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DIFFERENCE ANALYSIS OF THE IMPACT OF PORT ADJACENCY ON THE HIGH-QUALITY DEVELOPMENT OF URBAN ECONOMY IN HEBEI PROVINCE

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Abstract. *Port is a key node connecting land economy and sea economy. It promotes the economic development of adjacent areas. In 2017, the Chinese government believed that China's economy has shifted from high-speed development to high-quality development. Historical experience shows that the structure of high quality of China's economic development in the East and low quality in the West has a direct relationship with the fact that there are many ports in eastern China, while the western region is far away from ports. For Hebei Province, there are similar problems. The research on the impact of the adjacency of cities and ports on the high-quality development of urban economy in Hebei Province is typical. It has great reference significance not only for the future adjustment of industrial policy in Hebei Province, but also for the national adjustment of industry. Therefore, the problem of this paper is how the adjacency of cities and ports makes the spatial difference of urban high-quality development. In this paper we use analytic hierarchy process (AHP) to evaluate the high-quality development of urban economy in Hebei Province. Then we take the generalized nested spatial regression model as the basic model to research the mechanism of port adjacency affecting the high-quality development of urban economy. Through this study, we draw the following conclusions. Firstly, the port adjacency of cities in Hebei Province does affect the high-quality development level of urban economy, and there are obvious spatial differences. Secondly, the high-quality economic development of eastern coastal cities is negatively correlated with the adjacency of ports. It shows that port cities can no longer rely on ports to improve the quality of economic development. They must change their development ideas and promote high-quality economic development from other aspects. Thirdly, for central and western cities, we can promote high-quality economic development by accelerating infrastructure construction and improving the adjacency of cities to ports.*
Keywords: Port adjacency, High-quality development, Regional difference

1. **Introduction.** As a major transportation infrastructure for large-scale transfer of materials, the port is a key node connecting the land economy and the sea economy. It not only ensures the economic development of adjacent areas in terms of logistics and transportation, but also enables funds, talents and technologies to gather in the adjacent areas of the port, forming a port economic zone near the port, and promoting the economic development of adjacent areas [1,2]. In 2017, the Chinese government believed that China's

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economy has shifted from high-speed development to high-quality development [3]. In the "Beijing-Tianjin-Hebei" region, Hebei Province is the most backward pole, with the largest population and area. Therefore, the high-quality economic development of Hebei Province determines the success or failure of the "Beijing-Tianjin-Hebei" coordinated development strategy. At the same time, Hebei Province is also a coastal province. There are Tangshan port, Qinhuangdao port, Huanghua port and other ports in the province, and these ports are distributed in the east of Hebei. The cities in the central and western regions need to be connected with the world through the ports in the East. See Figure 1. Historically, China's economic modernization has shown a radiating trend from the port to the inland [4]. In view of the huge promotion and spatial effect of ports on urban economic development, this paper will study the regional differences of the impact of the proximity of cities and ports in Hebei Province on the high-quality development of urban economy. The results can provide policy suggestions for Hebei Province to adjust its development strategy and promote the high-quality development of urban economy. Historical experience shows that the structure of high-quality economic development in the East and low quality in the West is directly related to the fact that there are many ports in eastern China, while the western region is far away from the ports. For Hebei Province, there are similar problems. Hebei Province is a typical eastern coastal, central plain and western mountainous province. The research on the impact of the adjacency of cities and ports on the high-quality development of urban economy in Hebei Province is typical. It is of great significance not only for Hebei Province to adjust industrial policies in the future, but also for the whole country to adjust industries. Therefore, the problem of this paper is whether the spatial difference of high-quality urban development in Hebei Province can be explained by the adjacency of cities and ports, or how the adjacency of cities and ports makes the high-quality urban development show spatial differences.

