# Research on Trade Facilitation Performance Evaluation of China's Cross-Border E-Commerce Comprehensive Demonstration Cities Based on Entropy Right-Gray Correlation: From Research on Thirteen Cross-Border E-Commerce Cities

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**ABSTRACT**
Based on the literature and China's vigorous development of cross-border electricity and the digital economy, this article establishes a performance evaluation system for China's cross-border e-commerce comprehensive demonstration city trade facilitation. Then, based on the current data and trade levels of 13 cities in China that are more prominent in the development of cross-border e-commerce, the entropy weight method is used to solve the performance differences and weights of the indicators, and the gray correlation method is used to judge the correlation between the sample and each indicator. Based on the constructed indicator system, the performance of China's current cross-border e-commerce cities is evaluated. Based on the experimental results, sort out the factors that restrict and promote the development of cross-border e-commerce cities. Finally, through experimental conclusions, it is proposed that the development experience of each other to learn from each other will drive the development of cross-border e-commerce, and improve the relevant systems to provide logistical support for the development of cross-border electronic trade in cities.
***Keywords:*** *cross-border e-commerce trade facilitation, performance evaluation, entropy weight-grey correlation*

## 1. INTRODUCTION

With the advent of the "Internet +" era, cross-border e-commerce has gradually stood on the cusp of the capital market. In recent years, due to the gradual deterioration of the international trade environment and the gradual weakening of Japan and Europe's demand for China, China's export trade has continued to weaken. However, the pace of development of new trade methods represented by cross-border e-commerce is continuing to accelerate, and it is expected to become a new driving force for China's economic development. However, with the further development of cross-border e-commerce, China's shortcomings in the development of cross-border e-commerce trade are gradually exposed. The difficulty of logistics and after-sales service, the low efficiency of customs clearance procedures, the complex form of the network economic environment, and the lack of professional counterparts and other issues. Therefore, in the context of the digital economy, how to make China's cross-border e-commerce timely adjust the industrial structure to adapt to the current global development is one of the important strategic issues that our government and academic circles urgently need to study.

In recent years, the research on trade facilitation in the cross-border e-commerce development comprehensive demonstration area has mainly started from the technical index method. The research on the facilitation of trade facilitation has rarely been established. This article believes that the above approach has certain shortcomings. After following the above questions, First of all, based on the current status of cross-border e-commerce development in 13 cities where China 's current cross-border e-commerce development is high, the comprehensive literature is used to establish an indicator system for China 's cross-border e-commerce demonstration city trade facilitation index. Confirm the weight of each evaluation index of the 13 selected cities; Use the grey correlation method to determine the degree of correlation between the different weights of each city and the level of trade facilitation. This research deeply explores the effective information contained in historical data. Based on big data, it is suitable for evaluating and predicting the performance of China's cross-border e-commerce integrated demonstration city trade facilitation. At the same time, it provides path choices for the further development of China's cross-border e-commerce cities, continuously improves the e-commerce platform, and provides a certain reference for the sustainable and efficient development of the e-commerce industry.

 

## 2. LITERATURE REVIEW

In terms of the impact of trade facilitation on China's cross-border trade, scholar Bai Yuhang pointed out that it will facilitate the development of cross-border e-commerce cities in terms of simplifying cross-border e-commerce export processes, reducing commodity costs and promoting the development of export trade [1]. In the field of cross-border comprehensive demonstration city trade facilitation in China, domestic scholars have put forward different points of view from different angles, and this article roughly classifies them into two categories, The first is a study on the overall level of cross-border e-commerce development and the degree of trade facilitation, and the second is a study on the development status of cross-border e-commerce pilot cities.

