






Study on Network Structure Evolution of High-Quality Development in Beijing, Tianjin and Hebei Based on Social Network Analysis

Hongyun Zhou^(✉) , Yang Liu , and Ying Sun 

School of Economy, Shandong Women's University, Jinan, Shandong, China
{30076, sunying}@sdwu.edu.cn

Abstract. Scientific analysis of the spatial links of the Beijing-Tianjin-Hebei urban agglomeration and the economic connection network it constitutes will help promote the high-quality development of the Beijing-Tianjin-Hebei economy. This paper constructs an indicator system for high-quality economic development in Beijing, Tianjin and Hebei from five dimensions: coordinated development, structural adjustment, degree of openness, ecological environment, and improvement of people's livelihood. With the help of gravitational model and social network analysis, the structure of the economic connection network in Beijing-Tianjin-Hebei is analyzed. The research shows that the intensity of economic ties between Beijing, Tianjin and Hebei has experienced a state of development from a low level to a high level. There are gradient distribution characteristics of different degrees in urban agglomerations. Judging from the dynamic fluctuations, the fluctuations of the economic development level of the Beijing-Tianjin-Hebei region show four trends: "stability", "regression", "leap forward" and "shock".

Keywords: High-quality development · Social network analysis · Beijing-Tianjin-Hebei · Gravitational model

1 Introduction

2021 is the year to achieve the medium-term goal of the coordinated development of Beijing-Tianjin-Hebei, the beginning of the 14th Five-Year Plan, and an important year for the coordinated development of Beijing-Tianjin-Hebei. At present, China has the Beijing-Tianjin-Hebei urban agglomeration, the Yangtze River Delta urban agglomeration, and the Pearl River Delta urban agglomeration, compared with the latter two urban agglomerations, the gap between Beijing-Tianjin-Hebei urban development is large, and there are large differences in both economic aggregates and growth rates, and the competitiveness is relatively weak. In addition, at present, the Beijing-Tianjin-Hebei urban agglomeration still has problems such as the quality of regional development to be improved, the irrational industrial structure, and the external effects of the ecological environment. Under the background of the new era, improving the high-quality economic development level of Beijing, Tianjin and Hebei have an important strategic role

and practical value for accelerating the transformation of economic development mode and accelerating industrial transformation and upgrading [5].

Domestic scholars' research on the high-quality development of Beijing, Tianjin and Hebei is still in its infancy. In recent years, some scholars have begun to devote themselves to the study of synergies in the Beijing-Tianjin-Hebei urban agglomeration [3]. Based on the panel data of 13 urban agglomerations in Beijing-Tianjin-Hebei from 2012 to 2016, Mou Lingling (2019) used social network analysis methods to study the development level and fluctuations of the new urbanization level in the Beijing-Tianjin-Hebei region. The results show that there are obvious differences in the level of development between cities, with Beijing and Tianjin leading other cities in Hebei Province with absolute advantages, and there is also an echelon distribution between cities in Hebei Province.

Research on the quality measurement of economic development in urban agglomerations focuses on empirical research. Wang Deli, Zhao Hong, Sun Li, and Yang Weifeng (2021) divide the quality of economic urbanization into the Economic Efficiency Index (Economic Productivity Efficiency), the Economic Structure Index (the proportion of the added value of the tertiary industry to GDP), the Economic Development Cost Index (energy consumption and waste emissions) and the Economic Growth Momentum Index (average GDP growth rate) [1]. The results show that there are obvious spatial differences in the quality of economic development in the metropolitan area. When Li Lei and Zhang Guixiang (2017) measured the economic energy level of the cities in the Beijing-Tianjin-Hebei urban agglomeration, the total energy level index of the urban agglomeration was calculated based on the GDP energy level, the primary industry energy level, the secondary industry energy level and the tertiary industry energy level. The study classifies Beijing and Tianjin as first-class central cities, Shijiazhuang and Tangshan as second-level central cities, and other cities as third-level central cities, and from a time point of view, Beijing-Tianjin-Hebei still shows a development trend of Beijing and Tianjin as the core [2].

In summary, when different scholars study the quality of economic development in the Beijing-Tianjin-Hebei urban agglomeration, the models and methods used are very different, but the selection of indicators is similar, and the conclusions reached are similar. There are many articles on the measurement of the quality of economic development, but there are few articles on the quality of economic development in the Beijing-Tianjin-Hebei urban agglomeration [4][6]. There are also many articles using social network analysis models to study other problems in Beijing, Tianjin and Hebei (such as the level of new urbanization, economic correlation, etc.), but there are few articles using social network analysis models to study the quality of economic development. Based on this, the panel data of 13 cities in Beijing, Tianjin and Hebei from 2015 to 2019 constructed an evaluation system for high-quality economic development indicators from five dimensions: coordinated development, structural adjustment, degree of openness, ecological environment, and improvement of people's livelihood. With the help of gravitational model and social network analysis (SNA), the structure of the economic connection network of Beijing-Tianjin-Hebei is analyzed, and the spatial network structure of the economic connection of the urban agglomeration is examined, and corresponding countermeasures are proposed, which provides a theoretical basis for improving the high-quality development of the Beijing-Tianjin-Hebei urban agglomeration.

