Research on the Impact Factors of Logistics Industry Agglomeration on Logistics Industry Carbon Emissions in the Yangtze River Economic Belt

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Abstract: During the period of 2010-2021, an expert group consisting of 11 provinces and the Yang Economic Center Province conducted basic calculations on the carbon emissions and agglomeration of the logistics industry in the Yang Economic Center. A modern spatial Dubin a é t é tabli on the foundation of spatial economy, aimed at clarifying the impact of logistics industry alliances on the carbon mission of logistics industry. The main conclusions are as follows: (1) The logistics industry carbon emission representative offices in Shanghai, Jiangsu, Zhejiang, Hubei and other provinces pointed out that the carbon emissions of the logistics industry in these provinces mainly come from provinces within the Yangtze River Economic Circle, while the logistics industry carbon dioxide emission representative offices in Western regions continue to maintain stability . (2) The logistics industry agglomeration centers in Shanghai, Jiangsu, and Anhui have the highest status in the Yangtze River Economic Circle, which is an indicator of the level of industrial agglomeration. The localization coefficient of the logistics industry in the central region is fluctuating, showing a trend of "foreign trade". (3) In the Durbin model, the impact of industrial agglomeration on logistics carbon emissions tasks is positive, as well as on spatial visual restructuring. Firstly, the impact of energy integration, population and network capacity, as well as the influence of government intervention and network infrastructure construction.

Keywords: Yangtze River Economic Belt, logistics industry carbon emissions, logistics industry agglomeration level, spatial Durbin model, location entropy.

1. Introduction

As the strongest comprehensive strength and strategic support region in China, the modern logistics industry is an important guarantee for the rapid development of the Yangtze River Economic Belt and a pillar industry for the region's economic development. The agglomeration of logistics industry can improve regional innovation level, and the improvement of regional innovation level can promote regional economic growth. To a certain extent, industrial agglomeration has a positive promoting effect on regional economic growth. However, with the continuous expansion of production scale, excessive agglomeration will form between industries, and the crowding effect caused by excessive agglomeration will affect the generation of carbon emissions. In order to address the issue of carbon emissions, governments at all levels have proposed a series of sustainable development strategies, such as accelerating the construction of ecological civilization in the Yangtze River Economic Belt and promoting the green development of the logistics industry. Therefore, in the context of the "joint protection" of the Yangtze River Economic Belt, studying the impact of logistics industry agglomeration level on logistics industry carbon emissions is not only a response to the implementation of energy-saving and emission reduction policies in the Yangtze River Economic Belt, but also plays an important role in achieving regional sustainable development.

2. Overview of Relevant Theories

In the study of industrial agglomeration and carbon emissions, some scholars have analyzed the linear relationship between the level of industrial agglomeration and carbon emissions. The research results of Tian Yun et al. show that both industrial agglomeration and agricultural net carbon effect have spatial autocorrelation, and have a "positive N" - shaped correlation [1]; The research results of Zhu Dongbo et al. show that the relationship between industrial agglomeration and environmental pollution follows an inverted U-shaped curve, and industrial agglomeration is beneficial for reducing pollutant emissions [2]; The research by Cheng Jiesheng et al. shows that there is a non-linear U-shaped relationship between the carbon emission efficiency of ecotourism and environmental regulation [3]; Research by Miao Jianjun et al. found that increasing the level of manufacturing and productive service industry agglomeration would exacerbate environmental pollution, while industrial synergy agglomeration would reduce pollution levels [4]; Guo Anning et al. showed that the coordination between carbon emission efficiency and industrial structure in the Yellow River Basin showed a trend of first decreasing and then increasing [5].