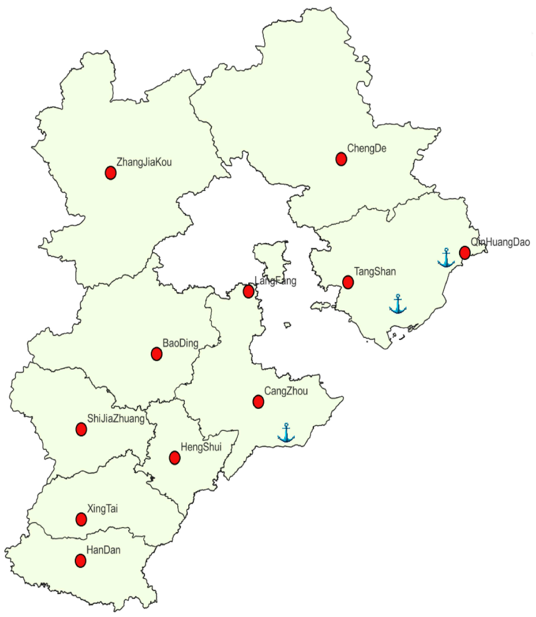

FIGURE 1. Map of Hebei Province

2. Model Building and Data Sources.

2.1. Evaluation model of high-quality development of urban economy in Hebei Province. A scientific and reasonable index system is the basic work to realize the evaluation of high-quality urban economic development. Therefore, this paper first puts forward a scientific evaluation index system of high-quality urban economic development through the study of relevant literature. In previous studies, different scholars have constructed the evaluation index system of economic development quality from different angles for different purposes.

In 1996, the United Nations Commission for Sustainable Development proposed a sustainable development indicator system composed of 33 core indicators. Song and Fan constructed an economic development quality evaluation index system including 16 specific indicators from four aspects: market quality, people's livelihood quality, environmental quality and sharing quality [5]. Ma and Chen constructed a quality evaluation index system of economic development in Shandong Province including 25 specific indicators from six aspects: economic growth, economic efficiency, economic structure, ecological environment, growth sustainability and financial development [6]. Liu constructed an evaluation index system of the economic development quality of big cities composed of 10 indicators from the four dimensions of sufficiency, coordination, innovation and sustainability [7]. In order to evaluate the economic development quality of 11 coastal provinces in China, Hu and Zhang, based on the five development concepts of innovation, coordination, green, openness and sharing, constructed an economic development quality evaluation index system including 16 element layers and 49 specific indicators [8]. Although these documents have constructed the evaluation index system of economic development quality from the national perspective, the perspective of big cities and the perspective of coastal provinces, there is no evaluation index system designed for the high-quality economic development of Hebei Province. Xu and Luo proposed a high-quality economic development evaluation index system consisting of six dimensions: economic vitality, structural optimization, scientific and technological progress, infrastructure, people's livelihood improvement and ecological optimization for the 13 cities in the Beijing-Tianjin-Hebei Urban Agglomeration in combination with the research results of other scholars. The index system includes 24 specific indicators. This paper aims to evaluate the economic development quality of 11 cities in Hebei Province, so this paper adopts this index system of [9]. See Table 1.

2.2. **Analytic hierarchy process model.** According to the nature of the problem and the general goal to be achieved, the analytic hierarchy process decomposes the problem into different constituent factors, and aggregates and combines the factors according to different levels according to the correlation and influence between the factors and the subordinate relationship to form a multi-level analysis structure model. Thus, the problem is finally reduced to the determination of the relatively important weights of the lowest level (schemes and measures for decision-making) relative to the highest level (overall goal) or the arrangement of the relative advantages and disadvantages.

The steps of AHP:

1) Establish a hierarchy model;
2) Construct the judgment (pairwise comparison) matrix;
3) Calculate the weight vector and check the consistency;
4) Calculate the combination weight vector and do the combination consistency test.

Consistency index calculation: $\mathrm{CI} = (\lambda - n)/(n - 1)$, $\mathrm{CR} = \mathrm{CI}/\mathrm{RI}$. CR is compared with 0.1. If $\mathrm{CR} < 0.1$, it means that the consistency test of the matrix is passed; when the eigenvalue and order are the same, $\mathrm{CR} = 0$, then the row corresponding to the matrix is proportional and the column corresponding to it is proportional, indicating that the consistency test is passed. The consistency index RI table is shown in Table 2.

After the above steps, this paper can get the weight of each index. Due to space limitations, weights will not be displayed here.

2.3. **Evaluation result analysis.** This paper uses analytic hierarchy process (AHP) to evaluate the high-quality development of urban economy in Hebei Province. Limited by space, the analytic hierarchy process model will not be repeated here. This study selected the economic and social data of 11 cities in Hebei Province from 2012 to 2018. The

TABLE 1. Evaluation index system for high quality development of urban economy in Hebei Province