During the research on the relationship between the development level of cross-border e-commerce and trade facilitation, in his research, Zhong Yaoyao scholars used factor analysis to establish indicators to evaluate the level of trade facilitation of 118 WTO members. The relationship between globalization and cross-border e-commerce constitutes four indicators of customs efficiency, regulatory environment, infrastructure and ICT applications. It is concluded that there is a significant positive correlation between trade facilitation and cross-border e-commerce exports [2].Wu Fen In his research, scholars established an indicator system through analytic hierarchy process to quantify the level of China's trade facilitation from 2008 to 2016, and explained the economic aggregates, TFI, FDI and tariffs of major trading partners The variables were regressed using a fixed utility model and found that trade facilitation and the level of development of China's cross-border e-commerce show a positive correlation [3]. The author believes that the shortcomings of these studies are the neglect of the correlation between the various indicators, which are used to deduce the correlation between the selected indicators and the objectives from a single aspect. This study will infer the effect of various factors on the facilitation of cross-border electronic trade by calculating the weight relationship between indicators.

In the process of urban cross-border e-commerce development, Lin Liumei scholars used Chongqing 's cross-border e-commerce development as one of the first batch of cross-border e-commerce cities as a reference. And advantages and disadvantages, as well as problems in Chongqing's cross-border e-commerce in logistics, payment, taxation, industry matching, and talent training. Measures such as improving customs clearance efficiency, carrying out financial reforms and joint supervision, promoting enterprise transformation and upgrading, and implementing a talent training model for school-enterprise cooperation are proposed [4]. Hong Zhenqin and other scholars used Guangzhou as an example to analyze the shortcomings and development space of Guangzhou in the construction of cross-border e-commerce through SWOT analysis. The countermeasures and suggestions for the construction of cross-border e-commerce trade in Guangzhou were proposed in the aspects of realizing the transformation and upgrading of traditional foreign trade and manufacturing industry [5]. Zhao Lina conducted in-depth research on the government policy of China's cross-border e-commerce in his research. Taking the first batch of pilot cities for cross-border e-commerce in China as a sample and drawing on the advanced experience in the United States, he proposed to improve our cross-border electronics Suggestions and countermeasures for business government support policies, with a view to providing a certain reference for academic research and solving practical problems, in order to improve cross-border e-commerce support policies, optimize the policy environment, improve the competitiveness of cross-border e-commerce enterprises, and promote cross-border e-commerce The development of the industry provides useful policy references and academic support [6]. Scholar Ji Hong Takes the Ningbo Cross-border E-commerce Comprehensive Demonstration Zone as an example, from the policy level, infrastructure construction, legal supervision system, cross-border financing and talent demand, five countermeasures to facilitate the development of cross-border e-commerce trade Explore. Corresponding countermeasures are proposed from the above five aspects [7]. For the research on the development of cross-border e-commerce in cities, scholars have selected relatively rich cities and index systems, from the study of a single city to the study of a group of cross-border e-commerce cities; also from the efficiency of customs clearance , Finance, government, etc. put forward countermeasures.

## 3. EMPIRICAL ANALYSIS

### *3.1. Construction of Evaluation Index System*

Based on the basic principles of objectivity, scientificity, availability, and systematization of data, this study adopted 13 domestic cross-border e-commerce cities (Shenzhen, Guangzhou, Hangzhou, Ningbo, Zhengzhou, Shanghai, Chengdu, Suzhou, Qingdao, (Hefei, Tianjin, Dalian) On the basis of literature review and data processing of cross-border e-commerce trade facilitation levels, combined with expert opinions, preliminary construction includes areas of trade scale, growth space, industrial penetration, support environment and third-party platform The five-level three-level evaluation index system mainly includes cross-sectional data for 2018, and its data sources include city yearbooks and the annual report of NetEco.However, due to the scarce data, only seven indicator layers are listed. These include five indicators (X1-X5) for the first-level strategy layer, 7 items (Y1-Y) for the second-level strategy layer, and specific indicators (Z1-Z) for the final selection of the indicator layer. The specific indicator system and its letter codes are shown in the following table 1:

