Land Bridge Channel", one of the main channels of the "Eight Vertical and Eight Horizontal" high-speed railway in the "Medium and Long-term Railway Network Planning" (2016 version).

[21] Located in Shaanxi, Gansu and Sichuan Provinces, it starts from Baoji in Shaanxi Province in the north and crosses the Qinling Mountains to Chengdu in Sichuan Province in the south, with a total length of 668.198km. The national railway is a Class I electrified railway, with the section from Baoji to Yangpingguan being a single-line railway due to topographical constraints and the section from Yangpingguan to Chengdu being a double-line railway.

[22] It is a Class I national railway connecting Lanzhou City in Gansu Province with Lianyungang City in Jiangsu Province; the line runs east-west, linking Northwest China, Central China and East China.

3.3.1 Overview of railway transport in Shaanxi Province

At present, Shaanxi Province has formed a railway skeleton network of "two columns, five horizontal and three hubs". With the Greater Xi'an as the center, the Longhai Line and the Baoxi Line[23] are the main east-west and north-south axes respectively. Five high-speed railway lines have been completed and are in operation: Xi'an to Zhengzhou, Xi'an to Taiyuan, Xi'an to Baoji to Lanzhou, Xi'an to Chengdu and Xi'an to Yinchuan. 81% of the major cities in China are covered by these lines, and the daily average number of passengers sent from Xi'an North Railway Station reaches 196,000. The "one-day high-speed railway living circle" between Xi'an and major provincial capitals has been initially formed, and a fast and convenient high-speed railway network has been gradually built to reach the surrounding city groups in 3 hours and the Yangtze River Delta, the Pearl River Delta,[24] and Beijing-Tianjin-Hebei in 4 to 6 hours. Xi'an East Station) and one auxiliary station (Apangong Station). With the commencement of the construction of the West-East High Speed Railway[25] , the Tongchuan-Yan'an section and the West-Kong High Speed Railway[26] , the

[23] It is a national railway grade I double-line electrified railway connecting Baotou City in Inner Mongolia Autonomous Region and Xi'an City in Shaanxi Province. It is an important channel for coal transportation in Shaanxi North and Huanglong coal fields among the thirteen large coal bases in China, and is an important part of the main backbone of China's railway network of eight vertical and eight horizontal Baotou (head) and Liuzhou (state).

[24] Located in the south-central part of China's Guangdong Province, it was known as Guangzhou Prefecture during the Ming and Qing dynasties and was the heartland and thriving place of the Guangfu culture, covering nine cities including Guangzhou, Foshan, Zhaoqing, Shenzhen, Dongguan, Huizhou, Zhuhai, Zhongshan and Jiangmen.

[25] It is an integral part of the "m" high speed rail network of Shaanxi and the Baohai high speed rail corridor. The line leads from the north end of Xi'an East Railway Station, the port area through Gaoling, Yanliang, Fuping, Yaozhou, Wangye, Yintai, Yijun, Huangling, Luochuan, Fuxian, Ganquan, and is introduced into Yan'an Railway Station and extended northward to Yan'an New Area Station, with a total line length of about 300 km and a total investment of 60 billion yuan, design speed of 350 km/h, scheduled to open for operation on October 31, 2025.

[26] It is the main north-south high speed railway network in Shaanxi, and will take as little as 40 minutes to

construction of high-speed railways in Shaanxi has entered a period of hard work. If the construction of the XISHR[27] starts as scheduled, by the end of the 14th Five-Year Plan, the prototype of the "米" high speed railway skeleton network (Figure 3-8) in Shaanxi will be basically completed. With the completion of the Xiyan, Xishe, Xiyu[28] and Yangyu E[29] high-speed railways, Shaanxi will be connected to high-speed railways in every city in the province. The provincial capital city of Xi'an will form an integrated transport network with high-speed railways and motorway networks as the core and a "米" shaped comprehensive transport corridor radiating to key cities across the country, realizing a transport travel circle with a 1 to 2-hour commute in the Xi'an metropolitan area and a 5 to 7-hour coverage of major cities across the country.

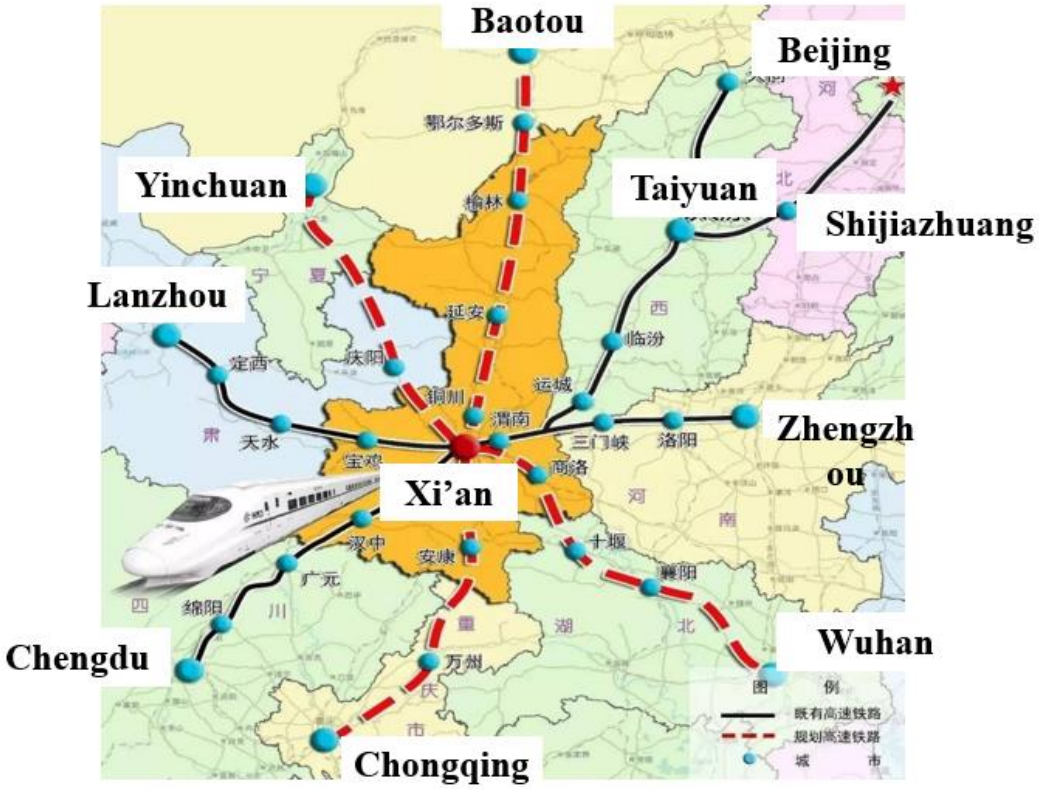
Figure 3-8: Shaanxi Province's "米" shaped high-speed railway skeleton network

reach Xi'an and Ankang when it is open to traffic. The Xikang High Speed Railway, together with the Xiyan and Yangyu High Speed Railway, will form the main skeleton of the north-south high speed railway network in Shaanxi, and will be of great significance in promoting coordinated regional development.

[27] It is a section of the Wuhan-Xi'an High Speed Railway, passing through the cities of Xi'an, Shangluo and Shiyan, and is expected to open for operation in 2026.

[28] The high-speed railway from Xi'an to Chongqing is currently under construction, with an undetermined opening date.

[29] Yan'an to Yulin to Ordos high-speed railway line from the West Yan high-speed railway terminal station Yan'an station through the lead, north in turn through the Yan'an City, Baota District, Yanchuan County, Yulin City, Qingjian County, Suide County, Mili County, Hengshan District, Yuyang District and Shenmu City, Ordos City, Yjinholuo Banner, the introduction of Ordos station to the end of the project, is currently in the planning stage.



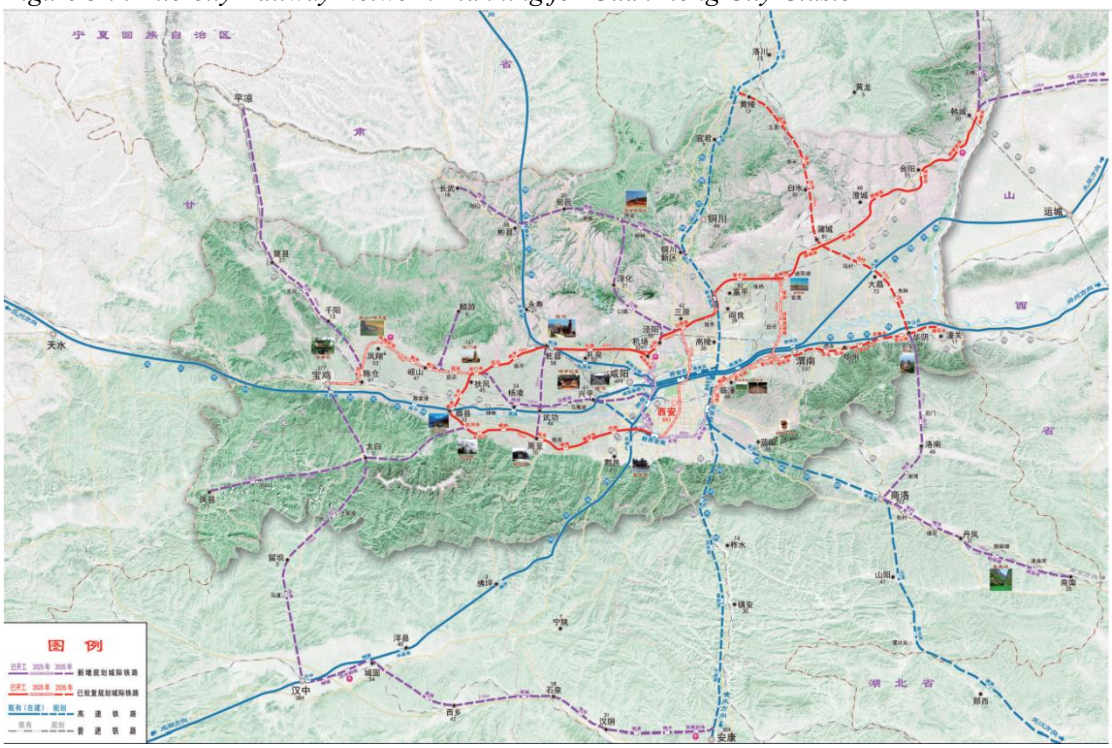
Source: drawn by the author

Shaanxi Province has always attached great importance to the construction of transport projects, promoting the comprehensive development of a comprehensive transport network and striving to add vitality to the sustainable development of the region. "Prior to the 13th Five-Year Plan, the railway network had not yet taken shape, with only a single railway linking the prefecture-level cities, except for the provincial capital city of Xi'an. Due to the flat and open terrain and economic advantages of the Guanzhong region, railway construction was significantly better than in northern and southern Shaanxi. The main railway lines in the province are the Baoxi Line, the Longhai Line, and the Baocheng Line, with the main network skeleton radiating outwards from Xi'an Xianyang. High-speed railways only cover Xi'an, Weinan,

Xianyang and Baoji, while the completed Zhengxi High-speed Railway, Xibao High-speed Railway and Daxi High-speed Railway all depart from Xi'an, making the provincial capital city much more accessible than the other prefecture-level cities. By 2020, Shaanxi's "米" high speed railway network will be basically completed, with high-speed railways extending northwards to Yan'an (not yet opened), southwards to Hanzhong to Chengdu, westwards to Yinchuan via Binxian, and eastwards from Weinan to Taiyuan and Zhengzhou. High-speed railway network. With the city of Xi'an as the centre, the "米" network of high-speed railways, mainly 300 km/h and supplemented by 250 km/h, will enable fast access from Xi'an to Zhengzhou, Shijiazhuang, Beijing, Wuhan, Changsha, Guangzhou, Shenzhen, Nanchang, Nanjing, Shanghai, Taiyuan, Lanzhou, Xining, Chengdu and Guiyang. By 2030, according to the high speed railway construction plan, combining the existing railway direction, the geographical location of the county and other factors, the six new lines will be located in the edge of Shaanxi Province, the topography of the better but not yet open high speed railway part of the county into the high speed railway network, then the southern and northern Shaanxi general railway network to further improve, so that the regional development imbalance of the gap gradually narrowed, Guanzhong area railway is more dense, after the optimization of the formation of a large The intercity railway network will be built on the basis of the high-speed railway network and supplemented by the channel links, so as to achieve rapid access to cities in the region and fully support the new urbanization of the Guanzhong Plain Cities Group. The network will also support the construction of the new urbanization of the Guanzhong

Plain urban agglomeration and the development of tourism resources in Shaanxi Province. One nucleus: the international comprehensive transportation hub of Greater Xi'an. Two rings: the Greater Xi'an Intercity Ring Road and the Guanzhong Tourism Ring Road. Six radiations: Longhai[30] development axis, Jingkun[31] development belt, Fuyin[32] development belt, northern Shaanxi, southern Shaanxi and surrounding areas. The specific layout is shown in Figure 3-9.

Figure 3-9: Intercity Railway Network Planning for Guanzhong City Cluster



Source: Shaanxi Province's 14th Five-Year Plan for Transport

3.3.2 Opening of high-speed rail in Shaanxi

The main information on the high-speed railways that have been opened for operation in Shaanxi province so far includes opening times, design speeds, line profiles and

[30] Lanzhou, Lianyungang
[31] Beijing, Kunming
[32] Fuzhou, Yinchuan

major cities along the lines in Shaanxi province.

(1) Zhengzhou - Xi'an High Speed Rail

Opening date: 6 February 2010

Design speed: 350KM/h

Line significance: an important part of the road and bridge corridor, the first high-speed railway in the central and western regions to be put into operation at a speed of 350 km/h

Cities along the HSR lines: Xi'an, Lintong, Weinan, Huashan

Figure 3-10: Zhengzhou-Xi'an high-speed rail route map (only marked with the name of the station that has been opened in Shaanxi Province)

Source: http://m.cgzdl.com/yongtu/donghua/5686.html

(2) Xi'an-Baogui-Lanzhou High Speed Railway

Opening date: 28th December 2013

Design Speed: 350KM/h (temporarily operating at 250KM/h)

Significance of the line: an important part of the road and bridge corridor, strengthening economic exchanges between Northwest China and Central, North and

East China

Cities along the HSR lines (Xibao section): Xi'an, Xianyang , Yangling, Qishan, Baoji

Figure 3-11: Xi'an-Baogui high-speed rail route map (only the names of stations in Shaanxi Province have been marked)

Source: https://www.sohu.com/a/155718465_486680

(3) Xi'an-Chengdu High Speed Rail

Opening date: 6 December 2017

Design speed: 250KM/h

Significance of the line: an important part of the Beijing-Kunming corridor, the first high-speed railway in China to cross the Qinling Mountains

Cities along the HSR lines: Xi'an, Foping, Yangxian West, Chenggu North, Hanzhong, Ningqiang

Figure 3-12: Xi'an-Chengdu high-speed rail route map (only the names of stations in Shaanxi Province have been marked)

Source: https://*freewechat.com/a/MjM5NTMwNzI3MA==/2649104757/1*

(4) Datong - Xi'an High Speed Rail

Opening date: 28 September 2018

Design Speed: 250KM/h (350KM/h reserved)

Line significance: an important part of the road and bridge corridor, taking into account the role of both intercity and high-speed rail

Cities along the HSR lines: Dali, Weinan, Xi'an

Figure 3-13: Datong-Xi'an high speed rail route map (only the names of stations in Shaanxi province have been marked)

Source: http://*www.kanxsw.com/szditiedongtai/shenzhenditie_499.html*

(5) Yinchuan-Xi'an High Speed Railway

Opening date: 26th December 2020

Design Speed: 250KM/h (350KM/h reserved)

Cities along the HSR lines: Xi'an North, Xianyang North, Liquan South, Qianxian, Yongshou West, Binzhou East

Figure 3-14: Yinchuan-Xi'an high speed rail route map (only marked with the name of the station in Shaanxi Province that has been opened)

Source: http://*bj.people.com.cn/n2/2020/1227/c233086-34496770.html*

In this thesis, some of the cities in Shaanxi Province through which the above five routes pass are the main subjects of study. They are Xi'an City, Lintong District, Xianyang City (Liquan County, Qian County, Yongshou County, Binzhou, Yangling District), Hanzhong City (Yang County, Foping County, Ningqiang County), Baoji City (Qishan County) and Weinan City (Huayin County, Dali County), a total of six

cities, one district and ten counties.

3.3.3 Economic overview of the regions along the high-speed rail line in Shaanxi

(1) Description of the main economic indicators

The 2010-2010 gross domestic product and total retail sales of consumer goods of the main study subjects are used as the main economic indicators.