Primary index	Number	Secondary index	Computing method
Economic vitality	1	Per capital GDP	GDP/Annual average resident population
	2	Labor productivity	Industrial added value/Average number of employees
	3	Economic growth rate	
	4	Actual utilization of foreign capital in GDP	
Structural optimization	5	The proportion of added value of tertiary industry in GDP	Value-added of tertiary industry/GDP × 100%
	6	Final consumption rate	GDP × 100% Final consumption expenditures/Expenditures GDP × 100%
	7	Urbanization rate	Permanent urban population/Total population × 100%
Advances in science and technology	8	R&D investment intensity	R&D expenditure/GDP × 100%
	9	The proportion of science and technology appropriations from local governments in government expenditure	Local finance science and technology appropriation/Local finance expenditure ×100%
	10	Number of invention patents granted per 10,000 people	Number of invention patents granted/ Annual average resident population
Infrastructure	11	Number of hospital beds per 10,000	Number of beds in health institutions/ Average-age annual resident population
	12	Highway density	Highway mileage/Area of land
	13	Investment in fixed assets per capita	Investment in fixed assets/Annual resident population
	14	Public libraries per capita	Total volume of public libraries/Annual resident population
Improvement of people's welfare	15	Urban and rural comprehensive Engel coefficient	Engel's coefficient of urban residents × proportion of urban population + Engel's coefficient of rural residents × proportion of rural population
	16	Urban per capita disposable income	
	17	Urban and rural income ratio	Urban per capita disposable income/ Rural per capital net income
	18	Urban registered unemployment rate	
	19	Local government appropriations for education as a percentage of GDP	Local government education allocation/ GDP × 100%
Eco-friendliness	20	Energy consumptions per GDP	Energy consumption/GDP
	21	Proportion of days with air quality above grade 2	
	22	Industrial wastewater discharge intensity	Industrial wastewater emissions/GDP × 100%
	23	Afforestation coverage rate of built-up area	
	24	Per capita park green area	Urban green space area/Annual average resident population

TABLE 2. Consistency index RI

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

data came from the Statistical Yearbook of Hebei Province and the statistical bulletin of national economic and social development of each city. Here is the evaluation result of urban economic development quality in Hebei Province.

The results are shown in Table 3.

Table 3. Evaluation results of urban economic development quality

City score	2012	2013	2014	2015	2016	2017	2018
Langfang	0.2908	0.3939	0.4213	0.4528	0.5301	0.5319	0.5800
Qinhuangdao	0.3996	0.4218	0.4122	0.4742	0.4683	0.4841	0.5338
Shijiazhuang	0.3749	0.3906	0.4054	0.4358	0.4365	0.4601	0.4952
Tangshan	0.3511	0.4035	0.4438	0.4537	0.4753	0.4383	0.4736
Cangzhou	0.3262	0.3278	0.3695	0.4103	0.4321	0.4704	0.4565
Handan	0.3504	0.3306	0.3592	0.4117	0.4246	0.4511	0.4294
Baoding	0.3307	0.3242	0.3241	0.3629	0.4354	0.4348	0.4419
Chengde	0.4005	0.3625	0.3982	0.3810	0.4252	0.4171	0.4755
Zhangjiakou	0.3244	0.3657	0.3787	0.3985	0.4191	0.3947	0.4342
Hengshui	0.2951	0.3262	0.3392	0.3625	0.3586	0.3808	0.4217
Xingtai	0.2814	0.3236	0.3388	0.3528	0.3742	0.3646	0.4242

3. Adjacency Measurement of Urban Cities to Ports in Hebei Province.

3.1. City port adjacency measurement model. The adjacency of urban ports is mainly affected by the distance between the city and the port and the cargo throughput of the port. Assumption D_i represents the port adjacency of city $i, j \in J$, where j is the collection of ports around Hebei Province. Then

$$D_i = \sum_{j \in J} D_{ij}$$

D_{ij} is the cargo throughput of the jth port/the distance from the ith city to the jth port.

3.2. Measurement results of urban port adjacency in Hebei Province. This study selected the economic and social data of 11 cities in Hebei Province from 2012 to 2018. The data came from the statistical yearbook of Hebei Province and the statistical bulletin of national economic and social development of each city. Using the above model we can get the results of urban port adjacency in Hebei Province. See Table 4.

Table 4. City port adjacency measurement results

City	2012	2013	2014	2015	2016	2017	2018
Langfang	0.30	0.29	0.41	0.58	0.71	0.88	1.01
Qinhuangdao	11.72	13.15	14.13	17.16	17.76	19.39	20.35
Shijiazhuang	0.12	0.12	0.17	0.24	0.29	0.36	0.41
Tangshan	30.11	24.41	37.12	50.89	64.77	84.61	98.90
Cangzhou	0.26	0.32	0.45	0.66	0.80	0.94	1.06
Handan	0.10	0.10	0.14	0.19	0.23	0.28	0.32
Baoding	0.17	0.18	0.25	0.34	0.42	0.51	0.59
Chengde	0.28	0.26	0.36	0.49	0.60	0.75	0.86
Zhangjiakou	0.14	0.13	0.18	0.25	0.31	0.38	0.44
Hengshui	0.15	0.16	0.22	0.31	0.38	0.46	0.52
Xingtai	0.10	0.11	0.15	0.21	0.25	0.31	0.35

