Evolution of cross-border e-commerce spatial pattern and its agglomeration level: Evidence from the Three Economic Zones in China

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ABSTRACT. Cross-border e-commerce has become an important factor driving the transformation and development of international trade and is of great significance in building a new development pattern of mutual promotion of domestic and international double cycles. Panel data of eight provinces and cities in the Yangtze River Delta, Beijing-Tianjin-Hebei, and Pearl River Delta economic zones from 2016-2021 were selected, and the location text data of their cross-border e-commerce enterprises were spatially visualized and analyzed through geocoding methods, and then the level of cross-border e-commerce agglomeration in the three economic zones was evaluated through locational entropy. It is found that the spatial pattern of cross-border e-commerce in the Yangtze River Delta, Beijing-Tianjin-Hebei, and Pearl River Delta economic zones shows the "core-edge" distribution characteristic of decreasing from the center to the peripheral edge, and the agglomeration centers are mostly located in provincial capitals and coastal cities. From an overall perspective, the level of cross-border e-commerce industry agglomeration in the three major economic zones is Pearl River Delta > Yangtze River Delta > Beijing-Tianjin-Hebei. While Guangdong and Shanghai are eye-catching in the development of the cross-border e-commerce industry, the cross-border e-commerce in Zhejiang Province has developed rapidly since 2018, and the development of cross-border e-commerce is more concentrated.

Keywords: component; cross-border e-commerce; spatial pattern evolution; agglomeration; three economic zones

1 Introduction

With the development of Internet technology and the support of the government, cross-border e-commerce in the form of "Internet + Foreign trade" is developing well in China, injecting new vitality into China's economic development, and also pulling China's export-oriented economy towards the goal of high-quality development. Nowadays, cross-border e-commerce has become an important factor driving the transfor-

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mation and development of international trade and is of great significance to the construction of a new development pattern in which domestic and international double cycles promote each other. On January 1, 2022, the Regional Comprehensive Economic Partnership(RCEP) officially entered into force, which not only promotes intra-regional trade and investment but also world economic integration, which is undoubtedly a major opportunity and challenge for China's cross-border e-commerce trade1. China also attaches great importance to the development of cross-border e-commerce in various provinces and cities and has set up comprehensive pilot zones for cross-border e-commerce from cities with developed economies and unique advantages. However, the development of cross-border e-commerce in China differs from region to region due to the different resources and economic development levels, resulting in different degrees of cross-border e-commerce development. As the head economies of China's cross-border e-commerce development, there is an inherent regional heterogeneity in the basis of cross-border e-commerce development within the Pearl River Delta, Yangtze River Delta, and Beijing-Tianjin-Hebei economic circles. This phenomenon of unbalanced development between regions, lack of communication between cities, and uncoordinated industrial structure largely limits the synergistic development of cross-border e-commerce in China. If the regional communities fail to formulate integrated development strategies to promote the synergistic development of cross-border e-commerce in the cities in the region, it will affect the pace of the integrated development of cross-border e-commerce trade as a whole2.

2 Literature review

The cross-border e-commerce industry, as a new industry, is receiving attention from academia in recent years. The research on cross-border e-commerce industry agglomeration is mainly reflected in its formation mechanism and influencing factors. For the formation mechanism level, Zeng Simin and Chen Zhongwen (2011) started with e-commerce stores and find that e-commerce stores are not free from spatial constraints, and there is a certain spatial dependence, showing a trend of agglomeration and specialization3. Fu Yuan (2015) argued that e-commerce reduces transportation costs and space dependence, so the development layout shows non-spatial clustering4. Xie Min and Xiong Guoxiang (2020) studied the issues related to the construction of cross-border e-commerce trade channels between China and ASEAN and concluded that geographical distance is a factor that negatively affects trade between the two countries, but the agglomeration effect formed by the development of cross-border e-commerce can reduce the impact of distance between the two countries5. Wang Peidong (2017) believed that the power sources of e-commerce industry agglomeration are mostly manifested in the industrial value chain, social capital, lead entrepreneurs, technological innovation, government support, market demand, and external competition6. Xu Zhibang et al. (2017), Wu Rongwei et al. (2018), and Hao Feilong et al. (2016) argued that the e-commerce industry is mostly concentrated in the "Yangtze River Delta", "Pearl River Delta", Fujian and other economically developed regions along the eastern coast[7,8,9].

