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Empirical research on coupling coordination degree of logistics industry and advantageous industries in Hu-Bao-Erdos urban agglomaration

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ABSTRACT. The advantageous industry in Hu-Bao-Erdos area is a composite industry including the energy chemical industry, metallurgical and building materials industry, agricultural and livestock products processing industry, equipment manufacturing industry, and strategic emerging industry. Based on panel data from 2011 to 2020, this paper measure and analyze the dynamic coupling synergy between the logistics industry system and the advantageous industries system the logistics industry system, and the five major advantageous industries subsystems. The results show that: in the past 10 years, the development level of the logistics industry is lower than that of the advantageous industry in Hu-Bao-Erdos, which restricts the development of the advantageous industries; the coupling synergy between logistics industry and the five dominant industries tends to be the same basically, and the logistics industry does not carry out deep coupling for a certain advantageous industry; the coupling synergy level between the logistics industry and the advantageous industry changes from being on the verge of imbalance to being mutually worn. It is in phase transition and still has a steady upward trend. In the future, Hu-Bao-Erdos Urban Agglomeration should vigorously develop the regional logistics industry, enhance its support and driving force for the development of regional advantageous industries, and further strengthen the coordination and cooperation between the logistics industry and the advantageous industries to achieve a higher level of coordination.

KEYWORDS. Hu-Bao-Erdos Urban Agglomeration, logistics industry, advantageous industry, indus-trial coordination, coupling coordination degree.

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1. INTRODUCTION

An urban agglomeration is an urban group with more than one megacity as the core and more than three megacities as the constituent units, which is formed by relying on developed infrastructure networks such as transportation and communication, has compact spatial organization, close economic ties, and finally realizes high urbanization and high integration, [1]. The development of urban agglomerations can optimize the allocation of resources, give play to the agglomeration effect, achieve coordinated development and drive the regional economy in a wider range. The logistics industry is the basic industry of the regional economy, has a coupling and interactive relationship with multiple industries, and plays a positive role in accelerating the construction of urban agglomerations. In recent years, the coordinated development of logistics and urban agglomerations has become the focus of attention and research by the government and scholars hotspots. Hu-Bao-Erdos is located in one of the key areas one of the "one belt, one road" and "Sino Mongolia Russian economic corridor". The gross domestic product accounts for more than 50% of the gross domestic product of the Inner Mongolia Autonomous Region. The Inner Mongolia Autonomous Region vigorously promoted the coordinated development of Hu-Bao-Erdos and the construction of the urban agglomeration, and issued the outline of the " Hu-Bao-Erdos collaborative development plan (2016 to 2020)". The development plan of Hu-Bao-Erdos urban agglomeration and other documents provide policy guidance for the construction of Hu-Bao-Erdos urban agglomeration and the realization of regional economic integration. The development of the regional economy mainly depends on the guidance of advantageous industries and the support of basic industries. The logistics industry is a basic industry that can effectively realize regional integration across industries, departments, and regions. It has a strong driving force for multiple industries and economies. This driving force is mainly through cooperation with regional advantages Based on the industrial development planning and current situation of the Inner Mongolia Autonomous Region, the advantageous industries are defined as composite industries including energy and chemical industry, metallurgy and building materials, agricultural and livestock products processing, equipment manufacturing and strategic emerging industries. The research on the coordinated development of regional logistics, economy, and industry has made some achievements in recent years. Most of the existing studies are carried out from the following perspectives: first, the collaborative relationship between logistics industry and regional economic system, [2, 3] have proved that there is a collaborative relationship between logistics industry and regional economy in China and Turkey in different periods, [4]. Based on Liaoning Province and local cities, the synergy degree between port logistics and hinterland economy is calculated and explore the synergy mechanism between logistics industry and foreign direct investment development, [5], the synergy degree between the two systems and find out the existing problems in their coordinated for development, [6]. The degree of synergy between regional logistics and regional economy in the Yangtze River Delta is calculated from the perspectives of region and inter-region, and the evolution law and spatial synergy characteristics of its collaborative development are found. It is not only confirmed that there is significant synergy between the two systems, but also further analyzed the system synergy from the perspective

