Research on the Coordinated Economic Development of Beijing-Tianjin-Hebei Urban Agglomeration Based on the Measurement of Compactness

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Abstract. Urban agglomeration is an important growth pole for China's future economic development. In recent years, the national high level has paid more and more attention to supporting the development of various urban agglomerations in China. As the third-largest urban agglomeration in China, the Beijing-Tianjin-Hebei urban agglomeration is led by Beijing and Tianjin and develops together with 11 prefecture-level cities in Hebei Province. However, the gap between the top two Yangtze River Delta and Pearl River Delta urban agglomerations is still not small. Meanwhile, the gap between different cities within the Beijing-Tianjin-Hebei urban agglomeration has always been considerable, and the coordinated development of each city is less effective than that of the other two urban agglomerations. This paper first calculates the compactness index to obtain the changes in the compactness of the Beijing-Tianjin-Hebei region from 2013 to 2019 and analyzes the development trend of the region in recent years. Among them, the compactness of space is growing rapidly, and the growth rate of industrial compactness and traffic compactness is relatively slow. It is based on identifying the core area of the urban agglomeration based on population density. We put forward ideas on achieving better coordinated regional developments and accelerating integrations.

Keywords: Compactness, urban agglomeration, coordinated economic development.

1. Introduction

An urban agglomeration is the highest form of spatial organization for urban development to mature stages. It is known that an urban agglomeration is a large, multi-core, multi-level urban group formed by many megacities and large, geographically concentrated cities. It is a consortium of metropolitan areas. Generally, with more than one megacity as the core, at least three or more large cities as the constituent unit. It has relied on the developed transportation and communication and other infrastructure networks to form a compact spatial organized, close economic tied, and ultimately achieve a high degree of urbanization and high integration. The process of urbanization in China is entering a new stage. Super urban agglomerations such as Beijing-Tianjin-Hebei have emerged and become necessary growth poles for urban agglomerations.

The concept of the Beijing-Tianjin-Hebei urban agglomeration was developed from the capital economic circle. Beijing plays an absolute core and radiation driving role in this urban agglomeration. However, there are still problems in developing the Beijing-Tianjin-Hebei urban agglomeration.

First, the overall level of economic development in the Beijing-Tianjin-Hebei urban agglomeration needs to be improved. The total economic volume of the Beijing-Tianjin-Hebei urban agglomeration is relatively large. However, the per capita GDP reflecting the regional economic development is much lower than that of the Yangtze River Delta urban agglomeration and the Pearl River Delta urban agglomeration.

Second, the driving role of core cities in regional development is not obvious. Beijing-Tianjin-Hebei has two core cities, but too many low-level towns and few medium-sized cities exist. Among them, Beijing's urban functions, technologies, and industries have begun to spread to the surrounding areas. Due to the development of Tianjin as the economic center of the north, the polarization role of Tianjin increases in a certain period. The economic strength of the 8 sub-central cities in Hebei is not strong, and the development level gap between the two cities of Beijing and Tianjin is significant. The ability to accept the radiation of the core economy is limited. It makes it difficult for the marginal areas of urban agglomerations to share the development achievements of central cities.

2. literature reviews

Because of the study of urban agglomerations, many scholars at home and abroad have tried to evaluate the degree of urban agglomeration development from quantitative analysis. In this way, we can compare the differences between different urban agglomerations and control the future development policies on the shortcomings of a specific urban agglomeration. In quantitative measurements of urban agglomerations, "Compactness" is a vital indicator. This indicator was first applied to urban geography research and then gradually extended to urban agglomeration research.

