Research on the Coupled Interaction Between Regional Logistics and E-commerce—A Case Study of Shaanxi Province

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Abstract. With the rapid development of e-commerce, the relationship between regional logistics and e-commerce is becoming increasingly close. Using data from 10 cities and districts in Shaanxi Province from 2016 to 2022, this paper evaluates the development levels of regional logistics and e-commerce. The study explores the coupled coordination relationship between regional logistics and e-commerce in Shaanxi Province. Over time, the average comprehensive development index, coupling degree, and coupling coordination degree show an upward trend with slight fluctuations. Spatially, only Xi'an is in the coordination stage, while other cities are in the borderline imbalance or mild imbalance stages. Based on the coupling coordination degree, relevant policy recommendations are proposed. The development of e-commerce logistics in Shaanxi Province requires the joint participation of logistics enterprises, e-commerce enterprises, users, and the government. Through continuous innovation and cooperation, resource sharing and complementary advantages can be achieved, promoting the economic development and social progress of Shaanxi Province.

Keywords: Regional logistics; E-commerce; Coupling coordination degree; Shaanxi Province

1   Introduction

With the development of e-commerce in China, especially the explosive growth of online shopping, the e-commerce logistics service industry, especially the express service industry, has been greatly promoted, making it an important channel for the circulation of social goods. In recent years, the e-commerce logistics service industry has received significant attention from both national and local governments. In February 2023, the Central Committee of the Communist Party of China and the State Council issued the No. 1 central document, proposing to accelerate the improvement of the e-commerce and express logistics distribution system in counties and villages. In August 2023, the National Development and Reform Commission and other five departments issued the "Notice on the Layout and Construction of Modern Circulation Strategic Pivot Cities," designating Xi'an as a comprehensive circulation pivot city. The Shaanxi

Provincial Department of Commerce and the Provincial Development and Reform Commission, along with ten other departments, jointly issued "Several Measures to Promote the High-Quality Development of Commercial Logistics" (hereinafter referred to as "Measures") to provide strong support for the construction of a new development pattern, and to promote the high-quality development of Shaanxi's commercial logistics through multiple measures.

As the effective carrier of e-commerce, logistics complements e-commerce, determining the service quality and efficiency of e-commerce transactions. Only the mutual enhancement of value between the two can attract more consumers and create more revenue for e-commerce and logistics enterprises[1]. However, treating regional logistics and e-commerce as two independent systems is relatively rare in domestic and foreign research, with more focus on the overall exploration of influencing factors and integration development strategies of logistics e-commerce in various regions[2]. Some scholars have explored the relationship between regional logistics and e-commerce, but the main content still separates the two, ignoring their interdependent relationship[3]. Zhu Xinying (2023), based on the background of rural revitalization, conducted a comprehensive and in-depth study on the development status and existing problems of regional logistics in China[4]. Li Yumin et al. (2020) studied the coordinated development of agricultural e-commerce and cold chain logistics systems in six central provinces by establishing a composite system coordination model and development trend evaluation model, deriving the interrelationships between subsystems, and identifying problems and proposing relevant countermeasures based on the actual development conditions of each province[5].

Therefore, this paper, from the perspective of regional coupling coordination, takes the regional logistics and e-commerce of 10 cities in Shaanxi Province as research objects. Using data from 2015 to 2022, it evaluates the comprehensive indices and determines the weights, exploring the coupling coordination relationship between the two[6]. Since regional logistics and e-commerce are inevitable developments of the times[7], this paper discusses their synergistic effects while analyzing their differences from temporal and spatial perspectives, seeking new paths for the transformation and upgrading of regional logistics and e-commerce, providing a strong basis for accelerating the development of logistics e-commerce in Shaanxi Province and even the whole country.

2   Construction of Regional Logistics and E-commerce Indicator System

2.1   Data Sources and Indicator Selection

This paper studies the coupling coordination degree of regional logistics and e-commerce in 10 cities and districts of Shaanxi Province. Regional logistics is selected as the first subsystem. The fixed asset investment in the logistics industry is a direct reflection of the government's attention to the industry and can indicate future development potential. Since there is no clear data on the logistics industry in the current statistical system, this paper adopts the research method of Wu Peijian et al. (2022), using

transportation and storage fixed investments as the main representation of fixed asset investment in the logistics industry[8]. Logistics turnover can reflect the basic situation of local transportation and the development level of the local logistics industry. The income of the logistics industry and the number of employees in the logistics industry reflect the development level and quality of the express logistics industry, which is also complementary to the development of the e-commerce industry[9]. Infrastructure references Zhu Xinyan (2021)'s logistics indicators, selecting the mileage of highways above the second level to reflect the infrastructure level of regional logistics[10]. The longer the mileage of highways, the more conducive it is to expanding the service scope and objects, and the local e-commerce industry's distribution services will gradually improve, thus promoting economic benefits. Therefore, this paper selects five indicators: fixed asset investment in the logistics industry, logistics turnover, the number of employees in the logistics industry at the end of the year, logistics industry income, and mileage of highways above the second level to measure the development level of regional logistics.