Domestic and foreign scholars have also conducted research and analysis on the mediating role and spatial spillover effects of industrial agglomeration level and carbon emissions, exploring the impact of industrial agglomeration level on carbon emissions. Research by Yang Chuan et al. shows that the energy consumption level of logistics enterprises is one of the mechanisms by which logistics industry agglomeration affects the carbon emissions of logistics enterprises [6]; Li Xiaofan et al. used the level of urbanization as a threshold variable to verify the threshold effects of different industrial agglomerations of productive services, manufacturing, and their synergistic industries on carbon emissions [7]; Zhao Fan et al. found through establishing a GMM model that when the industrial scale is large, the carbon emissions level of the Yangtze River Economic Belt is also high, but then there is a downward trend [8]; Xu Yingzhi et al. studied the impact mechanism of industrial agglomeration on haze pollution [9]; Yan Caozheng and others explored the impact mechanism of logistics industry agglomeration on China's green total factor productivity [10]; Wang Jian et al. used mediation effects, dynamic threshold effects, and asymmetry to study the impact of China's logistics industry agglomeration on cross regional carbon emissions transfer. The study found that carbon transfer under logistics agglomeration has an inverted U-shaped characteristic [11]; Pang Jiangang et al. analyzed the spatiotemporal characteristics and causes of the coupling and synergistic effect of industrial structure upgrading and carbon emission efficiency, revealing the coupling mechanism of the two [12]; Wei et al. explored the response mechanism and spatial effects under the logical framework of "regional development agricultural industry upgrading carbon emissions" [13]; Song et al. used the Kaya LMDI model to analyze the factors affecting carbon emissions and explored the relationship between industrial structure and carbon emissions through coefficient of variation (CV) [14]; Li H et al. used dynamic panel models and mediation effects models to verify the impact of industrial agglomeration on carbon emissions, and found that there is an inverted U-shaped relationship between industrial agglomeration and carbon emissions [15].

From the above literature, it can be seen that most of the relevant literature at home and abroad focuses on manufacturing, agriculture, and tourism industries, with relatively little research on logistics industry clustering and carbon emissions. The logistics industry accounts for about 9% of carbon emissions, making it the third largest source of carbon emissions in China after industry and construction. China is also vigorously developing the Yangtze River Economic Belt to drive the economic development of the western region, which cannot be achieved without the support of the logistics industry. Therefore, based on panel data from 11 provinces and cities in the Yangtze River Economic Belt from 2010 to 2021, this study used fossil fuel calculation method, location entropy method, and spatial Durbin model to analyze the influencing factors of logistics industry agglomeration level on logistics industry carbon emissions in the Yangtze River Economic Belt. The aim is to study the relationship between logistics industry agglomeration and logistics industry carbon emissions while the Yangtze River Economic Belt is developing rapidly under China's dual carbon goals, and promote the sustainable development of the logistics industry economy in the Yangtze River Economic Belt.

3. Research Methods and Data Sources

(1) Decomposition and Calculation of Carbon Emissions

Fossil fuel combustion is the main source of carbon dioxide emissions, and existing research typically estimates carbon emissions using fossil fuel consumption [16]. This study takes the Yangtze River Economic Belt as the research object, and selects eight energy sources including coal, coke, crude oil, gasoline, kerosene, diesel, fuel oil, and natural gas as the research objects according to the methods in the 2006 IPCC National Greenhouse Gas Inventory Guidelines. The specific calculation formula is as follows:

$$\text{Carbon emissions}=\Delta \boldsymbol{C}= \sum_i \boldsymbol{C_i} = \sum_i \boldsymbol{\alpha_i} \times \boldsymbol{\beta_i} \times \boldsymbol{M_i} \qquad (1)$$

In formula (1), is the carbon emissions generated by the consumption of the i-th type of energy in the logistics industry, α i is the conversion coefficient of the i-th type of energy to standard coal benchmark, β i is the carbon emission coefficient of the i-th type of energy, and Mi is the physical consumption of the i-th type of energy.

(2) Measurement of Industrial Agglomeration Level

Industrial agglomeration refers to the high concentration of the same industrial production factors in a certain geographical area under certain location conditions, and the sustained agglomeration of the same industrial production factors in space. The existing research mainly uses measurement methods such as location entropy, spatial Gini coefficient, and Hirschman Herfindahl index. The latter two methods are more suitable for measuring the overall clustering degree and absolute concentration degree, but lack consideration for the relative clustering degree of data. The location entropy method can reduce the differential impact between regions. Based on the analysis of the characteristics and limitations of logistics industry agglomeration in the Yangtze River Economic Belt, a comprehensive evaluation of logistics industry agglomeration in various provinces and cities within the Yangtze River Economic Region was conducted using the location entropy method:

$$LQ_Z = \frac{Q_Z/Q}{G_Z/G} \qquad (2)$$

In equation (2), represents the location entropy of the logistics industry in the Yangtze River Economic Belt region in region Z, represents the added value of the logistics industry in the Yangtze River Economic Belt region in region Z, represents the added value of the domestic logistics industry, represents the gross domestic product in region Z, and represents the gross domestic product. If the ratio is greater than 1, it indicates that there is a high degree of agglomeration in the logistics industry in the Yangtze River Economic Belt region.