In 1999, Bertaud and Malpezzi proposed many indicators to measure the compactness of cities, including various compactness indices [1]. In 2001, Galster proposed eight indicators to define urban sprawl. Among the 8 indicators, there is an indicator of concentration, which provides a basis for calculating urban compactness [2]. In 2002, NguyenxuanThinh proposed a model of gravitational attraction. The main technology on which the model relies is the GIS raster analysis technique. This technique stimulates the mechanism of the gravitational theorem and introduces it into the calculation of compactness [3]. Burton classified urban compactness into three categories: high-density cities, comprehensive functional cities, and density-increasing cities. Based on each category, a series of measures were identified, and population density was the primary condition for forming compact cities [4]. During this period, Elizabeth Burton established a comprehensive measurement system of urban compactness. [5]. In 2005, Yu-HsinTsai defined several compactness indicators and corresponding quantitative analysis methods at the metropolitan level. Spatial autocorrelation coefficients (Moran's I, Geary's C, and Gini coefficients) are proposed as indicators to measure compactness [6]. In 2007, Fang Chuanglin pioneered the construction of the urban agglomeration abundance index to reflect the degree of agglomeration of cities within the Chinese urban agglomeration [7]. In 2019, Gong Xueyao made compact calculations of nine cities in the Pearl River Delta. The correlation between urban compactness and urban development level is analyzed by grey correlation analysis. Provide new ideas for developing the Pearl River Delta urban agglomeration [8]. In 2019, Liu Yiming took the urban agglomeration in the middle reaches of the Yangtze River as an example. The entropy method and data envelopment analysis method are used. The multi-level Spatio-temporal variation law of urban compactness and urban land use efficiency was analyzed. Through the coupling coordination model, the coupling coordination level and the law of the two are revealed [9]. In 2020, Mao Jinhuang studied 39 counties in the Lanzhou-Xining urban agglomeration. With the help of the entropy right TOPSIS method (Technique for Order Preference by Similarity to an Ideal Solution), a comprehensive measurement model of county-level economic compactness in the Lanzhou-Xining urban agglomeration was established. The Spatio-temporal evolution of county economic compactness from 2011 to 2016 is analyzed comparatively [10]. In 2020, He Qingsong proposed a multidimensional landscape expansion index. The expansion index of the building patch was calculated using the Landscape Expansion Index. The proportion of each city's two expansions is indicated to the sum of the averages of all cities, which is compared to determine whether the compactness of the city is overestimated [11].

In summary, there are relatively mature urban agglomeration compactness measurement models at home and abroad. However, there is a lack of targeted compactness measurement and analysis in the Beijing-Tianjin-Hebei region.

3. Methodology

3.1. Synthetic measurement model

The comprehensive measurement model of urban agglomeration compactness is based on the idea of urban agglomeration compactness. To construct a comprehensive measurement method, three factors are included, such as industry, space, and transportation, which is shown in Figure 1:

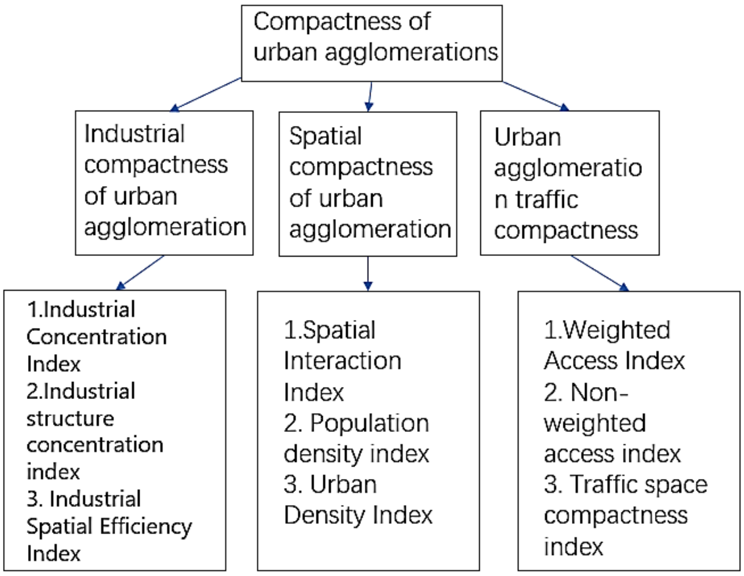

Figure 1. Schematic diagram of urban compactness measurement ideas

If I_c represents the industrial compactness index of the urban agglomeration. I_s is the spatial compactness index of the urban agglomeration. I_t is the traffic compactness index of the urban agglomeration. The α, β, γ represent the weighted influencing coefficients of industrial, spatial, and traffic compactness, respectively. Then the comprehensive compactness index of the urban agglomeration U_c is:

$$U_c=\alpha I_c+\beta I_s+\gamma I_t \tag{1}$$

3.2. A measurement model of industrial compactness in urban agglomerations

Through industrial compactness, the degree of extension of the industrial chain, the reasonableness of the industrial division of labor, and so on can be further analyzed. According to the concept of industrial compactness of urban agglomerations. The industrial concentration index, industrial structure concentration, and the index of economic connection intensity are constructed as the leading indicators for measuring the compactness of industries in urban agglomerations. The industrial concentration index and the industrial structure concentration index are non-spatial directivity indexes. The economic connection strength index is the spatial directivity index. The specific measurement model for the economic compactness of the urban agglomeration is:

$$Ic=\alpha cIcc+\beta cIcj+\gamma cIts \tag{2}$$

$$I_{CC} = \sqrt[2]{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1}} \times \frac{\sum x_i}{n} \tag{3}$$

$$x_i = \frac{M_i^2}{GDP_i} \tag{4}$$

$$I_{CJ} = \sqrt[2]{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1}} \times \frac{\sum x_i}{n} \tag{5}$$

$$x_i = \frac{\delta F_i + \emptyset S_i + \omega T_i}{GDP_i} \tag{6}$$

$$I_{CS} = \frac{\sum_{k=1}^{2}(\beta_i x_{ik} \times \gamma_j x_{jk})}{\sqrt[2]{\sum_{K=1}^{2} X_{ik}^2 \sum_{k=1}^{2} x_{jk}^2}} \qquad i \neq j \tag{7}$$

In Equation (2)—(7): α_c, β_c, γ_c are weighted, which can be seen by the calculation of the AHP (TheAnalytic Hierarchy Process)model supported by entropy technology, α_c=0.30, β_c=0.36, γ_c=0.34. *x* represents the index value of the Ith city in a selected urban agglomeration. $\overline{x}$ It is represented the average of each indicator (the same below). n is the number of cities in the urban agglomeration. M_I is the industrial added value of the Ith city within the urban agglomeration. GDP_i is the gross regional product of the Ith city. *Δ, φ, ω* are tertiary industry weighted values respectively. (According to the calculation of the expert group democratic decision-making method supported by entropy technology, the δ = 1.50, the φ = 3.87, and the ω = 4.63). F_i, S_i, T_i are the output value of the three industries in various local cities. x_{ik} is the proportion of the Kth industry in the Ith city of the urban agglomeration. The so-called relative importance of space refers to the fact that the tertiary industry plays a greater role in the geometric center. A simple way to determine whether it is a geometric center has three steps: The first is to connect two nodes, where the nodes are spatial neighbors. Eliminate interference from intermediary opportunities. The second is to determine the number of connecting lines for each node. The third is used to redistribute according to the quantitative relationship between φ=3.87 and ω=4.63, which establishes the quantitative relationship between φi and ω_i. The spatial efficiency index of industrial structure is transformed based on the index model of industrial structure similarity. The principle is that the greater the internal similarity, the lower the spatial efficiency, the higher the degree of development of the urban agglomeration, and the worse the compactness.

3.3. A measurement model of the spatial compactness of urban agglomerations

According to the concept of spatial compactness of urban agglomerations, three spatially directivistic indicators of spatial interaction index Isi, population density index Isp and urban density index Isu were selected as indicators for calculating the spatial compactness of urban agglomerations. The formula for calculating the spatial compactness index Is of the urban agglomeration is:

$$Is = \alpha sIsc + \beta sIsp + \gamma sIsu \tag{8}$$

$$I_{si} = \frac{\sum_{i,j=1}^{n} \frac{\sqrt{p_i GDP_i} \times \sqrt{p_j GDP_j}}{D_{ij}^2}}{1+2+\cdots+(n-1)} \tag{9}$$

$$I_{sp} = \sqrt[2]{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1}} \times \frac{\sum x_i}{n} \tag{10}$$