4. **Spatial Econometric Model.** This paper takes the generalized nested spatial regression model of Vega and Elhorst [10] as the basic model. This model considers that the quality of local economic development depends on the quality of economic development in its adjacent areas and a set of local characteristics observed, as well as the error caused by relevant omission changes in adjacent areas.

$$\begin{aligned} EE_{i,t} &= \alpha_i + \gamma D_{i,t} + X_{i,t}\beta + \rho \sum_{j=1}^{N} W_{i,j} EE_{i,t} + \sum_{j=1}^{N} W_{i,j} X_{i,t}\theta + \xi_t + \mu_{i,t} \\ \mu_{i,t} &= \lambda \sum_{j=1}^{N} W_{i,j} \mu_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where i is city; t is time; $EE_{i,t}$ is the quality of economic development for city i in period t; $D_{i,t}$ is the port adjacency (the weighted average of the distance from the city to the port and multiply the port throughput) for city i in period t; $X_{i,t}$ is the control variable; β is the coefficient of the control variables $X_{i,t}$; W is the spatial weight matrix of the relationship between city i and city j; γ is the spatial regression coefficient of the core variable; ρ is the spatial lag autoregressive coefficient; θ is the spatial regression coefficient of the control variable; λ is the autoregressive coefficient of spatial error; α_i is a fixed effect; ξ_t is the time effect; $\mu_{i,t}$, $\varepsilon_{i,t}$ are independent and identically distributed random variables. If $\rho \neq 0$, $\lambda = 0$, $\theta = 0$ in model (1), it becomes a spatial lag model; if $\rho = 0$, $\lambda \neq 0$, $\theta = 0$ in model (1), it becomes a spatial error model. This paper selects the queen adjacency method. If the city i and the city j have a common vertex or edge, it will become adjacent and set $W_{i,j} = 1$, otherwise $W_{i,j} = 0$.

5. **Empirical Analysis.**

5.1. **Spatial effect test.** Before spatial econometric model estimation, it is necessary to test whether the spatial effect of samples exists. This paper uses the global Moran's I index to test whether there is spatial autocorrelation in the quality of urban economic development in Hebei Province. The results are shown in Table 5.

TABLE 5. Spatial effect test results

Year	Moran's I
2012	0.2334*** (0.002)
2013	0.2974*** (0.005)
2014	0.3249*** (0.002)
2015	0.3356*** (0.003)
2016	0.3225*** (0.004)
2017	0.2549*** (0.004)
2018	0.0855 (0.225)

*** Significant at 1% significance level

** Significant at 5% significance level

5.2. **Model applicability test and empirical research.** In addition to Moran's I index test, for different data, whether to select spatial lag model (SLM) or spatial error model (SEM) needs to pass the following tests. According to the steps taken by Elhorst [11], use Lagrange multiplier test (LM) and robust Lagrange multiplier test (RLM) to test and select spatial error model or spatial lag model. The results are shown in Table 6.

Table 6. LM and RLM test results

Test variables	General hybrid panel	Spatial fixation effect	Time fixed effect	Time space double fixed effect
LM test no spatial lag	24.2058*** (0.000)	21.5712*** (0.000)	9.3981*** (0.001)	1.9152 (0.249)
LM test no spatial error	18.9617*** (0.000)	11.5821*** (0.000)	18.3872** (0.015)	2.6959 (0.127)
Robust LM test no spatial lag	10.1727*** (0.002)	18.5658*** (0.000)	5.0532*** (0.000)	0.7192 (0.389)
Robust LM test no spatial error	2.6555 (0.112)	12.3153*** (0.001)	14.5412*** (0.000)	0.9519 (0.435)

Note: The results can be obtained according to Matlab; P value in brackets; ***, **, * represent the significance levels of 1%, 5% and 10%, respectively.

5.3. **Result analysis.** According to the results of LM test and RLM test, the model range is reduced to spatial lag model (SLM) and spatial error model (SEM) with spatial fixed effect and time fixed effect. $W * D$ and $W * ERRO$ represent the spatial lag term and the spatial error term, respectively, and their coefficients are spatial correlation coefficients ρ and λ in the model (1). Through the comparison between the spatial fixed effect model and the time fixed effect model, it is found that the time fixed effect model has a higher degree of fitting, so the final model is locked into the spatial lag model (SLM) and the spatial error model (SEM) of the time fixed effect. The cities in Hebei Province are divided into East, middle and West. The estimation results of spatial lag model (SLM) and spatial error model (SEM) of time fixed effect are shown in Table 7.