Table 3-6: List of cities along the high-speed rail line in Shaanxi from 2010-2020 GDP, unit: RMB billion

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Xi'an	3241.69	3862.58	4366.1	4884.13	5492.64	5801.2	6282.65	7471.89	8349.86	9322.19	10020.39
Lintong District	150.61	184.75	211.53	226.58	231.45	192.34	183.11	221.01	237.52	242.69	252.53
Huayin County	48.75	58.31	67.627	74.056	78.351	80.4221	70.0225	84.9559	91.1614	70.79	72.4847
Weinan	801.42	1028.97	1153.8	1349.01	1423.75	1430.41	1488.62	1650.626	1767.71	1828.47	1866.27
Tongchuan	187.73	232.63	273.31	321.98	325.3596	307.16	311.61	348.43	327.955	354.72	381.75
Qian County	73.47	92.98	108.091	127.207	145.04	150.736	162.383	178.9429	173.6462	171.62	155.6212
Liquan County	72.57	93.24	108.615	127.86	145	151.83	164.15	174.166	160.5024	153.48	156.1833
Yongshou County	23.07	28.02	34.874	41.331	44.83	50.004	58.605	73.1052	85.4257	84.36	84.6225
Binzhou County	80.17	106.1	136.184	165.425	186.1	170.011	188.821	213.62	217.1142	231.1	216.1431
Xianyang	1098.68	1361.32	1573.68	1860.39	2085.15	2152.92	2390.97	2292.51	2376.45	2195.33	2204.81
Hanzhong	509.7	647.48	754.57	881.73	1002.831	1059.606	1156.49	1333.3	1471.88	1547.59	1593.4
Yang County	49.23	62.36	73.7539	85.046	94.4	100.2557	106.529	120.8965	140.0625	163.16	172.3561
Ningqiang County	32.05	41.65	48.498	55.852	61.935	64.124	71.538	83.2956	89.0472	100.01	106.6383
Foping County	3.23	4.09	4.8265	5.794	6.648	7.3202	8.558	9.798	10.9026	11.48	11.8813
Qishan County	96.74	113.57	134.0137	144.0875	149.0962	143.8455	156.1109	188.6295	193.0974	179.34	169.0945
Dali County	63.79	81.23	100.576	109.837	112.369	104.7265	115.9537	134.2446	150.5775	168.56	175.5119
Baoji	976.09	1175.75	1374.33	1545.91	1642.9	1787.628	1932.14	2191.611	2265.16	2223.81	2276.95

Table 3-7: List of total retail sales of consumer goods in cities along the high-speed railway in Shaanxi, 2010-2020, unit: RMB million

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Xi'an	16370367	19659774	22638601	25804235	30938908	34053816	39177909	42498077	48547037	51409280	49893328
Lintong District	402992.8	485405	559276	627089	726348.8	779895	846604	964690.15	615713	647730	550855.22
Tongchuan	465787.3	545624.4	638561.7	740330.3	966406.68	1100535.7	1349747.5	1382476.1	1443019	1565035	1331036.1
Baoji	3075227.5	3582322.3	4128347	4733918.5	5396667.1	6128419.8	7021616.2	7834266.2	8284648	9043135	8019424.2
Qishan County	277961.96	315208	342059	391633	406844.42	460904.1	523336	602455.3	604625	656944	603790.05
Xianyang	2963547.4	3451008.3	4010799	4626800.1	5288432.5	6015874.6	5379586.7	6076384.7	8189033	9003906	8361758.6
Qian County	305809.6	352532	404719.8	465008.5	526389.61	593758.8	661175.05	705125.8	727315	753019	715322.82
Liquan County	237349.05	277258	312932.11	361727.43	410560.56	462882.8	539773.92	623929.32	785698	843336	801665.8
Yongshou County	80736.955	94170	107899.05	124290.54	143928.29	180458.6	208525.6	243279.26	305193	336216	312228.88
Binzhou County	136397.34	161143	187883.38	217726.03	252562.24	285386.2	336826.68	396647.53	541503	596090	570671.34
Weinan	2378661.8	2789626.1	3263237.8	3761317.9	4419776.9	5032507.6	5740098.2	6518480.6	6646342	7188082	6335769.6
Dali County	304104	351976.57	412645.9	478866.3	537857.93	612249.1	694628.2	785340.6	775166	839906	765304.4
Huayin County	129632	148839.38	173491.59	200026.48	223045.22	253254.1	287296.1	325705.5	306327	324555	282503
Hanzhong	1575028.1	1844406	2160450.8	2481480.8	2816480.7	3190012.6	3691687.5	4210518.4	5078235	5543256	5198383.2
Yang County	85730.1	100587.6	118067.8	135735.5	154240.7	174904.6	223779.3	256719.5	344876	380238	358030.1
Ningqiang County	93914.3	109121.4	127535.2	146314.5	165795	187705.3	213192.5	245093.2	276930	304773	285825.3
Foping County	11941.9	13958	16346.2	18723.7	21169.9	23918.6	27111.8	30814.8	34374	37254	34547.2

Source: 2010-2020 Shaanxi Provincial Statistical Yearbook

(2) The composition of the output value of the three industries

Table 3-8: List of three industries in Shaanxi prefecture-level cities along the high speed rail line

2010-2020, unit: RMB billion

列1	列2	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Primary industry	Xi'an	140.06	173.14	195.59	217.76	214.55	220.2	232.01	281.12	258.82	279.13	312.75
Primary industry	Tongchuan	14.18	17.41	19.47	21.74	22.61	22.76	23.91	24.54	24.74	26.77	30.76
Primary industry	Baoji	104.2	128.56	143.26	157.65	161.33	165.129	171.46	175.317	163.39	178.75	205.14
Primary industry	Xianyang	203.29	252.46	283.1	315.44	321.72	328.78	345.32	312.17	284.97	304.17	339.51
Primary industry	Weinan	128.94	160.47	180	202.38	207.16	213.92	224.81	230.496	296.795	325.05	373.69
Primary industry	Hanzhong	110.39	142.29	159.47	177.71	183.98	191.532	205.74	209.98	205.48	227.63	261.36
Secondary Industry	Xi'an	1406.72	1674.31	1881.75	2117.66	2194.78	2126.29	2200.36	2596.52	2925.61	3167.44	3328.27
Secondary Industry	Tongchuan	116.5	147.41	176.82	215.07	204.88	170.31	159.76	179.1	141.656	130.63	133.34
Secondary Industry	Baoji	614.42	749.25	895.92	1017.45	1051.65	1141.43	1227.06	1417.64	1434.07	1273.88	1261.18
Secondary Industry	Xianyang	573.27	740.4	876.78	1076.17	1227.7	1230.41	1385	1320.18	1352.92	1011.62	972
Secondary Industry	Weinan	394.55	545.19	610.67	743.23	751.34	697.7	685.2	771.54	742.275	679.49	651.54
Secondary Industry	Hanzhong	199.5	267.58	320.42	397.68	453.6	459.017	495.03	617.88	702.15	662.88	641.48
Tertiary Industry	Xi'an	1694.91	2015.13	2288.76	2548.71	3083.31	3454.71	3850.28	4594.25	5165.43	5874.62	6379.37
Tertiary Industry	Tongchuan	57.05	67.81	77.02	85.17	97.8696	114.09	127.94	144.79	161.559	197.32	217.65
Tertiary Industry	Baoji	257.47	297.94	335.15	370.81	429.92	481.069	533.62	598.654	667.7	771.18	810.63
Tertiary Industry	Xianyang	322.12	368.46	413.8	468.78	535.73	593.73	660.65	660.16	738.56	879.54	893.31
Tertiary Industry	weinan	277.93	323.31	363.13	403.4	465.25	518.79	578.61	648.59	728.63	823.94	841.04
Tertiary Industry	Hanzhong	110.39	142.29	159.47	177.71	183.98	191.532	205.74	209.98	205.48	227.63	261.36
Tertiary Industry	Hanzhong	199.5	267.58	320.42	397.68	453.6	459.017	495.03	617.88	702.15	662.88	641.48
Tertiary Industry	Hanzhong	199.81	237.61	274.68	306.34	365.251	409.057	455.72	505.44	564.25	657.09	690.56

Table 3-9: List of three industries in Shaanxi counties along the high speed rail line, 2010-2020,

unit: RMB million

Cities	Industry category	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Liquan county	Primary industry	265700	373559	426842	464901	501987	494971	487955	480939	473923	499000	528900
Liquan county	Secondary Industry	208950	258511	360980	464100	560500	569366	578231	587097	595962	499000	443400
Liquan county	Tertiary Industry	251010	300330	298328	349602	387513	424452	461391	498330	535269	537000	589500
Qian county	Primary industry	170540	223290	254753	278552	296239	293944	291650	289355	287060	302180	352730
Qian county	Secondary Industry	291320	375770	465400	578190	674200	684975	695750	706525	717300	629060	428810
Qian county	Tertiary Industry	272880	330740	360757	415332	479961	542996	606031	669065	732100	784980	774670
Yongshou county	Primary industry	97490	108150	123842	133062	143000	153261	163523	173784	184045	200150	225700
Yongshou county	Secondary Industry	59580	85240	127570	164870	176500	226846	277192	327538	377884	273410	249420
Yongshou county	Tertiary Industry	73590	86810	97328	115378	128800	169682	210564	251446	292328	370010	371110
Binzhou county	Primary industry	97820	125990	144544	156689	168073	189985	207105	224226	241346	258467	275587
Binzhou county	Secondary Industry	565740	772370	1033510	1292550	1464500	1721044	1952814	2184584	2416354	2648124	2879894
Binzhou county	Tertiary Industry	138110	162640	183786	205015	228427	250498	272799	295100	317401	339702	362003
Foping county	Primary industry	6830	8810	9868	10740	11775	13181	14586	15992	17397	19181	22100
Foping county	Secondary Industry	9630	12880	15420	19950	23353	26608	29864	33119	36374	22630	44000
Foping county	Tertiary Industry	15880	19210	22977	27251	31352	37328	43304	49279	55255	72956	77100
Yang county	Primary industry	132100	170042	191251	209442	224026	240973	257919	274866	291812	321447	368800
Yang county	Secondary Industry	196830	255180	316940	380910	424718	478148	531578	585007	638437	735076	62000
Yang county	Tertiary Industry	163340	198378	229348	260105	295256	339036	382816	426596	470376	575057	610500
Ningqiang county	Primary industry	105340	135828	152006	164239	174047	170831	167614	164398	161181	178968	206300
Ningqiang county	Secondary Industry	84810	124320	147760	176440	200686	237644	274602	311560	348518	407758	58000
Ningqiang county	Tertiary Industry	130300	156352	185214	217843	244617	278656	312695	346734	380773	413391	438400
Qishan county	Primary industry	143723	184344	205104	224097	225449	224193	222936	221680	220423	239779	271348
Qishan county	Secondary Industry	580809	668900	816435	863840	864483	930162	995841	1061519	1127198	948469	810022
Qishan county	Tertiary Industry	242885	282456	318598	352938	401030	446611	492192	537772	583353	605134	609575
Huayin county	Primary industry	35680	44121	50360	52542	56300	56300	65953	75605	85258	92518	104800
Huayin county	Secondary Industry	269390	327000	389380	413400	420530	372594	350813	329031	307250	91335	99700
Huayin county	Tertiary Industry	182440	211960	236530	270233	306680	375327	423253	471180	519106	524045	520300
Dali county	Primary industry	182710	236790	266338	287831	311324	340659	369994	399328	428663	476872	557100
Dali county	Secondary Industry	129110	194390	293470	302510	253620	279620	305620	331619	357619	406013	354200
Dali county	Tertiary Industry	326130	381120	445952	531020	558746	598933	639120	679306	719493	802726	843800

The data source for the charts is the Shaanxi Provincial Statistical Yearbook, which is divided into two tables due to differences in units and rounding, while the data for 2021 is not used due to the large impact of the covid-19 epidemic. The analysis of the above graphs shows that the 17 counties and cities along the Shaanxi Province have all achieved steady and rapid economic development in the last decade, with rapid growth in total output value and output value of the three industries, a gradual decrease in the proportion of primary industries, a gradual expansion in the proportion of tertiary industries, and a continuous improvement in the structure of the three industries, resulting in rapid development of the national economy and an increasing improvement in people's living standards.

Chapter 4 The impact of high-speed rail on regional development

Transport is a very important component of the national economy as it is the vehicle of mobility, bridging production and consumption. The impact of transport on the economy is mainly divided into direct impact and brief impact. Direct impact refers to the direct economic impact of a series of transport investments. Indirect impact is the indirect pulling effect of transport on the economy through the linkage with other sectors of the national economy.

As a new mode of transport, high-speed rail makes up for the shortcomings of traditional transport modes, and its impact on regional economic development remains in both direct and indirect ways. The direct economic impacts include: reducing travel time, lowering transport costs, increasing the share of railways in the transport market, and promoting the development of high-speed rail-related industries(Yao, 2019). The direct economic impacts include: reduced travel times, reduced transport costs, increased rail share in the transport market and the development of HSR-related industries. As a breakthrough in the history of railway development, high-speed rail has greatly reduced the travel time of people, especially in the travel range of 150 to 800 km and is able to meet the needs of residents in terms of safety, speed and comfort of travel. Although the HSR is mainly used for passenger transport, it frees up transport resources, effectively relieves the transport bottleneck of traditional railways, improves the overall freight and passenger transport efficiency of railways, saves transport costs for enterprises, and increases the market revenue of

railways. The opening of HSR directly promotes the development of industries related to HSR construction, operation, maintenance and research and development, increasing the economic revenue of enterprises and providing employment opportunities for individuals as well as increasing tax revenue for the government. The indirect economic impacts of HSR include reducing barriers to access, increasing the intensity of inter-regional and inter-enterprise economic links, causing large-scale flows of people, goods, capital and information, and thus driving economic growth. Enhancing regional accessibility and changing the absolute and relative location advantages of the region, which in turn affects individual and business decisions and causes a redistribution of factors of production, such as population and capital, called the "distribution effect". Expanding the spillover range of the core city and strengthening its ability to diffuse knowledge, technology, capital and other resources to benefit more peripheral regions is called the 'diffusion effect'. The asymmetry in the flow of economic factors due to human tendency to profit, and the further absorption of talent, capital, and other important resources by large cities through the high-speed rail project, which further reduces the resource endowment of small and medium-sized cities, is called the 'siphon effect'.

All in all, the construction and operation of high-speed railways provides people with new transport options, optimizes the existing transport pattern, and achieves an optimal allocation of resources, thus having an important impact on regional economic development. Economic growth will inevitably affect the flow and

concentration of talent, natural resources, capital, technology and other factors, promoting more frequent and large-scale socio-economic activities within and between regions, such as business cooperation, commodity trading, scientific research cooperation, etc., which in turn will have an impact on employment, productivity, innovation capacity, etc., accelerating industrialization and urbanization, and ultimately creating an effect on the economic growth of the region as a whole. have a profound impact on the regional economy.

This chapter examines the mechanism of high-speed railways' effect on the economic development of the regions along the HSR lines, systematically analyzing the impact of high-speed railways on them in five aspects: regional economic growth, accessibility, spatial structure, industrial structure and employment respectively, clarifying the link between high-speed railways and the economic development of cities along the HSR lines, and elucidating the mechanism of high-speed railways' impact on the economies of cities along the HSR lines.

4.1 Impact on regional economic growth

There is a distinction between regional economic growth in a narrow sense and in a broad sense. Regional economic growth in a narrow sense refers to the increase in the total wealth of society within a region, expressed in monetary terms as an increase in GDP, and in physical terms as an increase in the total production of various products.

In a broader sense, regional economic growth also includes the control of population size, an increase in GNP per capita, and an increase in the demand for products. Generally speaking, the factors that influence economic growth are investment, labour and technological progress, and when applied to high-speed railways it can be said that the construction of transport facilities requires significant human, financial and material resources, which have a direct pulling effect on the regional economy. At the same time, the process of transport construction affects the economic growth of other sectors of the national economy through the investment multiplier effect.

High-speed rail for economic growth can be seen as three periods.

(1) During the planning period of the high-speed railway, before the construction of a high-speed railway in a particular area, the government and relevant departments start planning for the design of its route, and some manufacturers with a keen sense of smell start to invest in the layout along the high-speed railway to achieve the effect of gathering more manufacturers and enterprises. At the same time, the completion of the high-speed railway will enhance the accessibility of the region, which will increase the flow of passengers around the area. For manufacturers and enterprises, the surrounding area along the line will attract more human resources, and the completion of the high-speed railway will facilitate the flow of freight, so they choose to invest and build factories here, thus promoting the circular growth of the economy in the region.