$$x_i = \eta_i \frac{P_i}{A_i} \tag{11}$$

$$I_{su} = \frac{\sum a_j N_j}{\sum A_i} \tag{12}$$

Equation(8)—(12): *Isi* is the spatial interaction index. *Isp* is the population density index, and Isu is the urban density index. *αs, βs, γs* are weights. The *AHP* (TheAnalytic Hierarchy Process) model supported by entropy technology was used to obtain *αc*=0.35, *βc*=0.28, and *γc*=0.37. *Pi* and *Pj* are the total populations of the ith and jth cities. *GDPi* and *GDPj* are the *GDP* of the ith and jth cities. Moreover, *Dij* is the distance of the ith and jth cities. *n* is the number of cities in the urban agglomeration. *xi* represents the corresponding index value of the ith city of a selected urban agglomeration. $\overline{x}$ indicates the average value of the corresponding indicator. Futhermore, *n* is the number of cities in the urban agglomeration. *ηj* is the weight of different city levels (Obtained by calculating by the expert group democratic decision-making method under entropy technology support). *j* is 1-5. There are five levels of megacities, megalopolis, metropolises, Medium-sized cities, and small cities. The corresponding weights are 0.36, 0.28, 0.20, 0.12 and 0.04 respectively. *Pi* is the total population of the ith prefecture-level city. *Ai* is the area of the ith prefecture-level city. *j* is the weight of different city levels, *Nj* is the number of cities of the corresponding level (including county-level units), *j* is 1-5: a five-level town system. *Ai* is the area of a certain city.

3.4. A measure of the compactness of traffic in urban agglomerations

According to the concept of traffic compactness. Three indicators of the weighted accessibility index *Itt*, the non-weighted accessibility index *Itf*, and the traffic space compactness index *It's* were selected to measure the traffic compactness index *It* of the urban agglomeration:

$$It=\alpha tItt+\beta tItf+\gamma tIts \tag{13}$$

$$I_{ii}=\frac{\sum_{j=1}^{n}T_{ij}\times\sqrt{P_jGDP_j}}{\sum_{j=1}^{n}\sqrt{P_jGDP_j}} \tag{14}$$

$$I_{tf}=\sqrt[2]{\sum_{i=1}^{n}\frac{(x_i-\overline{x})^2}{n-1}}\times\frac{\sum x_i}{n} \tag{15}$$

$$x_i=\frac{\sum_{i=1}^{n-1}T_{ij}}{n-1} \tag{16}$$

$$I_{ts}=\frac{n\sum_{i=1}^{n}L_{Ni}}{\sum_{i=1}^{n}A_i\sqrt[2]{\sum_{i=1}^{n}\frac{(x_i-\overline{x})^2}{n-1}}} \tag{17}$$

In Equation (13)—(17), *Itt*, *Itf*, and *It's* are the weighted access index, the non-weighted access index, and the traffic space compactness index, respectively. *αt, βt, γt* are weights. Using the expert group democratic decision-making method supported by entropy technology, *αt*=0.28, *βt*=0.16, and *γt*=0.56 were calculated. *Itt* is a weighted accessibility index for node *i* within an urban agglomeration. *Tij* is the minimum time it takes for node *i* to reach the economic center *J* (or destination of activity). $\sqrt{P_jGDP_j}$ is to evaluate the flow of a certain socio-economic factor stream at a regional center and destination of activities within the scope of the system. *n* is the total number of nodes in the evaluation system except *i* nodes. *GDPj* is the gross regional product of *j* cities. *Pj* is the population of *J* city. *xi* represents the corresponding index value of the ith city in a selected urban agglomeration. $\overline{x}$ represents the average of the corresponding metric. *n* is the number of cities in the urban agglomeration. *Tij* is the minimum time it takes for node *i* to reach the economic center *J*. *Lni* is the number of outward direct contact line directions for node *I*, *n* is the number of nodes in the urban agglomeration. *Ai* is the area of *i* city, *xi* is the straight-line distance between nodes. $\overline{x}$ is the average distance of the line between nodes.

4. Result analysis

4.1. Below are the calculated compactness results for the Beijing-Tianjin-Hebei region from 2013 to 2019

Table 1 shows the industrial compactness index, including the industrial concentration index, the industrial structure concentration index, and the industrial structure spatial efficiency index. Moreover, Table 2 illustrates spatial compactness indicators, such as spatial interaction index, population density index, and urban density index. Table 3 demonstrates the traffic compactness index, including the weighted access index, the non-weighted access index, and the traffic compactness index. Table 4 illustrates the comprehensive compactness of urban agglomerations over the years. Figure 2 shows the change in compactness in the Beijing-Tianjin-Hebei region over the years.