E-commerce development is selected as another subsystem. Considering various factors and data availability, this paper constructs the e-commerce development level system from five indicators: e-commerce transaction volume, the number of enterprises with e-commerce transaction activities, the number of employees in the industry, the number of e-commerce online stores, and the number of internet broadband access users[11]. The specific results are shown in Table 1.

This paper selects 10 cities and districts in Shaanxi Province as research objects, with the study period from 2016 to 2022. The main data sources include "China Statistical Yearbook," "China Energy Statistical Yearbook," "China Tertiary Industry Statistical Yearbook," "Logistics Statistical Yearbook," and the statistical yearbooks of various cities in Shaanxi Province.

Table 1. Regional logistics development evaluation index and E-commerce development evaluation index and weight

Subsystem	Indicators	unit	weight
Regional logistics development evaluation index	Investment in fixed assets of logistics industry	Ten thousand yuan	0.133
	Volume of logistics turnover	Ten thousand tons	0.139
	Number of logistics personnel at the end of the year	Person	0.302
	Revenue from the logistics industry	Ten thousand yuan	0.223
	Grade II and above highway line mileage	Gigatonnes per kilometer	0.203
E-commerce development evaluation index	E-commerce transaction volume	Yuan	0.266
	The number of enterprises with e-commerce transaction activities	pcs	0.120
	Number of people engaged in E-commerce	pcs	0.180
	Number of e-commerce online stores	pcs	0.174
	Internet broadband access users	Ten thousand pcs	0.259

2.2   Entropy Method for Weight Calculation

When determining the weight of regional logistics and e-commerce indicators, the original data is processed by entropy value method, so as to ensure its objectivity and scientificity, so as to obtain the evaluation score of regional logistics and e-commerce development[12].

The entropy method was first used to weight the normalized data. The weight of each index is calculated. Qj represents the information entropy of i year in the j index. Wj is set as the weight of the j index. The larger the weight indicates that the index is more important. The calculation formula is:

$$W_j = \frac{1-Q_j}{\sum_{j=1}^{m}(1-Q_j)} \tag{1}$$

Finally, the comprehensive development index Uk is calculated, which is the sum of the weight and the standard value of the corresponding index. The formula is as follows:

$$U_k = \sum_{j=1}^{m} W_j \times X'_{ij} \tag{2}$$

2.3   Coupling Coordination Degree Model

To evaluate the coordinated development level of regional logistics and e-commerce, the coupling coordination degree model is used. This model can reflect the interaction and mutual influence between the two systems.

Coupling Degree Calculation.
The coupling degree reflects the interaction degree between two systems. The formula is shown in Equation (3):

$$C = \frac{2\sqrt{U_1 U_2}}{U_1 + U_2} \tag{3}$$

Where U_1 and U_2 represent the comprehensive evaluation scores of regional logistics and e-commerce, respectively. The coupling degree C ranges from 0 to 1. A higher C value indicates a higher degree of coupling between the two systems.

Coupling Coordination Degree Calculation.
The coupling coordination degree reflects the harmonious development degree between two systems. The formula is shown in Equation (4):

$$D = \sqrt{C \times T} \tag{4}$$

Where T is the comprehensive coordination index, calculated as:

$$T = \alpha U_1 + \beta U_2 \tag{5}$$

In this study, α and β are taken as 0.5, indicating that regional logistics and e-commerce have equal importance in the coupling coordination system. The coupling coordination degree D ranges from 0 to 1. A higher D value indicates a higher level of coordinated development between the two systems.

3   Empirical Results Analysis

3.1   Analysis of the Coupling and Coordination between Regional Logistics and E-Commerce

In general, in 2016, the coupling degree of regional logistics and e-commerce in Shaanxi Province has always maintained a stable development state, and the coordination degree has been improved substantially, and the coupling degree value is always higher than the coordination degree value. In Figure 1, the coupling degree and coordination degree between the two systems showed a fluctuation trend, but the coordination amplitude is more significant. First, the results of the coupling degree between regional logistics and e-commerce are analyzed. From the perspective of development trend, the coupling degree value between regional logistics and e-commerce increased from 0.9899 in 2016 to 0.9967 in 2017, and decreased by 0.0026 units in 2018. After that, it showed an upward trend and has been at a high level. From the perspective of coupling stage, regional logistics and e-commerce systems have always been at a high level of coupling from 2016-2022, which shows that in the development process of regional logistics and e-commerce, the interaction between the two systems is strong and still gradually increasing. Secondly, the coordination results between regional logistics and e-commerce are analyzed. From the perspective of development trend, the coordination degree between 2016 regional logistics and e-commerce systems since 2022 is in a fluctuating and rising trend. the coordination degree was 0.4271 in 2016, and it has reached 0.5164 by 2022. In terms of coordination type, the coordination type between the two systems also developed from the alignment phase in 2016 to barely coordination in 2022.
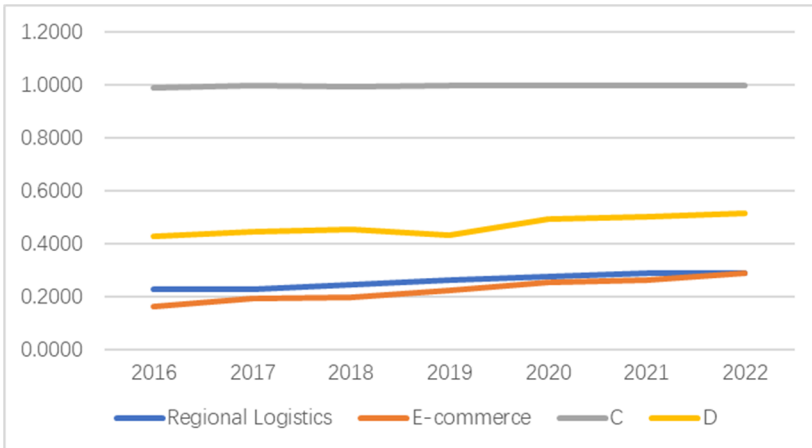