**Table 1** Cross-border e-commerce city trade facilitation indicator system

| Target layer | Strategy layer | Indicator layer |
|---|---|---|
| Cross-border e-commerce comprehensive demonstration city trade facilitation level (A) | Transaction scale (X1) | Total number of orders accepted throughout the year (Z1) |
| | | Annual transaction volume (Z2) |
| | Growth space (X2) | Trade growth rate (Z3) |
| | | Brand Growth Space Index (Z4) |
| | Industrial Penetration (X3) | Import and export industry penetration rate (Z5) |
| | Supporting environment (X4) | Policy Support Factor (Z6) |
| | Platform aggregation (X5) | Platform aggregation utility score (Z7) |
| | | Number of cross-border e-commerce companies (Z8) |

## *3.2. Entropy Weight Method*

Combining with the literature, in this paper, when calculating the data, the dimensionless quantization is performed first, and then the indicators are weighted [8]. In order to objectively weight, this article uses the entropy method to calculate the objective weight of the index based on the opinions of experts in data calculation. The calculation principle is as follows:

Step1: Because each indicator has different dimensions and units, it cannot be directly calculated and compared. Before calculating the weight of each indicator, it must be standardized first:

When the indicator is a positive indicator, its normalized formula is Equation (1):

$$x'_{ij} = \frac{x_{ij} - x_{jmin}}{x_j^{max} - x_j^{min}} \tag{1}$$

When the indicator is a negative indicator, its normalized formula is Equation (2):

$$x'_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \tag{2}$$

When the indicator is a medium-sized indicator, its standardized formula is Equation (3):

$$x'_{ij} = 1 - \frac{|x_{ij} - d_i|}{max|x_{ij} - d_i|} \tag{3}$$

Where $d_i$ is the determined standard value.

Step2: Considering that some index values may become smaller or even negative after being standardized, in order to facilitate subsequent calculations, this article will shift the standardized values to avoid the above situation. The specific method is as shown in formula (4):

$$x'_{ij} = H + x'_{ij} \tag{4}$$

Among them, H is the magnitude of the index translation, generally taken as 1.

Step3: Use the gravity method to make the data dimensionless. The specific method is as shown in formula (5):

$$y_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{n} x'_{ij}} \tag{5}$$

**Table 2** Dimensionless results

| | Shang hai | Cheng du | Su zhou | Chong qing | Qing dao | Shen zhen | Guang zhou | He fei | Tian jin | Hang zhou | Ning bo | Da lian | Zheng zhou |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z1 | 0.0780 | 0.0704 | 0.0715 | 0.0672 | 0.0586 | 0.1038 | 0.1005 | 0.0643 | 0.0692 | 0.0928 | 0.0778 | 0.0617 | 0.0104 |
| Z2 | 0.0140 | 0.0097 | 0.0136 | 0.0064 | 0.0017 | 0.6702 | 0.0541 | 0.0019 | 0.0023 | 0.1880 | 0.0202 | 0.0001 | 0.0222 |
| Z3 | 0.0163 | 0.0288 | 0 | 0.0148 | 0.3298 | 0.0054 | 0.0034 | 0.0222 | 0.5395 | 0.0055 | 0.0120 | 0.0047 | 0.0168 |
| Z4 | 0.0758 | 0.0739 | 0.0641 | 0.0689 | 0.0771 | 0.0917 | 0.0865 | 0.0704 | 0.0690 | 0.0904 | 0.0852 | 0.0667 | 0.0802 |
| Z5 | 0.0761 | 0.0779 | 0.0748 | 0.0724 | 0.0756 | 0.0985 | 0.0951 | 0.0663 | 0.0608 | 0.0665 | 0.0899 | 0.0641 | 0.0401 |
| Z6 | 0.0792 | 0.0761 | 0.0676 | 0.0735 | 0.0681 | 0.0957 | 0.0925 | 0.0671 | 0.0576 | 0.0939 | 0.0895 | 0.0623 | 0.0768 |
| Z7 | 0.0855 | 0.0722 | 0.0703 | 0.0647 | 0.0620 | 0.0997 | 0.0941 | 0.0708 | 0.0599 | 0.0941 | 0.0837 | 0.0600 | 0.0827 |
| Z8 | 0.0701 | 0.0101 | 0.0078 | 0.0069 | 0.1357 | 0.0339 | 0 | 0.0027 | 0.0203 | 0.5427 | 0.0475 | 0.0543 | 0.0678 |