At the level of influencing factors, Martin et al. (2010) argued that there is a mutually reinforcing relationship between industrial agglomeration and economic growth. On the one hand, the rapid agglomeration of leading and associated industries intensifies regional economic growth, on the other hand, regional economic growth had become an important driving force to promote agglomeration10. Gomez Herrera et al. (2014) provided a macro overview of cross-border e-commerce development in the EU, and they argued that trade costs and information costs may be the driving factors and barriers affecting the development of cross-border e-commerce11. Based on an empirical study of data from 39 countries, Alaveras G et al. (2015) concluded that geographical distance remains a significant constraint in cross-border e-commerce12. Han et al. (2019) argued that IT infrastructure plays a key role in informing consumers and facilitating cross-border e-commerce13. He Jiang et al. (2019) investigated the importance of logistics in cross-border e-commerce development by verifying the synergistic relationship between cross-border e-commerce and cross-border logistics14. Elia S et al. (2021) argued that digital export drivers influence firms to develop B2C cross-border e-commerce activities based on the RBV perspective of firms and firms' competitive capabilities15.

3 Research Methods and Data Sources

3.1 Method selection

1）Geocoding methods.

Geocoding can spatialize non-spatial data and realize the conversion of geographic text data and spatial coordinates. To quickly realize the transformation of address text data, the geocoding interface provided by Amap is used to realize geographic latitude and longitude output16. Based on the massive structured location text information of cross-border e-commerce enterprises obtained from the enterprise search platform, the geographic coordinates corresponding to the latitude and longitude of each text are obtained by using the geocoding method. According to the ID index, the conversion of latitude and longitude geographic location can be completed by calling the geocoding API (Application Interface) service of Amap for any structured text data containing domestic location information. The conversion example of structured text data to geographic location is shown in Table 1.

Table 1. Cross-border e-commerce enterprise registered address text data geocoding example

ID	Company Name	Registration Time	Registration Address	Longitude	Latitude
1	Guangzhou Tangqu Cross Border e-commerce Co., Ltd.	2016-07-06	No.8, Lane 2, South Street, Southeast Village, Hualong Town, Panyu District, Guangzhou Province	113.454768	23.043999

2	Hangzhou Eggshell Business Information Technology Co., Ltd.	2019-11-28	Room A21, 5/F, Building 3, Qianjiang International Times Square, Shangcheng District, Hangzhou, Zhejiang Province	120.206595	30.265119
3	Beijing Cross Border E-Commerce Co.	2021-10-22	619, 6/F, Building 3, 186A, Litang Road, Changping District, Beijing Province	116.415484	40.060691

2）Location Entropy.

Location Entropy is an indicator proposed by Hargate to measure the spatial distribution of factors in a region and reflect the status and role of a region in a higher-level region. Location entropy is often used to measure the level of industrial agglomeration in a region to determine the degree of specialization of industrial agglomeration17. The study will measure the location entropy to reflect the relative concentration degree of cross-border e-commerce industry in each province and city of the three major economic zones. The location entropy is calculated as follows:

$$LQ_{ij} = \frac{q_{ij} / q_j}{q_i / q} \tag{1}$$

In the above equation: q_{ij} denotes the number of cross-border e-commerce enterprises registered in the region j; q_j denotes the number of Internet e-commerce enterprises registered in the region j; q_i denotes the number of cross-border e-commerce enterprises registered in the country; q denotes the number of Internet e-commerce enterprises registered in the country. When $LQ_{ij} > 2$, it indicates that the cross-border e-commerce industry in the region is extremely aggregated and shows a state of concentration; when LQ_{ij} lies between [1, 2], it indicates that the cross-border e-commerce industry in the region is highly aggregated; when $LQ_{ij} < 1$, it indicates that the cross-border e-commerce industry in the region lacks the advantage of specialization and the aggregation degree is low.

