

# High-Speed Rail Network, Entrepreneurial Activity and High-Quality Development: Empirical Data from Chinese Cities

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## Abstract

This study delves into the impact mechanism of the high-speed rail network (HSRN) on the high development of the regional economy. Theoretically, the construction of HSRN facilitates resource mobility across urban regions, thereby enhancing entrepreneurial activities, and ultimately spurring high-quality development of regional economy. By utilizing empirical methodologies, the research examines the correlation between HSRN's expansion and the quality of economic development across 293 Chinese cities at the prefectural level and above, spanning the period from 2005 to 2021. The findings indicate that the development of HSRN does provide an environment conducive to entrepreneurial activities. Consequently, it can be inferred that the expansion of HSRN exerts a positive impact on entrepreneurial activities. Statistical analyses of pertinent data reveal that in the early phases of HSRN construction, its contribution to enhancing the quality of economic development is relatively modest. However, as the coverage of HSRN continuously expands and improves, its marginal promoting effect on the quality of economic development gradually intensifies, with the progressive incrementing nonlinear characteristics. The study shows that HSRN not only makes a positive impact on the development of the regional economy, but also generates a significant spatial spillover effect on the neighbouring regions. This effect contributes to creating synergies in regional economic development, driving the economy to a higher quality stage of development at the regional and national levels, thereby comprehensively promoting the structure optimization and quality improvement of the overall economy.

## Keywords

High-Speed Railway Network, Entrepreneurial Activity, High-Quality

## 1. Introduction

It is clearly pointed out in the 20<sup>th</sup> National Congress Report that achieving high-quality economic and social development is the core priority and primary strategic consideration in promoting China's socialist modernization. As China's economy experiences swift growth, the nationwide coverage of its high-speed rail (HSR) network has seen incremental enhancement, emerging as a critical component of the national strategic infrastructure. To date, the operational length of HSR in China has exceeded 40,000 kilometers. According to the "Medium and Long-Term Railway Network Plan," the HSR network (HSRN) is projected to extend to 45,000 kilometers by the year 2030. The expedited development of HSR has significantly enhanced the convenience of intercity travel, established rapid transit corridors for regional connectivity (Zhong et al., 2015), fostered population mobility between cities (Zhang & Feng, 2022), and facilitated synergistic regional development (Feng & Cui, 2020). The influence of HSR has led to transformative changes both tourism and manufacturing sectors, playing a pivotal role in advancing China's pursuit of high-quality growth. Concurrently, within the context of exploring multifaceted mechanisms driving high-quality development, entrepreneurial activities have been increasingly garnering focus. The State Council's "Opinions on Promoting High-Quality Development of Innovation and Entrepreneurship and Constructing a New Generation of Mass Entrepreneurship and Innovation" underscores the essential role of entrepreneurship as an intrinsic catalyst for economic expansion. As a core element in the strategy of high-quality development, it plays an important role in accelerating the transformation of old and new drivers of growth, promoting the optimization and upgrading of economic structure, broadening employment channels, improving people's livelihood, and promoting social equity and justice, as well as class mobility. The research by Zhao et al. (2020) illuminated that the digital economy significantly contributes to the advancement of high-quality urban development in China by bolstering entrepreneurial dynamism. Following this rationale, HSR, as a crucial component of the emerging infrastructure, is anticipated to exert a similar and profound positive impact on high-quality development, leveraging its distinctive benefits.

Nevertheless, distinct from the "pervasive benefit" attribute of the digital economy, the influences of high-speed railway (HSR) on urban development quality exhibit a complex network characteristic. Traditional studies have typically simplified the analysis of HSR's impacts by merely considering its presence or absence, neglecting the systemic integrality, nonlinearity, emergence, and evolutionary dynamics of HSR as a complex system. This necessitates a re-evaluation of HSR's impacts on fostering high-quality urban development through the lens of

complex system management theory. First of all, China's HSR system has coalesced into a comprehensive network, with [Zhang and Tao \(2016\)](#)'s study providing empirical insights into its economic growth effects on the non-regional central cities along the railways. In certain countries, the establishment of a high-speed rail network requires seeking financial support from international financial institutions ([Mchome & Nzoya, 2023](#)). The divergent policies across different nations will also lead to varying project costs. Secondly, as HSRN undergoes continual enhancement and entrepreneurial activities experience marked advancement, the potential benefits for relevant government departments and enterprises are expected to increase exponentially, hence the influence of HSRN on urban development quality may exhibit nonlinear characteristics ([Sun et al., 2022](#)). Furthermore, the concept of high-quality economic development pertains to an urban economic progression guided by the principles of innovation, coordination, greenness, openness, and sharing. This multifaceted process defies reduction to a single metric and involves interrelating and codependent indicators ([Zeng et al., 2019](#); [Chao & Ren, 2011](#)). Finally, the high-quality development of the first-mover cities may have a spillover effect on specific cities when intertwined with the HSRN. Therefore, whether the HSRN has a statistically significant support effect on the high-quality development of most cities in China and the underlying mechanism still needs to be further explored.

This paper aims to build a comprehensive analysis framework that encompasses three major factors: high-speed rail network, entrepreneurial activity and high-quality urban development. Specifically, based on the unique attributes of HSRN and with entrepreneurial activity as the entry point, this paper builds a theoretical analysis system. Subsequently, utilizing the established framework, we conducted a quantitative assessment of the integrated performance of the HSRN coverage and its impacts on high-quality development of 293 cities at the prefectural level and above in China over the period from 2005 to 2021. Employing a suite of econometric techniques, we explored the distinct impacts of HSRN on fostering high-quality urban development and the underlying mechanisms at play. The findings indicate that HSRN exerts a remarkable impact on advancing high-quality development, with entrepreneurial dynamism catalyzed as a pivotal driver in this process. In addition, the gradual improvement of HSRN has a promoting effect on high-quality development, which also shows the nonlinear characteristic of "increasing marginal efficiency," accompanied by an obvious spatial spillover effect.

This paper may contribute to forming new marginal perspectives in the following aspects. First, by comprehensively measuring the HSRN and high-quality development at the city level, this paper is able to delineate the spatial-temporal evolution of the two and their interactions in a more detailed manner, filling the gap in the existing research at the micro-scale. Secondly, under a unified logical framework, this paper deeply analyzes the core path of HSRN influencing economic development, especially through strengthening the intermediary mechanism of entrepreneurial activities, which provides a new perspective for understanding the

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economic effect of HSRN, and further enriches and deepens the research results in related fields.

