Article

Effect of Planning and Construction of Intercity Railways on the Economic Development of the Pearl River Delta Urban Agglomeration: An Analysis Based on the Spatial Durbin Model

Yiming Deng [1,*], Xiumin Li [2] and Jianming Zhu [1]

1　School of Information, Central University of Finance and Economics, Beijing 100081, China; zjm@cufe.edu.cn
2　School of Economics, Guangdong University of Technology, Guangzhou 510520, China; xiumin.li@gdut.edu.cn
*　Correspondence: 2023212377@email.cufe.edu.cn

Abstract: Efficient transportation is essential for regional economic development. Currently, the Pearl River Delta urban agglomeration is accelerating the construction of intercity railways in the region to strengthen the links between cities. To provide a more detailed account, this study examined data spanning the years 2010–2021 across nine key cities in the Pearl River Delta. Employing a spatial Durbin model, we sought to uncover specific spatial patterns associated with intercity railways, particularly their pronounced impact on neighboring cities. Our quantitative findings, derived from the spatial Durbin model, revealed a statistically significant positive contribution of intercity railways to overall regional development. Contrary to initial concerns, the results indicate that intercity railways contribute significantly without exacerbating existing imbalances. However, according to the decomposition analysis of effects, most coefficients of the explanatory variables with a direct effect were found to be positive and significant, indicating their positive impact, while those with an indirect effect were found to be nonsignificant, suggesting that the effect of planning and construction of intercity railways on the economic development of the Pearl River Delta urban agglomeration is currently at a stage of factor concentration. In conclusion, our study emphasizes the need for prioritizing regional connections in intercity railway construction. This strategy can facilitate production factor flow and foster the proactive development of transportation infrastructure, thereby ensuring a balanced and sustainable regional economic growth trajectory.

Keywords: intercity railways; spatial spillover effects; spatial Durbin model

1. Introduction

The nexus between transportation infrastructure and the national economy has perennially captured the attention of economists. Alfred Weber (1909), a distinguished German economic geographer, asserted in his seminal work, Über den Standort der Industrie (Theory of Industrial Location), that transportation costs stand as a pivotal determinant of decisions affecting the location of industries. Weber contended that the state of regional transportation infrastructure directly shapes transportation costs, thereby exerting a profound impact on the spatial configuration of regional economies [1].

Building on Weber's insights, Hoover (1948), an eminent American economist, hinted in his publication, The Location of Economic Activity, that the nature of a transportation infrastructure system profoundly impacts businesses' location choices through its implications for transportation costs [2]. This perspective has laid the theoretical groundwork for the evolution of transport hubs.

Following these foundational location theories, researchers have explored the intricate relationship between transportation and economic development. This research can be categorized into two primary facets. First, there is the aspect of transportation links with the outside world. Opening transportation routes enhances accessibility and efficiency,

thus fostering connections between local regions and world markets more broadly. This integration benefits peripheral areas by linking them with markets in central regions and amplifies the reach of economic centers toward the periphery. This, in turn, significantly affects regional economic development [3–5].

The second facet revolves around transportation routes and the flow of production factors. The opening of transportation routes diminishes barriers to the flow of production factors, diversifying their movement and enhancing the spatial allocation efficiency of regional factors. Consequently, this augments the total factor productivity and propels regional economic development [6–8].

As our understanding of transportation infrastructure continues to evolve, researchers increasingly acknowledge the nuanced indirect spillover effects of its construction on the national economy and on industries. A critical consideration emerges—if research models neglect spatial spillover effects, the estimated results may inadvertently exaggerate the driving role that transportation infrastructure plays in regional economic development [9]. Researchers, recognizing this complexity, have employed spatial econometrics and other methodologies to reveal the substantial impact of spatial spillover effects on regional economic development.

Specifically, the introduction of high-speed railways exerts a noteworthy effect on secondary and tertiary industries located along nearby railway lines. Notably, the external spillover effects of high-speed railways emerge as a pivotal factor affecting industrial upgrading [10–12]. Several studies have uncovered the fact that transportation infrastructure can have negative spatial spillover effects. Owing to agglomeration effects, improved transportation conditions prompt the migration of factors from economically underdeveloped areas to more developed areas, thus intensifying factor concentration in prosperous regions and enhancing their economic environment. Simultaneously, factors continue to flow out of less developed areas, thereby constraining their economic progress. In this scenario, the economic growth of one area may inadvertently contribute to the economic decline in other areas within the same geographic region [13]. This intricate interplay underscores the need for a comprehensive understanding of the spatial dynamics engendered by transportation infrastructure.

It is evident that the existing body of literature has extensively explored the mechanisms by which transportation infrastructure impacts economic development. However, there is a notable dearth of studies on intercity railways, with most researchers failing to differentiate between high-speed rail and urban rail [14]. In reality, high-speed rail and intercity rail exhibit significant differences in terms of both organization and operation. Without this critical distinction, accurately assessing the economic utility of intercity railways for urban cluster development becomes challenging.

Moreover, intercity railways share network characteristics and display spatial spillover effects akin to other types of transportation infrastructure. However, the existing literature minimally addresses the spatial spillover effects of intercity railways. Furthermore, many studies have confined their scope to the provincial or city level, overlooking the spatial organizational form of urban clusters and exploring the impact of transportation infrastructure on urban cluster development to a lesser extent.

In response to these gaps in the literature, this study focuses on the unique context of the Pearl River Delta urban agglomeration, a region characterized by its dynamic economic activities and rapid urbanization. This study adopts an empirical analysis research method by utilizing intercity railway data for the period 2010–2021 and multiple indicators reflecting economic development to establish econometric models based on different spatial weight matrices so as to empirically analyze the impact and mechanisms of intercity railways on the economic development of the Pearl River Delta urban agglomeration.

Our decision to focus on the Pearl River Delta stems from its distinctive characteristics, positioning it as a potentially illustrative case for examining the interplay between intercity railways and economic development. The region's intricate city network, diverse economic activities, and ongoing intercity railway developments provide a rich context

for exploring nuanced dynamics. Additionally, the methodological choices made in this study, particularly the utilization of the spatial Durbin model, are justified by their effectiveness in capturing the spatial dynamics inherent in intercity railway impacts. This approach suits the distinctive features of the Pearl River Delta, ensuring a nuanced and context-specific analysis.

The main contributions of this paper can be delineated as follows: from a perspective standpoint, it focuses on analyzing how intercity railways reinforce the "siphoning effect" and "diffusion effect" of central areas on surrounding regions, becoming a "double-edged sword" for the economic development of relatively underdeveloped cities. By compressing the temporal distances within a region, intercity railways enhance regional connectivity, facilitate the flow of production factors, create broader markets, promote factor concentration toward the center, and generate economic spillover effects for centrally located cities. From a methodological standpoint, by employing research methods from new economic geography, further analysis is imperative to ascertain whether the opening of intercity railways has a positive or negative impact on surrounding cities. It is crucial to examine intercity railways' growth benefits for and structural effects on regional economic development, which necessitates the construction of spatial econometric models to analyze the differences in spatial spillover effects of intercity railways across various time periods and regions.

2. Study Area

The Pearl River Delta urban agglomeration is located in the south of mainland China (Figure 1). As one of the earliest regions in China to open up to the outside world, the Pearl River Delta urban agglomeration has become one of the most economically developed regions in China. According to the World Bank's research, the Pearl River Delta urban agglomeration has overtaken Tokyo as the world's largest urban area in both size and population in 2010 [15].