(3) Spatial Durbin model

The Spatial Durbin Model (SDM) is a combined extended model of SLM and SEM, which can add corresponding constraint conditions to SLM and SEM. It predicts the impact of one variable on another variable by considering the interdependence between geographic spatial units. The regression model is presented in the following form:

$$Car_{it} = \rho W Car_{it} + a_1 Car_{it} + a_2 Z_{kit} + a_3 W Lag_{it} + \varepsilon_{it} \quad (3)$$

Among them, i and t respectively represent the province, city, and year, represent the carbon emissions of the logistics industry, represent the level of logistics industry agglomeration, represent the control variable, represent the random error term, and a represents the comprehensive impact of logistics industry agglomeration on logistics carbon emissions. If it is positive, it indicates that logistics agglomeration will increase logistics industry carbon emissions, and if it is negative, it indicates that logistics agglomeration will reduce logistics industry carbon dioxide emissions.

By deforming the three factor spatial correlation regression coefficients, we can obtain:

$$lnY_{it} = \beta_0 + \rho \sum W lnY_{it} + \beta_1 lnRdi_{it} + \beta_2 \sum lnRdi_{it} + \lambda \sum lnX_{it} + \theta W lnX_{it} + \varepsilon_{it} \quad (4)$$

In the formula, Yit is the dependent variable, representing the carbon emissions of the logistics industry in region i during period t; Rdi is the explanatory variable of logistics industry agglomeration level; Among them, W represents the spatial weighting matrix, represents the spatial autocorrelation regression coefficient, β represents the coefficient of the corresponding variable, represents the random error, X represents the control variable. At ρ =0，β=0，λ =0, it is a spatial autoregressive mode; At ρ =0，β=0，λ≠0, it is a spatial error model; When ρ≠0，β≠0，λ =0, we call it the spatial Durbin model. If the significance test is passed, the spatial econometric model can be used. The relevant indicators are listed in Table 1.

Table 1. Index System of Factors Influencing Logistics Carbon Emissions Caused by Logistics Industry Agglomeration

variable	index	Indicator Description
Explained Variable	carbon footprint	Calculated out
explanatory variable	industrial agglomeration	Calculated out
control variable	energy consumption	Calculated out
	government intervention	The ratio of fiscal expenditure to fiscal revenue
	Number of industrial population	Employees in the transportation, postal, and warehousing industries
	infrastructure construction	Regional highway mileage
	the volume of freight transport	Total freight volume of highways, railways, and waterways

(4) Data source

The research subjects are Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Chongqing, Sichuan, Guizhou, and Yunnan provinces in the Yangtze River Economic Belt. Panel data on energy consumption, transportation, postal, and warehousing industries in the logistics industry from 2010 to 2021 were selected from 11 provinces and cities in the Yangtze River Economic Belt. The data came from the China Statistical Yearbook and national data of the National Bureau of Statistics from 2010 to 2021, as well as the statistical yearbooks and bulletins of 11 provinces and cities in the Yangtze River Economic Belt from 2010 to 2021. According to geographical location, Shanghai, Jiangsu, and Zhejiang are defined as the eastern region of the Yangtze River Economic Belt; Anhui, Jiangxi, Hubei, and Hunan are the central regions; Chongqing, Sichuan, Guizhou, and Yunnan are the western regions. The observation period of the study is from 2010 to 2021.

4. Empirical Results and Analysis

(1) Calculation results of carbon emissions in the logistics industry

Calculate the carbon emissions of the logistics industry in the Yangtze River Economic Belt according to equation (1), and use Arcmap 10.7 software to conduct spatial visualization analysis of the carbon emissions of the logistics industry in four time periods of 2010, 2014, 2018, and 2021 in various regions of the Yangtze River Economic Belt, as shown in Figure 1.