of spatial synergy development characteristics [7]. Secondly, the synergy between the logistics industry and industrial clusters: confirmed that the logistics industry has a significant role in promoting industrial clusters, and there is a synergistic development relationship between them, [8]. Consideration the collaborative development environment between the construction of international logistics channels and regional key industrial clusters in Hefei and along the Yangtze River and put forward suggestions, and the paper analyzes the collaborative evolution and development relationship between automobile manufacturing industry cluster and regional logistics in Jiangxi Province. Through calculation, it is found that the collaborative dynamic trend of the two systems changes periodically, [9]. The third, the collaborative relationship between logistics industry and a certain industry, [10]. Sun Peng studied the linkage Perspective of logistics industry and manufacturing industry and how to carry out logistics technology innovation, [11]. This paper analyzes the collaborative relationship and evolution mechanism between modern logistics service industry and manufacturing industry, and constructs the realization mechanism of their collaborative development after calculating their degree of synergy [12]. The logistics system is divided into four logistics subsystems, the supply-demand coordination relationship between the manufacturing industry and the four logistics subsystems is analyzed, and a model reflecting the coordination relationship and degree between the manufacturing industry and the four logistics subsystems is established, [13]. Fourth, some scholars have deeply discussed the internal coordination of the logistics system, including the coordination of urban and rural logistics, [14]. The regional logistics internal ecosystem synergy is in , synergy among internal elements of logistics system, [15, 16]. At present, the research focuses more on the one-to-one collaborative relationship between the logistics industry and the regional economy or industry. At the same time, it does not refine it to the specific industry level. When exploring the collaboration with industry, it does not reflect the comparison between the logistics industry and different industries. It is difficult to reasonably allocate logistics resources and reflect the path of regional logistics development. One belt, one road, is to promote the coordinated development of the logistics industry and dominant industries. The logistics resources are allocated reasonably, the logistics industry is coordinated with the five major industries, and the regional competitiveness is better. This paper focuses on the Hu-Bao-Erdos urban agglomeration, analyzes the current situation of the coordinated development of logistics industry and advantageous industries in the urban agglomeration, uses the panel data from 2011 to 2020 to establish a coupling synergy model, calculates the synergy between Hu-Bao-Erdos logistics industry and advantageous industries, logistics industry and five sub advantageous industries, and summarizes the synergy The development trend of the synergy level between the logistics industry and various advantageous industries, further compare and analyze the synergy between the logistics industry and the five advantageous industries, find a breakthrough to promote the coordinated development of the logistics industry and advantageous industries and point out the direction for the coordinated development of the logistics industry and Regional Advantageous industries in Hu-Bao-Erdos Urban Agglomeration.

2. Analysis on the synergy mechanism between logistics industry and advantageous industries in Hu-Bao-Erdos urban agglomeration

2.1. **Development of logistics industry in Hu-Bao-Erdos Urban Agglomeration.** One belt, one road, and the economic corridor between China and Mongolia have widened the development channels for the development of the industry of the Hu-Bao-Erdos. The infrastructure construction has been gradually improved and the overall efficiency has been steadily increasing. It has become an important link for the development of various industries. It is mainly manifested in the following two aspects:

- Logistics resources continue to gather. In 2020, the national development and Reform Commission and the Ministry of transport, together with relevant departments, studied and formulated the layout and construction plan of the national logistics hub Hohhot, Baotou and Ordos are also listed as the supporting cities for the layout of national logistics hubs. With the radiation and driving role of national logistics hubs, Hohhot, Baotou, and Hubei logistics industry forms a hub economy with resource spatial agglomeration by relying on convenient transportation, logistics parks, Internet, and information platforms, and will gradually change from the supporting position of providing services for Regional Advantageous Industries to the guiding position Type status change.
- The popularity of intelligent technology. Hu-Bao-Erdos logistics industry is in a new stage of transformation and development. Now, intellectualization and information technology are gradually applied to production and logistics and ushered in the golden age of intelligent logistics. At the same time, the government also encourages logistics enterprises to actively explore the use of "Internet plus container". Modern logistics technologies such as multimodal transport and intelligent warehouse management promote the development of the logistics industry in the direction of intelligence.

2.2. **Development of advantageous industries in Hu-Bao-Erdos Hubei.** In 2018, the output value of energy and chemical industry, metallurgy and building materials industry, agricultural and livestock products processing industry, equipment manufacturing industry and strategic emerging industries in Hu-Bao-Erdos accounted for about 55.9%, accounting for more than 60% of the added value of the whole region, and the position of advantageous industries was obvious. The specific development status is as follows:

- High end energy and chemical industry. Hu-Bao-Erdos urban agglomeration strives to build a high-end energy and chemical industry cluster. On the one hand, it vigorously develops the coal chemical industry on the premise of environmental protection and pollution control, to achieve high-end energy production and utilization; on the other hand, it develops and utilizes clean energy such as wind energy, solar energy, biomass energy and natural gas according to its location characteristics to promote energy High end industrial structure.