Figure 1. The location of the study area: Pearl River Delta.

At present, the Pearl River Delta urban agglomeration is joining hands with the Hong Kong Special Administrative Region and the Macau Special Administrative Region to build the Guangdong–Hong Kong–Macao Greater Bay Area under the impetus of the national strategy. The goal is to become one of the world's four major Bay Areas on par with the New York Bay Area, the San Francisco Bay Area, and the Tokyo Bay Area.

The first intercity railway in Pearl River Delta urban agglomeration has been in operation since 2007. After its opening, intercity railway projects in various regions began to be constructed and put into use one after another. To date, the intercity railway network in the Pearl River Delta has formed a layout centered around Guangzhou and is spreading out to the neighboring cities (Figure 2).

Figure 2. Pearl River Delta's intercity railway system map.

3. Theoretical Foundation and Literature Review

3.1. Theoretical Foundation

Regarding the spatial evolution of regions, two discernible trends emerge: agglomeration and diffusion. Agglomeration, often termed the "siphoning effect", delineates the phenomenon whereby a region draws production factors from its surrounding areas endowed with robust economic strength and superior location conditions, such as capital and labor [16]. Over time, this region evolves into a developmental nucleus within the broader regional context. However, every specific region, given a certain technological level and economic circumstances, is limited by the extent of agglomeration it can achieve. This limitation arises from the law of diminishing marginal utility. Once this threshold is reached, the economic benefits derived from agglomeration begin to wane and may even transform from economies of scale to diseconomies due to additional costs [17].

In an area with a siphoning effect, an influx of competitors exacerbates external production conditions for enterprises, resulting in heightened production costs, intensified competition, and diminished profits. Agglomerated areas contend with challenges such as population expansion and traffic congestion, leading to escalated living costs and pressure on residents, as well as placing a strain on ecological carrying capacity. It is at this juncture that economic activities instigate the impetus for outward diffusion. In other words, enterprises from the central region establish subsidiaries, affiliated companies, and other business opportunities by making additional investments, transferring technology, and engaging in various economic activities in the surrounding areas [18]. This, in turn, attracts labor and other production factors seeking broader markets.

During the process of economic diffusion, the surrounding areas attract production factors to foster their own development in order to reduce the gap between themselves and the central area, thereby achieving coordinated regional development. This intricate interplay between agglomeration and diffusion encapsulates the dynamic evolution of

regions, acknowledging the inherent limits of agglomeration and the subsequent imperative for outward diffusion to sustain and enhance regional economic vitality.

Transportation costs, a pivotal factor affecting factor mobility, foster conducive circumstances for the diffusion of regional economic activities when transportation infrastructure undergoes improvements and the cost of factor mobility diminishes [19]. In this new era, intercity rail, as a crucial component of transportation infrastructure, not only enhances operational speed and compresses the space–time distance but also catalyzes the flow of capital, labor, and other factors.

The impact of intercity rail on regional coordinated development manifests in two primary dimensions. First, intercity rail augments regional accessibility and streamlines people's travel, potentially accelerating the concentration of labor and other production factors in central regions. This may result in surrounding areas grappling with an insufficient supply of production factors, thereby constraining their development. Concurrently, central regions absorb a greater share of factors, ameliorating their development conditions and exacerbating the developmental divide between central and peripheral regions.

Second, the development of transportation infrastructure enhances conditions for regional external exchanges, thus fostering the movement of talents, capital, technology, and other factors [20]. This facilitates the reconfiguration and allocation of production factors on a broader scale. Surrounding areas become more adept at receiving economic spillovers from central regions, propelling their own development and, in turn, narrowing the development gap. This sets the stage for overall economic growth under more favorable conditions [21].

In the long term, transportation infrastructure holds the potential to reshape the distribution patterns of regions and cities. With its inherent spillover effects, transportation infrastructure enables economically developed areas to drive the economic growth of underdeveloped areas through the diffusion of economic benefits [22]. Enhanced accessibility, stemming from convenient transportation links, serves to compress temporal distances, extend the boundaries of regions and cities, dismantle market fragmentation, and foster the creation of a more expansive market [23]. This, in turn, facilitates the integration of regional economic activities, gradually transforming multiple surrounding cities into regional city clusters. Such a progression achieves a synergy of complementary advantages and fosters coordinated development among cities. Therefore, the multifaceted contributions of intercity railways to regional coordinated development unfold in various ways, as described below.

3.1.1. Facilitating Production Factor Flow

Intercity railways may expedite the influx of production factors from surrounding areas to central regions, resulting in constrained development in the peripheries and an exacerbation of regional imbalances. As explained earlier, enhancements in transportation conditions facilitate a reduction in transportation costs, consequently instigating the flow of factors. Since the movement of production factors inherently follows a "Pareto improvement" process, which is driven by a profit-seeking motive, these factors gravitate from areas with lower output to those with higher output, aligning with market supply and demand dynamics.

With the continuous refinement of transportation infrastructure, production factors from underdeveloped areas can seamlessly migrate to more developed central regions, intensifying the concentration of factors from surrounding areas to the core. As production factors persistently exit the surrounding underdeveloped areas, the development prospects of these areas are stifled, giving rise to negative spillover effects [16]. On the other hand, following the introduction of an intercity railway, the accessibility of regions along the railway line experiences a rapid surge. The proliferation of operating routes fortifies the connections among these regions, thereby facilitating the unimpeded flow of production factors [24].

As production factors amass in the central areas, the development conditions in these core regions tend to become more favorable, establishing a cyclic pattern of "concentration–optimization–reconcentration". Conversely, for underdeveloped areas, the continuous outflow of production factors constrains their economic development, leading to a cycle of "outflow–deterioration–outflow" and an expansion of development gaps between the central and surrounding areas.

3.1.2. Promoting Personnel Exchanges and Knowledge, Information, and Technology Flow

Intercity railways have the potential to instigate diffusion effects, fostering the development of surrounding areas and, thereby, narrowing the development gap between these areas and central areas. The inauguration of intercity railways fortifies the ties between central and surrounding areas, enhancing the accessibility of the peripheries and enabling them to harness the economic spillovers from the central areas. This external effect catalyzes indigenous economic development in the surrounding areas, subsequently diminishing the development disparities with the central areas [24].

With the advent of intercity railways, the spatial boundaries of regions and cities expand. Swift and efficient intercity railways serve as a conduit for the flow of personnel, knowledge, information, and technology. This creates an enabling environment for knowledge spillover and the accumulation of innovative factors. Moreover, it also establishes channels through which surrounding areas can glean insights from the advanced experiences of developed central areas, facilitating the enhancement of technological innovation capabilities in the peripheries [25].

Aligned with the core tenet of endogenous growth theory, the pivotal role of endogenous technological progress emerges as a linchpin for sustained economic growth, rendering regions capable of achieving economic expansion without relying solely on external forces. Furthermore, as central areas continue to concentrate and corporate competition intensifies, some companies may diversify their strategies by establishing branches in surrounding areas, tapping into new markets and other opportunities. The advent of intercity railways augments regional accessibility, reduces travel time, and consequently lowers management and trade costs for companies. This, in turn, acts as a catalyst for increased investment in surrounding areas, thereby fostering their development [26].