(2) During the construction of high-speed railways, investment in the railway industry itself will increase, as will investment in upstream and downstream associated

enterprises related to the high-speed railway construction industry, such as the fixed equipment construction industry, the mobile equipment manufacturing industry, the energy industry and the transportation industry, a process that will cause an increase in the region's gross social product, thereby directly contributing to economic growth. (3) The indirect effect of the high-speed railway has gradually emerged after its completion and operation, as it has accelerated the flow of economic factors in the region: the flow of passengers and freight in the region has gradually increased, and economic activities have become more and more frequent, and the increased flow of people has led to the development of tourism in the region, as well as the development of the catering and service industries, indirectly promoting economic growth. This effect will not be significant in the immediate future, even in terms of the operation and management of the HSR, but as time passes, the effect on economic growth will become more significant in the longer term.

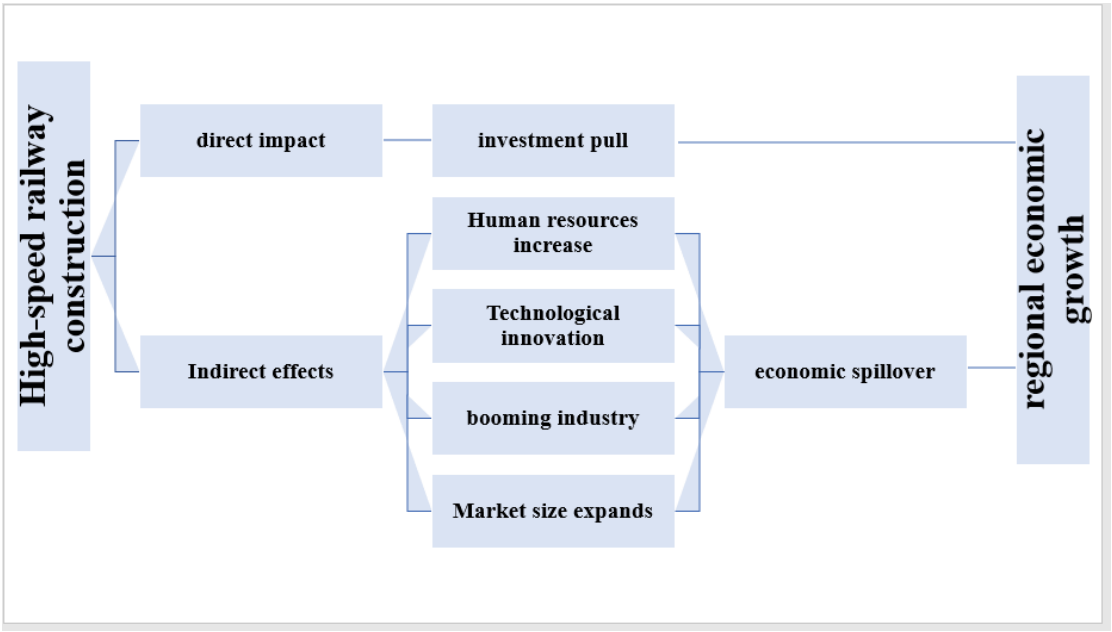
Transport has a (1) growth effect on regional economic development. Transport development undoubtedly contributes to local economic growth for each region and, at the national level, to national economic growth through inter-regional growth spillovers, as it generates economies of scale due to the reorganization and allocation of factor resources on a larger scale. Transport development not only reduces transport costs but also expands regional space as the number of cities connected by transport networks increases, leading to complementary interactions between regions and the development of regional synergies through inter-regional connectivity, which

brings about two changes: an increase in the number of factor resources available on the one hand, and an increase in the variety of factor resources on the other. In this process, more and broader resources are invested in the economic cycle of the whole society(Fujita, 2013) , the economic benefits of the integration of these resources are increased geometrically. The cities covered by the transport network can be integrated into the regional division of labor system through multi-directional choices, and when the density of the transport network is increasing, the market scale is further expanded through the accumulation of the cycle, and the market demand is also expanded, promoting the overall economic growth of the region through the inter-regional economic spillover effect. (2) Structural effect. After the opening of high-speed railways, the transport status of cities with high-speed railways will change, resulting in lower transport costs and accelerated mobility of factors and the spread of knowledge and technology, which in turn will promote regional economic growth and enhance the status of cities along the HSR lines in the region. The opening of high-speed railways will also enable a ' From point to area' development pattern through the effect of transport networks, which will help to integrate regional economic activities and to create complementarities between regions, thereby improving economic efficiency and reducing regional economic development differences, thereby achieving regional economic growth.

The construction of high-speed railways promotes transport development and economic growth through direct and indirect effects on the economy. The indirect

effect of high-speed railways on regional economic growth is more prominent than the direct effect, as the opening of high-speed railways deepens the openness between regions and accelerates the circulation of capital, technology, labor, information and other factor resources, making economic costs lower, leading to more frequent economic activities and more frequent market expansion, improving the allocation of resources and promoting economic growth. The mechanism of the impact of high-speed railways on regional economic growth is shown in Figure 4-1.

Figure 4-1: Mechanisms of impact of high-speed rail on regional economic growth



Source: drawn by the author

4.2 Impact on regional accessibility

Accessibility refers to how easy it is for one location to reach another location(Li, 2017). It is an important prerequisite for efficient resource allocation and is often used to characterize the ease with which the location can establish socio-economic links

with the surrounding region. In general, the ease of access between two locations is symmetrical, i.e., there is symmetry in regional accessibility, so the same indicator is usually used to measure the accessibility of a region as both an origin and a destination, which in this thesis can be measured in terms of travel distance, travel time or perceived distance.

The impact of regional accessibility on the regional economy is mainly through changing the location advantage of the region, thus promoting regional economic development. Location advantage refers to the fact that one region has a better location than another, and location advantage is not static, but changes as conditions change. Location conditions are crucial to the development of a region, and good accessibility usually represents the great convenience that transport conditions exhibit over time. However, a region with a good location is not the same as good accessibility, which depends on the composition of the region's overall transport network. The construction of transport facilities is the most effective way to improve regional accessibility. Different regions can plan their transport networks according to their own development requirements and scientifically combine different modes of transport on the same transport network to bring out the advantages of the entire transport network and the greatest advantages of their own location. The opening and operation of high-speed railways firstly directly increases the transport options in the areas where the stations along the lines are located, increasing the accessibility of the region, and improving the ease of reaching the region. Secondly, high-speed railways

change the economic geography of the region, improving the regional location advantage. The completion of high-speed railway networks shortens the space-time distance between cities and counties in the region, increases the psychological distance between people in the region, extends the accessibility of the region and brings about the spatial and temporal contraction effect(Wang, 2012). Previous studies have shown that the most intuitive impact of the opening of high-speed railways on regions and cities lies in their impact on the accessibility of regional cities, which leads to coordinated inter-regional development and greater economic benefits.

A large number of scholars have compared the impact of the presence or absence of HSR on overall accessibility, both horizontally and vertically, at different spatial scales and in different temporal phases. The findings show that with the expansion of HSR networks, the overall accessibility of regions has improved, and the spatial distribution of accessibility has changed. In China, the development of the HSR network has been very uneven, with the government prioritizing the eastern regions, followed by the central and western regions. Between 2008 and 2015, although accessibility has improved in the western and southwestern regions, the level of accessibility is low compared to the east(Yang and Guo, 2018), the development of accessibility in the western region is extremely uneven(Fan, 2019) . Between 2004 and 2018, the development of Korea's HSR network has reduced the overall accessibility gap, but the distribution of accessibility has not been equitable. The accessibility gap has been reduced by the development of the HSR network from

2004 to 2018(KIM and SULTANA, 2015).

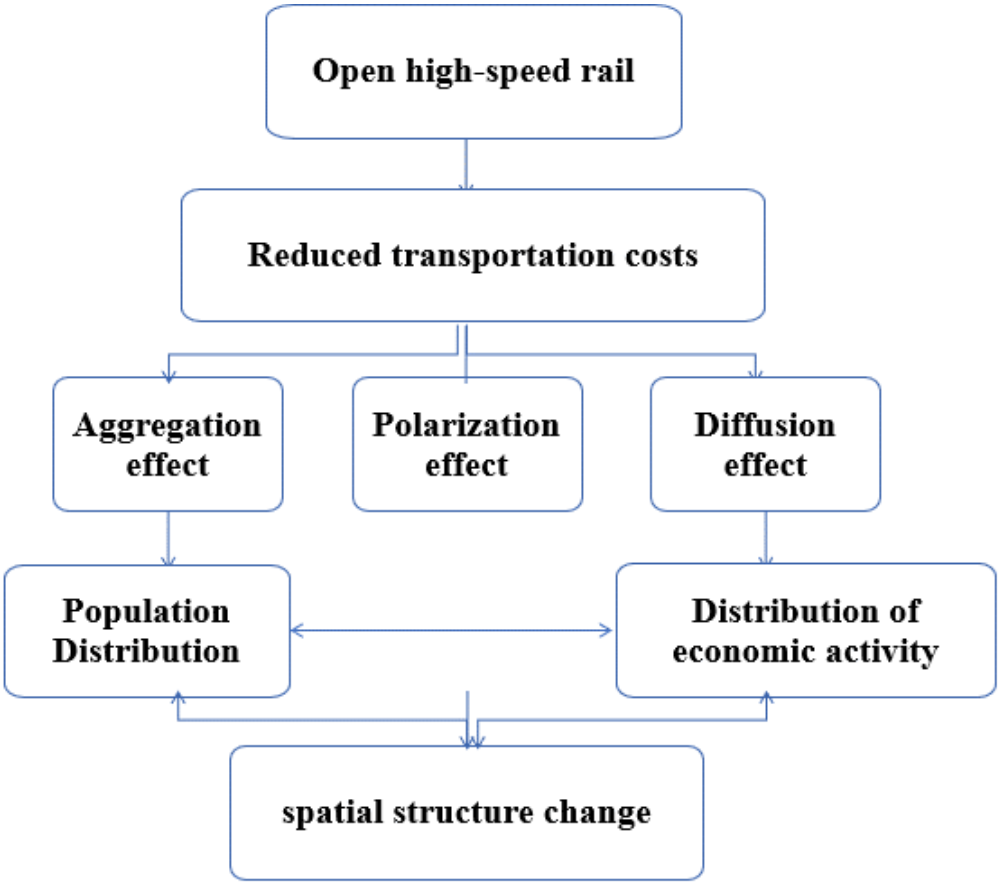
From the perspective of regional urban accessibility, the change in accessibility and the intensity of spatial interactions between cities along the HSR lines after the opening of the HSR are measured by indicators represented by weighted average travel times, which are used to evaluate the transport advantages of the region in terms of time and cost costs. Indicators, represented by daily accessibility and economic potential, measure the radiative capacity and attractiveness of the region. Weighted average travel time focuses on accessibility in the physical sense, i.e. the time it takes for a node to reach the economic center; economic potential focuses on accessibility in the economic sense, expressing the degree of interaction between the economic center and other nodes due to mutual attractiveness, which takes into account the economic strength of the node, its development potential, traffic conditions, etc. Both weighted average travel time and economic potential are effective measures of a region's accessibility, but the two indicators have different emphases. The former focuses on time, while the latter takes into account the interactions between nodes due to distance decay. The detailed empirical analysis is presented in Chapter 6.

4.3 Impact on spatial structure

Advances in the transport sector have led to a reduction in the cost of passenger and

freight transport, which in turn has affected the spatial pattern of the economy. The impact of HSR on economic space comes from two simultaneous forces: firstly, the transfer of resources from the periphery to the core region, forming a 'polarization effect' that further exacerbates the difference in resources between the core and peripheral regions; and secondly, the diffusion effect from the core to the periphery, reducing regional economic differences. As shown in Figure 4-2, the "agglomeration effect", "diffusion effect" and "polarization effect" formed by high-speed railways have a combined effect on the distribution of population and economic activities in the region, ultimately The spatial structure of the industry and even the spatial structure of the economy are affected. At the same time, the spatial structure of the economy will have a negative impact on regional accessibility, transport costs, population distribution and the distribution of economic activities. Cities are important carriers of China's socio-economic development, and the urbanization process is closely related to economic development and influenced by transport development. With the construction of high-speed railways, the spatial structure of China's cities inevitably changes due to changes in relative locational conditions. Among them, urban agglomerations, as a spatial form of agglomeration, have changed particularly significantly.

Figure 4-2: Mechanisms by which high-speed rail affects spatial structure



Source: drawn by the author

High-speed railways have a significant impact on the spatial structure at three scales: regional, urban and station. At the regional scale, high-speed railways greatly expand the spatial area of the region in which they are located. Within the one-day communication circle, high-speed railways cover more cities, have a higher ranking, and show a linear radiation. High-speed railways not only increase the tightness of links between different regions, but also have a significant impact on their primacy in regional urban clusters along the HSR lines. At the urban scale, high-speed railways change the spatial layout of urban population and industry, thus changing the direction of urban land expansion and contributing to the gradual formation of polycentric

urban development patterns. At the station level, each new high-speed railway station can form a new urban spatial growth point, and may form three typical areas: the basic functional area of the high-speed railway station (1000m radius), the urban functional area of the high-speed railway station, and the peripheral influence area of the high-speed railway.

The impact mechanism of high-speed railways on regional spatial structure is diversified. The construction of high-speed railways creates a comprehensive force for change in the regional spatial structure from various aspects. High-speed railway hubs have a growth pole effect, with high-speed railways having an unprecedented impact on people's travel patterns, travel times and spatial and temporal perceptions, thus having a significant impact on activities such as material and information express services and business circulation. At the same time, the high speed rail hubs are a major cluster of financial, commercial and residential urban activities, dramatically changing the appearance and function of the original area and its position in the city.

The construction of high-speed railways can shorten the spatial and temporal distances of cities and produce spatial convergence. On the one hand, it shortens the spatial and temporal distances between cities, saving time for the exchange of goods and the movement of passengers, promoting economic and social links between cities and contributing to the development of regional economic integration. On the other hand, due to the uneven nature of high-speed rail network construction, cities benefit

unevenly from network optimization, leading to changes in their 'relative location' conditions, which have an important impact on the reshaping of regional and urban spatial structures.

The accessibility of the central cities is further increased, intensifying the concentration of production factors. As high-speed railways run fast, there will not be too many stations set up along the line, so some cities cannot set up stations and must instead enhance their external accessibility through the central cities they are attached to. At the same time, some central cities often become the gathering point for high-speed railways, such as Xi'an in Shaanxi Province. The central city itself is well located and has a more developed social economy, and the convergence of multiple high-speed railways further strengthens the central city's location and increases the accessibility gap with other small and medium-sized towns.

With the opening of high-speed railways, the time cost between urban agglomerations has been shortened, which inevitably accelerates the concentration and exchange of various production factors in these areas, eventually forming a complete economy gradually around a metropolitan area with a metropolis as the core and a number of large, medium and small cities.

The impact of the construction of high-speed railways on cities is also reflected in another aspect: the expansion of the area of influence of urban agglomerations,

mainly along high-speed railways. Urban agglomerations are generally defined as one or two mega-cities as the center of a relatively complete urban 'agglomeration' with strong internal links between the cities, depending on the natural environment and transport conditions. The opening of high-speed railways can reduce travel time costs between core cities and neighboring cities, strengthen inter-city links and expand the 'radius' of the core cities, allowing more cities to enter the economic agglomeration. For example, with the opening of the high-speed railway, the radius of the central city will be further expanded to include more small and medium-sized cities, potentially forming a larger urban agglomeration as economic links are strengthened. At the same time, with the expansion of city clusters and the strengthening of economic ties within them, the development of cities in Shaanxi Province will shift from competition between individual cities in the past to competition among groups with city clusters as the mainstay, forming a diversified regional spatial pattern. The competition between urban agglomerations will start with the major cities as the core and integrate the surrounding small and medium-sized cities to form a complete metropolitan area. Small and medium-sized cities that are far away from the HSR need to integrate into their most connected major cities that have HSR locations and use road transport to form good connections in order to avoid marginalization.