3.2 Data Selection

Since the number of cross-border e-commerce enterprises can most intuitively reflect the development of cross-border e-commerce in each province (city), the number of registered cross-border e-commerce enterprises from 2016-2021 is chosen as the cross-border e-commerce indicator, and the data for this study are mainly from the enterprise

search platform (https://www.qcc.com/), with Hong Kong and Macao excluded due to missing data.

4 Empirical results

4.1 Spatial evolutionary features of the cross-border e-commerce industry

The text data of the location of cross-border e-commerce enterprises nationwide from 2016-2021 obtained from the enterprise search platform were converted into latitude and longitude coordinates by geocoding, and visualized and analyzed using ArcGIS software (Figure 1). In terms of the overall distribution, China's cross-border e-commerce agglomeration features are obvious, and cross-border e-commerce agglomerations are not only distributed along the coast, but also gathered in central inland cities, mainly in the Yangtze River Delta, Beijing-Tianjin-Hebei, and Pearl River Delta economic zones.

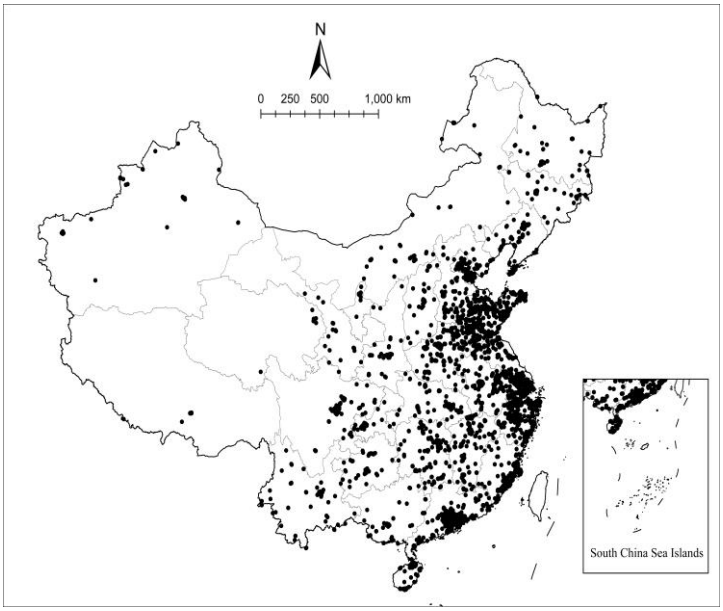

Fig. 1. 2016-2021 National cross-border e-commerce space pattern

(Note: This map is based on the standard map of the National Bureau of Surveying, Mapping, and Geographic Information (review number: GS (2019) 1822), and the base map is not modified.)

To further explore the spatial distribution characteristics of cross-border e-commerce clusters in the three major economic zones, the kernel density analysis of the POI data of cross-border e-commerce enterprises in the three major economic zones was conducted using ArcMap10.8 tool, with 100km as the image size, adjusting the appropriate search radius parameters, and using the geometric breakpoint method to divide it into

9 levels to obtain the kernel density maps of cross-border e-commerce enterprise distribution in the Yangtze River Delta, Beijing-Tianjin-Hebei and Pearl River Delta regions (Figure 2). The results show that the kernel density map of cross-border e-commerce enterprises in the Yangtze River Delta and Beijing-Tianjin-Hebei economic zones shows a "multi-core-edge" pattern with multiple aggregation center points and single aggregation center points spreading to the periphery, while the Pearl River Delta shows a "Single core-edge" pattern with single center points as the aggregation core and gradually decreasing to the periphery. Specifically, the Yangtze River Delta agglomeration area has formed 9 main centers, including Shanghai, Hangzhou, Shaoxing, Jinhua, Ningbo, Wenzhou, Wuhu, Suzhou, and Hefei, and 10 sub-centers, including Huzhou, Quzhou, Taizhou, Wuxi, Huangshan, Nanjing, Bengbu, Fuyang, Xuzhou and Lianyungang; the Beijing-Tianjin-Hebei agglomeration area has formed 3 main centers, including Beijing, Tianjin and Shijiazhuang, and 4 sub-centers, including Tangshan, Qinhuangdao, Xingtai, and Handan; The Pearl River Delta agglomeration formed three main centers, such as Guangzhou, Dongguan and Shenzhen, and four sub-centers, such as Foshan, Zhongshan, Zhuhai, and Huizhou.