- Industrial chain of Metallurgical Building materials. At present, Baotou Iron and steel industrial base focuses on special demand and high value-added steel products, promotes rare earth steel brands, and constructs non-ferrous metal production and processing industrial chains such as coal blue carbon ferrosilicon magnesium alloy processing. At the same time, the regional non-ferrous metal processing chain is extended to terminal products such as aluminum foil and zinc plate, to extend the industrial chain and improve the attachment Added value.
- Green agricultural and livestock products processing industry. Relying on regional leading enterprises such as Yili, Mengniu and Ordos, we will build advantageous industrial clusters of agricultural and livestock products with characteristics such as milk, meat, cashmere and potato. With the help of regional characteristic culture of Inner Mongolia, we will expand the development space of local agricultural and livestock products processing industry, further optimize and upgrade the production and processing industry of green agricultural and livestock products in Hohhot, and promote the development of sheep and poultry products in Ordos Upgrading of cashmere industry.
- Diversification of equipment manufacturing industry. Build Hohhot new energy automobile industrial park, Baotou and Ordos equipment manufacturing base to form a diversified development trend of engineering machinery, mining machinery, wind power equipment, chemical equipment, heavy trucks, automobiles and parts manufacturing.
- Modernization of strategic emerging industries. Build a network collaborative manufacturing cloud platform centered on Hohhot, and apply various platforms to major industries. Hohhot promotes the upgrading of high-end biopharmaceutical and biotechnology industries, Baotou promotes the development and innovation of national rare earth new material industry, and Ordos focuses on the planning of new energy industries such as wind energy and solar energy.

2.3. **Coordination mechanism between logistics industry and advantageous industries in Hu-Bao-Erdos Urban Agglomeration.** Most advantageous industries in Hu-Bao-Erdos are industrial industries, with a large number of logistics needs such as transportation, warehousing, packaging, circulation processing, loading and unloading, information processing, etc., which require the logistics industry to provide basic services to support the effective operation of regional advantageous industries. At the same time, as an important link for the linkage of advantageous industries, the logistics industry promotes the resource sharing and linkage development among advantageous industries, and provides guarantee for the integrated operation of supply chain among advantageous industries. On the other hand, the logistics industry is an industry that depends on the needs of other industries. The vigorous development and good operation of various advantageous industries are the driving force for the development of regional logistics industry. The requirements of various advantageous industries for logistics scale and level also promote the development of logistics industry. Regional Advantageous Industries represent the focus and direction of regional development. They are often accompanied by the agglomeration of key elements such as capital, information, technology and market, the

spatial agglomeration of production factors and the improvement and development of regional industrial division system, which derive great demand for logistics industry and lead to the transformation and upgrading of animal logistics industry.

3. Construction of research methods and index system

3.1. **Research methods.** Synergy degree is the degree of harmony and consistency between systems or internal elements in the development process, reflects the trend of the system from disorder (low-level development) to order (high-level development), reflects the dynamic development process between systems, which focuses today's social and academic circles. The coupling synergy degree model is widely used to measure the synergy degree. According to the basic principles of the model, the specific steps of measuring the synergy between logistics industry and advantageous industries steps are:

1. Establish the original data matrix of system development level. Using the evaluation index of the development level of logistics industry and advantageous industries, this paper constructs the original data matrix of the development level of logistics industry system and advantageous industry system, which are:

$$X = X_{ij},\ \ Y = Y_{il},\ \ i = 1, 2, ..., n,\ \ j = 1, 2, ..., m,\ \ l = 1, 2, ..., q \tag{1}$$

   where X_{ij} is the original data of logistics industry for j development index in the i year and Y_{il} is the original data of the advantageous industries for l development index in the i year.
2. Data standardization. The data units and dimensions of each index are different, the normalization technique is required. Since the indicators are positive, the standard values of logistics industry and advantageous industries are:

$$u_{ij} = \frac{X_{ij} - min_j(X)}{max_j(X) - min_j(X)},\ \ u_{il} = \frac{Y_{il} - min_l(Y)}{max_l(Y) - min_l(Y)} \tag{2}$$

   the maximum and minimum values of data was 1.01 times of the maximum value and 0.99 times of the minimum value of the development indicators of logistics industry and advantageous industries, so as to avoid the limit value of 0 or 1.
3. Determine the weight of each development indicator. The entropy value is calculated by entropy weight method, and the entropy values of logistics industry and advantageous industry are respectively $e_j,\ e_l$ as follows:

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{m} u_{ij} \ln u_{ij} \tag{3}$$

$$e_l = -\frac{1}{\ln q}\sum_{i=1}^{m} u_{il} \ln u_{il} \tag{4}$$

   Calculate the comprehensive development index of the system. The contribution to the whole system for the larger indexes are much higher, and lower indexes are vice versa.

Then, the weight of each development index of logistics industry and advantageous industry can be determined:

$$\omega_j = \frac{1 - e_j}{n - \sum_{j=1}^{n} e_j} \tag{5}$$

$$\omega_l = \frac{1 - e_l}{q - \sum_{l=1}^{q} e_l} \tag{6}$$

4. To calculate the comprehensive development index of logistics industry and advantageous industries based on weights at time t is described as:

$$u_x(t) = \sum_{j=1}^{n} \omega_j u_{ij}(t) \tag{7}$$

$$u_y(t) = \sum_{l=1}^{q} \omega_l u_{il}(t) \tag{8}$$

5. Build the coupling synergy model. The coupling synergy degree model is based on the coupling degree model CI to measure the synergy degree SD. The degree of coupling indicates the degree of interaction between the two systems, which does not reflect the contribution of each system development level to the overall coupling. The degree of mutual collaboration between systems is improved by weighting, forming a coupling collaboration model between systems [15], which measures the dynamic collaboration level between systems. The coupling and synergy degree model between logistics system and advantageous industrial system is constructed as:

$$CI = \sqrt{\frac{u_x(t) \times u_y(t)}{u_x(t) + u_y(t)}} \tag{9}$$

$$SD(t) = \sqrt{CI \times G} \tag{10}$$

Among $G = \alpha u_x + \beta u_y$ is the synergy index of the two systems, reflecting the contribution of their comprehensive development level to the degree of synergy, α and β is the contribution coefficient of the logistics system and the advantageous industrial system. Since the logistics industry is one of the service industries of the advantageous industries, it makes $\alpha = 0.4$, $\beta = 0.6$, [17]. Based on relevant achievements, this paper divides the degree of collaboration into five levels as shown in Table 1. Each level represents the corresponding collaboration stage and reflects the dynamic collaboration level between the two systems.

TABLE 1. Synergy level and classification standard.

Collaboration level	Serious imbalance	On the verge of imbalance	Mutual running in	Good coordination	High level collaboration
Synergy degree	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1

3.2. **Data collection and index system construction.**

3.2.1. *Description of data source and composition.* The research data are selected from the statistical yearbook, statistical bulletin and government work report of Inner Mongolia and three cities of Huhhot, Baotou and Ordos from 2011 to 2020, which are true, reliable and authoritative. The sub advantageous industries included in the advantageous industries and their specific industries are shown in Table 2. The index data of the advantageous industries are the sum of the index data of the sub advantageous industries, the index data of the sub advantageous industries are the sum of the original data of the specific industries, and the logistics industry data are the original statistical index data of the statistical yearbook or the sum of the indicators of transportation, warehousing and postal industry.

3.2.2. *Construction of development level index system of logistics industry and advantageous industries.* In the selection of indicators, the combination of frequency analysis and empirical analysis is adopted. Search the core journals of CNKI and was database from 2016 to 2020, select 50 literatures with high collaborative correlation with logistics industry and industrial industry (industry, manufacturing, etc.), remove some literatures that are not involved in the construction of index system, and select 36 literatures related to logistics industry and 42 literatures related to industrial industry including the construction of index system (the two are crossed), The frequency analysis Table 3 is established to count the occurrence times of indicators, select the 15 indicators with the highest frequency of the development level of logistics industry and industrial industry respectively, and further screen the identified 15 high-frequency indicators in combination with data availability, the development status of logistics industry and advantageous industries in Hu-Bao-Erdos Urban Agglomeration and policy guidance, and select 9 indicators for logistics industry, Seven indicators are selected for advantageous industries, and the development level index system of logistics industry and advantageous industries in Hu-Bao-Erdos Urban Agglomeration shown in Table 4 is constructed. At the same time, calculate the weight coefficient of each index according to formulas (3) and (4). From the overall perspective of Hu-Bao-Erdos Urban Agglomeration, in the logistics industry system, the largest proportion of highway mileage weight value is 0.132, and the smallest proportion of navigable City weight value is only 0.021; In the advantageous industrial system, the largest proportion of the total output value is 0.444, and the smallest proportion of the number of employees is 0.044.