3.1.3. Improving Regional Transportation for Overall Development

Intercity railways significantly improve regional accessibility, fostering the redistribution of production factors across a broader spatial scope and engendering economies of scale. Simultaneously, an intercity railway network acts as a conduit for economic spillovers from developed areas to underdeveloped areas, catalyzing comprehensive regional economic growth. By compressing temporal distances, establishing interconnectivity between regions, and expediting the flow of production factors, intercity railways facilitate complementary and coordinated development among regions [27].

Regional development typically initiates from areas endowed with superior location conditions, thus propelling more rapid growth due to their inherent advantages. This, in turn, attracts factors from surrounding regions, contributing to the exacerbation of development imbalances between regions [26]. As advantaged areas reach a certain level of development, the benefits of agglomeration diminish, prompting economic activities to disperse outward. This outward spread stimulates the development of surrounding areas, ultimately narrowing the gap with the leading areas. As the development divide gradually diminishes, areas with locational advantages become the first to embark on the next cycle of development.

From the perspective of neoclassical regional balanced development theory, factors exhibit a profit-seeking characteristic, and the flow of factors eventually leads to the convergence of economic development across various regions, thereby fostering balanced and sustained economic growth. Intercity railways play a pivotal role in expediting the cycle

of "agglomeration–spillover–re-agglomeration", which originates from a single central area and permeates the entire region, thereby achieving regional coordinated development.

In conclusion, by reinforcing the "suction effect" and "diffusion effect" of central areas on surrounding areas, intercity railways assume the role of a "double-edged sword" in the economic development of relatively underdeveloped cities. By diminishing time distances within a region, intercity railways enhance interregional connections, facilitate the flow of production factors, and cultivate broader markets. This, in turn, fosters the flow of production factors toward central areas and stimulates economic spillovers from central cities. Consequently, further analysis is imperative to discern whether the introduction of intercity railways yields positive or negative impacts on surrounding cities. Additionally, an examination of the growth benefits for and structural effects on regional economic development necessitates the construction of spatial econometric models to scrutinize the spatial spillover effects of intercity railways across different time periods and regions.

3.2. Literature Review

In China, intercity railway transit has a clear positioning, which is between high-speed railway and urban rail transit. The key difference between intercity railway transit and urban rail transit is in the spatial scope and function of their services. Urban rail transit mainly serves within cities, while intercity railway transit serves within urban agglomerations [28].

However, from a global perspective, some cities and urban agglomerations may have the functions of intercity railways mentioned above undertaken by high-speed railway or urban rail transit.

Although rail transit, represented by railways, has been widely used since the 18th century and has played an important role in promoting global economic development, urban rail transit is often regarded as a part of the urban transportation system, and its unique role has long been overlooked by scholars.

With the gradual dissemination of W. Christaller's Central Place Theory in the 1950s, the development patterns of some megacities began to shift from a single-core structure to a multi-core structure. For instance, in France, Paris underwent a transformation in its development model with the planning of the construction of five new towns in the suburbs in 1965. Consequently, there was a need to establish new regional rail connections or upgrade existing railways to serve as regional express lines as a means to strengthen the links between Paris and its surrounding areas to meet the transportation needs of new urban residents. The Réseau Express Régional (RER) was constructed as a result [29]. In the Tokyo Bay Area, a comprehensive urban rail network was developed, gradually transforming suburban stations into new towns. This strategic expansion facilitated the outward migration of certain functions from the city center, ultimately giving rise to an urban agglomeration [30]. In the 21st century, New York shifted its development objectives towards sustainability, with the municipal government proposing the vision of "A GREENER, GREATER NEW YORK". The goal of constructing rail transit was to provide New Yorkers more sustainable transportation options and ensure the reliability and high quality of the transportation network [31].

With the continuous expansion of megacities, the status of rail transit in urban transportation systems continues to rise, and scholars have begun to examine the impact of rail transit on urban economic development. From the perspective of a unified European rail transport system, Jan Erik Grindheim and Adam Manga (2011) found that a key element to a better quality of life was by improving access to certain areas and bringing people together [32]. Hensher et al. (2012) surveyed the economic impacts of the North-West Rail Link in Sydney. They found that high-quality transportation can improve the competitiveness of an area by attracting companies and inhabitants to its surroundings [33].

As research deepens, some scholars have also noticed that rail transit can have an impact on the rent of surrounding areas. Peng et al. (2023) used the DID method to study the light rail in Maryland and found that rent increased within a half mile radius of a light

rail station [34]. In addition, Hass-Klau et al. (2004) analyzed the economic impacts of 15 cities' rail transit. They discovered that the economic benefits of tram lines accrued to smaller towns as well as larger towns. As urban rail brought more people to a town, changes in the retail character of the town center included a greater number of fashion shops. Moreover, with increased rents, older industrial areas started to attract leisure and cultural activities [35]. From the perspective of urban sustainable development, rail transit can contribute to enhancing a city's image and quality, fostering the creation of a sustainable and livable urban environment, and significantly influencing urban landscapes [36,37]. Zhang et al. (2020) discovered that urban rail transit can have an impact on the spatial pattern of cities, thereby promoting urban revitalization [38].

From the aforementioned research, it is evident that rail transit plays a crucial role in economic development and urban sustainability. While existing literature has extensively delved into these aspects, the majority of studies are situated within the context of individual cities. Against the backdrop of advocating for regional coordinated development, some megacities have transitioned into polycentric urban agglomeration models. Intercity railways, designed specifically to serve these urban agglomerations, have emerged. Therefore, our study, which is set against the backdrop of the Pearl River Delta urban agglomeration, aims to explore the economic impact of intercity railways from a regional perspective within an urban agglomeration.

4. Data and Methodology

4.1. Data Sources and Variable Selection

In reality, economic development is the result of multiple factors. Therefore, this study selected multiple variables to construct an econometric model to accurately reflect the actual situation. The relevant data for this study spanned the period from 2010 to 2021 and were sourced from the National Railway Passenger Train Timetable, the 12306 website (www.12306.cn/en/index.html, accessed on 6 July 2022), and various local statistical yearbooks. The specific variables selected were as follows:

1. Dependent Variable

Economic output is denoted by Y. Gross domestic product (GDP) is one of the most direct indicators reflecting the level of regional economic development, which was adopted in this study.

2. Core Explanatory Variable

The number of intercity railway routes is denoted by T. This study used the number of operational intercity railway routes to assess the level of intercity railway construction in individual regions.

3. Control Variables

Labor force quantity is denoted by L. Currently, there are various statistical methods for measuring labor force quantity. Since the *Guangdong Statistical Yearbook* provides the total population of employees, this study directly selected this indicator to reflect the quantity of labor force in each region.

Urban capital stock is denoted by K. This study adopted the perpetual inventory method to calculate the urban capital stock using the following formula:

$$K_{it} = K_{i,t-1}(1 - \delta_i) + I_{it} \tag{1}$$

where i represents the region, t represents the year, I denotes investment amount, and δ represents the depreciation rate. Following the approach adopted by Shan (2008), the depreciation rate was set at 10.96% [39].

Human capital is denoted by H. Because of differences in human capital for different educational levels and the absence of a specific statistical method for measuring human capital, this study chose to estimate the human capital of an urban sample based on the average number of years of education, calculated as $Years = 6S_1 + 9S_2 + 12S_3 + 16S_4$,

where S_1, S_2, S_3, and S_4 represent the number of students per 10,000 people in primary schools, junior high schools, senior high schools, and regular higher education institutions, respectively. The coefficients represent the number of years required for individuals to complete education at each stage, whose calculation followed the approach proposed by Li (2007) [40].