## 2. Theoretical Analysis and Research Hypotheses

The concept of high-quality urban economic development entails the achievement of sustainable, robust, and balanced growth of the urban economy. This can be realized through the optimization of economic structures, promotion of production factor quality and efficiency, facilitation of industrial upgrading, improvement of people's livelihood, conservation of ecological environment and other multifaceted initiatives, all underpinned by the innovative, coordinated, green, open, and shared development philosophy. With substantial governmental investment, China's high-speed railway network (HSRN) has undergone continuous improvement. Investment in transportation infrastructure serves as a pivotal catalyst for fostering development and spatial integration both within and across national boundaries. On the one hand, such investment stimulates economic growth; on the other hand, it positively contributes to enhancing urban cohesion. Consequently, investment in transportation infrastructure is regarded as a crucial strategy for bolstering regional economic development.

### 2.1. The Impact Mechanism of HSRN on High-Quality Development

As a high-speed and convenient means of transportation, HSR can shorten the distance between different cities to the maximum extent, and enable the reasonable circulation of resources, talents, information, and other elements between regions. This geospatial integration can promote the coordinated development of regional economy, and then provide entrepreneurs with a broader market and more diversified resources. In regions where HSRN has been relatively complete, entrepreneurs can expand their businesses more easily, and find suitable partners and talents more conveniently and quickly, which will play a positive role in promoting entrepreneurial activities. [Bian et al. \(2019\)](#) proposed that the reduction of travel costs brought by HSR greatly facilitated the cross-regional mobility of people, increased the probability of face-to-face communication among R&D personnel, and promoted the improvement of local innovation level in knowledge sharing and learning. Based on the data of cross-city entrepreneurial investment events, [Zhuang \(2021\)](#) found that the optimal scope of HSRN on the entrepreneurial investment network is distributed in a circle according to the investment center. In areas with the radiation radius of the investment center from 100 km to 200 km, the positive impacts of HSR on the agglomeration force, radiation force, and connection intermediary force of the entrepreneurial investment network are significantly stronger than those in the areas within 100 km and beyond 200 km. The enhancement of HSRN facilitates industrial clustering, fostering interaction and synergistic advancement among enterprises across the supply chain. This mode of transportation diminishes the expenses associated with business communications and catalyzes technological progress as well as industrial upgrading.

Within this framework, entrepreneurs are better positioned to identify niches within the value chain, leveraging their strengths to achieve integration and innovation in the industrial ecosystem. In addition, the HSRN also promotes the formation of industrial clusters, making it more convenient for entrepreneurs to obtain resources such as policy, capital, and market, thus improving the success rate of entrepreneurship. Wang and He (2020) analyzed the impact of HSR on the network location of urban incumbent entrepreneurial investment institutions, and the results showed that the spatiotemporal compression brought by HSR would have an impact on the evolution of entrepreneurial investment networks. Therefore, the improvement of HSRN significantly and positively impacts the promotion of entrepreneurial activities. Through the geospatial integration and industrial agglomeration effect, the regions with well-constructed HSRN have better entrepreneurial conditions, which is conducive to the innovation and development of entrepreneurs. Therefore, further optimizing the layout and enhancing the perfection of HSRN will have a positive impact on the improvement of entrepreneurial activities in China.

Simultaneously, the increase in entrepreneurial activities also plays a positive role in fueling the high-quality development of the economy. These activities represent the intrinsic dynamism of economic growth, and have an important role in promoting high-quality development, such as expanding job creation (Huang et al., 2021), optimizing industrial upgrading (Feng & Li, 2019), and facilitating structural transformation (Wan, 2021). This will play a positive role in helping to fundamentally transform the traditional economic growth model characterized by “high investment, high energy consumption, and high pollution.” Especially for value contribution, Meng et al. (2024) pointed out that entrepreneurial activities can promote innovation. Entrepreneurial activities, where entrepreneurs are constantly experimenting with new business models, technologies, and services, can help stimulate innovative thinking and improve innovation ability. Driven by the innovation engine, enterprises can continuously improve production efficiency and reduce costs, thus driving economic growth. Qi and Zhang (2024) figured out that entrepreneurial activities help to adjust the industrial structure. With the development of science and technology and changes in market demand, entrepreneurial activities can promote the transfer of resources from inefficient, traditional industries to efficient emerging industries. Such industrial structure adjustment helps to increase output value and enhance the overall competitiveness of the national economy. Glaeser et al. (2015) pinpointed that entrepreneurial activities can improve the employment rate. Entrepreneurial activities can absorb a large number of labor resources and provide employment opportunities for the unemployed. Stable employment is the foundation of people’s livelihood, which helps to improve people’s living standards and promote social harmony and stability. Hence, in light of the preceding analysis, this paper proposes the following research hypotheses:

Research Hypothesis 1: The construction of HSRN can have a positive impact

on high-quality economic development by enhancing entrepreneurial activity.

## 2.2. The Nonlinear Spillover Effect of HSRN on High-Quality Development

The improvement of HSRN makes transportation between different cities more convenient, thus promoting the flow of talent, technology, capital and other factors. Regional connectivity helps to expand the market, provides more opportunities for entrepreneurship, and at the same time, brings wider space for cooperation and development to enterprises. The expansion of HSRN has driven the industrial upgrading of cities along the railway lines, and many regions along the lines have seized the opportunity to develop high-end industries such as high-tech industry and modern service industry. This upgrading of industrial chains is beneficial to improve the quality of regional economic development, thus laying a solid foundation for sustainable, high-quality growth. The establishment of high-speed rail has exerted a promotional effect on the economic growth of various cities and counties. Furthermore, as the duration of operation increases, the promotional impact becomes increasingly pronounced (Zhang, 2019). As noted by Huggins & Prokop (2017), the HSRN offers robust infrastructural backing for innovation in science and technology, facilitating technological research and development as well as innovation cooperation between enterprises and academic institutions. Furthermore, Storper and Venables (2004), Oosterhaven and Romp (2003), and Lin (2016) have highlighted that the convenient travelling mode of HSR attracts more top-tier talents and improves the overall level of science and technology innovation in China. Therefore, based on the insights of the above discussion, it can be found that with the continuous improvement of HSRN and a significant increase in entrepreneurial activities, the benefits gained therein by government departments and enterprises will also show geometric growth, and the enhancement effects will become increasingly discernible. With the improvement of HSRN development level and entrepreneurial activity, it may also have a nonlinear effect on the promotion of high-quality economic development by the development level of HSRN. Therefore, this paper intends to verify the nonlinear characteristics of the impact of HSR through the threshold model.

This aligns with Metcalfe's law, which is observed in the context of the high-quality progression of urban economies. Consequently, the following hypothesis is formulated based on the aforementioned discussion:

Research Hypothesis 2: The influence of HSRN on high-quality economic development exhibits a nonlinear characteristic, characterized by an intensifying marginal impact.