4.4 Impact on industrial structure

Economic structure is the most critical factor to measure the economic level of a

region or even a country, if the more reasonable the layout of the economic structure, the faster the economic level will be improved in the future. In the economic structure, the distribution of the three industries dominates the layout of the economic structure, the rationality of the layout of the industrial structure affects the efficiency of resource allocation, the more reasonable the industrial layout, the more conducive to the healthy development of the national economy, the construction and operation of high-speed railways can optimize the industrial structure and promote the transformation of the industrial structure. The construction period of high-speed railways requires overcoming technical difficulties to ensure that the projects can be further implemented, while at the same time, with the increase in the mileage of high-speed railways in operation, a major technical breakthrough has been made in the research and development of high-speed railways. During the construction period, the greatest demand is not for manpower, but for energy, such as gas, steel, metal parts, ore, etc. The extraction of these energy sources drives industries such as steel, electronic equipment, power fuels and extractive industries, and the manufacture of various types of machinery and equipment and locomotive parts drives the development of manufacturing and supply industries, and other shipping industries related to these industries will also develop as a result. The continuous upgrading of these industries has improved the structure of the secondary industry in the region. On the other hand, the opening of the high-speed railway has balanced the development of the industrial structure of the urban areas along the HSR lines, and the relatively low economic level of the region can achieve the transformation of traditional

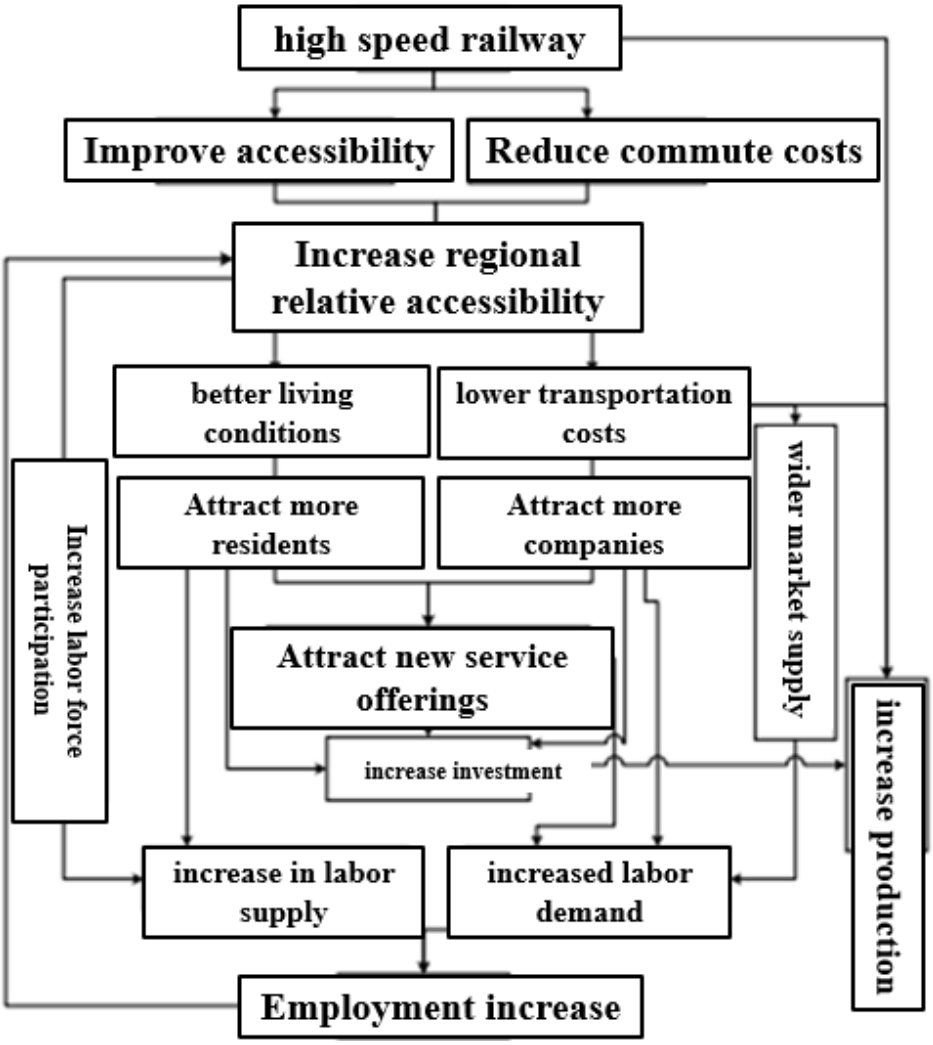
industries into new industries(Zhang, 2016). The opening of high-speed railways will stimulate the development of the industrial structure of the cities along the HSR lines. The opening of the high-speed railway will stimulate a large number of passengers to enter the region, resulting in a dramatic increase in the flow of passengers to the cities along the HSR lines, which in turn will lead to an increase in economic activities in the surrounding areas. The high-speed railway will integrate the tourism resources in the region, which will have the most significant effect on the tourism, catering, financial and medical industries, which will lead to a significant spillover effect on the tertiary industry and will lead to an industrial agglomeration. The economic development in the region has become more diversified(Li and Hu, 2016). For example, the construction of the high-speed railway has led to a gradual increase in the number of factories and residential areas along the line, and the number of people choosing to travel to the area has also increased due to more convenient transportation. In addition to this, the opening of the high-speed railway has attracted more people and information flows to the region and introduced more investment. The convergence of these resources plays a vital role in improving the economic structure of the entire region, which in turn promotes the continuous upgrading of the three industries, thereby boosting the economic development of the entire region. High-speed railways can act as a catalyst for regional development and play a vital role in industrial upgrading. High-speed railways change the psychological distance between cities through the effect of time and space, bringing into play the radiating effect of core cities, promoting the integration of advantageous resources between

regions and providing more quality services to the secondary and tertiary industries.

4.5 Impact on labor force employment

High-speed rail will not only increase the number of jobs directly related to high speed rail services, but more importantly, it can also act on the demand and supply side of the labor force in various indirect ways, substantially increasing employment(Oosterhaven and Romp, 2003) . As revealed in Figure 4-3, the mechanism of the impact of HSR on employment shows that, in terms of supply, regional accessibility is improved and people have more options to work and live, which in turn increases the number of laborer's in cities. In terms of demand, HSR not only effectively reduces transport costs for businesses by improving the efficiency of rail transport, which helps to expand the size of the market, but also brings new businesses to the city to invest, move in, cooperate and other economic activities, thus increasing the demand for labor.

Figure 4-3: Mechanisms for the impact of high-speed rail on labor force employment



Source: Dong, Y. and Zhu, Y. (2016) 'A study of the employment effects of high-speed rail construction - evidence based on a propensity-matching multiplier approach in 285 Chinese cities', Economic Management, 38(11), pp. 26 -44.

The construction of high-speed railways creates a large number of jobs during the planning, construction and post-opening phases. During the planning period, the location and design of the high-speed railway line requires a large number of designers to carry out the planning, as does the preparation of the location survey and other work. According to statistics, during the construction period of a high-speed

railway, one kilometer of railway consumes 100,000 man-days of labor to complete, in addition to the large amount of energy consumed, such as metal ores and construction materials, while the extraction of energy, the construction of facilities and the manufacture of equipment require a large number of human resources. With the increase in the number of railway lines, the companies involved started to increase their employment to meet the production needs. With the opening of high-speed railway lines, the lines require manpower to operate and manage, the facilities and equipment need to be serviced and maintained, and with the increase in passenger traffic and regional accessibility, the catering and tourism industries around the lines have also started to develop, with economic activities gathering in the region, thus providing more jobs. According to statistics, the railway construction in the Yangtze River Delta provides more than 100,000 jobs in Shanghai, Jiangsu, Zhejiang and Anhui provinces and cities every year, taking the Hukang Railway[33] , which is about to be commissioned, as an example, the construction investment of the line is about 370.27 billion yuan, creating a total of more than 30,000 jobs since the start of construction. These jobs are in a wide range of industries. These jobs are in a wide range of industries, including agriculture, construction materials and mineral products, transport equipment manufacturing and other industries, with the railway construction and commercial industries providing the most jobs and raising employment levels in upstream and downstream industries. The construction of high-speed railways not only improves accessibility to the region and enhances the overall economic level of

[33] That is, the Hefei-Hangzhou section of the Hefei-Hangzhou high-speed railway, a high-speed railway linking Huzhou City, Zhejiang Province and Hangzhou City

the region, but also accelerates the movement of people, while bringing more employment opportunities and attracting more talents, making the production sector and the introduction of labor in the region form a virtuous cycle, in which the economic structure of the region is improved, and the industrial structure is rapidly upgraded.

Chapter 5 Mechanisms of the impact of high-speed rail on urban areas along the HSR lines

5.1 Impacts and effects on areas along the HSR lines

5.1.1 Pathways of Influence

High-speed railways reduce the spatial and temporal distances between the cities along the high-speed rail lines by enhancing the attractiveness between the two areas. Under the condition that the temporal distance between the two cities is reduced, it will cause changes in the psychological distance, social distance, economic distance and probability distance of the actors between the two areas, further affecting the economic and social relevance of the areas along the lines.

Time distance refers to the time it takes for passengers to move between regions. As a fast and convenient modern mode of transport, high-speed rail has greatly reduced people's travel time. The reduction in arrival time between two places is a direct cause

of the decay of psychological, social, economic and probabilistic distances for the actors.

(1) Psychological distance. It is a cross-domain category, self-centered, with a zero point of reference, i.e., one's direct experience in the here and now, and contains four extended dimensions: spatial distance, temporal distance, social distance and probability distance. Changes in psychological distance affect people's judgements and decisions and, to return to the topic at this thesis, are reflected in a psychological preference for shorter-term behavior, which means a tendency to travel on high-speed railways. It is clear that psychological distance weakly decays as temporal distance decreases, and that psychological distance is more of a subjective and dynamic property of the actor, so it is thought that psychological distance is intrinsic to changes in social, economic and probabilistic distances.

(2) Social distance. It is an important indicator of the degree of identity understanding and intimate interaction between people, between groups and groups, and between people and groups. High-speed railways make the time and psychological distance between people much shorter, making it easier and faster to interact between two regions, between people, between groups and groups, and between people and groups, and can also further promote the human, technical and monetary exchanges between regions and enhance the links between regions.

(3) Economic distance. The distance between two places expressed in terms of freight costs, time and convenience (or comfort). Economic distance is mainly affected by transportation technology by progress and improved facilities. As the time distance,

psychological distance, and social distance between the two regions shorten after the opening of the high-speed railway, investment and consumption agents will further weaken the spatial distance when considering their economic behavior, thus leading to a reduction in economic distance and enhancing economic interactions between the regions.

(4) Probabilistic distance. It can also be referred to as hypothetical, and in this thesis represents the probability of residents travelling with uncertainty. High-speed rail makes it easier for people to travel, which obviously increases the opportunities or probability of residents to travel. In addition, travel has the potential to further expand and increase the probability of travel occurring, i.e. shorten the probability distance, influenced by the induced reduction in psychological distance, social distance and economic distance.

In summary, high-speed railways influence the development of areas along the HSR lines by affecting temporal distances inducing a shortening of other types of distances; psychological, social, economic, and probabilistic distances are related and superimposed on each other.

5.1.2 The High-Speed Rail Effect

This thesis classifies the effect of high-speed rail into internal and external to the cities along the HSR lines, clarifies the role played by the effect of high-speed rail in

the economic development of the cities along the HSR lines, and is conducive to exploring the construction of a comprehensive mechanism model of the economic impact of high-speed rail on the cities along the HSR lines on this basis.

The effects of HSR on the inner-city structure are the catalytic effect and the industrial agglomeration effect

(1) Catalytic effect. It refers to the facilitation or mediating role of external influences in the process of change and the resultant impact. The catalytic effect is mainly reflected in the high-speed railway station area, which has a catalytic impact on urban development in several aspects(Shi, Hou and Ji, 2013). The catalytic effect is mainly reflected in the HSR station area, which has a catalytic effect on urban development in several ways. The construction of HSR stations and the formation of their functional blocks will have a series of impacts on urban development. The construction process can directly stimulate economic investment and increase employment; after the opening of the HSR, the large-scale and high-frequency pedestrian activities brought about by the hub function of the station area will bring about accommodation, catering, shopping, tourism and other related business activities, promoting the development of related service economies. The simultaneous functioning of the HSR station area as a transport hub node and urban service function will lead to the enhancement and improvement of the overall functions of the city. In this process, the HSR station area acts as a catalyst for change in the city.

(2) Industrial agglomeration effect. Industrial agglomeration manifests itself as the

concentration of certain industries in geographical space, and its generation mainly comes from cost savings and external economies of scale. Industrial agglomeration can bring spillover of knowledge and technology and promote exchange and innovation. The impact of high-speed rail on industrial agglomeration is mainly focused on the following three aspects. Firstly, because of the convenient transport conditions, it divides up some of the share of raw materials and products that would otherwise be transported by air, bringing cost savings to enterprises. Secondly, not only can enterprises use high-speed railways to quickly obtain the raw materials needed for production, but they are also closer to the consumer market and have access to more information that is beneficial to their development. Finally, high-speed railways relieve the pressure on traditional railways, allowing them to improve their structure and better integrate with other modes of transport, which is also beneficial to the layout of more businesses. Therefore, high-speed railway stations in cities along the HSR lines can attract more enterprises to gather, forming industrial clusters and playing a positive role in the economic development of cities along the HSR lines.

The effects of the HSR on the external structure of the city are mainly the integration effect, the industrial diffusion effect, the siphon effect, and the gradient effect.

(1) Integration effect. This refers to the development trend of co-location and interaction between cities in adjacent areas or larger areas due to high economic and social density, as the administrative boundaries of individual cities tend to blur with the convenience of inter-city transportation and the continuous shortening of space-

time distances. High speed railways with high speed, all-weather running capability and high punctuality greatly improve the efficiency of commuting between neighboring cities and achieve a seamless connection between cities. The integration effect of high-speed railways mainly includes commuting and employment co-location: high-speed railways improve transport efficiency and meet commuting and employment needs, for example, Beijing-Tianjin inter-city high-speed trains shorten the minimum commuting time between Beijing and Tianjin, two municipalities directly under the Central Government, to 30 minutes, and residence and work can be completely separated in the two cities; industrial layout co-location: high-speed railways reduce the restriction of spatial distance on the flow of economic factors, and different levels, The industrial layout of cities of different levels, scales and economic development levels can play to their respective strengths and form a division of labor in a large industrial chain, forming a clear hierarchy, complementary advantages, reasonable division of labor and efficient operation of the industrial structure system; co-location of culture and entertainment: it can be seen that the high-speed railway can promote the co-location of commuting and employment in neighboring cities, and thus promote the formation of an hourly economic circle between the two cities, realizing the co-location of consumption of culture and entertainment between the two cities. This will enable the co-location of cultural and entertainment consumption between two cities, break down the cultural barriers between cities, change people's lifestyles and form a new concept of space-time.

(2) Industrial diffusion effect. It refers to the fact that with the development of the

economy, the economic centre will gradually start to radiate and spread to the surrounding areas, thus driving the development of the surrounding areas and narrowing the difference between them. The impact of high-speed rail on industrial diffusion effect is mainly focused on the following two aspects. First, the diffusion effect arising from the flow of factors driven by high-speed rail. Generally speaking, big cities have the advantages in the fields of technology, capital, talents and information, while the development of small and medium-sized cities needs to be supplemented by these factors, due to the industrial diffusion effect, the production and economic factors of big cities are more likely to flow to the surrounding small and medium-sized towns, providing impetus to the development of the central towns. Secondly, due to the diffusion brought about by congestion and rising costs, a large number of people gather in large cities and produce big city disease, which is not only detrimental to urban development but also adds a cost burden to enterprises and individuals in cities. Rising costs cause businesses to spread to the central towns.

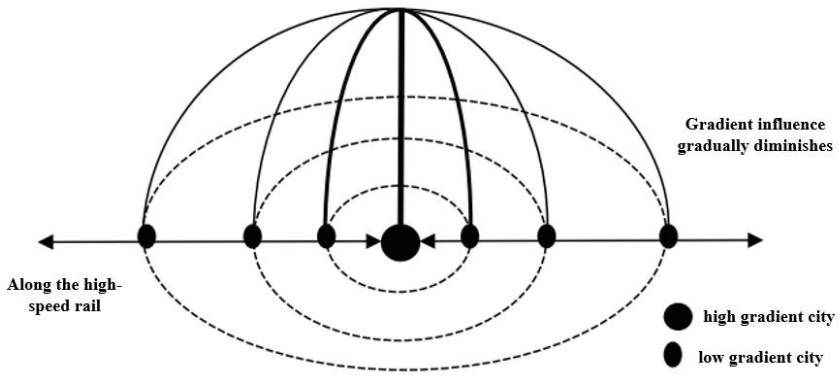
(3) Siphon effect. The siphon effect refers to the phenomenon that a certain region attracts production factors from other surrounding regions to gather in itself due to its own advantageous location, while weakening the development base of other regions. The construction and development of high-speed railways has enhanced inter-city and inter-regional mobility, making it easier for production factors to flow to areas with higher levels of economic development and better development environments, further strengthening the dominant position of large cities, enhancing their attractiveness and gathering stronger development momentum. On the contrary, regions with slow

economic development and lack of resource endowments suffer from further loss of scarce factors of production such as talent, capital and technology, which will inevitably weaken their own development, thus widening the development gap between different cities. The siphon effect has, to a certain extent, affected the development of small and medium-sized cities.