2 Evaluation System Construction

2.1 Data Sources

In this paper, the economic growth of 11 cities in Beijing, Tianjin, Baoding, Tangshan, Langfang, Shijiazhuang, Handan, Qinhuangdao, Zhangjiakou, Xingtai, Chengde, Cangzhou and Hengshui was selected as the research object, and the data was from the Wind database. The proportion of the three industries in each city comes from the "2019 National Economic and Social Development Statistical Communiqué" of each city. The inter-city geographic distance data is derived from the 360 map, and the centrality score is obtained after the Uinet degree center degree processing.

2.2 Index System Construction

Unswervingly promoting the high-quality development of Beijing, Tianjin and Hebei is an important export to relieve the problem of "big city disease" in Beijing and Tianjin, and at the same time is the basic development idea of creating an economically strong province in Hebei. The high-quality development of the Beijing-Tianjin-Hebei urban agglomeration is quite different from the high-quality development of other regions, and the high-quality development of regional coordination is mainly reflected in the integrated development of structural adjustment, transportation and ecology. Therefore, based on the development goals of the 13th Five-Year Plan on Beijing-Tianjin-Hebei, this paper is based on the five new development concepts of "coordinated development, structural adjustment, degree of openness, ecological environment and improvement of people's livelihood" on the basis of other scholars, and the evaluation system for the economic development quality of 13 cities in Beijing-Tianjin-Hebei is constructed in combination with the actual research.

3 Empirical Analysis

3.1 Network Structure Analysis

In this paper, UINET is used to calculate the comprehensive relationship matrix of high economic development quality of the Beijing-Tianjin-Hebei urban agglomeration, and then the economic connection intensity of the Beijing-Tianjin-Hebei urban agglomeration is calculated according to the established gravitational model, and the visual structure diagram of the economic connection network is formed accordingly, and the network centrality analysis of the network structure is performed on the matrix (Table 1).

It can be seen that the intensity of economic ties in the Beijing-Tianjin-Hebei urban agglomeration varies greatly, and the overall gradient distribution is presented. The first gradient is that the economic ties between Beijing and Tianjin are the strongest in the Beijing-Tianjin-Hebei urban agglomeration, far higher than other cities in Hebei Province. Among them, Beijing's economic connection intensity is the highest, in the measurement of high-quality development of all dimensions of the indicators are the highest, GDP contribution rate to its economic connection intensity is the highest, and the geographical distance from other cities is very close, so the intensity of economic

Table 1. Comprehensive relationship matrix of the strength of economic ties in Beijing-Tianjin-Hebei (owner-draw)

	Beijing	Tianjin	Booding	Tangshan	Langfang	Shijiazhuang	Handan	Qinhuangdao	Zhangjiakou	Xingtai	Chengde	Cangzhou	Hengshui
Beijing	0.00	10.61	22.08	21.04	66.26	8.25	12.49	15.11	42.82	13.75	57.58	29.31	19.38
Tianjin	-4.28	0.00	9.45	14.08	19.15	3.13	5.99	7.19	15.09	6.17	28.86	22.33	11.23
Booding	-2.35	-2.49	0.00	0.28	-0.17	-1.16	0.72	0.58	2.31	3.46	3.09	0.70	3.77
Tangshan	-4.00	-6.64	-0.50	0.00	-0.72	-1.27	0.24	0.32	1.36	0.68	5.74	0.98	1.43
Langfang	-6.07	-3.64	0.14	0.34	0.00	-0.97	0.50	0.23	3.21	1.12	5.28	1.82	1.28
Shijiazhuang	-1.34	-1.26	1.77	1.08	1.72	0.00	3.10	0.75	3.56	7.35	4.44	3.59	7.16
Handan	-1.23	-1.46	-0.99	-0.12	-0.53	-1.88	0.00	-0.18	0.96	1.62	1.19	0.20	0.71
Qinhuangdao	-0.69	-0.85	-0.25	-0.08	-0.41	-0.21	0.09	0.00	-2.61	0.37	6.82	0.42	0.54
Zhangjiakou	-1.85	-1.61	-0.94	-0.31	-1.51	-0.95	-0.42	-1.23	0.00	-0.01	0.86	-0.39	-0.41
Xingtai	-0.81	-0.90	-1.91	-0.21	-0.72	-2.66	-0.97	-0.84	0.02	0.00	0.49	-0.42	0.36
Chengde	-2.39	-2.97	-1.20	-1.25	-2.39	-1.14	-0.50	-6.22	-1.23	-0.35	0.00	-0.74	-1.47
Cangzhou	-2.89	-5.46	-0.65	-0.51	-1.96	-2.18	-0.20	-0.91	0.89	0.70	1.75	0.00	0.98
Hengshui	-0.81	-1.16	-1.48	-0.31	-0.58	-1.84	-0.30	-0.50	0.40	-0.25	1.48	-0.41	0.00