Fig. 1. Comprehensive development index, coupling degree and coordination degree of regional logistics and e-commerce in Shaanxi Province

This paper analyzes the comprehensive development index, coupling degree and coupling coordination degree of regional logistics and e-commerce of 10 cities in

Shaanxi province from 2016 to 2022, and calculates the average coupling coordination degree of 10 cities, and analyzes the regional heterogeneity of regional logistics and e-commerce by region, as shown in Table 2.

Table 2. Average and ranking of coupling coordination between logistics and e-commerce in Shaanxi Province

City	2016	2017	2018	2019	2020	2021	2022	D	grade	rank
Xi'an	0.733	0.768	0.802	0.853	0.909	0.935	0.962	0.852	Good coordination	1
Baoji	0.432	0.462	0.479	0.493	0.530	0.532	0.530	0.494	On the verge of dysregulation	2
Yulin	0.423	0.443	0.457	0.484	0.500	0.503	0.532	0.477	On the verge of dysregulation	3
Xianyang	0.422	0.450	0.445	0.458	0.466	0.477	0.489	0.458	On the verge of dysregulation	4
Weinan	0.409	0.411	0.441	0.461	0.473	0.484	0.494	0.453	On the verge of dysregulation	5
Han-zhong	0.393	0.406	0.422	0.427	0.448	0.453	0.467	0.431	On the verge of dysregulation	6
Yan'an	0.393	0.400	0.401	0.410	0.431	0.442	0.452	0.419	On the verge of dysregulation	7
Ankang	0.372	0.383	0.387	0.396	0.414	0.428	0.441	0.403	On the verge of dysregulation	8
Shangluo	0.348	0.365	0.364	0.374	0.386	0.388	0.399	0.375	Mild dysregulation	9
Tongchuan	0.347	0.360	0.366	0.378	0.382	0.390	0.397	0.374	Mild dysregulation	10

From the perspective of the average coupling coordination degree of all cities in Shaanxi Province, the change range is between 0.3742 and 0.8515, which is within the interval of mild coordination to good coordination. The average coordination degree of Xi'an city is 0.8515, which is in the good coordination category. Most regional average coupling coordination changes range between 0.3 and 0.5, in the mild and near dysregulation stages. The level of coupling and coordination degree among different cities in Shaanxi Province varies greatly, and only Xi 'an city has a high level, indicating that as the provincial capital city of Shaanxi Province, the development level of logistics and e-commerce is much higher than that of other cities, and the local city in the imbalance stage is mainly in other cities except Xi' an. The coordination types of cities were also changing in different periods, but by the end of the study, most of them were in the disorder phase.

Finally, the coupling degree and coordination degree of regional logistics and e-commerce are comprehensively analyzed. Since 2015, regional logistics and e-commerce have been in the stage of continuous development, but due to the gap between the two systems in the development level of different cities, the development of the coordination level between the two is slow, and the coordination relationship is in the stage of excessive imbalance and coordination.

4   Conclusions

By constructing the evaluation system of regional logistics and e-commerce in Shaanxi Province and combining the coupling coordination model of the two systems, calculating the regional logistics and e-commerce development index of 10 cities from 2015-2021, and analyzing the time characteristics of the coupling coordination and the spatial variation of the regional logistics and e-commerce in Shaanxi province from 2015-2021, and many cities are in the disorder stage, and the development between regional logistics and e-commerce is not coordinated. Only Xi'an is in the coordination stage, while other cities are on the verge of imbalance and mild imbalance stage. In order to better development, it is necessary to develop regional logistics as soon as possible, and at the same time, the infrastructure construction of e-commerce should be done well to improve the coordinated development level of the two, and then improve the coupling and coordination of the two systems.

With the continuous development of the logistics industry in Shaanxi Province, the government attaches great importance to the development of the local logistics industry, and the logistics in each city has been developed to different degrees. The coupling development mechanism between logistics and e-commerce in Shaanxi Province is a multi-faceted systematic project, which requires the joint participation of logistics enterprises, e-commerce enterprises, users and the government. Through continuous innovation and cooperation, it can realize resource sharing and complementary advantages, and jointly promote the economic development and social progress of Shaanxi Province.

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