Table 1. Industrial compactness index schematic table

Year	Spatial compactness metric			
	Spatial Interaction Index	*Population density index*	*Urban Density Index*	*Spatial compactness of urban agglomerations*
2013	1.433726	1.568623	0.88547	1.268553
2014	1.542842	1.576396	0.89005	1.309836
2015	1.722591	1.571456	0.90269	1.380948
2016	1.860527	1.619672	0.93242	1.462149
2017	2.124731	1.712795	0.95783	1.584494
2018	2.172289	1.791826	0.97279	1.624228
2019	2.392058	1.876743	0.99793	1.732462

Table 2. Schematic table of spatial compactness indicators

Year	Industrial compactness indicator			
	Industrial Concentration Index	*Industrial Structure Concentration Index*	*Spatial Efficiency Index of Industrial Structure*	*Industrial Compactness of urban agglomerations*
2013	1.171008	0.856282	0.92654	0.974588
2014	1.208902	0.832532	0.93357	0.9843
2015	1.212803	0.828624	0.94147	0.983968
2016	1.248206	0.825843	0.96735	0.998664
2017	1.318404	0.812523	0.96153	1.01603
2018	1.377508	0.810381	0.97504	1.032904
2019	1.385408	0.782822	0.98894	1.0337

Table 3. Schematic table of traffic compactness indicators

Year	Traffic compactness indicator			
	Weighted Access Index	*Non-weighted access index*	*Traffic space compactness index*	*Urban agglomeration traffic compactness*
2013	0.226034	0.262357	0.836182	0.362322
2014	0.218653	0.246807	0.848424	0.36931
2015	0.215942	0.221902	0.859173	0.380782
2016	0.211735	0.213568	0.903641	0.410014
2017	0.210793	0.170221	0.920746	0.425726
2018	0.213458	0.180165	0.924611	0.42845
2019	0.203457	0.155784	0.962794	0.455778

Table 4. Calendar year compactness table

Year	Comprehensive compactness of urban agglomerations
2013	0.90261
2014	0.92350
2015	0.95386
2016	0.99819
2017	1.05495
2018	1.07627
2019	1.12585

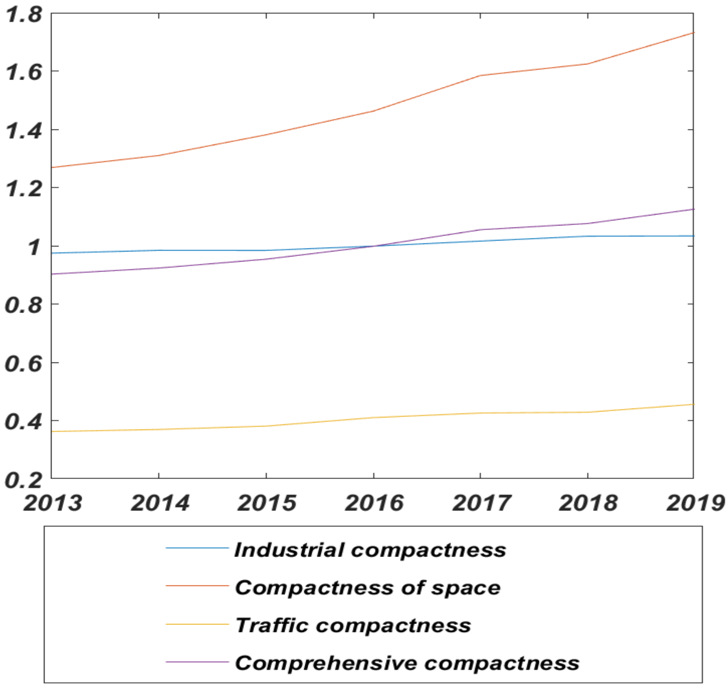

Figure 2. Chart of the change in compactness over the years in the Beijing-Tianjin-Hebei region

According to Figure 2, it is found that between 2013 and 2019, all compactness indicators in the Beijing-Tianjin-Hebei region showed an upward trend. However, the increase in compactness varies significantly from type to type. Among them, the compactness of space is growing rapidly, and the growth rate of industrial compactness and traffic compactness is relatively slow. In terms of industrial compactness. In the past 6 years: the industrial concentration index *Icc* has increased by 18.1%. Industrial Structure Concentration Index *Icj* Decreased by 8.5%. Industrial Structure Spatial Efficiency Index *Ics* Grows by 6.7%. It can be seen that the industry has still had a specific concentration trend over the years. However, the industrial structure has not been optimized too well.