TABLE 2. Industries and the sub advantageous industries

Industries	Sub advantageous industries
Energy and chemical industry	Coal mining and washing industry; Petroleum processing and nuclear fuel processing industry; Chemical raw materials and chemical products manufacturing; Production and supply of electricity and heat; Gas production and supply industry.
Metallurgical Building Materials Industry	Ferrous metal mining and dressing industry; Nonferrous metal mining and dressing industry; Ferrous metal smelting and rolling processing industry; Nonferrous metal smelting and rolling processing industry; Metal products industry.
Agricultural products processing industry	Agricultural and sideline food processing industry; Food manufacturing; Textile industry; Textile and garment industry; Leather, fur, feather and their products and shoemaking industry.
Equipment manufacturing industry	General equipment manufacturing; Special equipment manufacturing; Electrical machinery and equipment manufacturing; Manufacturing of computers, communications and other electronic equipment.
Strategic emerging technology industry	Information transmission, software and information technology services Scientific research and technology services

4. EMPIRICAL ANALYSIS

4.1. **Analysis on the comprehensive development level of Hu-Bao-Erdos logistics industry and advantageous industries.** Using the panel data of Hu-Bao-Erdos urban agglomeration from 2011 to 2020, combined with the above evaluation index system and the weight of each index, calculate the comprehensive development index of Hu-Bao-Erdos logistics industry, advantageous industry and sub advantageous industry Table 5, with formulas (5) and (6), and use the broken line diagram to show the trend of its comprehensive development level Figure 2. The outcome perspective of the logistics industry, the comprehensive development level of the logistics industry shows a low-speed and steady upward trend, and there is still a large gap between the overall level and advantageous industries, which reflects that there is still a large development space for Hu-Bao-Erdos logistics industry in the future.

The processing perspective of advantageous industries, the comprehensive development level of advantageous industries shows a fluctuating upward trend, and the growth rate is faster than that of the logistics industry. Specifically, the five sub advantageous industries such as Hu-Bao-Erdos agricultural and livestock products processing and energy and chemical industry also showed a fluctuating upward trend, and the comprehensive development index of energy and chemical industry showed an obvious upward trend. In the early stage, due to the serious

TABLE 3. Index frequency analysis

Logistics industry index	Freq.	Industrial indicators	Freq.
Highway mileage (km)	36	Total investment in fixed assets (100 million ¥)	41
Freight volume (10000 tons)	36	Number of enterprises (PCs.)	40
Cargo turnover (100 million tons / km)	34	Growth rate of fixed asset investment (%)	39
Railway mileage (km)	31	Industrial added value (100 million ¥)	38
Logistics employees (10000 persons)	29	Employment (10000 persons)	37
Civilian trucks (10000)	28	Growth rate of industrial added value (%)	33
Total post and telecommunications business (100 million ¥)	27	Industrial output value (100 million ¥)	30
Total length of postal Road (km)	21	Average labor remuneration (¥)	22
Total value of logistics industry (100 million ¥)	18	Asset contribution rate (%)	21
Express business volume (10000 pieces)	15	Total tax revenue (100 million ¥)	12
Logistics fixed asset investment (100 million ¥)	14	Cost profit margin (%)	12
Postal business outlets (PCs.)	11	Labor productivity (%)	8
Navigable cities (PCs.)	10	Profit margin (%)	6
Number of Internet users (10000)	9	Proportion of tax in added value (%)	2
Capacity of mobile telephone exchange (10000)	3	Completed investment in pollution control (10000 ¥)	1
Number of 3 patent applications (item)	2		
Number of students in Colleges and universities (10000)	2		

impact of the economic crisis in 2011, the comprehensive development level of the energy industry was low, and in the later stage, high-speed development was achieved through industrial internal structure adjustment, but it declined in 2020; The comprehensive development index of Metallurgical Building materials industry has been at a high level in the early stage, but it shows a high-level and stable development trend in the later stage. In 2020, the comprehensive development level reached 0.5446, and the comprehensive development degree is the best among the sub advantageous industries; The comprehensive development index of the agricultural and livestock products processing industry increased steadily from 2011 to 2018, and declined to a certain extent from 2019 to 2020 due to the impact of the price and quality of agricultural storage products; The comprehensive development level of the equipment manufacturing industry