ties measured according to the gravitational model is the largest; Tianjin's high-quality development level is also very high, but in the structural adjustment dimension of high-quality development, its centrality score is negative, which lowers the overall level of high-quality development in Tianjin.

The second gradient is Shijiazhuang, Baoding, Langfang, Qinhuangdao, the intensity of its economic ties is positive, although the central value is lower than Beijing, Tianjin, but higher than other cities in Hebei Province, taking Shijiazhuang and Qinhuangdao as an example, in the indicators affecting the strength of economic ties in Shijiazhuang, the level of high-quality development is the most important indicator, which is far lower than Beijing and Tianjin, although leading other cities in Hebei Province, but there is still a big gap with Beijing and Tianjin; Qinhuangdao GDP contribution rate to its economic ties intensity is low, And the geographical distance from other cities is the largest, which greatly reduces the overall score of the intensity of economic ties.

The third gradient is Handan, Tangshan, Hengshui, the intensity of economic ties is negative, taking Tangshan as an example, GDP contribution rate to the intensity of economic ties is 7.68, ranking third in the urban agglomeration, but the level of high-quality development is low, which leads to the low intensity of its economic ties.

The fourth gradient is Xingtai, Zhangjiakou, Cangzhou, Chengde, its economic connection intensity is negative, and far lower than other cities, taking Chengde as an example, chengde's high-quality development level in 2019 is low, in the Beijing-Tianjin-Hebei urban agglomeration is at the bottom, GDP has the smallest contribution rate to the intensity of its economic ties, ranking third in the distance with other cities, so the economic connection intensity is the lowest according to the gravitational model.

3.2 Strength and Direction of Economic Connection

According to the centrality value and ranking of the Beijing-Tianjin-Hebei urban agglomeration from 2015 to 2019, it is divided into stable, weak and strong types according to its fluctuation amplitude. Beijing, Tianjin, Shijiazhuang, Qinhuangdao, Hengshui belong to the stable type, Beijing has been in the first, the most stable; Tianjin fluctuations are small, hovering between the second and third, the overall is stable, the fluctuation is between 0 and 1; Shijiazhuang, Qinhuangdao and Hengshui Comprehensive ranking has not changed. Langfang, Handan, Zhangjiakou, Xingtai, Chengde and Cangzhou are in a weak range, and their fluctuations are 2–3. There are Baoding and Tangshan in a strong range of fluctuations, and their fluctuation amplitude is ≥ 4 (Table 2).

According to the economic development level and fluctuation direction of different cities, the development of cities can be divided into four states: “stability”, “regression”, “leap forward” and “shock”. Although the intensity of economic ties in Shijiazhuang, Qinhuangdao, and Hengshui is low, their economic development level is relatively stable, and the level of economic development in Chengde is relatively low, but the overall trend of change is relatively stable; Tangshan, Langfang, Handan, and Zhangjiakou are in a “retrogressive” situation; Xingtai and Cangzhou are in a “leap forward” situation; Baoding and Langfang are in a “shock” situation.

Table 2. The intensity of economic ties between Beijing, Tianjin and Hebei and its ranking (owner-draw)

City	2016		2017		2018		2019	
	Centrality	Ranking	Centrality	Ranking	Centrality	Ranking	Centrality	Ranking
Beijing	334.08	1	310.42	1	317.22	1	318.69	1
Tianjin	126.37	2	119.80	2	126.29	2	138.37	2
Baoding	-0.76	7	-0.52	8	4.89	5	8.73	4
Tangshan	23.05	4	13.32	4	10.82	4	-2.37	8
Langfang	-3.55	8	-0.34	7	-2.72	8	3.24	5
Shijiazhuang	35.82	3	31.42	3	28.55	3	31.93	3
Handan	5.54	5	5.08	5	-2.06	7	-1.73	7
Qinhuangdao	2.56	6	1.48	6	1.28	6	3.13	6
Zhangjiakou	-8.32	10	-8.98	10	-10.33	11	-8.77	11
Xingtai	-10.96	11	-10.41	11	-6.84	10	-8.57	10
Chengde	-19.64	13	-15.52	12	-15.41	12	-21.86	13
Cangzhou	-18.75	12	-15.82	13	-15.91	13	-10.44	12
Hengshui	-7.87	9	-8.41	9	-6.06	9	-5.77	9

4 Conclusions and Countermeasures

This paper uses gravitational model and social network analysis to study the network structure of high-quality development and economic linkage of the Beijing-Tianjin-Hebei urban agglomeration from 2015 to 2019, and comprehensively evaluates it, and draws the following conclusions and countermeasures:

The intensity of economic ties in the Beijing-Tianjin-Hebei urban agglomeration is accelerating, and Beijing and Tianjin, which are at the core of the space network, have a strong radiation driving effect on surrounding cities, accompanied by a certain degree of siphon effect.