Year	Shanghai	Jiangsu	Zhejiang	Anhui	Jiangxi	Hubei	Hunan	Chongqing	Sichuan	Yunnan	Guizhou
2010	5469.836	4246.365	3328.836	1537.453	1382.462	3577.826	2563.352	1589.264	2865.835	1506.254	2493.632
2011	5687.831	4300.139	3581.773	1622.76	1399.487	3686.713	2676.44	1749.135	2519.11	1545.651	2680.585
2012	5790.524	4652.812	3758.146	2355.447	1458.908	3708.19	2404.128	2051.985	2707.715	1849.645	2868.469
2013	5790.67	5001.967	3921.831	2592.673	1810.693	3733.706	2986.394	2268.708	1904.084	1730.511	2718.643
2014	5776.233	5475.105	3993.251	2871.722	1852.851	4045.335	3264.955	2157.900	2819.968	1856.652	3075.984
2015	6061.846	5696.434	4236.578	2887.157	2019.087	4117.823	3701.786	2573.619	2747.905	2116.005	2976.711
2016	6748.001	5856.783	4243.384	2919.209	2045.492	5079.985	3847.019	2745.529	3971.708	2334.836	3115.895
2017	7384.861	6123.549	4410.57	3097.723	2118.099	5152.173	3901.762	2887.364	4158.544	2052.315	3185.194
2018	7227.292	6488.622	4302.24	3232.698	2443.427	5273.352	4213.967	2586.715	4174.513	2201.104	3581.684
2019	7510.278	6873.724	4009.272	3119.959	2645.154	5855.251	4365.663	2670.493	4371.078	2353.092	3901.407
2020	6233.596	6935.005	4180.278	3042.595	2619.383	4957.042	4271.2	2482.986	4176.293	2392.482	3752.68
2021	6541.341	6660.567	4342.581	2975.559	2635.962	5802.778	4753.949	2482.644	4334.195	2677.92	3856.296
2022	5387.82	6338.807	4198.295	2740.627	2577.904	5029.147	4715.92	2050.322	4324.754	2673.95	3592.224

Figure 1. Spatial distribution of carbon emissions from logistics industry in various provinces and cities along the Yangtze River Economic Belt

From Figure 1, it can be seen that from 2010 to 2021, the overall carbon emissions level of the logistics industry in provinces and cities along the Yangtze River Economic Belt was relatively stable, and the carbon emission intensity of the logistics industry in the western region continued to steadily improve during the observation period. Shanghai, Jiangsu, Zhejiang, and Hubei provinces are the main sources of carbon emissions from the logistics industry in the provinces and cities along the Yangtze River Economic Belt. The total annual carbon emissions from the logistics industry account for over 67.54% of the total regional carbon emissions for that year. The logistics industry in Shanghai has the highest carbon emissions, accounting for 23.33% of the regional logistics industry's carbon emissions, while the logistics industry in Yunnan Province has the lowest carbon emissions. The overall control of carbon emissions in the logistics industry in Chongqing is relatively stable.

(2) Analysis of the Agglomeration Level of Logistics Industry in the Yangtze River Economic Belt

By collecting relevant statistical data from various regions of the Yangtze River Economic Belt, the logistics industry location entropy coefficients of each province and city in the Yangtze River Economic Belt from 2010 to 2021, as well as their development and evolution in the eastern, central, and western regions, were calculated using formula (2), as shown in Figures 2 and 3.

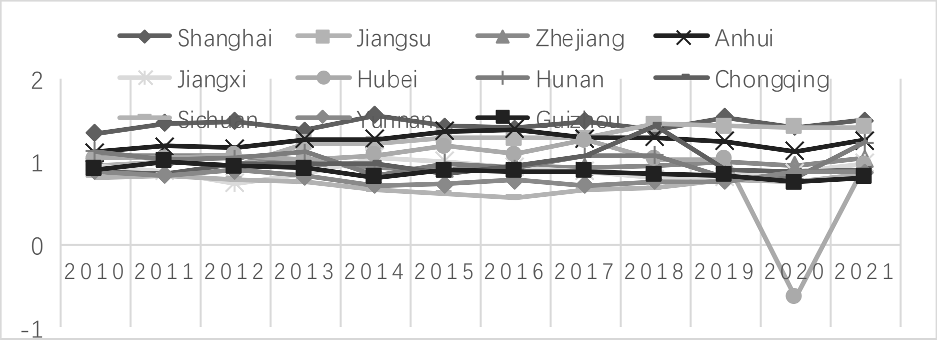

Figure 2. Trend of Entropy Coefficient Changes in Logistics Industry Location in Various Provinces of the Yangtze River Economic Belt from 2010 to 2021