4.2. Spatial Weight Setting

To conduct spatial econometric research, it is necessary to incorporate location information related to space into existing panel data. Therefore, a spatial weight matrix, which reflects location information, needs to be introduced into the original econometric model to obtain a spatial econometric model.

Based on the theoretical analysis conducted in this study, the shorter the distance between regions, the more connections they have, indicating a stronger spatial correlation. Conversely, the greater the distance between regions, the fewer connections they have, indicating a weaker spatial correlation. Traditional geographic weight matrices are constructed with matrix elements w_{ij} as the reciprocal of the distance between two locations, reflecting the negative correlation between the strength of spatial correlation and geographical distance. However, as mentioned in the theoretical analysis, intercity railways strengthen the connections between regions by reducing the time distance between them. Even if the geographical distance between regions remains unchanged, with the opening of intercity railways, the time distance between peripheral areas and central areas will shorten, thereby enhancing the connections between two areas. Therefore, if the spatial weight matrix based on geographical distance continued to be used, the impact of the opening of intercity railways could not be taken into account, which would not conform to the actual development situation. Thus, this study introduced a weight matrix based on time distance. Travel time and spatial correlation are negatively correlated, similar to the geographic distance weight matrix. The elements of the time–distance weight matrix, denoted by w_{ij}, are the reciprocals of the time distance t_{ij} between two locations, reflecting the relationship between time distance and spatial correlation. This still complies with Tobler's first law of geography, which states that "everything is related to everything else, but near things are more related than distant things".

When constructing spatial econometric models, different spatial weight matrices may yield different measurement results. Therefore, to ensure a higher level of reliability in the measurement results, this study constructed three types of spatial weight matrices. Of these, the time–distance matrix and the economic distance matrix were used primarily. However, if only time or economic distance were included in the weight matrix, the estimated results would have certain limitations. Therefore, this study also constructed a nested weight matrix incorporating both geographic and economic factors, which was applied in the robustness tests.

1. Weighted Matrix Based on Time Distance ($w1$):

$$w_{ij} = \begin{cases} \frac{1}{t_{ij}}, & i \neq j \\ 0, & i = j \end{cases} \tag{2}$$

2. Binary Spatial Weight Matrix based on Geographical Proximity ($w2$):

$$w_{ij} = \begin{cases} 1, & \text{Regions } i \text{ and } j \text{ are adjacent.} \\ 0, & \text{Regions } i \text{ and } j \text{ are not adjacent.} \end{cases} \tag{3}$$

3. Geographical and Economic Nested Weight Matrix ($w3$):

$$w_d = \begin{cases} \frac{1}{d_{ij}}, & i \neq j \\ 0, & i = j \end{cases} \tag{4}$$

$$w_e = \begin{cases} \frac{1}{|y_i - y_j|}, & i \neq j \\ 0, & i = j \end{cases} \tag{5}$$

$$w_{ij} = \varphi w_d + (1 - \varphi) w_e \tag{6}$$

Of these, w_d is the weight matrix for geographic distance, d_{ij} represents the shortest road distance between city i and city j, w_e is the weight matrix for economic distance, and y_i and y_j represent the average GDP per capita of city i and city j, respectively, from 2010 to 2021. For the convenience of analysis, this study adopted the approach used by Shao et al. (2016) and set the value of φ to be 0.5 [41].

4.3. Basic Model Settings for Re-Aggregation

This study focused on the spatial spillover effects of the intercity railway network on the economic development of the Pearl River Delta urban agglomeration (PRDUA). As transportation infrastructure could directly promote economic growth as a factor of production and indirectly stimulate economic growth through network externalities, intercity railways were considered to be a type of transportation infrastructure in this research. Therefore, the Cobb–Douglas production function was used to reflect the impact of intercity railway investment on the economy at a certain level of technological and economic development:

$$Y = A(t)L^\alpha K^\beta H^\gamma \tag{7}$$

Here, Y represents the total economic output, $A(t)$ represents the comprehensive development level, L represents the quantity of the labor force, K represents capital stock, H represents human capital, and α, β, and γ are the elastic coefficients of labor force, capital stock, and human capital, respectively. The distribution of transportation networks is one of the important factors affecting the comprehensive development level. Thus, it can be defined as a function of the distribution of intercity railway networks: $A(t) = A(e^{\chi T})$, where T represents the number of operational intercity railway lines in a local area, and χ is the elasticity coefficient. By substituting this equation into the previous one and taking the natural logarithm, we obtain the following equation:

$$\ln Y = \chi T + \alpha \ln L + \beta \ln K + \gamma \ln H + e \tag{8}$$

Here, e represents the error term, and L, K, H, and T constitute a set of explanatory scalar variables in four different dimensions to explain the dependent variable Y.

Having introduced the concept of a spatial econometric model, the spatial autoregressive model (SAR), spatial error model (SEM), and spatial Durbin model (SDM) can be derived. Their expressions are as follows:

1. SAM:

$$\ln Y_i = \delta \sum_{j=1}^{n} w_{ij} \ln Y_j + \chi T_i + \alpha \ln L_i + \beta \ln K_i + \gamma \ln H_i + \varepsilon_i \tag{9}$$

where w_{ij} represents the spatial weight matrix, reflecting the spatial connections between regions; δ represents the spatial autoregressive coefficient, reflecting the spatial dependence of sample observations; and $w_{ij} \ln Y_j$ represents the spatial lag term, $\varepsilon_i \sim N(0, \sigma^2 I_n)$.

2. SEM:

$$\ln Y_i = \chi T_i + \alpha \ln L_i + \beta \ln K_i + \gamma \ln H_i + \varepsilon_i$$
$$\varepsilon_i = \lambda \sum_{j=1}^{n} w_{ij} \varepsilon_i + \mu_i \tag{10}$$

where λ is the spatial error coefficient, reflecting the spatial correlation in the error structure of the sample.

3. SDM:

$$\ln Y_i = \delta \sum_{j=1}^{n} w_{ij} \ln Y_j + \chi T_i + \alpha \ln L_i + \beta \ln K_i + \gamma \ln H_i + \varepsilon_i$$
$$\varepsilon_i = \lambda \sum_{j=1}^{n} w_{ij} \varepsilon_i + \mu_i \tag{11}$$

If $\lambda = 0$, the SDM degenerates into an SAM. If $\delta = 0$, the SDM degenerates into an SEM [42].

5. Empirical Analysis

5.1. Spatial Autocorrelation Analysis

The Moran's index (Moran's *I*) is used mainly to test the degree of spatial autocorrelation, and the calculated value is used to determine the positive or negative correlation of space. The formula for calculating Moran's *I* is as follows:

$$\text{Moran's } I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \overline{x})(x_j - \overline{x})}{S^2 \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}} \tag{12}$$

where *n* represents the sample size, x_i and x_j represent the GDP of city *i* and city *j*, respectively; $S^2 = \frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n}$ is the variance of the sample x_i; $\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$ is the average value of x_i; and w_{ij} is the element of the spatial weight matrix, representing the spatial relationship between city *i* and city *j*. To determine the economic development relationship within the study area, this study introduced an economic distance weight matrix in the calculation of Moran's *I*, with matrix elements composed of the average GDP values of the cities from 2010 to 2021. The range of Moran's *I* is [−1, 1], with values closer to 1 indicating a stronger positive spatial autocorrelation, values closer to −1 indicating stronger a negative spatial autocorrelation, and a value of 0 indicating a random distribution pattern with no spatial correlation. Taking the nine prefecture-level cities in the PRDUA as the research object, and using city GDP values as the observed variable, the Moran's *I* values of the PRDUA from 2010 to 2021 were calculated (Table 1). All of the calculated Moran's *I* values were positive and significant at the 1% level, indicating the presence of significant spatial autocorrelation in the economic development of the PRDUA. Specifically, the Moran's *I* values showed an upward trend followed by a downward trend, rising from 0.776 in 2010 to 0.806 in 2016, then remaining above 0.8, dropping to 0.788 in 2019, and rising again to 0.797 in later years.