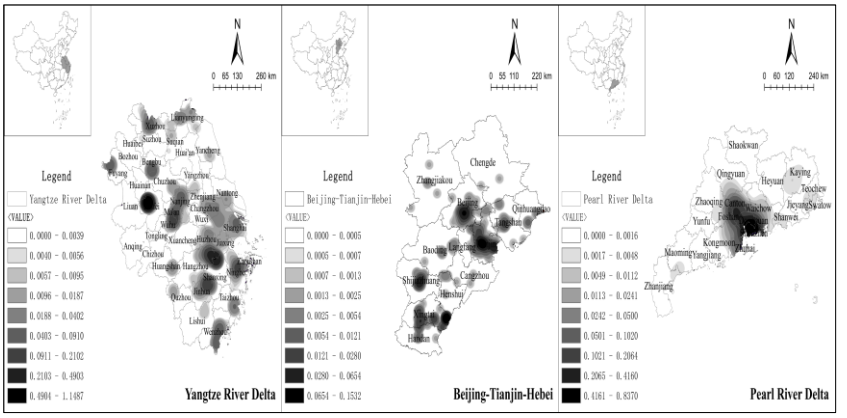

Fig. 2. Spatial pattern of cross-border e-commerce in the three major economic zones in 2016-2021

To further reveal the evolution of the spatiotemporal pattern of cross-border e-commerce in eight provinces (cities) within the three economic zones, the micro spatiotemporal dynamics of each province (city) is analyzed based on the POI data of cross-border e-commerce enterprises in Shanghai, Zhejiang, Anhui, Jiangsu, Beijing, Tianjin, Hebei, and Guangdong from 2016-2021. From the spatiotemporal dynamics of each province (city) from 2016-2021 (Figure 3), the overall number of cross-border e-commerce enterprises in each province (city) grows significantly and has an obvious agglomeration trend, showing the trend of central cities clustering and gradually spreading to surrounding cities. In terms of the density of cross-border e-commerce enterprises in each province (city) (Figure 4), the density of cross-border e-commerce enterprises in each province (city) increased year by year from 2016 to 2021, with Shanghai having the highest density of cross-border e-commerce enterprises, followed by Guangdong, Zhejiang, Beijing, Tianjin, Anhui, Jiangsu and Hebei. In addition Shanghai,

Beijing, and Hebei Province cross-border e-commerce enterprise density growth rate is relatively flat, while Guangdong, Zhejiang, Tianjin, Anhui, and Jiangsu growth rate is larger, and in 2021 substantial growth.