Step4: Calculate the entropy value of the j-th index, the specific method is as shown in formula (6):

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{n} y_{ij} \ln y_{ij} \quad (6)$$

Step5: The difference coefficient of the j-th index, the specific method is as shown in formula (7):

$$g_j = 1 - e_j \quad (7)$$

Where j = 1,2, ... p

Step6: The weight of the j-th index, the specific method is as shown in formula (8):

$$\omega_j = \frac{g_j}{\sum_{j=1}^{p} g_j} \quad (8)$$

Where $j = 1,2, \ldots p$

**Table 3** Calculation results of the index weights of the entropy method

| | Entropy | Coefficient of difference | Entropy weight | Weight ranking |
|---|---|---|---|---|
| Z1 | 0.919283955 | 0.080716045 | 0.067984636 | 4 |
| Z2 | 0.443521873 | 0.556478127 | 0.468704366 | 1 |
| Z3 | 0.482503816 | 0.127624938 | 0.10749455 | 3 |
| Z4 | 0.997433543 | 0.002566457 | 0.002161648 | 8 |
| Z5 | 0.966092194 | 0.033907806 | 0.028559499 | 5 |
| Z6 | 0.995177599 | 0.004822401 | 0.00406176 | 7 |
| Z7 | 0.993942678 | 0.006057322 | 0.005101895 | 6 |

From the above experimental results, it can be seen that there is a large difference between the weights. The first tiers Z2, Z3, and Z8, that is, the annual total transaction volume, transaction value growth rate, and number of cross-border e-commerce companies, have the largest weights, 46.9% respectively , 31.6%, 10.7%. Therefore, this study believes that the level of cross-border e-commerce trade transaction volume, industry infrastructure construction level, and cross-border e-commerce enterprise development level have a greater impact on the level of urban cross-border e-commerce facilitation.

### *3.3. Grey Correlation Method*

The gray correlation method is based on the gray system theory proposed by the self-national scholar Deng Julong (1981), which is suitable for research objects with small samples and small data. Combined with the characteristics of this article, the gray correlation method is used to calculate the correlation between the basic data of the city and the indicators, which can better ensure the scientificity and integrity of the evaluation index system. Then, based on the experimental results, calculate the gray correlation between each indicator data and the target. Degree, to provide a reference for China to choose the appropriate path to improve the level of cross-border e-commerce trade facilitation.

Step1: Initialization of raw data

Because there are certain differences in the value range, data availability, and economic significance of various indicators, in order to facilitate calculation and comparison, this paper performs dimensionless processing on the data before calculation to eliminate the personality factor of the data and become standardized on a unified scale Orderless data. The specific method is shown in the following formula (19):

$$x'_{ij} = \frac{x_{ij} - x_{j}^{min}}{x_j^{max} - x_j^{min}} \quad (19)$$

Step2: Calculate the absolute difference between the comparison sequence and the reference sequence. The specific method is shown in the following formula (20):

$$\Delta = \left(|x_{ij} - x_{0j}|\Delta_{0j}(j)\right)_{n*p} \quad (i = 1,2, \ldots, n,\ j = 1,2, \ldots, n) \quad (20)$$

The comparison sequence refers to a data sequence composed of factors of system behavior, and it is constructed by using the index value of the evaluated object.

Step3: Calculate the grey correlation coefficient of the indicator system

The gray correlation coefficient refers to the performance of correlation in the gray theory, specifically the geometric distance between the reference sequence and the comparison sequence at each time point. The larger the value, the greater the degree of mutual correlation between the two parties in the corresponding index sequence. The calculation formula is shown in the following formula (21), and the specific calculation results are shown in Table 4 below:

$$\zeta_{0j}(j) = \frac{min\Delta_{0j}(j) + \rho max\Delta_{0j}(j)}{\Delta_{0j} + \rho max\Delta_{0j}(j)} \quad (0 < \rho < 1) \quad (21)$$

Where ρ is a constant. In general, ρ is 0.5. In this paper, ρ is equal to 0.5.