(4) Gradient effect. The various weak attenuation of distance brought about by HSR will promote the allocation of resource factors on a larger regional scale, causing changes in the regional development pattern along the HSR lines. In particular, within a specific period of time, HSR tends to strengthen the siphoning effect of factors in some cities along the HSR lines, while the centrifugal effect will occur to varying degrees for other cities(Zhang, 2014). This is mainly due to the fact that the HSR is a major factor in the development of cities along the HSR lines. This is mainly due to the differences in economic scale, development level, urban functions, and innovation capacity of cities along the HSR routes. This difference in the role of HSR in different cities is summarized here as a gradient difference, i.e., cities on the higher gradient will have access to more factor resources, while cities on the lower gradient are at risk of factor outflow. High-gradient cities are generally central cities with high overall potential, cities with specialized functions, etc.; low-gradient cities are mainly small and medium-sized cities with small scale and less specialized functions. When there is no high-speed railway connection, this gradient difference is often not obvious, but after the high-speed railway connects the high-gradient cities with the low-gradient cities, the gradient difference of the cities along the HSR lines will be revealed, thus

changing the development pattern of the region along the high-speed railway, affecting the change of the potential energy of different cities along the high-speed railway, and the phenomenon of this and that. In addition, it is worth noting that the siphoning effect of high-gradient cities on other low-gradient cities along the line will, on the one hand, expand the scope of their radiation effect due to the HSR link, and on the other hand, gradually weaken as the distance of HSR access increases (Figure 5-1), i.e. there should be a theoretical interval for the radiation effect of HSR central cities on cities along the line.

Figure 5-1: Schematic diagram of the gradient effect of HSR on cities along the HSR lines



Source: drawn by the author

5.2 Mechanistic modelling of the impact of high-speed rail on cities along the HSR lines

The impact of high-speed rail on regional development is multi-faceted and multi-level, and cities can be refined into large cities, regional centers, small and medium-

sized cities, and townships (which are not being considered at present). The economic impact of high-speed rail on cities along the HSR lines is in the following areas.

(1) The high-speed railway affects the spatial structure, and the development and construction of the high-speed railway station area and the surrounding areas are conducive to expanding the development space of the city, even making it develop into a new functional center of the city, thus changing the spatial structure form of urban development.

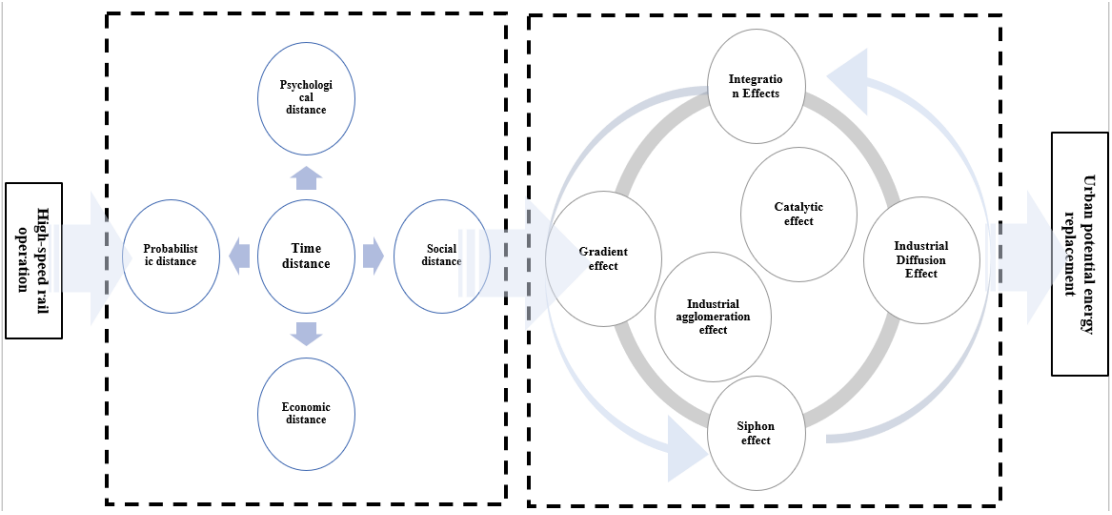
(2) High-speed rail affects regional accessibility, as shorter travel times make it more convenient to travel between cities along high-speed rail routes, which helps to expand the scope of people's economic activities, while large-scale, high-frequency flows of people will drive the flow of other economic factors between high-speed rail regions.

(3) The HSR will drive the integration of the regions along the HSR lines into the wider regional development pattern, promote the integration of resource elements and the division of functions in the wider regional context, and further influence the industrial structure of the cities along the HSR lines.

As can be seen in the previous two sections, HSR access causes a decay of spatio-temporal, psychological, economic, social and probabilistic distances between cities, which further drives changes in urban potentials through a combination of catalytic effects, industrial agglomeration effects, industrial diffusion effects, integration effects, siphon effects and gradient effects. The effects here constitute the intrinsic

mechanism of action of HSR affecting regional development. In this way, a mechanism model of the impact of HSR on cities along the lines can be constructed (see Figure 5-2).

Figure 5-2: Mechanistic model of the impact of high-speed rail on cities along the HSR lines



Source: drawn by the author

The six effects interact with each other. Among them, the industrial agglomeration and diffusion effect is the core and key, to a certain extent, determines the force of the other effects, all the effects of high-speed rail together and thus have different levels and degrees of influence on the development of the city, and ultimately promote the change of urban potential energy. Here, urban potential energy includes comprehensive potential energy, economic potential energy, and specialization potential energy, etc. It is worth noting that: firstly, the implied conditions of the mechanism model have fully considered the natural attributes and development basis of cities, and respected the objective differences of different cities; secondly, the time variables should be fully considered, i.e. the impact of HSR on cities has the property

of stage, in the construction stage of HSR station area, after the operation of HSR and in the process of potential energy turnover of cities along the HSR line, the impact of HSR on cities along the line (positive or negative) and its Thirdly, the government and other higher planning authorities should guide the positive effect of HSR on urban development, while it is not desirable to blindly magnify the effect of HSR without following the intrinsic mechanism of its effect on the development of cities along the HSR lines.

Chapter 6: Empirical analysis of the economic impact of high-speed railways on cities along the HSR lines within Shaanxi Province

6.1 Cities accessibility impacts along the HSR lines

6.1.1 Introduction to the measurement model

Previous studies have shown that the most intuitive impact of the opening of high-speed railways on regions and cities lies in the impact on the accessibility of cities along the HSR lines, which leads to coordinated inter-regional co-development. In this section, the spatial interaction between cities along the line is measured from the perspective of regional city accessibility and how the accessibility of cities along the line changes after the opening of the high-speed railway in Shaanxi, and when the spatial interaction between cities along the line is further strengthened, it can be inferred that the flow of production factors between cities along the line is cheaper

and faster, with closer ties and a faster process of regional integration. The more commonly used indicators for evaluating accessibility are the weighted average travel time model and the economic potential model.

The weighted average travel time model measures accessibility in the physical sense, i.e., the time it takes for a node to reach the economic center, while the economic potential focuses on accessibility in the economic sense, expressing the degree of interaction between the economic center and other nodes due to mutual attraction, which takes into account the economic strength, development potential and traffic conditions of the nodes. Both the weighted average travel time and the economic potential are effective measures of accessibility to cities along the HSR lines, but the two indicators have different emphases. The former focuses on time, while the latter takes into account the interactions between nodes due to distance decay. The measurement models can be based on a weighted average travel time model (6-1) and an economic potential model (6-2).

Weighted average travel time model (6-1)

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

$L_i$indicates the accessibility of node i along the HSR lines.

n denotes the total number of urban nodes in the evaluation system other than place i;

T_{ij}Indicates the minimum time it takes to reach an economic centre (or activity destination) from city node i via a transport facility and network.

M_jThe flow of a socio-economic factor in an economic center and an activity

destination within the evaluation system, i.e. the economic strength of the economic center or its radiance or attractiveness to the surrounding activity area, using indicators such as gross GDP, total population, etc.

Economic Potential Model (6-2)

$$P_i = \sum_{j=1}^{n} \frac{M_j}{T_{ij}^{\alpha}}$$

$P_i$denotes the economic potential of city node i.

T_{ij}, M_j , n is expressed in the same sense as Equation 6-1

α denotes the distance friction factor between urban nodes i and j, usually taken as 1.

The intensity of spatial interactions between cities has a direct impact on urban integration, co-location and regional integration. Therefore, this section uses an appropriate accessibility measure to measure the intensity of spatial interactions between cities at nodes along the opening of five high-speed railways in Shaanxi Province, and to quantitatively analyze the effect of the opening of high-speed railways in Shaanxi on the sustainable development of cities along the HSR lines.

6.1.2 Indicator Selection and Research Methodology

Indicator selection: According to the theory of the law of distance decay, the spatial interaction between cities is related to distance, specifically the interaction between geographical factors is inversely proportional to the square of distance. Simply put, the greater the spatial distance between cities, the longer the transport time and the

higher the transport costs, and the higher the economic cost of the time cost of moving various factors of production between cities. We have chosen the most commonly used accessibility indicator, the urban potential model indicator (6-2), this indicator incorporates the combined forces of spatial gravity between cities in the region into the analysis and reflects the spatial interaction of cities along the HSR lines based on the law of distance decay.

Data processing: In order to initially measure the impact of high-speed railways in Shaanxi on the spatial accessibility of cities in the regional center nodes along the HSR lines, this thesis focuses on the most significant impact of high-speed railways on regional space - the reduction of inter-city transport time, therefore, we will use transport time as the spatial distance variable for the accessibility measurement method.

Research method: Using the with/without comparison method, a control group was set up with or without high-speed railways to compare and analyze accessibility indicators and changes in values. By comparing the accessibility changes of six central node cities, one district and ten counties along the HSR lines with and without the opening of high-speed railways, the study measures the impact of the opening and operation of high-speed railways in Shaanxi on the spatial interaction between cities along the HSR lines, and then quantifies how the opening of high-speed railways in Shaanxi has contributed to the coordinated regional development of cities along the

HSR lines.

6.1.3 Subject of study and calculation process

Research object: 17 central node regions along the high-speed railway in Shaanxi. The economic gravity data are mainly selected from the number of resident population and gross product of each city. The specific selection range is as follows: Xi'an, Tongchuan, Baoji, Xianyang and Weinan Hanzhong are the main urban areas, while the other counties use the data of the city and county jurisdictions under their jurisdiction respectively. The specific data are shown in Table 6-1.

Table 6-1: Basic information on node cities in Shaanxi Province in 2020

Cities	Regional area（Km²）	Resident population (10,000 people)	GDP (100 million yuan)	Total retail sales of social consumer goods (ten thousand yuan)
Xi'an	10106	1296	10020.39	49893328.2
Lintong District	916	67.6	252.53	550855.2195
Tongchuan	3881	71	381.75	1331036.089
Baoji	18120	332	2276.95	8019424.2
Qishan County	855	36.52	169.0945	603790.05
Xianyang	10323	396	2204.81	8361758.6
Qian County	1000	45.668	155.6212	715322.8249
Liquan County	1011	36.5555	156.1833	801665.8001
Yongshou County	888	16.023	84.6225	312228.8789
Binzhou County	1181	30.0226	216.1431	570671.3434
Weinan	13033	469	1866.27	6335769.6
Dali County	1696	59.2888	175.5119	765304.4
Huavin County	675	20.5119	72.4847	282503
Hanzhong	27093	321	1593.4	5198383.2
Yang County	3194	34.5354	172.3561	358030.1
Ningqiang County	3256	25.6373	106.6383	285825.3
Foping County	1269	2.6597	11.8813	34547.2

Source: Self-drawn by the author, data from Shaanxi Provincial Statistical Yearbook 2021

The actual transport distances for each node city along the Shaanxi route are shown in Table 6-2.

Table 6-2: Actual transport distance by node city in Shaanxi Province, unit: km

Cities	Xi'an	Lintong District	Tongchuan	Baoji	Qishan County	Xianyang	Qian County	Liquan County	Yongshou County	Binzhou County	Weinan	Dali County	Huayin County	Hanzhong	Yang County	Ningqiang County
Xi'an																
Lintong District	32															
Tongchuan	75	107														
Baoji	167	200	332													
Qishan County	130	166	225	51												
Xianyang	28	56	182	149	116											
Qian County	66	107	142	136	89	48										
Liquan County	53	97	123	163	104	38	22									
Yongshou County	95	126	161	168	113	88	31	50								
Binzhou County	133	171	134	147	167	125	78	96	54							
Weinan	55	31	105	236	194	85	127	114	146	191						
Dali County	108	101	137	308	267	158	190	176	219	264	64					
Huayin County	121	94	193	296	255	146	187	174	206	251	62	48				
Hanzhong	242	371	436	180	219	319	300	331	340	314	399	470	463			
Yang County	193	425	485	229	268	368	354	381	390	368	453	524	513	56		
Ningqiang County	318	450	515	254	293	394	379	406	415	294	478	550	538	105	164	
Foping County	140	241	294	233	192	184	177	197	245	290	269	340	329	143	92	230

Source: Self-drawn by author collecting data

The transport distances between nodal cities in Shaanxi are converted into transport times (without considering platform stops and waiting times) according to the maximum average speed of existing ordinary railway transport and the average running speed of high-speed rail, respectively, and are listed in Tables 6-3 and 6-4.

Table 5-3 Minimum time for existing rail transport between node cities in Shaanxi, unit: minutes

Cities	Xi'an	Lintong District	Tongchuan	Baoji	Qishan County	Xianyang	Qian County	Liquan County	Yongshou County	Binzhou County	Weinan	Dali County	Huayin County	Hanzhong	Yang County	Ningqiang County
Lintong District	26															
Tongchuan	115	71														
Baoji	111	133	221													
Qishan County	90	111	150	34												
Xianyang	26	37	121	99	77											
Qian County	44	71	95	91	59	32										
Liquan County	35	65	82	109	69	25	15									
Yongshou County	63	84	107	112	75	59	21	33								
Binzhou County	89	114	89	98	111	83	52	64	36							
Weinan	54	21	70	157	129	57	85	76	97	127						
Dali County	72	67	91	205	178	105	127	117	146	176	43					
Huayin County	81	63	129	197	170	97	125	116	137	167	41	32				
Hanzhong	161	247	291	120	146	213	200	221	227	209	266	313	309			
Yang County	129	283	323	153	179	245	236	254	260	245	302	349	342	37		
Ningqiang County	212	300	343	169	195	263	253	271	277	196	319	367	359	70	109	
Foping County	93	161	196	155	128	123	118	131	163	193	179	227	219	95	61	153

Source: Self-drawn by the author, data converted from table transport data distances

Table 6-4 High-speed railway transport between node cities in Shaanxi, unit: minutes

Cities	Xi'an	Lintong District	Tongchuan	Baoji	Qishan County	Xianyang	Qian County	Liquan County	Yongshou County	Binzhou County	Weinan	Dali County	Huayin County	Hanzhong	Yang County	Ningqiang County
Lintong District	9															
Tongchuan	20	29														
Baoji	46	55	80													
Qishan County	41	45	61	14												
Xianyang	13	15	50	41	32											
Qian County	29	29	39	37	24	13										
Liquan County	20	26	34	44	28	10	7									
Yongshou County	30	34	44	46	31	24	8	14								
Binzhou County	45	47	37	40	46	34	21	26	15							
Weinan	15	8	29	96	53	23	35	31	40	52						
Dali County	36	28	37	104	73	43	52	48	60	72	17					
Huayin County	28	26	53	81	70	40	51	47	56	68	17	13				
Hanzhong	76	101	119	49	60	87	82	90	93	86	109	128	126			
Yang County	53	116	132	62	73	100	97	104	106	100	124	143	140	15		
Ningqiang County	101	123	140	69	80	107	103	111	113	80	130	150	147	29	45	
Foping County	43	66	80	64	52	50	48	54	67	79	73	93	90	39	17	63

Source: Self-drawn by the author, data converted from table transport data distances

An important aspect of the integration effect of high-speed rail is that commuting to work can be done across city boundaries. In the past, people working in city A could only settle in city A, but after the opening of the high-speed railway, people working in city A can settle in city B. The fast and flexible nature of the inter-city high-speed railway and its bus-based operation provide people with this possibility. Considering that travel time is the most fundamental factor affecting labor mobility, the weighted average travel time between nodal cities along the HSR lines and its variation is calculated using Equation 6-1 for both scenarios with and without HSR, the results of which are shown in Table 6-5.