Table 1. Moran's index (Moran's *I*) of GDP from 2010 to 2021.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Moran's *I*	0.776	0.783	0.796	0.800	0.804	0.804	0.806	0.803	0.802	0.788	0.794	0.797
p-value	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

Subsequently, the time–distance weight matrix was introduced to calculate the local Moran's *I* values for both 2010 and 2021 (Figure 3). It was observed that Guangzhou and Shenzhen were consistently in the high and low agglomeration areas, indicating that their own economic development level was higher across the examined time period, while that of the surrounding areas were lower. Foshan was in a high–high agglomeration area, indicating that its own economic development level was high and that of the surrounding areas was also high. Huizhou and Zhaoqing were in a low–high agglomeration area, indicating that their own economic development level was low, but the surrounding areas had a higher economic development level. Zhuhai, Zhongshan, and Jiangmen were in a low–low agglomeration area, indicating that both their own economic development level and that of the surrounding areas were low. Dongguan, on the other hand, moved from a high–high agglomeration area to a low–high agglomeration area, indicating that the construction of intercity railways accelerated the outflow of production factors in Dongguan and posed challenges for its own economic development.
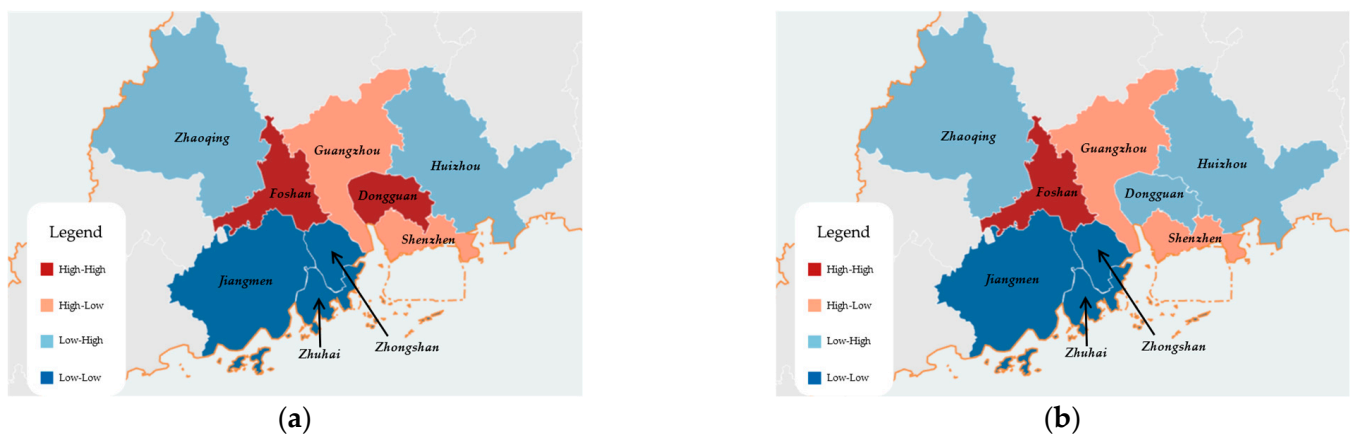
(**a**)   (**b**)

Figure 3. Moran's Index (Moran's *I*) for (**a**) 2010 and (**b**) 2021.

The above results indicated that the spatial pattern of intercity railways was not randomly distributed; it had similar characteristics to the spatial distribution of economic output. Therefore, it is necessary to explore the relationship between intercity railway networks and economic growth.

5.2. Space Panel Estimation Analysis

By analyzing the presence of spatial correlation, the SDM offers consistent estimations for all variables potentially affected by spatial spillover effects, enabling their quantification [41,42]. Table 2 presents the estimated outcomes of the SDM, SAR, and SEM.

Table 2. Estimated results of spatial panels.

| Matrix | | *w*1 | | | *w*2 | |
Model	SDM	SAR	SEM	SDM	SAR	SEM
T	0.0342 ***	0.0194 ***	0.0325 ***	0.0382 ***	0.0247 ***	0.0501 ***
ln *K*	0.656 ***	0.604 ***	0.605 ***	0.530 ***	0.588 ***	0.610 ***
ln *L*	0.143	0.316 ***	0.243 ***	0.212 ***	0.304 ***	0.217 ***
ln *H*	−0.294 **	0.106	−0.0360	0.193 **	0.152	0.232 **
R^2	0.867	0.899	0.946	0.802	0.889	0.893
log *L*	181.1610	166.3457	172.4402	194.6530	164.8799	172.4827
N	108	108	108	108	108	108

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

An analysis of the results in Table 2 revealed a discernible degree of spatial correlation within the PRDUA. The estimated outcomes derived from the time–distance weight matrix underscored the substantial and positive impact of intercity railways on economic output, highlighting the pivotal role of these railways as an infrastructure in urban economic development. Notably, the estimates based on the geographic distance matrix revealed that a 10% increase in the number of operating intercity railways corresponded to a 0.382% uptick in economic output. These findings signify the existence of spatial spillover effects of intercity railway construction.

The reduction in temporal distances between areas, especially the strengthening of connections between adjacent areas, is highlighted as a key mechanism by which intercity railways augment the economic spillover effects, thereby fostering the overall economic development of the PRDUA.

This study focused on the economic spillover effects of intercity railways, particularly due to the reduction in time distance between areas, with the aim of enhancing the impetus on neighboring areas and fostering regional coordinated development. Utilizing panel data for the period 2010–2021, the construction phases of the Pearl River Delta intercity railway network were segmented into two time periods: 2010–2015 and 2016–2021. Spatial

regression analysis was conducted for the time–distance weight matrix. To offer a more intuitive representation of the impact of geographical distance factors and spatial spillover effects on regional coordinated development, Table 3 presents the estimated results for different models or matrices, denoted as (1)–(5). These include traditional ordinary least squares (OLS), the SDM with the time–distance matrix, the economic distance matrix, and the results for the periods 2010–2015 and 2016–2021 under the time–distance weight matrix. According to the basic setting of the models we used, if the coefficient of an explanatory variable is positive and meets the confidence level requirements, it indicates that the variable has a positive impact on the dependent variable.

Table 3. Model regression results.