TABLE 4. Index system for coordinated development of Hu-Bao-Erdos logistics industry and advantageous industries

Primary index	Secondary index	Tertiary indicators	Type	Weight
	Infrastructure indicators	Basic investment in logistics (100 million ¥)	+	0.074
		Highway mileage (km)	+	0.132
		Railway operating mileage (km)	+	0.125
		Navigable cities (PCs.)	+	0.021
Logistics industry system	Development indicators	Motor vehicle ownership (10000 vehicles)	+	0.128
		Freight volume (10000 tons)	+	0.093
		Post and telecommunications business income (100 million ¥)	+	0.106
		Cargo turnover (100 million ton km)	+	0.126
		Number of employees (10000)	+	0.069
	Development scale index	Basic industrial investment (10000 ¥)	+	0.153
		Number of enterprises (PCs.)	+	0.167
		Total output value (10000 ¥)	+	0.444
Advantageous industrial system	Operation benefit index	Number of employees (person)	+	0.044
		Payroll payable (10000 ¥)	+	0.058
		Enterprise production efficiency (10000 ¥/ piece)	+	0.055
		Average staff salary (¥)	+	0.078

is low, the growth rate is slow from 2011 to 2014, and there is an obvious upward trend from 2015; The comprehensive evaluation index of the strategic emerging technology industry has been steadily improving, but the year-on-year level is low and the development speed is slow.

4.2. **Analysis on the synergy between Hu-Bao-Erdos logistics and advantageous industries.** Based on the calculation of the comprehensive development index of Hu-Bao-Erdos

TABLE 5. Comprehensive development index of Hu-Bao-Erdos logistics industry and advantageous industries

	Logistics industry	Advantageous industry	Energy chemical industry	Metallurgical Building Materials Industry	Agricultural and livestock industry	Equipment manufacturing industry	Strategic emerging industries
2011	0.019	0.0601	0.0122	0.0204	0.0424	0.0324	0.0434
2012	0.0508	0.0783	0.0898	0.2074	0.1244	0.1184	0.0958
2013	0.0756	0.1153	0.1626	0.2436	0.181	0.116	0.1724
2014	0.105	0.257	0.2166	0.3524	0.2028	0.1246	0.211
2015	0.1494	0.26	0.34	0.4232	0.3174	0.3072	0.3734
2016	0.184	0.3124	0.5672	0.3774	0.3444	0.323	0.3954
2017	0.1982	0.416	0.503	0.3838	0.454	0.335	0.4882
2018	0.2192	0.4919	0.4658	0.464	0.4702	0.4238	0.5064
2019	0.2276	0.4533	0.5068	0.4668	0.4212	0.3738	0.4038
2020	0.2718	0.533	0.4422	0.5446	0.4252	0.3702	0.3674

logistics industry and advantageous industries, the synergy between logistics industry and advantageous industries, logistics industry and sub advantageous industries Table 6, and its trend Figure 3 are calculated with the help of formula (8).

It can be seen that the level of synergy between Hu-Bao-Erdos and the logistics industry and the advantageous industries has been steadily improved. The degree of synergy between the logistics industry and the subsystems of the advantageous industries has increased from the serious imbalance stage of about 0.23 in 2011 to the mutual running-in stage of about 0.5 in 2020. The synergy situation has been significantly improved and there is still much room for improvement. In 2011, the synergy between the logistics industry and energy and chemical industry was the highest, 0.2476, and the synergy with the metallurgical building materials industry was the lowest, 0.2227; In 2020, the synergy between the logistics industry and agricultural and livestock products processing industry was the highest, 0.5141, and the synergy with the equipment manufacturing industry and strategic emerging industries was low, 0.4844 and 0.4839 respectively. Except for 2011, the synergy between the logistics industry and the advantageous industries is lower than that between the logistics industry and the sub advantageous industries, but the gap is gradually shortened, indicating that the advantageous industries are gradually coordinated. At the same time, from 2011 to 2020, the synergy degree of Hu-Bao-Erdos logistics industry, advantageous industries, and five sub advantageous industries converged, indicating that the logistics industry and the five sub advantageous industries developed synchronously and cooperatively, and there was no high-level synergy relationship with some advantageous industries, which greatly affected the synergy between Hu-Bao-Erdos