**Table 4** Gray correlation matrix of China's cross-border e-commerce demonstration city trade facilitation levels

| | Shanghai | Chengdu | Suzhou | Chongqing | Qingdao | Shenzhen | Guangzhou | Hefei | Tianjin | Hangzhou | Ningbo | Dalian | Zhengzhou |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z1 | 1 | 1 | 1 | 1 | 0.9980 | 0.3090 | 0.9639 | 0.953 | 0.9988 | 0.9988 | 1 | 0.9728 | 0.9996 |
| Z2 | 0.8985 | 0.6495 | 0.472 | 0.6854 | 1 | 0.00049 | 0.3333 | 1 | 0.9996 | 0.8073 | 0.8392 | 1 | 0.8333 |
| Z3 | 0.9077 | 0.3971 | 0 | 0.4849 | 0.4278 | 0.0541 | 1 | 0.333 | 0.3333 | 0.9975 | 0.9087 | 0.9554 | 0.8974 |
| Z4 | 0.9976 | 0.9684 | 1 | 0.9611 | 0.9929 | 0.6080 | 0.9692 | 0.897 | 0.9975 | 0.9985 | 0.9907 | 0.9672 | 0.9976 |
| Z5 | 0.9998 | 0.9734 | 0.9795 | 0.9694 | 0.9944 | 1 | 0.9669 | 0.936 | 0.9999 | 1 | 0.9919 | 0.9709 | 0.9993 |
| Z6 | 0.9972 | 0.9684 | 0.9937 | 0.950 | 0.9952 | 0.3333 | 0.9644 | 0.920 | 1 | 0.9984 | 0.9897 | 0.970 | 1 |
| Z7 | 0.9953 | 0.9826 | 0.9881 | 0.9926 | 0.9966 | 0.1734 | 0.9644 | 0.909 | 0.9997 | 0.9985 | 0.9939 | 0.9719 | 0.9979 |
| Z8 | 0.3333 | 0.3333 | 0.3333 | 0.333 | 0.3333 | 0.00035 | 1 | 0.571 | 0.7907 | 0.3333 | 0.3333 | 0.3333 | 0.3333 |

Step4: Calculate the gray correlation coefficient of each indicator system

The gray correlation degree is to collect a series of correlation coefficients, obtain specific values through a certain method, and reflect the correlation between the reference sequence and other indicators as a whole. Specifically, the value of the gray correlation degree is negatively correlated with the correlation.

The calculation formula of the comprehensive gray correlation is shown in Equation (22), and the calculation result is shown in Table 5:

$$r_{0j} = \sum_{j=1}^{p} \omega_j \zeta_{0j}(j) \quad (i = 1,2,\dots,n) \tag{22}$$

**Table 5** Comprehensive grey correlation of indicators of China's cross-border e-commerce demonstration cities

| | Z1 | Z2 | Z3 | Z4 | Z5 | Z6 | Z7 | Z8 |
|---|---|---|---|---|---|---|---|---|
| Grey correlation | 1.524408 | 1.189953 | 0.96220 | 1.54335 | 1.5978 | 1.51026 | 1.49561 | 0.67032 |

First of all, the academic community generally believes that indicators with a comprehensive gray correlation degree of 0.5 or more with the research subject will have a strong influence and correlation on the subject. Therefore, it can be found that all the indicators selected in this paper have a correlation with the level of openness greater than 0.5, so it can be proven that the index system of openness constructed previously is very scientific. Secondly, it can be found that the correlation degree of most indicators is stable at about 0.9 to 1.6. Among them, the gray correlation degree of Z5, Z4, Z1, and Z6 is the highest, including: the penetration rate of the import and export industry (15.23%), and the brand growth space index ( 14.71%), the total number of orders for the whole year (14.52%), and the policy support factor (14.39%). Therefore, this study believes that factors such as industrial cross-penetration, brand growth potential, trade volume levels, and policy support have a significant impact on the level of trade convenience of China's cross-border e-commerce demonstration cities.