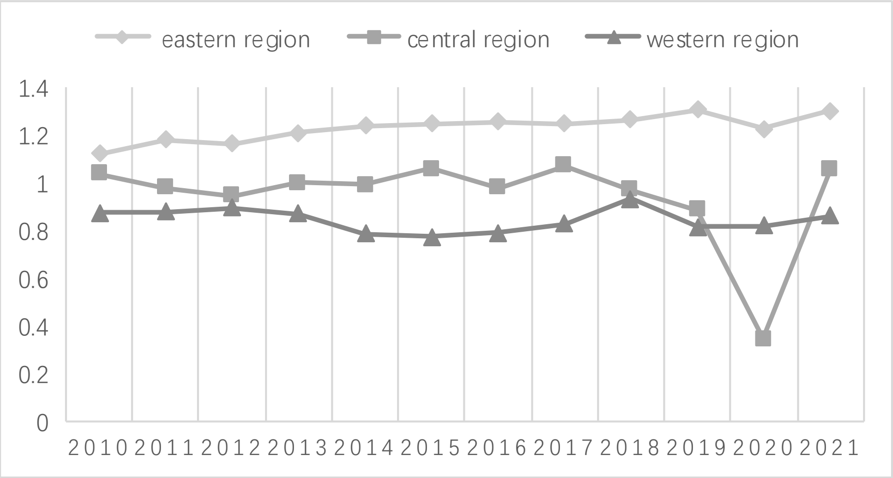

Figure 3. Trend of Entropy Coefficient Changes in Logistics Industry Location in the Three Major Regions of the Yangtze River Economic Belt from 2010 to 2021

From Figures 2 and 3, it can be seen that from 2010 to 2021, there were three provinces and cities in the Yangtze River Economic Belt region with a location entropy of logistics industry clustering level greater than 1, indicating a high degree of industry clustering, namely Shanghai, Jiangsu Province, and Anhui Province. The location entropy of the logistics industry agglomeration level in the Yangtze River Economic Belt is highest in Shanghai, with an average value of 1.4416, followed by Anhui Province, with an average value of 1.2427. Among the 11 provinces and cities, Sichuan Province has the lowest location entropy value for logistics industry clustering, which is 0.7272. Hubei Province had a negative location entropy (-0.6351) in 2020, which may be due to the regression of GDP level that year. The entropy coefficient of logistics industry location in the eastern region of the Yangtze River Economic Belt has shown a slow upward trend in all years except for 2020 when it fell to a low point due to the impact of the epidemic. The entropy coefficient of logistics industry location in some regions shows a fluctuating trend, presenting a "midstream subsidence" trend of logistics industry agglomeration development. The location entropy coefficient of the logistics industry in its western region shows a double "U" - shaped development characteristic of first decreasing and then increasing. The location entropy coefficient reached its minimum value in 2015, then increased year by year, and reached its peak in 2018, gradually narrowing the gap with the central region.

(3) Analysis of the influencing factors of industrial agglomeration on carbon emissions in the logistics industry

1. Selection and verification of spatial econometric models

Currently, based on the different types of spatial interaction effects, there are three commonly used spatial econometric models: Spatial Lag Model (SLM), Spatial Error Model (SEM), and Spatial Durbin Model (SDM). On this basis, we use spatial econometric models to test this spatial correlation. Using formulas (3) and (4), based on the dependent variable, explanatory variable, control variable, and spatial econometric model described in Table 1, LM test was performed using Stata15.1 to identify the required spatial econometric model. The results are listed in Table 2.