## 2.3. The Spatial Spillover Effect of HSRN on High-Quality Development

Sheng and Yu (2021) suggest that "complex system management" emerges as a novel domain within the management sciences, arising from the integration of

complex systems theory and management principles, grounded on complex systems thinking and paradigms. The conceptual framework of complex system management posits that within intricate systems, the dynamic interactions and influences among diverse components are in a state of perpetual evolution, leading to a high degree of interconnectivity, mutual influence, and reciprocal interaction between the elements within the system. And in many cases, the elements of a problem are interconnected through intricate, explicit or implicit associations, thereby making a cohesive whole. As an important part of China's modern infrastructure, HSRN has a significant spatial spillover effect on promoting high-quality development as mentioned above. The construction and operation of HSRN have optimized interregional transport conditions, significantly shortened the spatial and temporal distance between cities and promoted the efficient flow of production elements (Du et al., 2020). This not only enhances the integration capacity of China's industrial chains, but also promotes the optimization and upgrading of industrial structure. The rapid development of HSRN has spurred the vigorous economic growth of cities along the railway lines (Xuan et al., 2019). In the areas where HSR connects to a network, it compresses space and time and promotes cooperation or communication among cities (Shi, 2018). The industrial agglomeration effect and regional coordinated development effect along the HSRN have gradually emerged, providing a strong driving force for economic growth. At the same time, the convenient travel mode of HSR has attracted a large number of passengers, promoted the development of high-value-added industries such as tourism and modern service industries, and injected new vitality into economic growth. In addition, the spatial spillover effect of HSRN on high-quality development is also reflected in improving people's livelihood, promoting urban-rural integration and contributing to poverty alleviation. The popularization of HSR has reduced people's travel costs, improved travel efficiency, and made it more convenient for urban and rural residents to enjoy high-quality urban resources. Concurrently, the accessibility provided by HSR services facilitates the migration of rural labor to urban areas, fostering the harmonized growth of the urban-rural economy and establishing a robust foundation for comprehensively constructing a modern socialist nation. Therefore, it is proved that the impact of HSR shows evolutionary characteristics. This paper intends to test the evolutionary characteristics of HSR through spillover effect. Therefore, based on the above analysis, this paper makes the following hypotheses:

Research Hypothesis 3: The HSRN can affect the economic development quality of neighboring areas through spatial spillover effect.

### **3. Research Design**

#### **3.1 Model Construction**

In order to test the above hypotheses, the following basic model of the direct transmission mechanism is first constructed:

$$Hqd_{i,t} = \alpha_0 + \alpha_1 Hsr_{i,t} + \alpha_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{1}$$

In Formula (1),  $Hqd_{i,t}$  represents the level of high-quality economic development of city  $i$  in period  $t$ ,  $Hsr_{i,t}$  is the HSR construction of city  $i$  in period  $t$ , vector  $Z_{i,t}$  represents the control variable,  $\mu_i$  represents the individual fixed effect of city  $i$  that does not change with time,  $\delta_t$  is the control time fixed effect, and  $\varepsilon_{i,t}$  represents the random disturbance term.

In addition to the direct effect reflected in Formula (1), in order to analyze the possible action mechanism of HSRN on high-quality economic development, combined with the previous analysis, this paper tests whether entrepreneurial activity will play a mediating effect between the two. The specific steps in the testing process are as follows: On the basis of testing the significance of coefficient  $\alpha_1$  of the linear regression Model (1) of HSRN construction index  $Hsr$  for high-quality development  $Hqd$ , the linear regression equations of  $Hsr$  for mediator variable entrepreneurial activity  $Entrep$  and of  $Hsr$  and mediator variable  $Entrep$  for  $Hqd$  are constructed respectively, and the mediating effect is analyzed by analyzing the significance of regression coefficients  $\beta_1$ 、 $\gamma_1$ 、 $\gamma_2$  and so on. The specific representation of the following regression model is as follows:

$$Entrep_{i,t} = \beta_0 + \beta_1 Hsr_{i,t} + \beta_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{2}$$

$$Hqd_{i,t} = \gamma_0 + \gamma_1 Hsr_{i,t} + \gamma_2 Entrep_{i,t} + \gamma_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{3}$$

In the process of empirically testing the indirect transmission mechanism, in addition to the mediating effect model, it is also necessary to comprehensively consider the Metcalfe’s law that exists in the HSRN itself: the value of HSR shows a square proportional relationship with the number of train trips. Moreover, as the development of HSRN and entrepreneurial activities progress, there could be an indirect impact on the nonlinear and dynamic spillover effects deriving from the HSRN’s advancement, which promotes high-quality economic development. In light of the aforementioned analysis, the subsequent panel threshold model is established:

$$Hqd_{i,t} = \varphi_0 + \varphi_1 Hsr_{i,t} \times I(Adj_{i,t} \leq \theta) + \varphi_2 Hsr_{i,t} \times I(Adj_{i,t} > \theta) + \varphi_c Z_{i,t} + \mu_i + \varepsilon_{i,t} \tag{4}$$

In the above formula,  $Adj_{i,t}$  represents threshold variables such as HSR and entrepreneurial activity, and  $I(\cdot)$  is an indicator function with a value of 1 or 0. If the conditions are met, the value is 1; if not, the value is 0.

Conclusively, to examine the spatial spillover impact of HSR on high-quality development, a spatial panel econometric model is derived, incorporating the spatial interaction terms for both and additional pertinent control variables into Equation (1):

$$Hqd_{i,t} = \alpha_0 + \rho WHqd_{i,t} + \phi_1 WHsr_{i,t} + \alpha_1 Hsr_{i,t} + \phi_c WZ_{i,t} + \alpha_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{5}$$

In Formula (5),  $\rho$  stands for the spatial autoregressive variable, and  $W$  stands for the spatial weight matrix. Where  $\phi_1$  and  $\phi_c$  represent the elasticity coefficients

of spatial interaction terms between core explanatory variables and control variables. In Formula (5), the spatial interaction term between the explained variable and the explanatory variable is included, which is called the spatial Durbin model (SDM).