## 4. CONCLUSION

By constructing an evaluation index system for cross-border e-commerce demonstration cities' trade facilitation levels, this article uses cross-section data from 13 cities that currently have excellent cross-border e-commerce development in China to measure their respective cross-border e-commerce facilitation levels And calculated the correlation of each index of each city, and reached the following conclusions:

First, from the index system and data results, Shenzhen, Guangzhou, and Hangzhou have relatively high levels of trade facilitation. Second, Ningbo, Zhengzhou, and Shanghai, which are in the second echelon, rely on their excellent economic environment and policy support. The performance was not bad; finally, cities such as Chengdu, Suzhou, Chongqing, Qingdao, Hefei, Tianjin, Dalian, etc., the level of cross-border e-commerce trade and trade facilitation is low. In general, China's cross-border e-commerce trade facilitation level is high in the south and low in the north. The main factors in this study include urban economic development, national policy factors, and urban infrastructure construction.

Second, according to the experimental results, the main factors of China's cross-border e-commerce city trade facilitation include: the level of cross-border electronic trade, the status of industrial interaction and penetration, the level of brand growth space, and national policy support. This study believes that the reasons for the above-mentioned indicators having a large multiplier effect include: in foreign trade, product prices are greatly affected by brand factors, and good brands bring higher benefits; the increase in trade volume will drive regional cross-border electronics The construction of business and trade infrastructure and the development of third-party trading platforms have a greater impact on the improvement of trade facilitation; a good policy support system can provide convenience in cross-border trade development while reducing constraints to a greater extent.

## 5. COUNTERMEASURES

Based on the above conclusions, this study believes that to further promote the level of trade facilitation in China's cross-border e-commerce cities, it is necessary to focus on mutual reference between regions, improve policy support systems, develop corporate infrastructure, increase brand awareness and the number of well-known brands And improve third-party trading platforms. The specific countermeasures and paths are as follows:

First, the regions learn from each other. Cities in the early stages of cross-border e-commerce development learn from cities with higher levels of cross-border e-commerce development, such as Guangzhou, Shenzhen, and Hangzhou, and combine their own advantages to develop cross-border e-commerce with local characteristics. Trade, to improve the level of trade facilitation; point to line and line to line. Most cities with a high level of cross-border e-commerce development are mostly located along the coast and along the Yangtze River. They are scattered. Firstly, the development of cross-border e-commerce trade in coastal cities along the river will be promoted by point and strip lines. Level of trade facilitation in e-commerce cities. Balance the imbalance of North-South cross-border e-commerce development.

Second, improve the policy support system. Starting from the customs of import and export of goods, the trade environment has been improved. Under the premise of accepting inspection and quarantine, and completing legal and compliant customs clearance procedures, the complexity of customs clearance procedures should be appropriately reduced and management transparency should be improved. Convenient, safe, and efficient customs are more conducive to the development of cross-border e-commerce trade; improve the laws and regulations and industry systems related to cross-border e-commerce; at the same time, learn from the experience of the United States in developing cross-border e-commerce trade, and continue to improve based on its actual situation Market supervision mechanism for cross-border e-commerce trade; actively develop cultural and economic exchanges with neighboring countries, expand bilateral customs exchanges and cooperation, achieve complementary advantages of ports on both sides of cross-border trade, actively act as a bridge, and open up the development of cross-border e-commerce What a market. Develop enterprise infrastructure. Cross-border e-commerce enterprises should increase the pace of informatization construction, develop network construction and connect with e-commerce platforms, and integrate internationally; export enterprises should continuously improve product quality and structure according to different points of demand for products in different countries, and improve brand effectiveness and visibility; For importing companies, make good use of the convenience brought by cross-border trade, purchase goods and raw materials globally, and provide more choices for enterprise manufacturing; train professionals, cross-border e-commerce trade as an emerging industry, professional counterparts There are only a few college graduates. Enterprises need to cultivate professional talents and build competitive teams according to their actual needs. Looking at the world, cross-border e-commerce companies should choose marketable markets based on their own product and service advantages, and pay attention to strategic differences. Optimize the market structure of enterprises.

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