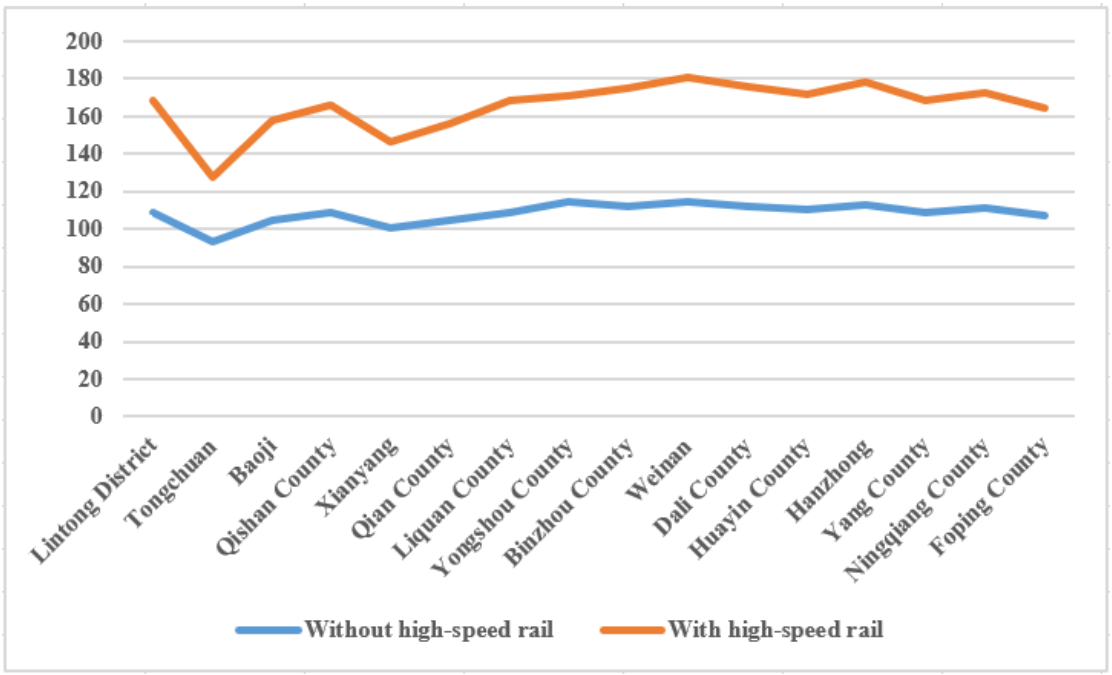
Table 6-5: Weighted average travel time values and comparisons by city with and without high-speed rail

Cities	Without high-speed rail	With high-speed rail	change value	Rate of change
Lintong District	109.0561	59.47607	-49.58	54.07
Tongchuan	93.11637	34.42637	-58.69	54.65
Baoji	104.6606	52.95061	-51.71	54.12
Qishan County	108.4108	57.88085	-50.53	54.78
Xianyang	100.4235	46.11349	-54.31	54.54
Qian County	104.3737	52.24368	-52.13	54.41
Liquan County	109.1534	59.66336	-49.49	54.02
Yongshou County	114.3188	56.87563	-47.56	54.37
Binzhou County	111.7611	63.04108	-48.72	54.45
Weinan	114.4651	66.69515	-47.77	54.68
Dali County	112.1087	63.54873	-48.56	54.44
Huayin County	110.4806	60.96061	-49.52	54.71
Hanzhong	113.0326	65.15258	-47.88	54.12
Yang County	109.0763	59.38627	-49.69	54.20
Ningqiang County	110.9017	61.55172	-49.35	54.73
Foping County	107.4251	57.05505	-50.37	54.11

Source: Self-drawn by the author, calculated from Equation 6-1 and previous data

In order to visualize the impact of high-speed railways in Shaanxi on the weighted average travel time of each node city along the HSR lines16, a line graph was made based on the results of the calculations (see Table 6-6).

6-6: Change in weighted average travel time



Source: Authors' plot based on previous calculations

The results show that, without taking into account waiting time and station stopping time, the opening of high-speed rail in Shaanxi will shorten the travel time between node cities along the high-speed rail line by more than 50%, enabling one-hour reachability between cities along the line and half-hour reachability between some cities. The speed advantage of high-speed railway shortens the journey transportation time, brings the distance between the node cities along the line closer, improves the transportation efficiency and achieves a wide range of displacement in the same time.

A comparative analysis was also carried out and the relevant data was substituted into the economic potential model equation, Equation 6-2, where α is taken as 1 andM_j The geometric mean of the city's population and gross product were taken and calculated to obtain the economic potential values of each city in the two scenarios with and without HSR respectively, and a difference comparison was made to compare the changes in the economic potential values of each city in the two scenarios with and without HSR. The results of the calculations are detailed in Table 6-6.

Table 6-6: Economic potential values for cities along the HSR lines

Cities	Before the opening of the high-speed rail	After the high-speed rail opened	change value	rate of change/%
Lintong District	68335.55	154747.9	86412.35	127.453
Tongchuan	77710.29	175274	97563.72	126.548
Baoji	79073.48	178448.3	99374.81	126.674
Qishan County	190194.5	424778.5	234583.98	124.339
Xianyang	82348.2	185594.7	103246.52	126.378
Qian County	124402	277859.4	153457.36	124.356
Liquan County	137689.8	306424.5	168734.69	123.547
Yongshou County	129411	287275.5	157864.54	122.987
Binzhou County	147016.6	325710.8	178694.25	122.547
Weinan	89462.44	201804	112341.57	126.574
Dali County	163764.9	366910.3	203145.42	125.047
Huayin County	196441.7	439607	243165.32	124.785
Hanzhong	108331.5	243758.9	135427.38	126.012
Yang County	238929.9	533695.2	294765.37	124.369
Ningqiang County	211030.3	469453.7	258423.45	123.458
Foping County	232200.2	518635.5	286435.25	124.357

Source: Authors' own calculations and drawings

The opening of the high-speed railway not only improves the accessibility between large, medium and small cities along the HSR lines, making the transport time between cities along the HSR lines greatly reduced, while transport costs are further reduced, but also makes it easier for cities along the HSR lines to reach other regions due to the speed advantage of the high-speed railway, improving the location conditions of cities along the HSR lines and facilitating the formation of new location advantages. At the same time, labor, as a core element of regional economic development, is able to move more freely within the region and between cities under these conditions, providing the possibility of further optimizing the allocation of labor within Shaanxi, which is conducive to the formation of an integrated labor market in Shaanxi province that is more regulated by market demand relations, with more

options for workers to choose employment and further activating the vitality of economic development.

6.2 Impact on the economic development of cities along the HSR lines

In this thesis, Xi'an, Lintong and Huayin along the Zhengxi Line; Baoji, Qishan and Xianyang on the Xibaoxi Line; Weinan and Dali on the Daxi Line; Tongchuan, Liquan, Qianxian, Yongshou and Binzhou on the Yinxi Line; and Hanzhong, Yangxian, Foping and Ningqiang on the Xicheng Line were selected as the study cash to analyse the impact of five high-speed railways on the economic growth of cities of different sizes along the line. The changes in GDP of cities along the line from 2010-2020 are shown in Figure (6-1, 2, 3 and 4).

Figure 6-1: Change in GDP of major cities along the HSR lines, 2010-2020

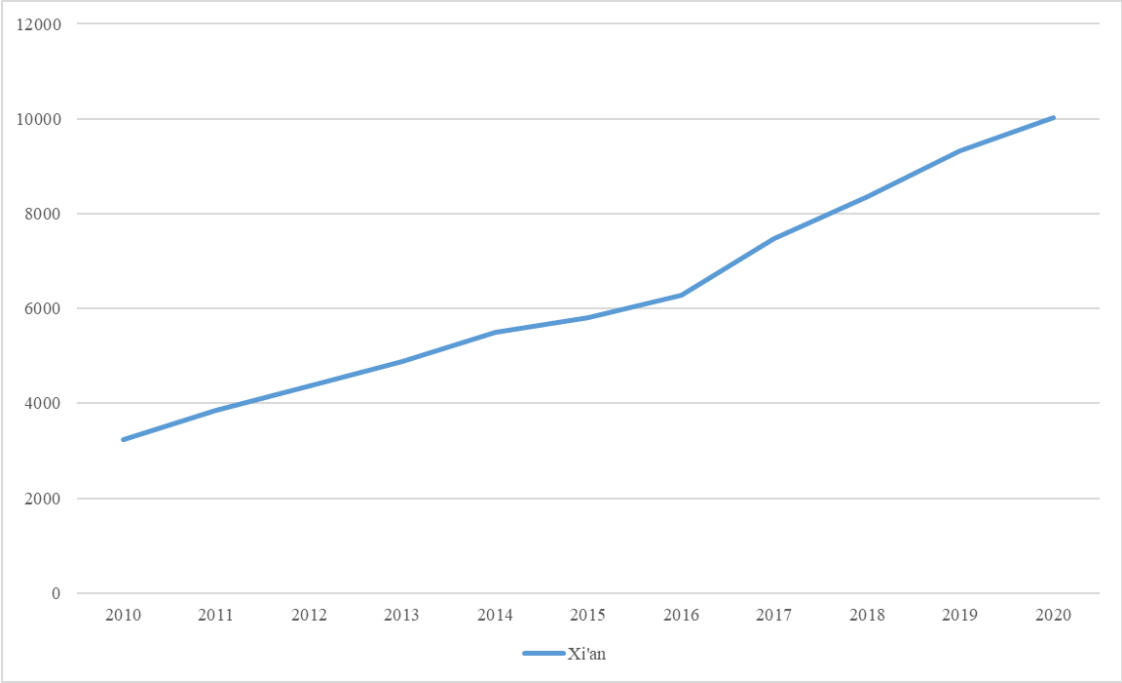


Figure 6-2: Change in GDP of small and medium-sized cities along the HSR lines, 2010-2020

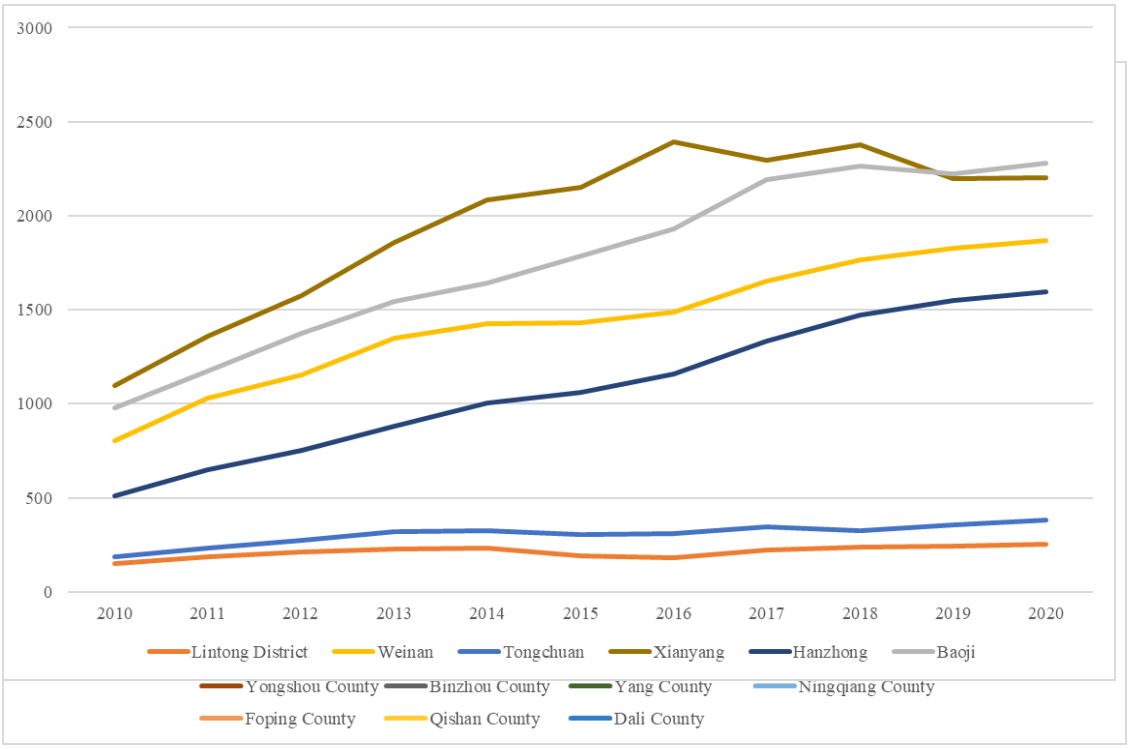


Figure 6-3: Change in GDP 2010-2020 in counties along the HSR lines

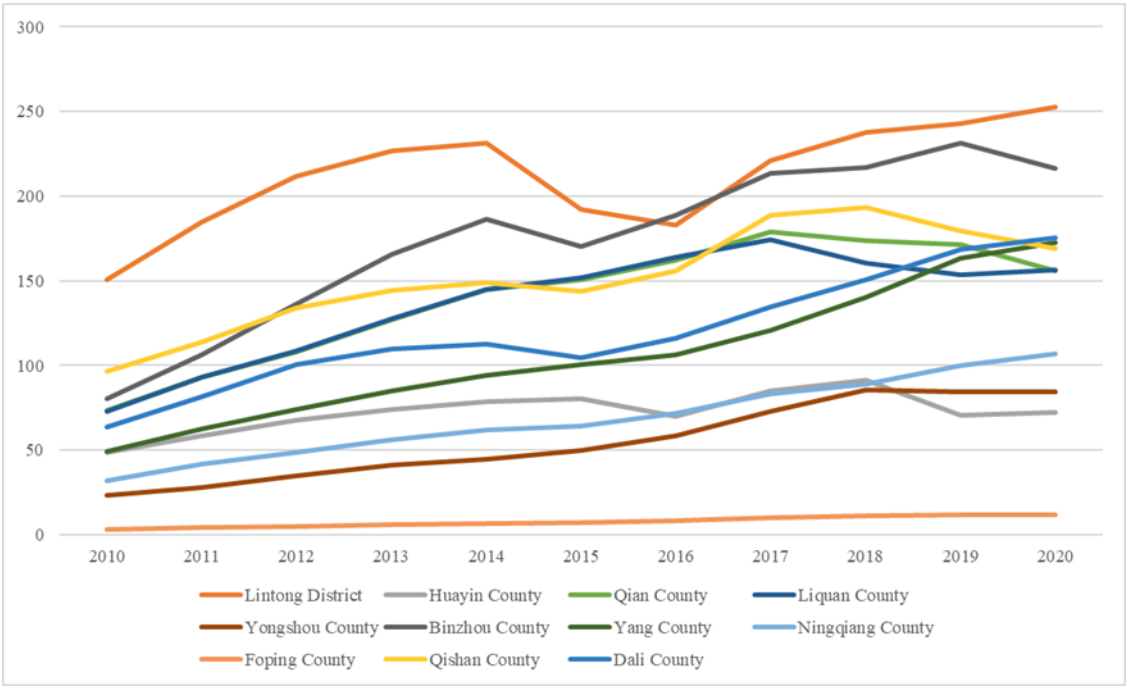
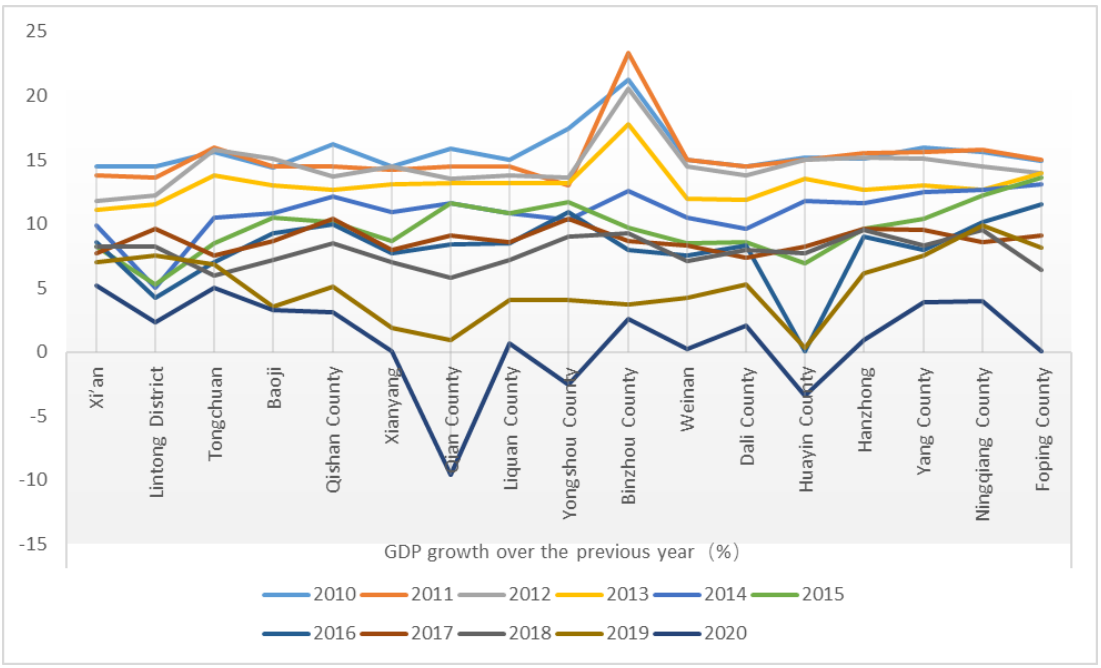


Figure 6-4: Level of change in GDP from the previous year for cities along the HSR.