From the spatial characteristics of the intensity of economic ties in the Beijing-Tianjin-Hebei urban agglomeration, Beijing and Tianjin are in an absolutely leading position, far higher than the 11 cities in Hebei Province; there are also different degrees of gradient distribution characteristics between 11 cities in Hebei Province, and cities should give full play to their advantages and leading roles according to their own development characteristics, overcome disadvantages, and better integrate into the coordinated development of Beijing-Tianjin-Hebei.

From the perspective of dynamic fluctuations, the fluctuations in the economic development level of the Beijing-Tianjin-Hebei urban agglomeration from 2015 to 2019 showed four trends: “stability”, “regression”, “leap forward” and “shock”. Cities should seek better and more stable development according to fluctuations.

Based on the research conclusions of this paper, we put forward policy suggestions for improving the quality of the coordinated economic development of Beijing, Tianjin and Hebei:

Accelerate the integration process of key areas and promote a reasonable layout within the industrial chain of the Beijing-Tianjin-Hebei urban agglomeration. The second gradient, the third gradient and the fourth gradient urban agglomeration are actively integrated into the coordinated development of Beijing-Tianjin-Hebei. Actively introduce the advanced scientific and technological achievements of the first gradient city, complete the transformation in the city, such as technology research and development in Beijing and Tianjin, and complete the transformation and production in the gradient city, driving the city to form a new industrial cluster. In addition, by undertaking the high-tech information industry, gathering upstream and downstream enterprises, cultivating new kinetic energy, and gradually realizing industrial rebirth and upgrading.

Optimize the regional layout and realize the integrated development of industry, transportation and ecology in Beijing, Tianjin and Hebei. First of all, use innovation to enhance the competitiveness of the industrial chain of the urban agglomeration and improve the level of industrial chain development. Second, establish a Beijing-Tianjin-Hebei ecological compensation mechanism, explore a long-term and sustainable environmental protection governance structure, and achieve the comprehensive and harmonious development of the Beijing-Tianjin-Hebei urban agglomeration. Finally, we will gradually realize the integration of transportation, accelerate the laying of the expressway network in Xiong'an New Area, strengthen the close practice in the hinterland of Beijing, Tianjin and Hebei Provinces, promote the upgrading of the industrial structure of the Beijing-Tianjin-Hebei urban agglomeration, and optimize the regional economic layout.

Acknowledgement. This work was granted by Shandong Provincial Social Science Planning Research Project (NO: 21CSDJ51); Key research topics of philosophy and Social Sciences in Jinan in 2021(JNSK21B48); 2019 The Social Science Planning Research project of Shandong(19CJJJ27); 2020 High Level Scientific Research Project Cultivation Fund Project of Shandong Women's University (2020GSPSJ07).

References

1. Chang G H, Brada J C. (2002). The paradox of China's growing under-urbanization. *J. Economic Systems*. 30, 24-40.
2. Chen M, Liu W, Lu D, et al. (2018). Progress of China's new-type urbanization construction since 2014: A preliminary assessment. *J. Cities*. 78, 180-193.
3. Han Y, Ma L. (2019). Study on total factor productivity in the change of industrial structure in Beijing-Tianjin-Hebei. *J. Journal of Quantitative and Technical Economics*. 36, 62-78.
4. Lin P, Meng N. (2020). Measurement and Dynamic Deconstruction of Economic Development Quality in Beijing-Tianjin-Hebei Region under Environmental Constraints: Based on the Perspective of Green Total Factor Productivity. *J. Economic Geography*. 40, 36-45.
5. Liu H. (2020). Taking the construction of the pilot free trade zone as an opportunity to promote the coordinated development of Beijing, Tianjin and Hebei -- a summary of the 2020 counselor Seminar on the coordinated development of Beijing, Tianjin and Hebei. *J. Economy and Management*. 6, 1-5.
6. Luo K, Li G. (2020). Lao Xin. Restructuring and Optimal Regulation of Industrial Space in Beijing-Tianjin-Hebei Urban Agglomeration. *J. PROGRESS IN GEOGRAPHY*. 39, 179-194.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