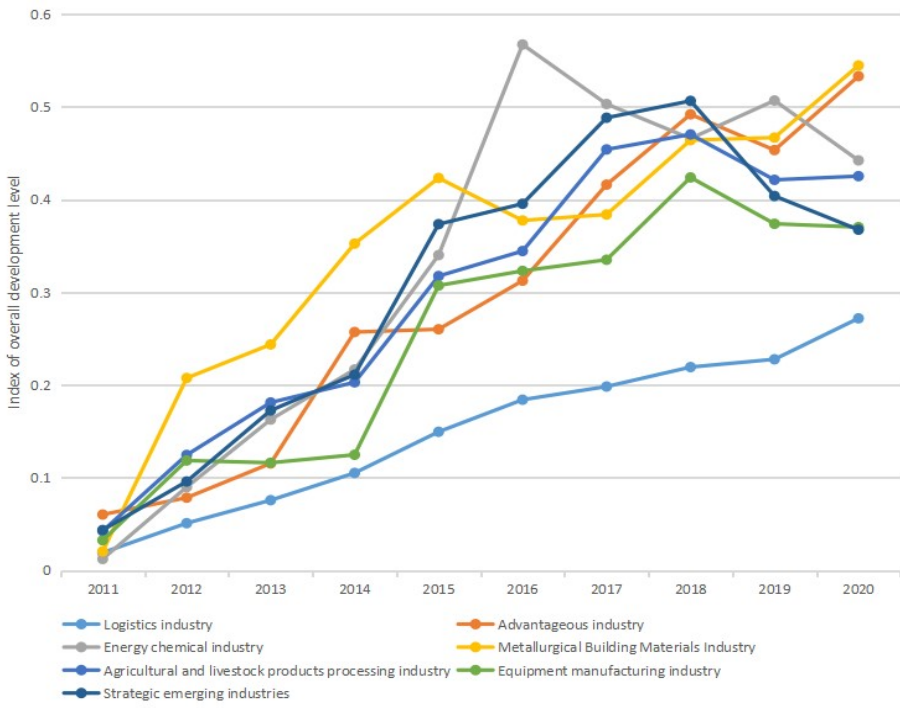

FIGURE 1. Comprehensive development level trend of advantageous industries in Hu-Bao-Erdos.

urban agglomeration logistics industry and advantageous industries, This may also be an important reason why its synergy stage is at a medium and low level. Therefore, one belt, one road, is to strengthen the cross-regional cooperation between the logistics industry and the dominant industries in Hu-Bao-Erdos, and to complement the shortboard of the coordinated development between industries. The acceleration and optimization of the superior industries of Hohhot and Baotou and Hubei will help enhance the market competitiveness of the Hu-Bao-Erdos region and the role of the industrial and commercial exchanges and cooperation between China, Mongolia, and Russia, along with the economic and commercial corridor along the ”one belt” along the route. ”Bridgehead” status.

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the compound system theory and the coupled synergy model, this paper analyzes the development status and collaborative development of the Hu-Bao-Erdos logistics industry and advantageous industries Using the mechanism, this paper constructs the measurement index system of the comprehensive development level of the logistics industry and advantageous

TABLE 6. Synergy between Hu-Bao-Erdos logistics industry and various advantageous industries

	Logistics and advantageous industries	Logistics and energy chemical industry	Logistics and Metallurgical Building Materials Industry	Logistics and agricultural and livestock products	Logistics and equipment manufacturing	Logistics and strategic emerging industries	Collaborative phase
2011	0.2915	0.2469	0.2648	0.2557	0.2602	0.2579	
2012	0.3523	0.3569	0.3779	0.3673	0.3726	0.3699	On the verge of unbalance
2013	0.3887	0.4008	0.4121	0.4064	0.4093	0.4078	
2014	0.4394	0.4336	0.4485	0.4410	0.4447	0.4428	
2015	0.4667	0.4773	0.4847	0.4810	0.4829	0.4819	mutual running-in
2016	0.4905	0.5134	0.4987	0.5060	0.5023	0.5041	
2017	0.5090	0.5164	0.5056	0.5110	0.5083	0.5096	
2018	0.5149	0.5225	0.5223	0.5224	0.5224	0.5224	
2019	0.5129	0.5294	0.5259	0.5276	0.5268	0.5272	
2020	0.5375	0.5386	0.5487	0.5436	0.5462	0.5449	