On the contrary, in recent years, it has declined, and the industrial structure space has only been slightly optimized in terms of space compactness. In the past 6 years: the spatial interaction index *Isi* has increased by 66.8%. Population Density Index *Isp* increased by 19.6%. Urban Density Index *Isu* up 12.7%. Combined with the influencing factors of spatial interaction, it can be seen that the population is further concentrated. There is a significant trend from rural to urban, small to large cities. At the same time, the population density index of the city has not been improved too much. It is shown: the scale of large cities is expanding too fast.

In terms of traffic compactness, these 6 years: Weighted Access Index *Itt* reduced by 10%. Non-weighted accessibility index *Itf* decreased by 40.6%. Traffic Space Compactness Index *It* increased by 15.14%. It can be seen that the overall transportation in the Beijing-Tianjin-Hebei region has been optimized, which has been used to a certain extent over the years. The convenience of transportation between cities has been greatly improved.

4.2. Element analysis of Beijing-Tianjin-Hebei urban agglomeration.

It is generally believed that the services of transportation, medical care, and commerce, which play a decisive role in the services of urban agglomerations, are concentrated in densely populated areas. The radiation structure of the entire urban agglomeration is very obvious. The urban agglomeration structure is based on the Beijing-Tianjin core service area and radiates in the south direction. If it is subdivided according to the administrative units at the urban district level. Combined with general cognition, the areas with different service levels in the urban agglomeration are classified into three categories. The city service area classification can be obtained as follows:

Table 5. Number of Urban Service Areas Table I

city	Number of tier 1 urban service areas
BeiJing	5
TianJin	5

Table 6. Number of Urban Service Areas Table 2

city	Number of tier 2 urban service areas
BaoDing	2
TangShan	4
ShiJiaZhaung	2
CangZhou	5

Table 7. Number of Urban Service Areas Table 3

city	Number of tier 3 urban service areas
QinHuangDao	2
ZhangJiaKou	2
HengShui	1
HanDan	5
ChengDe	2
LangFang	3

4.2.1. Analysis of the interior area of the Beijing-Tianjin-Hebei urban agglomeration based on the central land

a) Discussion on the relationship between Beijing's first-level service area and surrounding service area.

Although Beijing and Tianjin belong to the same first-class service area, Tianjin has a special status in the Beijing-Tianjin-Hebei urban agglomeration and belongs to the coastal port city. Therefore, the connection and attractiveness of road and railway with other regions are far inferior to that of Beijing. Therefore, this paragraph mainly discusses the relationship between Beijing and the surrounding secondary service areas. Tianjin will be discussed later as a particular case.

Several sub-service areas are directly linked to Beijing: Tangshan, Langfang, Baoding, Cangzhou, Chengde, and Zhangjiakou. Considering the demographic situation of the surrounding environment of each service area. Although Zhangjiakou and Chengde are three-level service areas, the actual service status and the second-level service area are at the same level in their areas. The relationship between Beijing and the surrounding sub-service areas follows the assumption of the central distribution model. The distance between each sub-center and the core city is roughly equal, and the radiation capacity of the city is relatively uniform. However, there is a difference in the plot attributes of the Yanshan Mountains and the North China Plain in Beijing's location. There is a significant difference in population distribution. From the spatial analysis alone, the layout of Beijing and the surrounding service areas is reasonable. The only thing that needs to be emphasized is the Langfang area. Although it belongs to the tertiary service area in terms of population distribution. However, because it is too close to the two core areas of Beijing and Tianjin, it is a personnel output area in terms of actual personnel mobility. In the integrated urban development of Beijing and Tianjin, Langfang can play an important role as a transit node.

b) Discussion of service interval relationships in the southern region.

In the southern region of Hebei Province, urban service divisions are not as reasonable as in the north. First, there is a lack of strong centers to attract Shijiazhuang, Baoding, and Cangzhou. At the same time, it shows the abnormal situation that there are more secondary centers than tertiary centers.