Model	OLS (1)	Temporal Distance (2)	Geographical Proximity (3)	Temporal Distance (4)	Temporal Distance (5)
Period	2010–2021	2010–2021	2010–2021	2010–2015	2016–2021
T	0.0760 ***	0.0342 ***	0.0382 ***	0.0362 ***	0.0596 ***
$\ln K$	0.803 ***	0.656 ***	0.530 ***	2.060 ***	0.481 ***
$\ln L$	0.440 ***	0.143	0.212 ***	0.0709	−0.203
$\ln H$	−0.232	−0.294 **	0.193 **	0.569 ***	−0.190
Constant term	2.106 **	—	—	—	—
R^2	0.953	0.922	0.886	0.777	0.870

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

An examination of the estimated results in Table 3 reveals that the models selected for this study exhibit a robust goodness of fit, suggesting their ability to objectively reflect the reality of intercity railway operation and economic development in the PRDUA. The coefficients of the core explanatory variable T in the results of (2) and (3) are positive, indicating the presence of spatial spillover effects of intercity railways and signifying a positive impact on the economic output of the PRDUA. This implies that the operation of intercity railways actively promotes the economic development of the region. Notably, the coefficient of the core explanatory variable T in the result of (3) is slightly higher than that for the result of (2), suggesting a greater impact of spatial spillover effects on the economic development of neighboring cities.

Comparisons between the results of (1) and (2) highlight that, after considering the effects of geographical factors on economic output, the coefficients of the explanatory variables, including intercity railway routes T, urban capital stock K, labor force quantity L, and human capital H, for the results of (2) are smaller than those for the results of (1). This suggests that, without accounting for spatial spillover effects, the selected models might overestimate the role of these variables in economic growth.

Comparing the results of (4) and (5) reveals that the core explanatory variable T is significant at the 1% level for both, with the coefficient for the result of (5) being larger than that for the result of (4). This discrepancy can be attributed to the initial stage of Pearl River Delta intercity railway construction between 2010 and 2015, when some cities did not have operational intercity railways, limiting their impact on regional economic output. However, from 2016 to 2021, as intercity railways were progressively constructed and opened in nine cities, the Pearl River Delta intercity railway network took shape, thus intensifying the economic spillover effects between cities.

In summary, the empirical results demonstrate that the opening of intercity railways had a more pronounced impact on neighboring cities, aligning with the characteristic of spatial spillover effects diminishing with geographical distance. Within the PRDUA, the construction of intercity railways facilitated overall regional development. Contrary to expectations, the decrease in transportation costs and the reduction in time distance did not lead to a deterioration in the economic environment in the surrounding areas or an accelerated flow of production factors toward the central area. This finding underscores the

importance of mitigating regional development imbalances within the context of intercity railway expansion.

5.3. Decomposition of Effects

This study delved deeper into the impact of intercity railways on economic development by breaking down the effects into direct, indirect, and total effects. In spatial econometric models, "direct effects" represent the magnitude of the impact of an independent variable in a certain region on the dependent variable. And "indirect effects", also known as spatial spillover effects, are used to measure the impact of an explanatory variable (such as technological innovation) in a "neighboring" region on the dependent variable in the region [43]. The decomposition results presented in Table 4 reveal that both direct and indirect effects, when compared with the time–distance matrix, exhibit larger coefficients (core explanatory variable *T*) under the geographical distance matrix. This suggests that the opening of intercity railways contributed more significantly to the economic output growth of neighboring areas. Regarding indirect effects, under the influence of the time–distance matrix, a 10% increase in the number of intercity railway routes resulted in an indirect economic output growth of 0.401%. Conversely, under the influence of the geographic distance matrix, the same increase in intercity railways led to a more substantial indirect economic output growth of 0.949%. This implies that intercity railways fortified the connection between central and adjacent cities, exerting a more pronounced impact on neighboring areas.

Table 4. Estimated results of unpacking effects.

Matrix	*w*1			*w*2		
Unpacking Effect	**Direct**	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
T	0.0254 ***	0.0401 **	0.0655 ***	0.0266 ***	0.0949 ***	0.121 ***
ln *K*	0.662 ***	−0.0289	0.633 ***	0.552 ***	−0.198	0.353 **
ln *L*	0.293 ***	−0.633 ***	−0.340	0.233 ***	−0.121	0.113
ln *H*	−0.0440	−1.128 ***	−1.172 ***	0.145 *	0.395 **	0.541 ***

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

Regarding other explanatory variables, most variables exhibit positive and significant coefficients for direct effects, while the coefficients for indirect effects are negative but not statistically significant. This suggests that the PRDUA may currently be in a phase of factor concentration. The construction of intercity railways facilitates production factor flow by reinforcing the connections between areas, thereby enhancing the appeal of the central area for capital factors from the surrounding areas. This reflects the proactive nature of transportation infrastructure construction in both the economic and social dimensions.

5.4. Robustness Test

To verify the reliability of the results obtained in this study, a robustness test was conducted. Since the geographical and economic nested matrix (Formulae (4)–(6)) considers both the effect of geographical distance and regional economic disparity, it can more comprehensively and objectively reflect spatial correlation. Therefore, this study used the geographical and economic nested matrix *w*3 to re-fit the data to test the stability of the results. The results presented in Table 5 indicate that, although there are differences compared to the estimated results of the matrices *w*1 and *w*2, the signs of the explanatory variable coefficients are roughly the same. Therefore, it can be concluded that the overall research results are reliable.

Table 5. Estimated results of the robustness test.

Variable	SDM	Direct	Indirect	Total
T	0.0643 ***	0.0376 ***	0.135 ***	0.172 ***
ln K	0.487 ***	0.695 ***	−1.044 ***	−0.349
ln L	0.182 ***	0.388 ***	−0.989 ***	−0.601 **
ln H	−0.215	−0.00417	−1.058 ***	−1.062 **

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

6. Discussions

Studies employing spatial econometric methods akin to those used in this study have predominantly focused on high-speed rail to investigate the impacts it brings to the regions along its route. In contrast, our study focused on intercity railways within an urban agglomeration, specifically exploring the effects of a network comprising multiple routes on the entire region.

A noteworthy observation from a review of the existing literature is the scarcity of studies dedicated to the economic impact of intercity railways. This scarcity is attributed to the intertwining operations of intercity railways and subways in most urban agglomerations, such as the Tokyo Bay Area and the New York Bay Area, where intercity railways seamlessly integrate with other intra-city transit systems. Consequently, individually measuring the economic influence of intercity railways in these regions proves challenging.

However, the case of rail transit in China presents a unique scenario. Different standards have been set for railways of distinct classifications, and the majority of intercity railways are newly constructed lines. This distinction allows us to isolate and study intercity railways as an independent research subject in China. It also affords us the opportunity to delve deeper into the economic impact of intercity railways, offering a fresh perspective and understanding for this field of research.

In our discussion of this study's findings below, we elaborate on how these unique circumstances influence our discoveries. We also highlight how such distinct characteristics contribute to the depth of our research and, more importantly, how they enhance the generalizability and applicability of our findings on a global scale.

1. Absence of Regional Development Imbalance

Our empirical findings reveal a significant indirect effect of PRDUA intercity railways, as a transportation infrastructure, on regional development, confirming the spillover characteristics associated with transportation infrastructure. Through the application of three distinct weight matrices in the spatial Durbin model, we discovered that, under the influence of the matrix of geographical proximity, the coefficient of the core explanatory variable T is larger, indicating a more substantial impact of intercity railway operations on the economic development of adjacent cities. Furthermore, the positive coefficient of the core explanatory variable T suggests that the impact of intercity railways on the economic development of PRDUA is positive. The phenomenon mentioned in the first point of the second section regarding the "exacerbation of regional development imbalance" did not occur.