industries and uses the panel data from 2011 to 2020 to calculate the comprehensive development level of the logistics industry and advantageous industries, and the synergy between logistics industry, advantageous industries and sub advantageous industries in Hu-Bao-Erdos Urban Agglomeration in the past 10 years. The research results show that the comprehensive development level of the logistics industry and advantageous industries in Hu-Bao-Erdos urban agglomeration has increased significantly from 2011 to 2020, but the comprehensive development level of the logistics industry is lower than that of advantageous industries, indicating that advantageous industries contribute greatly to coordinated development, and the logistics industry restricts the development of Regional Advantageous industries, Advantageous industries play a driving role in the logistics industry. Therefore, in the future, Hu-Bao-Erdos urban agglomeration should strengthen the construction of logistics infrastructure, improve the operation efficiency of the regional logistics industry, improve the comprehensive development level of the logistics industry, and realize the benign and high-level development of the logistics industry. The collaborative evolution characteristics between the logistics industry of Hu-Bao-Erdos Urban Agglomeration and the five sub advantageous industries in the past ten years show that the degree of synergy is the same every year, and the trend of synergy is highly

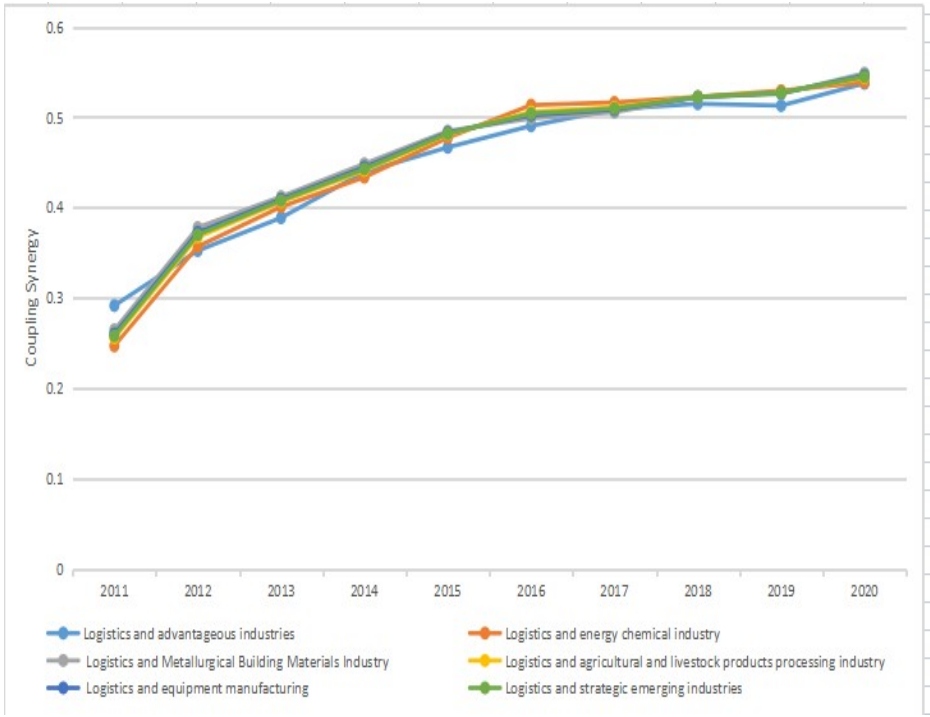

FIGURE 2. Synergy trend of logistics industry and advantageous industries

consistent, indicating that the logistics industry does not have a deeply collaborative relationship with a sub advantageous industry in the development process. The degree of synergy between Hu-Bao-Erdos logistics industry and advantageous industries and their sub advantageous industries has continued to rise in the past decade, from the development on the verge of imbalance to the mutual running in stage at the present stage, but it has not yet evolved to a higher level of synergy stage, and the speed of development and evolution is relatively slow, so the synergy level has great potential and space to improve. Given this, at present, Hu-Bao-Erdos Urban Agglomeration needs to find the entry point for the coordinated development of the logistics industry and advantageous industries. It is suggested to select the energy chemical industry and agricultural and livestock products processing industry with a low degree of synergy, strengthen the integration of the logistics industry and these two industries, and vigorously develop coal chemical logistics and agricultural and livestock products logistics. At the same time, accelerate the construction process of Hukou Baotou Hubei integration, make full use of the advantages of industrial integration and development of urban agglomeration, and realize a higher level of coordination.

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