Table 2. LM Inspection

Test	Statistic	df	p-value
Spatial error:			
Moran's I	1.394	1	0.000***
Lagrange multiplier	0.915	1	0.000***
Robust Lagrange multiplier	3.469	1	0.000***
Spatial lag:			
Lagrange multiplier	8.903	1	0.000***
Robust Lagrange multiplier	11.456	1	0.034**

Note: *, * *, * * * respectively indicate passing the significance tests of 10%, 5%, and 1%.

The results of the LM test in Table 2 show that both the LM test and Robust LM test of SEM are significant at the 1% level, The LM test of SLM reached a significance level of 1%, and the Robust LM test reached a significance level of 5%. The results showed that both SEM and SLM tests passed the significance level test, indicating that spatial econometric models can be used for research and SDM models should be selected. To verify the accuracy of the results, perform LR and Wald tests again to determine whether to choose the SDM model. The results of LR test and Wald test are shown in Table 3.

Table 3. Spatial econometric model verification

Testing methods	Spatial Error Model (SEM)		Spatial Lag Model (SLM)	
	Statistical	P	Statistical	P
LM-test	0.915***	0.008	8.903***	0.006
Robust LM-test	3.469	0.122	11.456*	0.082
LR-test	22.42***	0.0042	19.94**	0.0106
Wald-test	20.31***	0.0024	21.05***	0.0037
Hausman	25.56***	0.0006		

Note: *, * *, * * * respectively indicate passing the significance tests of 10%, 5%, and 1%.

From Table 3-LR and Wald test results, it can be seen that the LR test of SLM is significant at the 5% level, and the Wald test is significant at the 1% level. The SEM statistics all pass the significance test at the 1% level, indicating that SDM cannot degrade into SEM or SLM. In this case, SDM, i.e. the spatial Durbin model, is chosen. The Hausman results in the table passed the 1% significance test, indicating that fixed effects are superior to random effects models. Therefore, the fixed effects spatial Durbin model is used to study the spatial spillover effect of logistics industry agglomeration on logistics industry carbon emissions in the Yangtze River Economic Belt.

2. Regression analysis of logistics carbon emissions and industrial agglomeration results

For the spatial Durbin model, due to the lack of consideration of the spatial lag term of the independent variable on the mutual influence between adjacent regions, there is a certain degree of bias. However, the effect decomposition of the spatial Durbin model can reflect the direct and indirect effects of logistics carbon emissions in a region and its surrounding areas. The decomposition results of relevant factors are shown in Table 4, and the specific analysis is as follows:

Table 4. Decomposition Results of Durbin Model Effects

variable	direct effect	indirect effect	Total effect
Lnx1	0.870***(15.860)	0.431**(2.100)	1.300***(5.580)
Lna1	0.676*(1.780)	5.223***(3.280)	5.899***(3.200)
Lna2	- 0.232*(-1.760)	0.701 (1.750)	- 0.470(0.960)
Lna3	- 0.444***(6.650)	1.379***(-3.740)	0.935**(-2.250)
Lna4	-0.110(-1.510)	-0.940***(-4.010)	-1.049***(-3.830)
Lna5	0.349***(7.050)	0.478***(2.770)	0.827***(4.180)

Note: * * *, * *, * represent significant levels of 1%, 5%, and 10%, respectively, with Z values in parentheses.

From the decomposition of effects in Table 4, it can be seen that: (1) The direct and indirect effects of industrial agglomeration (lnx1) are significantly positive, indicating that industrial agglomeration not only increases the logistics carbon emissions of the local area, but also increases the logistics carbon emissions of its adjacent areas. Specifically, the direct effect coefficient is 0.870, significant at the 1% significance level, and the spillover effect coefficient is 0.431, significant at the 5% significance level, with direct effects being greater than indirect effects. For every 1% increase in the overall industrial agglomeration level of the Yangtze River Economic Belt, logistics carbon emissions will increase by 1.300%, indicating that industrial specialization agglomeration can promote the increase of logistics carbon emissions.

(2) The direct and indirect effects of energy consumption (lna1) are both positive. For every 1% increase, logistics carbon emissions will increase by 5.8990%, indicating that energy consumption can promote the increase of logistics carbon emissions. Among them, the direct effect coefficient is 0.676, and the significance level is not high. The spillover effect coefficient is 2.223, which is significant at the 1% significance level. Promoting energy consumption by logistics enterprises will lead to an increase in logistics carbon emissions in neighboring areas.