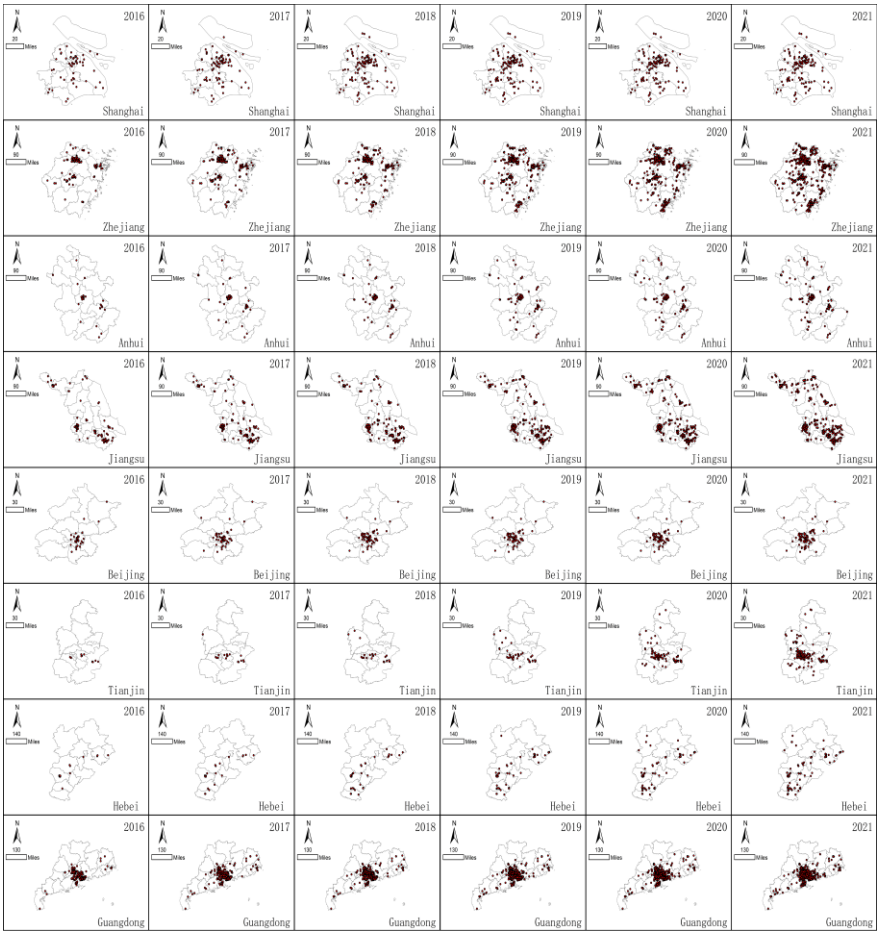

Fig. 3. Spatial and temporal dynamics of cross-border e-commerce enterprises in provinces (cities) of the three major economic zones in 2016 - 2021

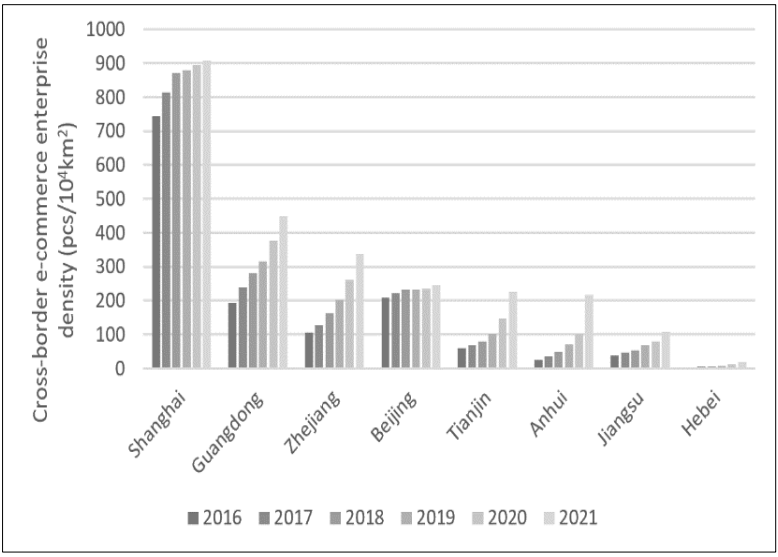

Fig. 4. Comparison of the quantity density of cross-border e-commerce enterprises by province（city）in the three major economic zones from 2016 to 2021