### 3.2. Variable Measurement and Description

#### 1) Measurement of the level of high-quality economic development

The level of high-quality economic development denotes a model of progress that, on the ground of economic growth, enhances economic, social, and ecological benefits, optimizes the economic structure, boosts innovation capacities, and fosters harmonious coexistence between human beings and nature in order to pursue sustainable development. During the phase of high-quality economic advancement, the economic growth rate is moderate, with a heightened focus on quality, efficiency, and equity. Emphasis is placed on green growth, innovative progress, coordinated advancement, and inclusive development. Throughout the analytical process, this study establishes a multi-dimensional evaluation framework comprising five secondary indicators, encompassing aspects such as industrial composition and inclusive Total Factor Productivity (TFP). This system is employed to gauge the quality of economic development across 293 cities over the period spanning from 2005 to 2021. The derived measurement is represented as *Hqd*.

a) Industrial Restructuring: The adjustment of industrial structures helps to optimize resource allocation and improve production efficiency. In the context of the ongoing scientific and technological revolution and the global transformation in industrial paradigms, economies have sought to adjust and upgrade their industrial structures to achieve high-quality economic progression. The Chinese government has initiated the strategy of supply-side structural reform, targeting the transition of industrial structure from the lower end to the middle and higher end by reducing excess capacity, depleting inventories, decreasing leverage, lowering costs, and bolstering weak sectors. Emerging sectors serve as pivotal drivers of economic growth, with continuous breakthroughs in scientific and technological innovation propelling the emergence of new industries that inject fresh momentum into economic development. For instance, cutting-edge technology sectors like artificial intelligence, big data, and cloud computing have seen widespread adoption and growth globally, exerting a positive influence on economic development. Elevating the level of industrial chain contributes to the augmentation of an economy's value-added and competitive edge. High-quality economic development can be realized through reinforcing collaborative innovation across the industrial chain's upstream and downstream segments and advancing the chain towards the high-end spectrum. The Chinese government has introduced an industrial chain upgrading strategy, which is geared towards strengthening the weaker links of the chain and propelling it towards the apex of the value chain. Industrial restructuring aids in fostering the harmonious development of regional

economy. By optimizing the industrial layout and promoting the rational circulation and optimal allocation of resources and factors, the aim is to narrow the developmental disparity among regions and achieve nationwide high-quality economic growth. The Chinese government has proposed regional development strategies, such as the integrated development of the Beijing-Tianjin-Hebei region and the advancement of the Yangtze River Economic Belt, with the objective of promoting the balanced development of the regional economy.

b) Total Factor Productivity (TFP) Inclusivity: Inclusive TFP refers to the comprehensive efficiency of production factors, including technological progress, human capital, and capital stock, within a country or region's economic growth trajectory over a specific timeframe. An increase in inclusive TFP signifies an improvement in the allocative efficiency of production factors, leading to reduced production costs for enterprises and an uptick in production efficiency. During the phase of high-quality economic development, boosting production efficiency is pivotal for achieving the quality and benefits of economic growth. Increases in inclusive TFP are typically accompanied by technological progress, which serves as the central catalyst for high-quality economic development. Innovation in technology fosters the upgrading of industrial structures, optimizes resource allocation, and sustains momentum for economic growth. The increase of inclusive TFP implies the optimized utilization of human capital, which is beneficial for enhancing the quality of the workforce and the income levels of employees. High-caliber human capital is a cornerstone of high-quality economic development and contributes to the inclusiveness and equity of economic growth. The betterment of inclusive TFP facilitates the optimized allocation of capital, ensuring that a greater proportion of capital is directed towards high-efficiency and high-value-added industries and sectors. This redirection of capital is instrumental in achieving industrial restructuring and in driving the transformation of the economic growth model, thereby promoting high-quality economic development.

c) Technological Innovation. In the current era, the rapid development of new technologies and theories, such as artificial intelligence (AI), big data, cloud computing and the Internet of Things, has provided new drivers for high-quality economic development. Advanced technologies such as AI can be applied to various industries to improve production efficiency and reduce costs. Through automation, intelligent production lines and other means, the manufacturing industry can be upgraded and transformed to improve product quality and meet consumer demand. The emergence of new technologies promotes the continuous optimization of industrial structure, promotes the upgrading of traditional industries, and cultivates emerging industries. Taking artificial intelligence as an example, its deep integration with all walks of life brings digital and intelligent transformation to traditional industries, thus improving the competitiveness of the whole industrial chain. Technological innovation has given rise to many new business models, such as sharing economy and platform economy, which have provided strong support for economic development. At the same time, enterprises can use new

technological means to achieve personalized customization, precision marketing and other strategies to improve market competitiveness. The construction of new technology infrastructure can help achieve coordinated development among regions and improve the efficiency of resource allocation. For example, HSR, 5G communication and other infrastructures have reduced the spatial and temporal distance between regions, promoted the layout optimization of industrial chains, and promoted the coordinated development of regional economies. In the process of analysis, this paper chooses the city-level innovation index in the Report on China's Urban and Industrial Innovation as the third-level indicator of the innovation level dimension. In this report, considering that the number of valid invention patents per year varies by age, the innovation index is finally obtained by estimating the average value of patents of different ages and weighing them according to different cities.

d) Ecological Environment. The ecological environment provides abundant natural resources for economic development, such as water, land and minerals. A good ecological environment helps to improve the efficiency of resource utilization and ensure sustainable economic development. Regions with good ecological environments tend to have higher productivity and innovation capacity. Environmental conditions such as clean water, air and soil help enterprises reduce production costs and improve the quality of products and services, thus promoting high-quality economic development. As living standards ascend, an increasing number of individuals are concerned about the ecological environment and have a higher demand for eco-friendly, low-carbon, and sustainable products and services. A pristine ecological environment aligns with the populace's aspirations for an enhanced quality of life, thereby underpinning the advancement of high-quality economic development. Environmental challenges impel enterprises and research institutions to intensify their efforts in technological innovation, culminating in the development of more eco-efficient production technologies and solutions. Such innovation serves as a critical driving force for high-quality economic progress. For the purposes of this research, the volume of sulfur dioxide emissions abated, as reported in the annual statistical yearbooks of various cities, was employed as the key indicator.

e) The Improvement of Residents' Living Standards: As the living standards of the populace rise, consumer preferences are transitioning from fulfilling fundamental survival needs to the pursuit of quality and enjoyment. This shift has incentivized enterprises to escalate their innovation efforts and offer superior products and services, thereby facilitating the upgrading of economic structure. Improved living standards among residents signify a quest for superior life quality, necessitating the transformation and upgrading of industrial structures. During this process, emerging and high-tech sectors will experience rapid growth, propelling the enhancement of the quality and efficiency of economic growth. Concurrently, as living standards improve, so do the educational attainment and skill levels of residents, accelerating the accumulation of human capital. High-caliber

human capital boosts labor productivity, generates more value for enterprises, and fosters high-quality economic development. The elevation of living standards indicates that innovation has emerged as a pivotal driver of economic progress. In this context, both enterprises and individuals are likely to place more emphasis on innovation and invention, thereby enhancing overall innovative capacity and providing a sustained impetus for economic development. Within the scope of this study, per capita GDP, per capita expenditure on education, and the number of hospital beds per capita are adopted as the three metrics under the dimension of residents' living standards, and are integrated into the high-quality economic development framework. The population base for these indicators is the urban resident population.