2. Strengthening of the "Siphon Effect" in the Central City

In response to the second theoretical proposition, we conducted an effect decomposition analysis. The effect decomposition analysis revealed that, for the direct effects, the values of the explanatory variables are positive and significant, while the values of the indirect effects, although positive, are not significant. This indicates that the current operation of the intercity railway network in PRDUA is in a stage of factor concentration. This finding addresses the second point of the second section, affirming that the current operation of the intercity railway network enhances the "siphon effect" in the central city. Furthermore, the calculation results of the Moran's Index also indicate that the economic situation in Dongguan has deteriorated after the operation of the intercity railway network, providing evidence for the existence of the "siphon effect" in the central city.

3. Promoting Economic Efficiency through Improved Traffic Conditions

From another perspective, the significant direct effects also show that intercity railways can directly promote the economic development of the region, which confirms the "forward-looking" construction of transportation infrastructure. We argue that the current impact is transitioning from the first stage (direct investment) to the second stage (applications benefiting enterprises and residents). As more routes become operational, the overall improvement in traffic conditions will reduce economic operating costs, enhance social operation economic efficiency, and promote economic growth. This provides a response to the third argument point. In addition, the impact of transportation infrastructure in the second stage may be one of the directions for further research on this topic. In the future, the mediating effect method can also be used to measure the impact of infrastructure on the economy and explore the transmission path of infrastructure to economic development.

7. Conclusions and Outlook

7.1. Conclusions

This study empirically verified the spatial spillover effects of intercity railways on urban economic development. Failure to consider these spillover effects may lead to an overestimation of the impact of intercity railways on economic development. Through spatial model estimation using multiple weight matrices, the results indicate that the operation of intercity railways can strengthen the economic spillover of a city and significantly affect the development of neighboring cities. At the regional level, the construction of intercity railways shortens the temporal and spatial distances between areas, thereby reinforcing the spatial spillover effects of central areas and promoting the development of surrounding areas, leading to an adjustment and optimization of the regional development pattern. Based on our findings, we arrive at the following conclusions and recommendations:

1. Intercity railways have spatial spillover effects

The empirical results of this study demonstrate that the operation of intercity railways in the Pearl River Delta promotes the overall economic development of the urban agglomeration. Our research findings suggest the presence of spatial spillover effects of intercity railways, particularly in enhancing the economic connections and spillover effects among neighboring cities. Thus, it is recommended that the construction of intercity railways in the PRDUA be continued to strengthen the economic spillover effects in the central areas and drive the development of surrounding areas.

2. Continue to promote intercity railway construction

According to the impact patterns of transportation, the effects of intercity railways extend laterally along their route, and the higher the density of the intercity railway network, the more regions can be reached to increase their economic development. When the network density reaches a certain level, it forms a development pattern characterized by a "network leading to surface". Currently, the transportation development in the western region of the Pearl River Delta lags behind, and the calculated results for Moran's *I* indicate a significantly lower economic development level in the western region compared to the eastern region. Therefore, it is recommended that the planning and construction of the railway network in the western region of the Pearl River Delta be accelerated to strengthen connections with the more developed eastern region. The results of this study suggest that the construction of an intercity railway connecting Zhaoqing, Jiangmen, and Zhuhai should be considered to create a corridor from the western region to the more developed eastern areas, which could help drive the development of the western region in the PRDUA.

3. Seize the opportunity

For small and medium-sized cities, it is crucial for local governments to embrace a perspective that recognizes both opportunities and challenges. Faced with potential suction effects and diffusion effects, leveraging the characteristics of intercity railways in reducing temporal and spatial distances, strengthening the connections with central areas, and capitalizing on local advantages can all be instrumental. Formulating proactive

investment and talent recruitment strategies and seizing development opportunities are both recommended.

7.2. Outlook

This study employed panel data for the period 2010–2021 in the Pearl River Delta urban agglomeration (PRDUA) to construct a spatial econometric model, aiming to assess the spillover effects of the intercity railway network on the economic development of the urban agglomeration and investigate its potential to promote regional coordinated development. The spatial Durbin model (SDM) was utilized in this study to examine the economic spillover effects of intercity railways in the PRDUA. As an extended form of the spatial autoregressive model and spatial error model (SEM), the SDM offers enhanced power for explaining spatial variable relationships. Our research results show that the construction of intercity railways can promote the economic development of urban agglomerations, especially the mutual promotion between neighboring cities.

This not only helps deepen the understanding of the positive economic impact of intercity railway development, but also provides a reference and an experience in promoting sustainable development for other city clusters. In the current context of promoting regional coordinated development, the development of a region presents a trend of "multi-core structure", which means coordinated cooperation and common development between cities. This inevitably requires strengthening the connections between these cities through intercity railways.

From the perspective of urban sustainable development, the results of this study have important guiding and planning significance, which can help guide local governments to plan and promote intercity railway construction in urban agglomerations more effectively so as to promote overall economic prosperity.

However, this study also has some shortcomings, such as the specific mechanism underlying the spillover effects of intercity railways is not yet clear. In the future, more in-depth research is needed through the use of other methods to explore the specific mechanism of action underlying such effects.

Author Contributions: Conceptualization, Y.D. and X.L.; methodology, Y.D.; software, Y.D.; validation, Y.D., X.L. and J.Z.; formal analysis, Y.D.; investigation, Y.D.; resources, Y.D.; data curation, Y.D.; writing—original draft preparation, Y.D.; writing—review and editing, Y.D., X.L. and J.Z.; visualization, Y.D.; supervision, X.L. and J.Z.; project administration, J.Z.; funding acquisition, J.Z. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Publicly available datasets were analyzed in this study. These datasets can be accessed at http://stats.gd.gov.cn/, accessed on 1 December 2022.

Conflicts of Interest: The funders had no role in the design of this study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Weber, A. *Industrial Location Theory*, 1st ed.; The Commercial Press: Beijing, China, 1997.
2. Hoover, E.M. *The Location of Economic Activity*, 1st ed.; McGraw-Hill Book Company, Inc.: New York, NY, USA, 1948.
3. Linneker, B.J.; Spence, N.A. Accessibility measures compared in an analysis of the impact of the m25 London orbital motorway on Britain. *Environ. Plan. A* **1992**, *24*, 1137–1154. [CrossRef]
4. Meng, D.Y.; Lu, Y.Q. Impact of high-speed railway on accessibility and economic linkage of cities along the railway in Henan Province, China. *Sci. Geogr. Sin.* **2011**, *31*, 537–543.
5. Jiao, J.; Wang, J.; Jin, F.; Du, C. Understanding relationship between accessibility and economic growth: A case study from China (1990–2010). *Chin. Geogr. Sci.* **2016**, *26*, 803–816. [CrossRef]