Source: Self-drawn by the author, data from the National Economic and Social Development Statistical Bulletin 2010-2020

From Figures 6-1, 2, 3 and 4, we can conclude the following.

(1) The GDP of most of the cities along each high-speed railway line are in a stable growth state, and several important times can also be seen in the chart, such as 2010 (opening of Zhengxi high-speed railway), 2013 (opening of Xibao high-speed railway), 2017 (opening of Xicheng high-speed railway) and 2018 (opening of Daxi high-speed railway), all showing significant GDP growth after a delay of 1-2 years, while some of the years when the high-speed railway was not opened cities had lower GDP growth rates (e.g. Qian County, Huayin County and Yongshou County of the Yinxi high-speed railway line, which will only be opened in 2020), reflecting to some extent that high-speed railways have a catalytic effect on the regional economy.

(2) By the small and medium-sized cities due to their geographical location, resource

endowment and other conditions, there is a siphoning effect, for example, the economic development of Lintong District has been suppressed, and the GDP of 2014-2016 showed a declining trend, and Tongchuan City did not see significant growth in GDP level during the decade.

(3) The effect of HSR on the GDP of county-level cities is heterogeneous, with some showing a boost such as Binzhou, Yangxian and Ningqiang gradually overtaking cities that were at a lower economic level at the beginning, while others show a less pronounced effect, for example, Foping County does not show a significant increase in economic level.

(4) It shows uneven growth between cities and between years, with the amount of economic growth in large cities being higher than that in small and medium-sized cities than in county cities. High-speed rail has a positive effect on the economic growth of mature resource cities. Among the many factors contributing to the variability of the policy effect, the industrial factor accounts for the largest share, and for cities with poor basic economic levels, incomplete industrial structures and fewer job opportunities, the construction of high-speed rail may risk the outflow of human resources and other factors, which in turn inhibits the significant increase in local GDP.

(5) As can be seen from Figure 6-4, all cities showed a downward trend in GDP in the 20 years affected by the covid-19 pandemic.

6.3 Impact on the spatial structure of cities along the HSR lines

As changes in spatial structure are abstract and non-quantifiable, this section will explore the impact of high-speed railways on the spatial structure of cities along the HSR lines, taking urban clusters in Shaanxi Province as the target of the study.

China has entered the era of high-speed rail, and there are no longer any boundaries between mountains and plains in front of it. High-speed trains have broken through the Qinling barrier and the Loess Plateau, speeding up travel, information and logistics wherever they go. In the era of high-speed rail, all major cities are actively planning to build high-speed railways. In Shaanxi, during the 13th Five-Year Plan, a "米" high speed railway network layout was proposed (see Figure 3-8), with Xi'an as the centre, to build a 1-hour commuting circle for city groups and a 2-3 hour intercity traffic circle to neighbouring provincial capitals.

Thanks to the rapid development of high-speed railways, the importance of the Guanzhong city cluster is gradually becoming apparent. The five cities of the Guanzhong Plain include Xi'an, Xianyang, Baoji, Weinan and Tongchuan. With the opening of the "米" shaped high speed rail link centred on Xi'an, it will further break through the scope of the Guanzhong Plain City Cluster and will enable Hanzhong and Ankang in southern Shaanxi and Yan'an in northern Shaanxi to be integrated into the Guanzhong Plain City Cluster and truly become a Guanzhong City Cluster.

The Guanzhong Plain City Cluster Development Plan was officially released in 2017

for the planning period 2017-2035.In 2019, the Shaanxi Provincial Development and Reform Commission will focus on the construction of a central city and promote the synergistic development of three segments to provide support for the development of the Guanzhong Plain City Cluster. The main measures include: supporting the construction of Xi'an as a national central city, striving to introduce policy initiatives with high gold content, focusing on the construction of a national central city and driving the development of the Guanzhong Plain City Cluster; increasing guidance on the integration of Xi'an[34] and Fuyan[35] , supporting the innovative development of Xi'an New Area, and planning the synergistic development of Xiwei, Xitong and Xishang; promoting provincial-ministerial, inter-provincial and intra-provincial cooperation, seeking policy and project support, and promoting key cooperation projects; accelerate the implementation of planning lists, project lists and policy lists to form a strong synergy for the development of the Guanzhong Plain City Cluster(*Shaanxi Daily*, 2019). The high-speed railway has accelerated the development of urban clusters in Shaanxi Province. The high-speed railway has accelerated competition among urban clusters in Shaanxi Province, and the Guanzhong Plain Urban Cluster will break down administrative barriers, strengthen collaboration and synergy, take infrastructure interconnection as a precursor, focus on the rational allocation and free flow of production factors, gradually promote the common construction and sharing of public services, focus on building a unified and open market system, and vigorously promote integrated development(国家发展改革

[34] Xi'an, Xianyang
[35] Fuping County, Yanliang County

委, 2018).

The construction of the Guanzhong Plain City Cluster is beginning to bear fruit:. Firstly, the urban system has been optimised. The population and economic carrying capacity of Xi'an has been significantly enhanced, and the modern industrial system has gradually grown, with the total output value of the six pillar industries exceeding RMB 400 billion. Baoji City focused on enhancing the influence of manufacturing industries, insisted on transformation, and upgrading, and the industrial system became more optimised. Xianyang City, Weinan City, Tongchuan City, Xianyang City, and other comprehensive carrying capacity continued to enhance. Second, the infrastructure support capacity has been significantly enhanced. To high-speed railways as the focus of the city group of external transport channels to speed up the expansion and extension of Xi'an City as the centre, Baoji City as a sub-center, Weinan City and other nodes of the city group of integrated transport hub system is becoming more and more perfect. The "metre" high speed rail network has been improved, with high speed trains from Xi'an to Zhengzhou, Lanzhou, Taiyuan and Chengdu coming into operation one after another. The construction of smart cities and communication infrastructure has progressed significantly, with the completion and operation of the national secondary node (comprehensive service platform) for industrial Internet identification and resolution in Shaanxi Province, the implementation of industrial Internet platforms in Xi'an and Baoji, and the successful opening of a dedicated international Internet data channel in Xi'an. Third, the level of

industrial synergy and resource sharing has been continuously improved. The concentration of key industries such as equipment manufacturing, electronic information and aerospace continued to rise, and the output of monocrystalline silicon products ranked first in the world. The construction of the Xi'an Science Park of the Chinese Academy of Sciences was accelerated, the National Additive Manufacturing Innovation Centre was inaugurated, and the construction of the Qin Chuang Yuan innovation-driven platform was accelerated. Xi'an Hi-tech Zone signed agreements on collaborative development with national hi-tech zones in Baoji, Yangling, Weinan and Xianyang, and the sharing of resources between cities continued to deepen. Agreements were signed to implement regional tourism city cooperation action plans and jointly develop the surrounding tourism market, integrating tourism resources, docking tourism routes and carrying out overall publicity. Fourth, a new pattern of opening up to the outside world was basically formed. The construction of the China-Europe Class Train (Xi'an) Consolidation Center has made remarkable achievements, with 15 trunk routes covering the entire Eurasian continent and 15 consolidation routes radiating to major cargo sources such as the Yangtze River Delta, the Pearl River Delta, Beijing-Tianjin-Hebei, Jin-Shaan-Yuangtze River Delta, etc. The core indicators such as the number of operations, heavy load rate and cargo volume in 2020 steadily ranked among the top in China. Three fifth-rights policy passenger and cargo routes, including "Seoul-Xi'an-Los Angeles", have been launched, and 92 international routes have been opened, with access to 74 major hubs and cities in 36 countries around the world. Fifth, the regional reform and innovation capacity has

been continuously enhanced. The institutional mechanism for the development of Xi'an New Area was comprehensively rationalized, and the pace of Xi'an-Xianyang integrated development was accelerated. Twenty-one typical experiences of the Shaanxi Pilot Free Trade Zone were replicated and promoted nationwide, and the business environment was significantly improved. The West Ham joint area of the national pilot zone for integrated urban-rural development solidly promoted five pilot tasks and achieved initial results.

At the end of 2020, the resident population of the city cluster has reached 38.87 million, the regional GDP has reached 2.2 trillion yuan, the per capita GDP has reached 57,000 yuan, with an average annual growth rate of nearly 10%, and the comprehensive capacity and integrated development level of the city cluster has reached a new level. This shows that high-speed railroads have a strong optimization effect on the spatial structure of cities along the route after forming the initial prototype of urban agglomerations, supplemented by reasonable government planning guidance, which will have an extremely strong effect on urban and regional economic development.

6.4 Impact on the industrial structure of cities along the HSR lines

This section analyses the impact of high-speed railways on the industrial structure of cities along the HSR lines. The data are obtained from the statistical yearbooks of

cities along the high-speed railway line in Shaanxi Province for the years 2010 to 2020 and the statistical bulletin on national economic and social development for the years. In this thesis, the ratio of secondary industry to total output value is used to measure the industrialization level of the region, and the comparison of the output value of tertiary industry to total output value is used to measure the change of industrial structure. This is shown in Figures 6-5, 6, 7 and 8.

Figure 6-5: Changes in industrialization levels in prefecture-level cities along the HSR lines, 2010-2020

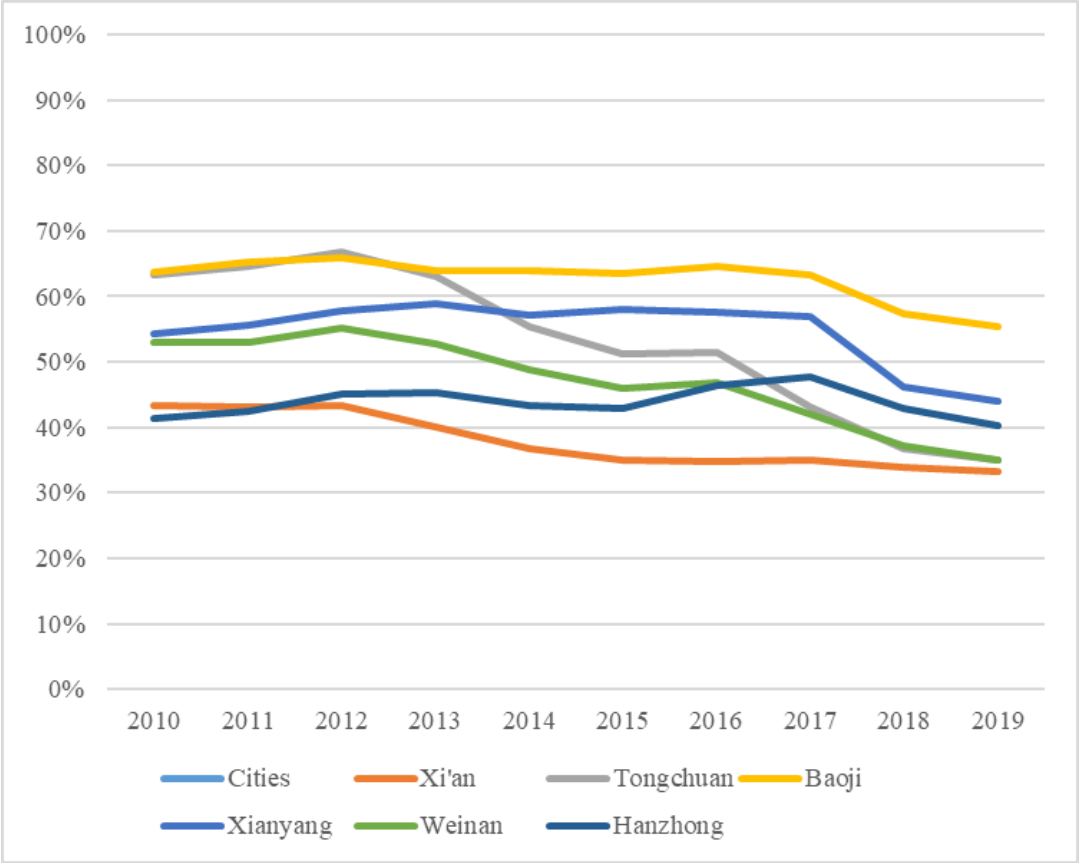
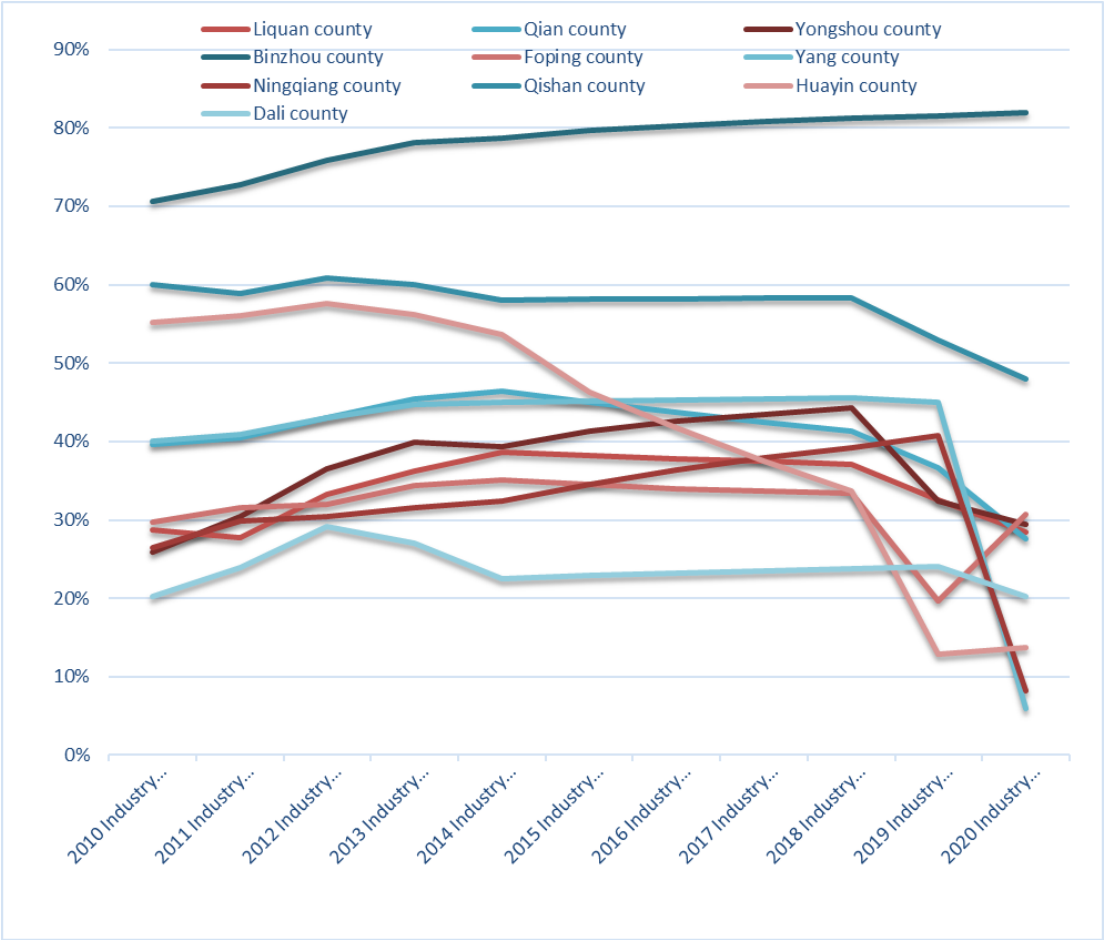


Figure 6-6: Changes in industrialization levels in counties along the HSR lines, 2010-2020



Source: Self-drawn by the author

It is clear from Figure 6-5 that the prefecture-level cities along the high-speed rail line in Shaanxi Province generally show a declining trend in the share of secondary output value, with Hanzhong City clearly visible as the boundary point in 2017, which is the point in time when the Xicheng high-speed rail line opened, in which the rate of decline in the share of secondary industry subsequently accelerated. Baoji has the highest share of secondary output among the six prefecture-level cities, falling from 65% to around 55%, and Tongchuan has the fastest decline in the share of secondary industry, from 65% to 35%.

From Figure 6-6, it can be seen that Binzhou, Qishan County, Yang County and Qian County have a high proportion of secondary industry. except for individual counties, the rest of the cities show a trend of rising and then falling, but the development of different cities is uneven. Binzhou County has the highest proportion of secondary industry output value, rising from 70% in 2010 all the way to 82% in 2020. cities that began to see a decline in the proportion of secondary industry after 2012 maintain a trend that has been declining, with 2018 as the node, the downward or upward trend is basically stable and conducive to industrial transformation.