Table 7. Estimated results

Model	Eastern region		Central region		Western region	
	SLM	SEM	SLM	SEM	SLM	SEM
D	−0.5483*** (−4.152)	−0.2638** (−3.084)	0.527* (1.4223)	0.5788 (1.742)	0.9765*** (3.7911)	0.8713*** (2.9937)
$W * EE$	−0.2854** (−2.3517)		−0.2453*** (−2.6325)		−0.2581** (−1.9618)	
$W * ERRO$		−0.408*** (−4.9596)		−0.28*** (−3.8314)		−0.432*** (−4.7238)

Note: t value in brackets; ***, **, * represent the significant level of 1%, 5% and 10%, respectively.

Limited by space, the main results are summarized as follows.

1) Port adjacency has a significant spatial correlation with the high-quality development of urban economy in Hebei Province. This can be confirmed by the spatial lag term coefficient $W * EE$ and the spatial error term coefficient. Both the spatial lag model and the spatial error model have significant spatial correlation coefficients at the level of 1%.

2) Port adjacency has a significant regional gap for high-quality economic development. In eastern cities, port adjacency has a negative effect on high-quality economic development. The "high limit effect" of the adjacency of ports with high-quality economic development in the eastern region has emerged. In the central plain area and the western

mountainous area, the adjacency of ports has a positive impact on the high-quality economic development.

6. **Conclusions.** Through this study, we draw the following conclusions. Firstly, the port adjacency of cities in Hebei Province does affect the high-quality development level of urban economy, and there are obvious spatial differences. Secondly, the high-quality economic development of eastern coastal cities is negatively correlated with the adjacency of ports. It shows that port cities can no longer rely on ports to improve the quality of economic development. They must change their development ideas and promote high-quality economic development from other aspects. Third, for cities in central and western China, high-quality economic development can be promoted by accelerating infrastructure construction and improving the adjacency of cities to ports.

Although this paper systematically analyzes the spatial differences of the impact of port adjacency on the high-quality development of urban economy in Hebei Province, the impact of control variables on the high-quality development of urban economy in Hebei Province is not considered in this study. In the next study, the author will consider the control effects of technological innovation, population size and other factors on the relationship between port adjacency and high-quality urban economic development.

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REFERENCES

[1] M. Zhang, Research on the relationship between port prosperity and regional economic development – Empirical analysis based on panel vector autoregressive model, *The World of Survey and Research*, no.9, pp.58-64, 2021.

[2] Z. Guo, H. Kang, W. Zhao and Q. Liu, Research on the interactive relationship between port logistics and regional economic development of Beijing-Tianjin-Hebei region – Analysis based on Granger causality test and grey correlation degree, *Mathematics in Practice and Theory*, vol.50, no.5, pp.32-39, 2020.

[3] Y. Yang and P. Zhang, Logic, measurement and governance in China's high-quality economic development, *Economic Research*, no.1, pp.26-42, 2021.

[4] S. Wu, Port hinterland: A geographical perspective on the study of modernization process, *Academic Monthly*, no.1, pp.121-124, 2007.

[5] M. Song and X. Fan, Exploration and experiment of economic development quality evaluation index system, *Reformation & Strategy*, vol.35, no.4, pp.23-31, 2019.

[6] G. Ma and F. Chen, Evaluation on regional economic development quality of various cities in Shandong, *Journal of Qingdao University (Natural Science Edition)*, vol.33, no.4, pp.110-114, 2020.

[7] W. Liu, Evaluation on economic development quality of Beijing, Shanghai, Guangzhou and Shenzhen, *Cooperative Economy and Science and Technology*, no.1, pp.48-50, 2022.

[8] Z. Hu and X. Zhang, Quality evaluation and obstacle factor diagnosis of economic development in coastal provinces of China, *Statistics and Decision*, no.4, pp.112-117, 2022.

[9] Y. Xu and P. Luo, Evaluation of the quality of economic development of Beijing-Tianjin-Hebei urban agglomeration, *Journal of Hebei University (Philosophy and Social Science)*, vol.45, no.4, pp.85-98, 2020.

[10] S. H. Vega and J. P. Elhorst, The SLX model, *Journal of Regional Science*, vol.55, no.3, pp.339-363, 2015.

[11] J. P. Elhorst, MATLAB software for spatial panels, *International Regional Science Review*, vol.37, no.3, pp.1-17, 2014.