6. Sun, Y.F. The important role of Beijing-Kowloon railway to the passenger and freight transportation and economy development. *China Railw.* **2005**, *44*, 10–15.
7. Li, X.Z.; Ji, X.L.; Zhou, L.L. Can high-speed railway improve enterprises' resource allocation? Micro-evidence from the annual survey of industrial firms in china and high-speed railway geographic data. *Econ. Rev.* **2017**, *38*, 3–21.
8. Bai, Y.L.; Kang, Z.N. Urban functional connection network and its spatial effect of coordinated development in the Yangtze River economic Belt. *J. Chongqing Univ.* **2023**, *29*, 16–32.
9. Zhang, X.L. Has transport infrastructure promoted regional economic growth? With an analysis of the spatial spillover effects of transport infrastructure. *Soc. Sci. China* **2017**, *33*, 60–77.
10. Wang, Y.H.; Zhao, J.; Rong, W.Y. Study on influence of Changchun-Jilin intercity on regional economic development. *J. Dalian Jiaotong Univ.* **2022**, *43*, 13–18.
11. Teng, F. Research on the impact of high-speed railway on regional economic development: Taking the Zhengzhou-Kaifeng intercity railway as an Example. *China Logist. Purch.* **2022**, *43*, 67–71.
12. Li, Q.; Wang, Y.C. Research on the impact of high-speed rail network on the industrial upgrading of the Yangtze River Economic Belt. *Soft Sci.* **2022**, *36*, 78–85.
13. Boarnet, M.G. Spillovers and the locational effects of public infrastructure. *J. Reg. Sci.* **1998**, *38*, 381–400. [CrossRef]
14. Hu, M.W.; Wu, W.L.; Zhao, Q.; He, G.Q. Analysis on the relationship between accessibility of intercity rail transit and urban economic development. *J. Shenzhen Univ.* **2022**, *39*, 287–295. [CrossRef]
15. World Bank Group. *East Asia's Changing Urban Landscape: Measuring a Decade of Spatial Growth*; World Bank: Washington, DC, USA, 2015.
16. Bian, Y.C.; Wu, L.H.; Bai, J.H. Does high-speed rail improve regional innovation in China? *J. Financ. Res.* **2019**, *62*, 132–149.
17. Zhou, Q.M. Study on the Spatial Spillover Effects of Transportation Infrastructure on Regional Economic Growth. Ph.D. Dissertation, Zhejiang University, Hangzhou, China, 2004.
18. Tanaka, K.; Hashiguchi, Y. Spatial spillovers from foreign direct investment: Evidence from the Yangtze River Delta in China. *China World Econ.* **2015**, *23*, 40–60. [CrossRef]
19. Hu, Y.; Li, H.C. The estimate of transport hub level and its spatial spillover effects—A spatial panel data study on China's prefecture level city. *China Ind. Econ.* **2015**, *33*, 32–43.
20. Tang, E.B. Study on impact and spatial spillover effect of Beijing-shanghai high-speed rail on urban innovation capability along the line. *Areal Res. Dev.* **2021**, *40*, 57–62.
21. Wang, S.; Sun, T. Transportation infrastructure, labor allocation and the urban-rural integrated development in China: From the perspective of dual coupling of labor force with the industry and the region. *J. Guangdong Univ. Fin. Econ.* **2023**, *38*, 98–112.
22. Wang, Y.C.; Zhou, X.M.; Wu, X.F. Spatial infrastructure on regional economic growth. *Price Theor. Pract.* **2022**, *42*, 12–17.
23. Baum-Snow, N. Did highways cause suburbanization? *Q. J. Econ.* **2007**, *122*, 775–805. [CrossRef]
24. Yang, X.; Shi, D.Q. Transportation infrastructure, factors mobility and urban-rural income gap. *South China J. Econ.* **2019**, *37*, 35–50.
25. Tsekouras, K.; Chatzistamoulou, N.; Kounetas, K.; Broadstock, D.C. Spillovers, path dependence and the productive performance of European transportation sectors in the presence of technology heterogeneity. *Technol. Forecast. Soc. Chang.* **2016**, *102*, 261–274. [CrossRef]
26. Zhang, K.Z.; Tao, D.J. The economic distribution effect of transportation infrastructure—Evidence from the opening of high-speed rail. *Econ. Perspect.* **2016**, *57*, 62–73.
27. Dong, Y.M.; Zhu, Y.M. Can high-speed rail construction reshape the layout of China's economic space—Based on the perspective of regional heterogeneity of employment, wage and economic growth. *China Ind. Econ.* **2016**, *34*, 92–108.
28. Liang, M.Z.; Peng, L.; Zhao, D.T.; Wang, Z.B. Efficiency Improvement Experience and Enlightenment of Urban Railway and Intercity Railway in Tokyo Metropolitan Area. *Urban. Mass. Transit.* **2022**, *25*, 6–9. [CrossRef]
29. Yin, Y.; Ju, Z.Q.; Wu, Y.Y.; Chen, J.Q. The Enlightenment of Foreign Rail Transit Development to the Rail Transit Integration of China Megalopolis. *J. Transp. Eng. Inf.* **2021**, *19*, 52–58. [CrossRef]
30. Wang, Y.N.; Fan, Z.Q. Research on the Development of New Towns in Tokyo Metropolitan Area Guided by Rail Transit. *Urban. Rapid Rail Transit.* **2016**, *29*, 122–126. [CrossRef]
31. Bloomberg, M. *A Greener Greater New York*; The City of New York: New York, NY, USA, 2006; pp. 15–17.
32. Grindheim, J.E.; Manga, A.D.A.M. Intercity Corridors Restructuring Europe. In *The Role of the Regions? Networks, Scale, Territory*, 1st ed.; Herrschel, T., Tallberg, P., Eds.; Kristianstads Boktryckeri: Stockholm, Sweden, 2011; pp. 223–254.
33. Hensher, D.A.; Truong, T.P.; Mulley, C.; Ellison, R. Assessing the wider economy impacts of transport infrastructure investment with an illustrative application to the North-West Rail Link project in Sydney, Australia. *J. Transp. Geogr.* **2012**, *24*, 292–305. [CrossRef]
34. Peng, Q.; Knaap, G.; Finio, N. Do Multifamily unit Rents Increase in Response to Light Rail in the Pre-service Period? *Int. Reg. Sci. Rev.* **2023**. [CrossRef]
35. Hass-Klau, C.; Crampton, G.; Benjari, R. *Economic Impact of Light Rail-the Results of 15 Urban Areas in France, Germany, UK and North America*; Environmental and Transport Planning: Brighton, UK, 2004.
36. Ferbrache, F.; Knowles, R.D. City boosterism and place-making with light rail transit: A critical review of light rail impacts on city image and quality. *Geoforum* **2017**, *80*, 103–113. [CrossRef]

37. Park, J.-S. Efficiency Analysis of Tramways in the Metropolitan Areas in South Korea: Focusing on the Daejeon Metropolitan Area. *Future Transp.* **2023**, *3*, 1223–1239. [CrossRef]

38. Zhang, C.; Dai, S.; Xia, H. Reuse of Abandoned Railways Leads to Urban Regeneration: A Tale from a Rust Track to a Green Corridor in Zhangjiakou. *Urban. Rail Transit.* **2020**, *6*, 104–115. [CrossRef]

39. Shan, H.J. Reestimating the capital stock of China: 1952~2006. *J. Quant. Technol. Econ.* **2008**, *25*, 17–31.

40. Li, X.M. Human capital, human capital structure and regional coordinative development: The evidence from Chinese provinces. *J. Cent. China Norm. Univ.* **2007**, *46*, 47–56.

41. Shao, S.; Li, X.; Cao, J.H.; Yang, L.L. China's economic policy choices for governing smog pollution—Based on spatial spillover effects. *Econ. Res. J.* **2016**, *51*, 73–88.

42. Jin, C.Y.; Cheng, H. Is there a spatial spillover effect between China's manufacturing industry agglomeration and regional specialization—Empirical evidence from spatial durbin models. *Quant. Econ. 21st Century* **2013**, *13*, 506–527.

43. LeSage, J.; Pace, R.K. *Introduction to Spatial Econometrics*, 1st ed.; Chapman & Hall, Limited: London, UK, 2009.