Figure 6-7: Change in the share of tertiary sector output value in prefecture-level cities along the HSR lines, 2010-2020

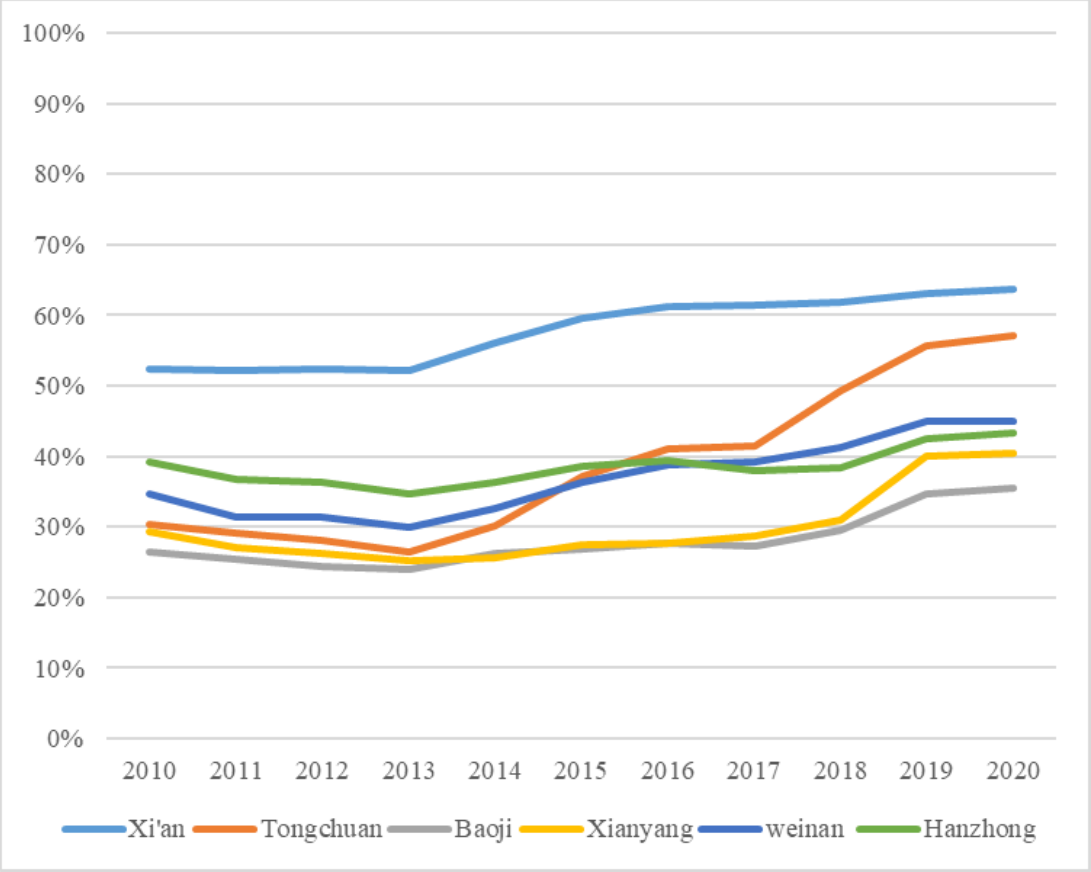
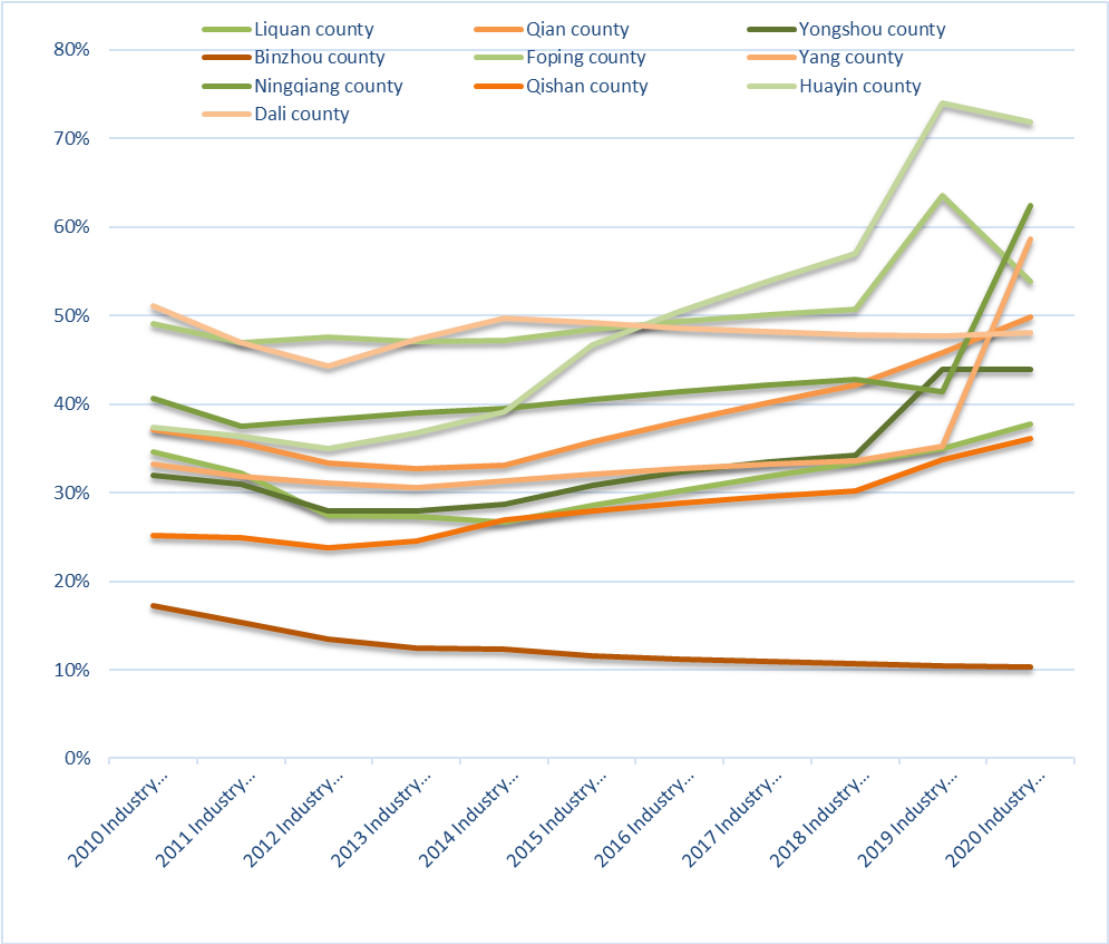


Figure 6-8: Change in the share of tertiary sector output value between 2010 and 2020 in counties along the HSR lines



Source: Self-drawn by the author

From the graph of changes in the share of tertiary industry in prefecture-level cities in Figure 6-7, it is easy to see that the share of tertiary industry in all prefecture-level cities has been rising steadily and continuously over time, with Xi'an, as the capital city of Shaanxi Province, always being significantly ahead of other cities in terms of the share of tertiary industry output, increasing from 52% in 2010 to 63% in 2020, and Tongchuan, which has since risen to the top, being the fastest increasing prefecture-level city, increasing from 30% in 2010 to 58%.

As can be seen from Figures 6-8, the proportion of tertiary industry output value in all

regions except Binzhou County generally shows a trend of first decreasing and then increasing, with a steady rise since 2012. Among them, Huayin County's tertiary industry rose rapidly, and combined with the existence of its city's own tourism resources - Mount Hua - it is easy to see how the opening of the high-speed railway has contributed to the city's industrial transformation.

The analysis of the proportion of the overall three major industries' output value in cities along high-speed railways of different scales in Shaanxi Province is in line with China's economic development strategy, which has been expanding in recent years, with increasing pressure on environmental resources, changing the mode of economic development and the need for enterprises to enhance their competitiveness, all of which require the support of the tertiary industry. The opening of the high-speed railway provides favourable conditions for promoting the development of the tertiary industry and offers new potential and space for promoting economic growth at the moment. It also shows that the opening of the high-speed railway has played a significant role in finding the right positioning for the development of the city and optimising its industrial structure. Firstly, as a transport service industry, the construction of high-speed railways has stimulated the rapid development of the service industry, prompting the transformation of the economic structure from manufacturing to service, thereby reducing the proportion of secondary production, which is the main source of pollution in the city, and facilitating the transition of the city's economic growth from a sloppy to a green development.(Liang, 2019) . This is

conducive to the transition of the city's economic growth from a sloppy to green development. Secondly, the increase in investment in the construction of high-speed rail is also conducive to the synergistic development of the three industries(Peng, 2019) . This will in turn lead to a more efficient green development of the city through the upgrading of the industrial structure. The graphs in this section also demonstrate the substitution effect of HSR on the industrial structure between the secondary and industrial sectors.

Chapter 7 Conclusions and Recommendations

7.1 Key findings

Based on the study and reference of previous research results, this thesis has explored the impact of high-speed railways on the regional economy as the core, has systematically analyzed the mechanism of the impact of high-speed railways on the economy of cities along the HSR lines and describes in detail the economic effects of high-speed railways. The opening of high-speed railways is not only an opportunity but also a challenge for the economic development of cities along the HSR lines in Shaanxi. Based on the existing research results, this thesis adopted a combination of qualitative and quantitative analysis, and used location economic theory, growth pole theory, economic radiation theory and new economic geography as the theoretical basis to do research on the economic development of seventeen cities along the high-speed railway in Shaanxi Province from 2010 to 2020 using mathematical models.

The following main conclusions were drawn.

(1) High-speed railways have an impact on the regional economy by improving regional transport conditions, changing the locational advantages of cities and speeding up the flow of production factors.

(2) The effects of the opening of high-speed rail on the economic development of cities along high-speed rail lines in Shaanxi Province mainly include the catalytic effect, the industrial agglomeration and diffusion effect, the integration effect, the siphon effect and the gradient effect. The high-speed railway effect has a differentiated impact on large, medium and small cities of different sizes, bringing both positive effects and exacerbating the gap between central and peripheral cities, and bringing certain negative effects to less economically developed cities.

(3) The opening of the high-speed railway has improved the accessibility and economic development potential of cities along the high-speed railway in Shaanxi Province. The opening of high-speed rail has had a significant effect on improving the accessibility of nodal cities along the line, with the transport time of cities along the line shortened by more than half after the opening of high-speed rail and the time cost of inter-city travel significantly reduced. The economic potential of cities along the line has increased by more than 20%, and the opportunities for spatial interaction between cities along the line have increased significantly, resulting in lower costs for the flow of various factors of production between cities and further optimization of resource allocation, making the opening of the HSR a powerful boost to coordinated regional economic development.

(4) The impact of high-speed railways on the economic development of cities along the HSR lines is differentiated. The empirical results of this thesis find that the changes in economic growth, industrial structure and spatial structure of cities of different scales after the opening of five high-speed railways in Shaanxi Province are distinctive.

7.2 Countermeasures and recommendations

High-speed railway construction investment is huge, and the return period is long, if large-scale construction of high-speed railway, although conducive to the development of rapid urbanization, but due to high-speed railway exists siphon effect, remote areas of capital, labor and other factors of production to accelerate the gathering of large cities, will cause the urban disease of large cities in general widen the gap between urban and rural areas. At the same time, the new high-speed railway increases the diversity of travel options for passengers, making people who originally relied on road passenger transport among the high-speed rail passenger transport, so significantly reducing the passenger traffic of other modes of transport, increasing the impact on road passenger transport. Therefore, it is necessary to scientifically plan the construction routes of high-speed railways, reasonably set up high-speed railway stations, connect with highways and ordinary railways, and establish an intensive and efficient comprehensive transport system.

The strategic planning of high-speed railways and regional economic construction planning should be mutually supportive and coordinated. The development strategy of the regional economy is mainly based on the development of high-speed railway, and the development planning of high-speed railway is mainly aimed at supporting and pulling the development of regional economy, which is the dialectical and unified relationship between the two. High-speed railways, as one of the important conditions for regional economic development, have a very important driving force, as can be seen from the above arguments. Under the current conditions such as the need for transformation of China's economic structure and the new situation facing regional economic development, it is a key and difficult issue to promote the transformation of economic structure and generate new growth points for economic development. "As a typical representative of advanced productivity in the field of transportation, high-speed railway is a product of integrated innovation of modern science and technology in the field of transportation and is an important achievement of high integration of transportation and related industries. The emergence of high-speed railways has changed the traditional transport structure and the shape of "economic geography", which has a profound impact on the development and progress of the economy and society.

There is a large regional variation in the development process and construction scale of high-speed railways in Shaanxi Province. The northern Shaanxi region is dominated by the energy economy, with information showing that the gross domestic

product of northern Shaanxi accounted for 21% of the province in 2017, and the contribution rate has been on the rise, with high regional economic potential, but the lack of transport connectivity with neighboring cities, especially with the provincial capital, and the lagging concept in urban planning and urban outlook has constrained its development. For example, the Guanzhong region is typically characterized by a large number of people and little land. The disorderly development of land in recent years has caused the original planning lines to lag in construction, traffic congestion, a growing urban population, disorderly traffic vehicles and urban road distribution, traffic status does not match, this is currently the biggest problem in the development of urban transport in Guanzhong, the city traffic congestion and other problems caused by time wastage, serious air pollution. Noise pollution. The construction of high-speed railways in the province will step up Xi'an's accessibility and radiation to third and fourth-tier cities in the province and promote the overall economic network in Shaanxi, but it will also have a siphoning effect on marginal cities, so be wary of the challenges this brings.

In accessibility studies, it can be seen that the completion of high-speed railways brings about a significant reduction in spatial and temporal distances. Its convenience accelerates the flow of people, capital and other factors, and the rapid passage of large numbers of passengers stimulates intra-regional consumption, facilitates knowledge creation and business exchange, promotes the development of tertiary industries such as the tourism economy, catering, commerce, and services, and has a catalytic effect

on regional industrial restructuring. At the same time, the development of high-speed railways will enhance the radiation capacity and scope of core cities such as the provincial capital of Xi'an, improve the integration of advantageous resources between regions, promote the coordinated development of all aspects of the city's economy, drive the synergistic progress of different regions in Shaanxi Province, thus providing more adequate and better quality services to the secondary and tertiary industries and promoting the upgrading and optimization of the city's industrial structure. In terms of the flow of people and capital, new high-speed railways can promote the concentration of production factors in the areas along the line, thus providing a favorable opportunity for the optimization of the industrial structure. With the rapid flow of capital, the economic activity of the areas along the high-speed railways is high, creating high speed economic corridors. Specifically, the construction of high-speed railways will not only promote the extension of the high-speed railway manufacturing industry chain, but will also drive the development of many related industries such as steel, electronic equipment, locomotive manufacturing, power and fuel, as well as the energy extraction industry along the HSR lines, causing the primary and secondary industries to transform into tertiary industries; at the same time, the development concept of relatively backward regions should follow the law of high-speed railway development, starting from labor-intensive industries such as manufacturing Accumulating transformation capital.

The most direct impact of HSR construction on economic development is to stimulate

regional economic growth, which refers to the increase in the number of products and labor produced in a region. The pattern of impact of HSR construction on economic development varies from region to region, for example, it acts as a catalyst for economic growth in less developed regions, which generally have relatively closed resources, and the opening of HSR breaks through the closed geographical constraints, allowing effective resource flows and thus catalyzing economic development.

In summary, the goal of the development of high-speed rail construction in Shaanxi Province is to enable the construction of high speed rail to strengthen the competitiveness of the central areas of Shaanxi Province such as the Guanzhong City Cluster, with its economic activities spreading to the periphery and the developed areas that started first driving the less developed areas that developed later. This will promote a rational distribution of resources in Shaanxi Province and reduce regional differences, thereby achieving sustainable economic development.

7.3 Shortcomings and outlook

Due to academic constraints, this thesis has shortcomings, the main ones being the following.

In terms of theoretical analysis, the impact of high-speed rail on urban economies is very comprehensive and complex, and this thesis considers only a few of these

aspects, with limited depth and breadth of analysis.

In the empirical analysis section, due to the availability of statistical data and the lag of the impact, only a few cities along the HSR lines that have been opened so far are selected, and the analysis belongs to the same time period change analysis, failing to discuss each high-speed railway separately according to its years, and therefore not accurate enough for each city. In addition, in the accessibility section, external factors that may affect accessibility, such as road traffic congestion and the number of high-speed railway trips, are ignored in the speed of the road network, simplifying and abstracting the actual road network, which will make the time travel costs deviate from the actual.

Finally, this thesis treats Shaanxi Province as a relatively closed study area, ignoring the possible impact of the construction of high-speed railways and roads in neighboring provinces on socio-economic development within the region, resulting in deficiencies in the connectivity and interaction between cities and the outside world. If the surrounding areas and their central cities are included in the subsequent study, the spatial accessibility of cities and the benefits of economic linkages will be measured more comprehensively and accurately.

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