(3) The direct effect of government intervention (lna2) is

positive, and the indirect effect is negative. For every 1% increase, logistics carbon emissions will decrease by 0.470%, indicating that government intervention can suppress the increase of logistics carbon emissions, but the significance level is not high. The direct effect coefficient is -0.232, significant at the 10% significance level, while the spillover effect coefficient is 0.701, not significant. Government intervention has a positive spillover effect, and it can cause regional industrial constraints.

(4) The direct effect of the industrial population size (lna3) is negative, and the indirect effect is positive, both of which have passed the significance test. Among them, the direct effect coefficient is 0.444, significant at the 1% significance level, and the spillover effect coefficient is -1.612, significant at the 1% significance level. The direct effect of industrial population size is greater than the indirect effect. For every 1% increase in the overall logistics industry population in the Yangtze River Economic Belt, logistics carbon emissions will increase by 0.935%, indicating that the number of industrial population can promote the increase of logistics carbon emissions.

(5) The direct and indirect effects of infrastructure construction (lna4) are both negative, with a direct effect coefficient of -0.110, which is not significant, and a spillover effect coefficient of -0.940, which is significant at the 1% significance level, indicating that infrastructure construction will lead to a 0.940% reduction in logistics carbon emissions in neighboring areas. For every 1% increase, the overall logistics carbon emissions in the Yangtze River Economic Belt will decrease by 1.049%, indicating that infrastructure construction can curb the increase in logistics carbon emissions.

(6) The direct and indirect effects of freight volume (lna5) are both significantly positive, with a direct effect coefficient of 0.349, significant at the 1% significance level, and a spillover effect coefficient of 0.478, significant at the 1% significance level. From the perspective of freight volume, the larger the freight volume, the greater the logistics carbon emissions. For every 1% increase in freight volume, it will lead to a 0.349% increase in logistics carbon emissions in the local area, while promoting a 0.478% increase in carbon emissions in neighboring areas. The indirect effect on neighboring areas is greater than the direct effect. On an overall level, for every 1% increase in freight volume, logistics carbon emissions will also increase by 0.827%, indicating that the transportation of goods will cause an increase in carbon emissions in the logistics industry.

5. Conclusion and Implications

This article is based on panel data from 11 provinces and cities in the Yangtze River Economic Belt from 2010 to 2021. Firstly, the location entropy method and carbon emission measurement method are used to measure and analyze the industrial agglomeration level and carbon emission level of the logistics industry in the Yangtze River Economic Belt. Then, a spatial Durbin model is constructed to explore the direct and indirect effects of logistics industry agglomeration on logistics carbon emissions in the Yangtze River Economic Belt. The conclusions are as follows:

(1) From the perspective of carbon emissions in the logistics industry, the overall level of carbon emissions in the logistics industry of provinces and cities along the Yangtze River Economic Belt is relatively stable. Shanghai, Jiangsu, Zhejiang, and Hubei provinces are the main sources of carbon emissions in the logistics industry of provinces and cities along the Yangtze River Economic Belt. The carbon emission intensity of the logistics industry in the western region has continued to steadily improve during the observation period.

(2) From the perspective of logistics industry agglomeration level, from 2010 to 2021, there were three provinces and cities with logistics industry agglomeration level location entropy greater than 1, indicating a high degree of industry agglomeration, namely Shanghai, Jiangsu Province, and Anhui Province. The entropy coefficient of logistics industry location in the central region shows a fluctuating trend, indicating a "midstream subsidence" trend.

(3) From the Durbin model, industrial agglomeration has a significant positive impact on the total carbon emissions of China's logistics industry, and has a significant spatial spillover effect. In addition, the total effect of energy consumption, population size, and freight volume is significantly positive, while the total effect of government intervention and infrastructure construction is significantly negative.

Based on the above research conclusions, this article draws the following insights:

(1) Improve the configuration mechanism of logistics and environment in the development process, accelerate the construction of logistics infrastructure in various provinces and cities of the Yangtze River Economic Belt, maximize its role in promoting regional economic efficiency, actively enhance industrial diversification and agglomeration, promote industry specialization and scale production, enhance the green emission reduction technology innovation efficiency of logistics enterprises, and provide strong support for the healthy development of logistics in the Yangtze River Economic Belt.