## **2) Measurement of high-speed railway network**

The study of HSRN's development level has consistently been a pivotal focus within the realm of China's transportation planning and advancement strategies. Previous studies often employed a dummy variable approach to indicate the initiation of HSR services. Nonetheless, this representation method possesses inherent limitations and fails to fully reflect the real development status of HSRN. In order to more accurately and comprehensively measure the development level of HSRN in urban agglomerations, this study innovatively incorporates the concept of centrality from social network analysis, referred to as the relative degree of centrality, to represent the HSRN development level. Relative degree centrality, as an index to measure the status and influence of nodes in the network, can well reflect the relative importance of each urban agglomeration in the HSRN. Compared with absolute degree centrality, relative degree centrality is more applicable to different scales of HSRN, which can ensure that each node has comparability in different scale networks. This means that in the analysis of HSRN development level, the relative degree centrality is able to provide more objective and fairer basis. The spatial structure of HSRN can be divided into three types: R, L and P. The R space takes trains as nodes, the L space takes stations as nodes, and the P space takes stations at both ends of the line as nodes. The three types of space reveal the characteristics of HSRN from different perspectives respectively, providing a rich point of view for studying the development level of HSRN. For example, the R space can reflect the operation status of HSR lines, the L space can reflect the distribution of HSR stations, while the P space can help to analyze the impact of stations at both ends of HSR lines on the whole network. By conducting an in-depth analysis of HSRN's development status, this paper aims to gain a nuanced understanding of the current situation of China's HSRN. The findings are intended to offer valuable insights for future HSR planning and development strategies. In addition, this research method can also be applied to the study of other transportation networks, providing a scientific basis for the development of China's transportation industry. In conclusion, the method of relative degree centrality and social network analysis proposed in this paper provides a new method and idea for studying the development level of HSRN, which is expected to make a greater

contribution to the development of HSR in China.

This paper mainly measures the connection of HSRN between cities in China through stations at both ends of the P-space lines. In urban clusters, each city is not only connected through HSR to other cities within the urban cluster, but also to the cities outside the urban cluster. Therefore, when evaluating the strength of HSRN connection, a HSRN connection matrix containing 293 prefecture-level cities is constructed. The specific research methods are as follows: first, a 293\*293 HSRN connection matrix with the number of prefecture-level cities as the dimension is constructed. If a HSR line is opened between two cities in year  $t$ , the corresponding element in the matrix is set to 1, otherwise, it is set to 0. Then, with the application of social network analysis software, the relative degree of centrality in social network analysis method is used to measure the connection strength of HSRN in urban agglomerations. Relative degree centrality is an indicator that describes the degree of connection between a node city and other cities in the network. In the HSRN, if the relative degree of centrality of a city is larger, it indicates that the city has extensive HSR connections and is in stronger HSRN connection with other cities. The formula for calculating the relative degree of centrality is as follows. This paper, through this method, has carried out a detailed analysis and research on the HSRN connection between cities in China. By measuring the connection strength of HSRN, we can better understand the status and role of each city in the HSRN, and provide data support for the planning and optimization of HSRN in the future. In addition, this research can also benefit the coordinated development of China's urban agglomerations, and promote the balanced development of regional economy.

$$Hsr_{i,t} = \sum_{i=1}^n K_{i,t} / D_t \quad (6)$$

In Formula (6),  $Hsr_{i,t}$  is the relative degree centrality of city  $i$  in year  $t$ . This paper uses the percentage of relative degree centrality for empirical analysis;  $K_{i,t}$  is the number of node cities connected to other cities in city  $i$  in year  $t$ , and  $D_t$  is the maximum possible degree of network points in year  $t$ . The larger the  $Hsr_{i,t}$  value is, the higher the development level of HSRN in this city is, and the stronger the initiative and influence are.

### 3) Measurement of entrepreneurial activity

In the process of analysis, this paper draws on the research method provided by Ye et al. (2018), and obtains the number of newly established private enterprises at the city level from the Qixin database, which takes the National Enterprise Credit Information Disclosure System as the main data source.

### 4) Control variables

In the process of analysis, in order to better analyze the spillover effect of HSR construction in the course of high-quality development of urban economy, control variables that may have an impact on the high-quality development of the economy should also be set. It mainly includes the following aspects:

- a) Fiscal decentralization degree (*Finadp*): Degree of fiscal decentralization

refers to the degree of division and coordination of fiscal affairs among governments. The measurement of fiscal decentralization can be approached by examining the dimensions of fiscal revenues and expenditures among all levels of government. Typically, the higher the degree of fiscal decentralization, the greater the financial autonomy between the different levels of government, which is conducive to stimulating the enthusiasm of local governments and promoting economic development. However, an excessively high degree of fiscal decentralization may lead to intensified local fiscal competition, unbalanced development among regions, and even fiscal risks, as indicated by the ratio of budgetary revenue to budgetary expenditure.

b) Economic development level (*lnGDP*): Level of economic development refers to the development degree of a country or region in economy, science and technology, society, culture and other aspects in a certain period of time. Generally, a country or region with a high level of economic development has a high production capacity, living standard, scientific and technological innovation capability and international competitiveness. In this study, GDP per capita is used to control the possible nonlinear effect of economic development level.

c) Foreign investment (*FDI*): International investment encompasses the investing and development activities of foreign enterprises and investors within China, such as the establishment of new enterprises, mergers and acquisitions, capital infusions, and the reinvestment of profits. The contribution of foreign investment is substantial in spurring China's economic progress, broadening employment opportunities, enhancing technological capabilities, and increasing tax revenue. In this study, the significance of foreign investment is quantified as the ratio of the actual utilized foreign investment to the gross domestic product (GDP) of the corresponding year.

d) Urbanization level (*Urban*): The urbanization level denotes the extent to which a nation or region has advanced in its urbanization journey, commonly assessed through indicators such as the percentage of the population residing in urban areas and the urbanization percentage. The level of urbanization reflects the economic development, social progress, infrastructure construction, population mobility and other aspects of a country or region. In this paper, it is expressed by the logarithm of population density

e) Financial development level (*Finance*): Financial development level refers to the degree of development of a country or region in terms of financial system, financial market and financial services. The level of financial development significantly influences a country or region's economic expansion, social progress, risk management capacities and other aspects. Within this study, the level of financial development is represented by the ratio of institutional deposit and loan balances to the regional Gross Domestic Product (GDP).

### 3.3. Data Sources and Descriptive Statistics

In the process of analysis, a total of 293 cities at the prefecture level and above in

China from 2005 to 2021 were studied. All the data used in this study, except for the number of start-ups and innovation index, come from the China City Statistical Yearbook, statistical annual reports of some prefecture-level cities and the Wind Consulting Database. **Table 1** shows the descriptive statistical results of the variables analyzed. Combining the data in the table, it can be found that the mean value of *Hqd* is 2.267, the maximum value is 5.231, the minimum value is 0.002, and the standard deviation is 0.326. The quality of economic development varies greatly among different regions. The same characteristic is also seen from the perspective of HSRN level and entrepreneurial activity.