4.2 Cross-border e-commerce agglomeration efficiency measurement

The locational entropy index can portray the agglomeration characteristics of cross-border e-commerce in two dimensions: time and space. As shown in Table 2, from an overall perspective, the level of cross-border e-commerce industry agglomeration is shown as Pearl River Delta > Yangtze River Delta > Beijing-Tianjin-Hebei. The location entropy indices of the Pearl River Delta economic zone from 2016 to 2021 are all greater than 1, indicating that the Pearl River Delta economic zone has a high degree of cross-border e-commerce industry agglomeration and shows an overall agglomeration phenomenon. The Yangtze River Delta and Beijing-Tianjin-Hebei economic zones show an upward trend in the level of cross-border e-commerce industry agglomeration, and the location entropy index is greater than 1 in 2018 and 2021, respectively, and the cross-border e-commerce industry agglomeration phenomenon is obvious. In 2016, the location entropy indexes of Shanghai, Jiangsu Province, and Guangdong Province are greater than 1; in 2019, Zhejiang Province and Beijing Province are added, and Jiangsu Province is removed; in 2021, Jiangsu Province and Tianjin City are added. As China's traditional economic powerhouse provinces, Guangdong and Shanghai are eye-catching in the development of the cross-border e-commerce industry, while Zhejiang Province's cross-border e-commerce has developed rapidly since 2018, and the development of cross-border e-commerce is more concentrated, forming a cluster of cross-border e-commerce development and generating agglomeration effect.

Table 2. 2016-2021 Entropy in 8 Provinces and Cities

City	2016	2017	2018	2019	2020	2021	Average value
Shanghai	1.12	1.19	1.60	1.96	1.64	1.16	1.29
Zhejiang	0.74	0.75	1.48	1.47	1.57	1.87	1.16
Anhui	0.15	0.16	0.24	0.37	0.44	0.82	0.30
Jiangsu	1.01	0.78	0.81	0.99	0.95	1.17	1.03
Beijing	0.68	0.83	1.28	1.73	1.81	2.01	1.16
Tianjin	0.35	0.37	0.48	0.69	0.95	1.39	0.61
Hebei	0.22	0.24	0.30	0.41	0.58	0.69	0.47
Guangdong	1.54	1.50	1.91	2.13	2.06	2.21	1.85
Yangtze River Delta	0.76	0.72	1.03	1.20	1.15	1.26	0.94
Beijing-Tianjin-Hebei	0.42	0.48	0.69	0.94	1.11	1.36	0.75
Pearl River Delta	1.54	1.50	1.91	2.13	2.06	2.21	1.85

5 Conclusion and inspiration

5.1 Conclusion

It is found that the spatial pattern of cross-border e-commerce in the Yangtze River Delta, Beijing-Tianjin-Hebei, and Pearl River Delta economic zones all show the "core-edge" distribution characteristic of gradually decreasing from the center to the peripheral edge, with the agglomeration centers mostly distributed in provincial capitals and coastal cities. From an overall perspective, the level of cross-border e-commerce industry agglomeration in the three major economic zones is Pearl River Delta > Yangtze River Delta > Beijing-Tianjin-Hebei. Guangdong and Shanghai are eye-catching in the development of the cross-border e-commerce industry, while the cross-border e-commerce in Zhejiang Province has developed rapidly since 2018, and the development of cross-border e-commerce is more concentrated.

5.2 Policy recommendation

1. Give full play to the strong driving effect of cross-border e-commerce industry clusters on economic development and play a positive external effect. The government should fully understand the role of cross-border e-commerce industry clusters in promoting a series of factors such as economy, innovation technology, logistics, and transportation in the region. At the same time, it should strengthen the cross-regional flow of factors, realize the interconnection and interoperability of cross-border e-commerce service support system, product circulation system, and support guarantee system between regions, and thus promote the coordinated development of the regional economy.
2. Promote branding and the balanced development of cross-border e-commerce clusters among regions. This is because cross-border e-commerce in various provinces and cities in China presents different development characteristics. Therefore, regional governments should face their differences in the process of developing cross-

border e-commerce, combine different regional characteristics, create localized cross-border e-commerce brands, and promote the personalized development of cross-border e-commerce enterprises, to drive the development efficiency of the industry.

3. Make full use of RCEP globalization and strengthen the construction of international trade cooperation mechanisms. RCEP has removed tariff barriers and greatly reduced the obstacles to the flow of resources, commodities, and talents among RCEP member countries. It can actively lay out the construction of overseas warehouses, accelerate the extension of the cross-border e-commerce industry chain outside China, and expand the degree of trade opening. At the same time, we can cultivate RCEP-oriented cross-border e-commerce industry clusters, form Chinese cross-border e-commerce brands, and enhance the influence and competitiveness on international platforms.

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