(2) The spillover effect of logistics industry agglomeration on carbon emission intensity has significant spatial heterogeneity, and different regions should formulate differentiated strategies according to their own development situation. Secondly, there is regional heterogeneity in the spillover effects of logistics industry agglomeration on carbon emission intensity, highlighting the importance of coordination and cooperation among different regions for carbon emission intensity.

References

[1] Tian Yun; Yin Conghao Research on the Impact of Industrial Agglomeration on the Net Carbon Effect of Chinese Agriculture [J]. Journal of Huazhong Agricultural University (Social Sciences Edition), 2021, (03):107-117+188.

[2] Zhu Dongbo, Li Hong The environmental effects of China's industrial agglomeration and its mechanism of action [J]. China's Population, Resources and Environment, 2021,31 (12): 62-70

[3] Cheng Jiesheng, Lei Junxia The spatiotemporal dynamic impact of environmental regulations on the carbon emission efficiency of the ecotourism industry in national level urban agglomerations [J]. Journal of Central South University of Forestry and Technology, 2023, 43 (03): 175-186

[4] Miao Jianjun; Guo Hongjiao The impact mechanism of industrial synergy agglomeration on environmental pollution: an empirical study based on panel data of the Yangtze River Delta urban agglomeration [J]. Modernization of Management, 2019, 39 (03): 70-76

[5] Guo Anning, Chen Xiao, Li Mi Coupling and Coordination Analysis of Carbon Emission Efficiency and Industrial

Structure Optimization in the Yellow River Basin [J]. Regional Research and Development, 2023, 42 (05): 134-139

[6] Yang Chuan The Mechanism of Industrial Agglomeration on the Carbon Emission Level of Logistics Industry under the Trend of Carbon Neutrality [J]. Business Economics Research, 2022, (13):103-106.

[7] Li Xiaofan; Zhang Hongchao Research on the Impact of Industrial Agglomeration on Carbon Emissions: Nonlinear Analysis with Urbanization Level as Threshold [J]. Ecological Economy, 2019, 35 (10): 31-36+57

[8] Zhao Fan, Luo Liangwen The impact of industrial agglomeration in the Yangtze River Economic Belt on urban carbon emissions: heterogeneity and mechanism of action [J]. Reform, 2022, 335(01):68-84.

[9] Xu Yingzhi, Liu Qi The impact mechanism of industrial agglomeration on haze pollution: an empirical study based on spatial econometric models [J]. Journal of Dalian University of Technology (Social Sciences Edition), 2018, 39 (3): 24-31

[10] Yan Caozheng, Yin Lujiang, He Bo Logistics industry agglomeration, spatial spillover effects, and agricultural green total factor productivity: empirical analysis based on provincial data [J]. China Circulation Economy, 2022 (9): 3-16

[11] Wang Jian, Lin Shuangjiao The Mechanism of Logistics Industry Agglomeration on Cross regional Carbon Emission Transfer [J]. China Environmental Science, 2021, 41 (07): 3441-3452

[12] Pang Jiangang, Li Sisi The spatiotemporal coupling and influencing factors of industrial structure upgrading and carbon emission efficiency in counties of the Chengdu Chongqing Economic Circle [J]. Research on Science and Technology Management, 2023, 43 (02): 101-111

[13] Silin W ,Yinsheng Y ,Ying X .Regional development, agricultural industrial upgrading and carbon emissions: What is the role of fiscal expenditure? —- Evidence from Northeast China[J].Economic Analysis and Policy,2023,801858-1871.

[14] Song J ,Du J W ,Wang F .Carbon Emission and Industrial Structure Adjustment in the Yellow River Basin of China: Based on the LMDI Decomposition Model[J].Nature Environment and Pollution Technology,2023,22(4):2249-2259.

[15] Li H, Liu B. The effect of industrial agglomeration on China’s carbon intensity: Evidence from a dynamic panel model and a mediation effect model[J]. Energy Reports, 2022, 8: 96-103.

[16] Sun Yaohua, Li Zhongmin Research on the decoupling relationship between economic development and carbon emissions in China's provinces and regions [J]. China's Population, Resources and Environment, 2011, 21 (5): 87-92