By the middle term to 2020, the permanent population of Beijing will be controlled by 23 million people. Major problems such as Beijing's "big city disease" will be alleviated, regional integrated transportation networks will be basically formed. The quality of the ecological environment will be effectively improved, and major progress will be made in the development of industrial linkage. The co-construction and sharing of public services have achieved positive results, the coordinated development mechanism has been effectively operated, and the development gap in the region has tended to narrow. They are initially forming a new situation of coordinated development, mutual benefit, and win-win results in Beijing, Tianjin, and Hebei. In the industrial upgrading campaign carried out in Beijing in the past decade, many heavily polluted secondary industries were relocated to Hebei Province, such as the Capital Iron and Steel Group in Tangshan. In developing urban agglomerations, Hebei province is doomed to phase out or clean heavy polluting industries. At this time, a strong regional center is also needed to provide talent, technology, and infrastructure services.

4.2.2. Analysis of the composition of core transportation facilities in urban agglomerations

a) highway

According to the prospects for the development of the Beijing-Tianjin-Hebei urban agglomeration, the three industrial development belts and urban agglomeration axes of Beijing-Tianjin, Beijing-Baoshi, and Beijing-Tang-Qin are the main frameworks supporting the coordinated development of Beijing-Tianjin-Hebei. These three axes are made of three highway traffic arteries of Beijing-Shi Expressway, Beijing-Tianjin Expressway, and Beijing-Qin Expressway. On this basis, the urbanization development and division of labor in the northern part of the Beijing-Tianjin-Hebei urban agglomeration can be better supported. At the same time, the east-west highway network can also ensure that the industry will not gather along the highway and has a better external radiation effect. The most direct highway route from Hengshui to the advanced node is the Yandaguang Expressway to Beijing, which is not conducive to reducing the service pressure in Beijing. The effect of coordinated development within the region is also relatively limited. So, in the south of the urban agglomeration, the existing expressway network has met its social and economic development needs based on future development and industrial iteration. It is still necessary to further supplement the construction of a small number of expressways and strengthen the interconnection of various nodes in a small area.

b) Railway

The distribution of railways in the Beijing-Tianjin-Hebei urban agglomeration is densely packed in the north, the sparser distribution characteristics of the south. At the same time, the trend of spreading in all directions with Beijing as the core is obvious. It is coordinated development trend of port and railway formed in the early years of urbanization not only ensures the freight volume of the railway and the economic development along the railway but also establishes the special status of Tianjin in the Beijing-Tianjin-Hebei urban agglomeration. However, its connection with service nodes other than Beijing in the urban agglomeration is weak. It can still use railways to exert its advantages as a high-quality port city and radiate adjacent non-port areas through the shipping capacity of bulk cargo.

Tianjin's close ties with Beijing established its specialized existence. In a sense, Tianjin is Beijing's port and navigation service point and forms an organic unity with Beijing to serve the entire urban circle. An illustration of this view is the Beijing-Shanghai line railway to Tianjin. However, contrary to this, the Beijing-Tianjin-Hebei urban agglomeration has relatively few railways in its southern part. The inflow of imported products from ports and shipping can also better explore the consumption potential of the vast number of township populations. With Beijing and Tianjin as the core, it is also an inevitable requirement to expand and improve the railway construction to the south of the urban agglomeration. Only in this way can the basic design of the scientific research results enriched in Beijing be put into production and transformation in Hebei Province.

5. Conclusion

The compactness indicators from 2013 to 2019 are calculated. The dynamic change of compactness is obtained by the visual method. In recent years, the coordinated development effect of urban agglomerations in the Beijing-Tianjin-Hebei region has been explored based on this condition. Subsequently, based on the theory of central land, the internal space of the Beijing-Tianjin-Hebei urban agglomeration is analyzed, and the composition of the core transportation facilities of the urban agglomeration is analyzed. Suggestions are provided as follows:(1) The state needs to upgrade the energy level of small and medium-sized cities around Beijing and Tianjin and provide sufficient capital and technical support to ensure that small cities can smoothly undertake large city industries. (2) The efficiency of industrial cooperation in Beijing-Tianjin-Hebei cities is not high. So, efforts need to be made to break down administrative barriers between one province and two cities between regions and achieve efficient industrial cooperation. (3) The comprehensive transportation system needs to be further improved. Strengthen the connection between small cities and core cities. The distance between cities is basically within 400km, which is suitable for vigorously supporting the construction of intercity rail transit.

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