**Table 1.** Descriptive statistical results of variables.

	Variables of interest	Number of observations	Mean	Standard deviation	Minimum	Maximum
Explained variable	<i>Hqd</i>	5070	2.267	0.326	0.002	5.231
Explanatory variables	<i>HSR</i>	5070	5.498	0.326	0.022	10.959
Mediating variable	<i>Entrep</i>	5070	2.496	1.446	0.010	5.111
	<i>Finadp</i>	5070	0.496	0.285	0.0002	0.99998
	lnGDP	5070	16.222	1.087	12.604	19.884
Control variables	<i>FDI</i>	5070	6.010	3.250	0.004	11.998
	<i>Urban</i>	5070	4.964	2.657	0.00023	9.99989
	<i>Finance</i>	5070	8.9889	4.935	0.008	17.997

## 4. Empirical Test of High-Speed Rail Network on High-Quality Development

### 4.1. Benchmark Regression Results

The linear regression results of HSRN on the high-quality development are given in **Table 2**. Combined with the regression analysis results of Model (1), it can be found that HSRN has a positive impact on the high-quality development of regional economy. And combined with the regression analysis results of Model (2), it can be seen that after adding the control variable to Model (2), although there is a positive correlation between the development level of each regional economy and the high-quality economic development, the relationship between the two is not significant, which indicates that with the increase of economic aggregate, the high-quality development of regional economy is not reasonably improved. From the actual situation of foreign investment (FDI) index, the coefficient value is negative and there is no significant relationship, indicating that foreign investment does not significantly improve the high-quality economic development of the region. As for the two indicators of fiscal decentralization and urbanization level, they also fail to pass the significance test at the level of 10%, and the correlation coefficient between urbanization level and regional high-quality economic

development is negative, which also proves that although the urban scale continues to expand, it is not conducive to the regional high-quality economic development.

**Table 2.** Benchmark regression results of the impact of HSRN on high-quality development.

Variables	<i>Hqd</i>	
	(1)	(2)
<i>HSR</i>	0.112** (0.0385)	0.135** (0.0611)
<i>lnGDP</i>		0.01211 (0.121)
<i>FDI</i>		-2.1223 (1.335)
<i>Finadp</i>		-0.112 (0.215)
<i>Finance</i>		0.151*** (0.0311)
<i>Urban</i>		-0.211 (0.633)
Constant term	0.151** (0.0333)	0.811 (3.152)
$R^2$	0.212	0.352

In the theoretical analysis, the transmission mechanism of the impact of entrepreneurial activity on high-quality economic development has been studied. In order to verify the hypothesis of the mechanism, this paper uses the mediating effect model to conduct an empirical analysis, and the regression results are shown in **Table 3**. Combined with the data results in the table, it can be found that Model (3) verifies that HSRN will play a positive role in promoting high-quality economic development. Similarly, it can be found from the verification results of Model (4) that with the continuous expansion of HSRN index, the entrepreneurial activity of the region will be further improved, and the regression coefficients of the two models are all positive and present a significant correlation at the level of 1%. On this basis, the mediating variable of entrepreneurial activity is introduced into the regression equation. From the coefficient changes, the coefficient of Model (5) is lower than that of Model (3), which also shows that entrepreneurial activity will have a mediating effect in the process of HSRN affecting the high-quality development of regional economy. Therefore, Hypothesis 2 proposed in this paper is established.

**Table 3.** Test results of the impact mechanism of HSRN on the high-quality development of regional economy.

Variables	<i>Hqd</i> (3)	<i>Entrep</i> (4)	<i>Hqd</i> (5)
<i>HSR</i>	0.129** (0.0311)	0.689** (0.113)	0.0795 (0.0392)
<i>Entrep</i>			0.0589** (0.0109)
$R^2$	0.311	0.452	0.136

### 4.2. Nonlinear Effect Analysis

Combined with the theoretical analysis results, it can be found that there is a “marginal effect” of HSRN on the high-quality development of regional economy. Therefore, in the process of analysis, it is also tested whether there is a nonlinear spillover effect of HSRN on the high-quality development of regional economy. With reference to the existing research literature and utilization of the bootstrap method for repeated sampling for 1000 times, the results show that the threshold variable of HSRN index passes the single threshold, but does not pass the double threshold and triple threshold test, but the entrepreneurial activity does pass the double threshold test. Therefore, on the basis of the above analysis, the regression model of the corresponding threshold number is set, and the regression results are shown in **Table 4**.

**Table 4.** Regression results of the threshold model of HSRN influencing high-quality economic development.

Variables		Moderating variables	
		3.2.6 HSR	(7) Entrep
Threshold value	q <sub>1</sub>	-1.128	0.725
	q <sub>2</sub>		2.158
Dige-I (Th ≤ q <sub>1</sub> )		0.112* (0.0392)	0.108 (0.0311)
Dige-I (q <sub>1</sub> < Th < q <sub>2</sub> )		0.286** (0.0387)	0.269** (0.109)
Dige-I (Th ≥ q <sub>2</sub> )			0.312** (0.0412)
R <sup>2</sup>		0.318	0.255

Integrating the findings from Model (6), we observe that as the value of HSRN index escalates, the spillover effects on high-quality development exhibit a nonlinear pattern characterized by a significantly positive and incrementally stronger “marginal effect.” In contrast, the statistical outcomes from Model (7) reveal that the promoting impact of HSRN on urban high-quality development trends towards continuous intensification, with the network’s positive and ascending “marginal effects” maintaining their nonlinear characteristics. Therefore, in light of these data analyses, it becomes evident that the impact of HSRN on regional economic development will not only be affected by its own aggregate level, but also exert a moderating influence on entrepreneurial activities. Overall, a robust and favorable correlation exists between HSR and urban entrepreneurial activity, thereby substantiating Hypothesis 1.

### 4.3. Spatial Spillover Effect Analysis

Before the spatial econometric analysis of the above data, it should be analyzed whether there is a spatial effect in the studied objects, that is to say, we need to test

the spatial autocorrelation between the HSRN index and the high-quality development index. In this paper, Moran's I index method is used to calculate the spatial effect of different years under the geographical example matrix, and the results are shown in **Table 5**. Combined with the data obtained in **Table 5**, it can be found that the Moran' I index of HSRN index and high-quality development index from 2005 to 2021 under the weight of geographical distance all meet the significance level of 1%. This also proves that there is a significant spatial autocorrelation between the HSRN index and the high-quality economic development in different cities in China from 2005 to 2021, that is to say, there is a clustering phenomenon between the two indexes from the perspective of spatial distribution.

**Table 5.** Sprawl characteristics of urban economy and high-quality development from 2005 to 2021.

Year	HSR		Hqd	
	HSR	Z value	Moran' I	Z-score
2005	0.722**	16.987	0.321*	7.211
2006	0.711**	16.111	0.356*	7.359
2007	0.689**	15.897	0.389*	7.456
2008	0.589**	15.569	0.411*	7.698
2009	0.632**	15.489	0.421**	8.115
2010	0.698**	15.211	0.432**	8.369
2011	0.735**	15.058	0.458*	8.841
2012	0.658*	14.948	0.469*	8.918
2013	0.611**	14.911	0.511**	9.129
2014	0.658*	14.288	0.569**	9.238
2015	0.633**	14.111	0.597*	9.356
2016	0.621*	13.987	0.611**	9.841
2017	0.619	13.759	0.623**	10.251
2018	0.659*	13.658	0.635*	11.236
2019	0.658*	13.547	0.692*	12.512
2020	0.599*	13.289	0.711*	13.589
2021	0.611*	13.215	0.721**	14.699

Subsequently, the spatial regression models of HSRN index and high-quality development under different spatial weight matrices were calculated; the results are shown in **Table 6**. Prior to this, following the test approach proposed by **Elhorst (2014)**, the combined methods of LM test, fixed effect of SDM model, Hausman test and simplified test of SDM model are carried out successively, which constitute the "specific to general" and "general to specific" combination method. Eventually, the SDM model with spatial-temporal double fixed effects is determined

as the most reasonable choice. In order to analyze the robustness of the model, this paper also calculates the results of the spatial lag model with spatial-temporal double fixed effects. Combined with the results in **Table 6**, it can be found that the spatial autoregressive coefficient of high-quality development in the SDM model is significantly positive, while the coefficient of the spatial interaction term of HSRN index is positive, which also indicates that in the sample, there is not only the exogenous interaction effect of HSRN, but also the endogenous interaction effect of high-quality development at the spatial level. Hence, HSRN can influence the quality of economic development in adjacent regions via spatial spillover effects, thereby substantiating Hypothesis 3.

**Table 6.** HSRN impacts high-quality development space model of the regression results.

Model Setting Spatial Matrix Type Variables	SAR			SDM		
	Geographic Distance (8)	Economic Distance (9)	Adjacency Matrix (10)	Geographic Distance (11)	Economic Distance (12)	Adjacency Matrix (13)
P	0.311** (0.0351)	0.258** (0.0368)	0.289** (0.0211)	0.359* (0.0398)	0.269** (0.0599)	0.311* (0.0010)
<i>HSR</i>	0.209* (0.0299)	0.215* (0.0411)	0.0891* (0.0499)	0.135** (0.0659)	0.159* (0.0488)	0.256* (0.0311)
$W \times HSR$				0.0589 (0.089)	0.0382 (0.091)	0.0789** (0.0148)
Direct Effect	0.211** (0.0411)	0.236* (0.0399)	0.198** (0.0598)	0.205* (0.0609)	0.201* (0.0611)	0.232* (0.0721)
Spillover Effect	0.0789** (0.0118)	0.0841 (0.0201)	0.0911 (0.0315)	0.119 (0.0781)	0.159 (0.0152)	0.0898 (0.158)
Total Effect	0.290* (0.0511)	0.320** (0.0508)	0.290* (0.0625)	0.324** (0.0781)	0.360* (0.0874)	0.322* (0.214)
LogL	-588.235	-689.247	-988.311	-685.218	-678.211	-998.258
R <sup>2</sup>	0.115	0.135	0.108	0.129	0.152	0.0899

## 5. Conclusion and Suggestions

### 5.1. Conclusion

With the continuous advancement of globalization and technological innovation, HSRN, as an important part of the modern transportation system, plays an increasingly significant role in promoting regional economic integration, improving urban accessibility and promoting social and economic development. The construction and improvement of HSRN not only greatly shorten the physical distance between cities, but also accelerate the flow of information, capital and talent resources, which in turn has a far-reaching influence on entrepreneurial activities. Entrepreneurial activity is a key indicator of a region's economic vitality and development potential, reflecting the frequency of new business formation and the prevalence of entrepreneurial activities in the region. Entrepreneurship can not

only create jobs, but also promote technology innovation and industry upgrading, which is of great significance for achieving high-quality development. However, although existing studies have explored the impact of transport infrastructure on economic growth, especially the positive effect of HSRN on regional economic development, there is still relatively limited research on how HSRN affects entrepreneurial activity and how this impact further affects regional high-quality development. In view of this, this study aims to fill this research gap and delve into the correlations amongst HSRN, entrepreneurial activity and high-quality development. The current study draws upon data from 293 Chinese prefecture-level cities spanning the years from 2005 to 2021. Utilizing the indices for HSRN development and high-quality economic development, the research employs a suite of analytical models, including the panel fixed effects model, threshold model, spatial model, and mediating effects model, to empirically investigate the influence of the HSRN on fostering high-quality economic development, as well as to explore the underlying mechanisms from multiple perspectives. The main conclusion is as follows: firstly, the study finds that the construction of HSRN provides convenience for entrepreneurial activities, including improving regional transportation linkage, shortening travel time, reducing logistics costs and promoting information exchange. These factors work together to stimulate entrepreneurship spirit and innovation vigor, thereby promoting the high-quality development of economy. Therefore, it can be confirmed that the construction of HSRN has a positive impact on enhancing entrepreneurial activity. Secondly, through the statistical analysis of relevant data, the results show that in the early stages of the construction of HSRN, its effect on the promotion of economic development quality is relatively less evident. However, with the continuous expansion and improvement of HSRN coverage, its marginal contribution to high-quality economic development gradually increases, presenting an incremental nonlinear characteristic. This implies that the continuous investment and optimization of HSRN are crucial to achieving long-term, high-quality economic development. Thirdly, the study reveals that HSRN not only has a positive impact on the economic development of the region, but also has a significant spatial spillover effect on the surrounding areas by promoting inter-regional talent flow, knowledge dissemination and capital allocation. These spatial spillover effects help to form the coordination effect of regional economic development and promote high-quality economic development in the whole region and even at the national level.

## 5.2. Suggestions

### 1) Increasing the construction of HSR

As an important part of China's modern transportation system, the HSR is of great significance in enhancing the comprehensive national strength, promoting economic development, and improving people's livelihoods. Therefore, the government should increase the capital investment in HSR projects, especially in the early stages of infrastructure construction, in order to ensure the smooth progress

of projects. The government should assume the main responsibility for HSR projects. As the defender of public interest and the provider of public services, it is imperative for the government to play a leading role in guaranteeing the seamless advancement of HSR initiatives. Increasing capital investment for HSR projects is beneficial in strengthening the cornerstone of national infrastructure construction and providing strong support for China's economic and social development. We will encourage private capital and foreign investment to participate in HSR construction. This study aims to fully mobilize the enthusiasm of diverse private investors and give full play to the decisive role of the market forces in resource allocation. The participation of private capital and foreign capital can not only share part of the government's investment pressure, but also provide more diversified financing channels for HSR construction and reduce project risks. The adoption of innovative financing mechanisms, such as the Public-Private Partnership (PPP) model, diversifies risks and improves the efficiency of capital use. The Public-Private Partnership (PPP) model, a fusion of governmental and private financing mechanisms, is designed to allow full play to the respective strengths of the government and the market, thereby achieving a synergy of complementary benefits. Adopting PPP and other innovative financing mechanisms can attract more social capital to participate in HSR construction and achieve efficient use of funds. Last but not least, supporting policies and safeguard measures should be strengthened. The government should provide a series of policy support for the project construction, including preferential tax, land use rights, loan subsidies, etc. At the same time, it should also strengthen the supervision in the process of project construction to ensure project quality and schedule, so as to provide a strong guarantee for smooth progress.

## 2) Optimizing network planning

In the process of planning and designing HSRN, various factors need to be considered comprehensively. It is necessary to pay full attention to the actual needs of regional economic development. This is because in the layout of HSRN, densely populated and economically active regions are the key nodes, and they play an important role in the operational efficiency and vitality of the whole network. Therefore, these regions should be prioritized for connection in the planning process to meet the current economic needs and developmental potential. Attention should be paid to the prediction and reservation of future development needs by the HSRN. With the steady economic growth and social progress in China, the demand for inter-regional transport will continue to rise. For this reason, in the process of planning HSRN, a certain amount of space should be reserved for expansion, leaving some room for adjusting to future changes. Such foresight and forward-looking thinking will help to ensure the sustainable development of HSRN. Attention should also be paid to the impact of HSRN on the geographical economic pattern. In the process of planning, it is necessary to fully study the development potential of various regions so that resources can be allocated in a rational manner. By connecting regions with potential development space, it is

possible to enhance inter-regional economic collaboration, thereby further advancing the high-quality development of China's economy. HSRN planning also needs to take into account the needs of society, the environment and people's livelihoods. In the process of planning and design, it is imperative to fully consider factors such as the regional ecological environment and cultural history of the regions along the railway lines, so as to ensure the construction and operation of HSRN can bring about positive impacts on the local society and people's livelihood. Simultaneously, this study emphasizes the role of HSRN in fostering the collaborative growth of other transportation modes, aiming to realize the synergistic benefits of diverse transit systems and enhance the overall efficiency of the transportation infrastructure. In the HSRN planning and design, various factors should be considered comprehensively to ensure that the plan is reasonable, scientific and forward-looking. By giving priorities to connecting densely populated and economically active regions, reserving space for expansion, paying attention to changes in the geographical economic pattern, and taking into account the social needs, the environment and people's livelihoods, it is expected that an efficient, green and sustainable HSRN will be constructed, which will make a greater contribution to the prosperity of China's economy.

### 3) Promoting regional coordinated development

The important role of HSRN in China's economic development is increasingly prominent, and its spatial spillover effect provides strong support for regional coordinated development. Taking advantage of the characteristics of HSRN, China can formulate a series of regional coordinated development strategies to break the geographical administrative barriers and promote inter-regional resource sharing and industrial cooperation. It is necessary to make full use of the convenience of HSRN to optimize the industrial layout and promote regional economic integration. The opening of HSRN has greatly shortened the distance between cities, facilitating the movement of enterprises and the flow of talent. Therefore, the opportunity can be taken to guide industries to cluster in regions along HSR lines and form the industrial cluster effects. Such an approach can not only elevate the economic development level of the regions along the lines, but also drive the common development of adjacent areas and achieve the coordinated development of the regional economy. Policy guidance and incentives serve as the key to promoting the formation of urban clusters and economic belts along the HSR lines. The government at the policy level can provide incentives for the regions along the lines, such as tax reduction and exemption, land policy support, etc., in order to attract enterprises and investors. In addition, support in infrastructure construction and talent introduction can also be provided to promote the economic vitality of regions along these lines. The coverage of HSRN can help to promote inter-regional resource sharing. Regions should leverage their unique strengths to engage in industrial collaboration, aiming for the efficient allocation of resources. For instance, the regions adjacent to HSR can engage in cooperative efforts within the industrial chain, facilitating industry complementarity, reducing business

expenses, and enhancing economic returns. Ultimately, the emergence of urban clusters and economic belts along the HSR lines can help to realize the integrated development of regional economy. Throughout this process, it is essential for all regions to enhance communication and collaboration, jointly formulate development strategies, and form development synergy. Additionally, emphasis on ecological environmental conservation is crucial to guarantee the sustainable development of regions along the HSR lines. Making use of the spatial spillover effects of HSRN, China can actively advance regional coordination and achieve economic integration. This endeavor should involve the full utilization of policy guidance and incentives, the reinforcement of inter-regional collaboration, the realization of resource optimization, and the promotion of sustainable, robust, and eco-friendly economic development along the HSRN. Through such a series of measures, China's regions along the HSR lines will become a new engine for economic development and contribute to the sustained prosperity of the national economy.

#### 4) Improving supporting measures

The strategic planning and construction of regions surrounding HSR terminals are pivotal in enhancing the city image, and attracting talent and enterprise investments. Therefore, it is necessary to create a high-quality environment around HSR stations based on the following aspects: a) building a convenient transportation network; Efficient and convenient transportation networks should be planned and constructed around HSR stations, including subway, bus, taxi and other modes of transportation. This can provide passengers with diversified travel options, shorten travel time, reduce travel costs, and further promote the agglomeration of people at HSR stations. b) Creating a good commercial, leisure and residential environment. The commercial, leisure and residential environment around HSR stations is crucial to attracting talent and enterprises. We should make full use of the human flow advantage of HSR stations and introduce high-quality commercial facilities, leisure and entertainment projects and residential areas to provide a comfortable and convenient living and working environment for residents and passengers. c) Strengthening the seamless connection between HSR stations and urban public transportation. In order to improve the travel experience of passengers, we need to strengthen the connection between HSR stations and urban public transport and achieve seamless transfer of various transportation modes. This includes measures such as optimizing the setting of bus routes, extending the operation hours and improving the transfer efficiency so that passengers can travel more conveniently. d) Improving the travelling experience of passengers. In addition to convenient transport and a good surrounding environment, we also need to pay attention to passengers' travel experience. This includes improving the service level of HSR stations, optimizing service facilities for passengers, and strengthening information publicity. Through these measures, we can provide passengers with a more comfortable and pleasant travel experience. e) Enhancing the integrated regional development of HSR terminals. The planning and construction around these stations must be undertaken in conjunction with the development of

adjacent regions, rather than in isolation. It is essential to bolster the coordinated advancement of HSR stations with their neighboring urban centers and industrial sectors, aiming for resource sharing and complementary advantages. This approach is intended to propel the economic progress of the whole region.

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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