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# Design and analysis of e-commerce and modern logistics for regional economic integration in wireless networks

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## Abstract

The rapid development of e-commerce has greatly promoted the development of modern logistics. The application level of e-commerce and the application status of modern logistics largely determine the development of a regional economic structure. Under such circumstances, it is particularly important to comprehensively strengthen the research on the impact of e-commerce and modern logistics on the network regional economy. China is as one of the most active regions over the world. Therefore, in this paper, we take the network regional economic as the research object. Firstly, we obtain relevant regional logistics nodes and e-commerce information through wireless networks. Secondly, based on information acquisition, we propose an empirical analysis of the development status of the logistics industry and e-commerce, and we also explain their contributions to regional economic growth. Finally, this paper proposes countermeasures to further increase the contribution of logistics and e-commerce to economic growth. This will provide a reference for building a regionally coordinated logistics-e-commerce system and realizing regional economic integration.

**Keywords:** Network e-commerce, Modern Logistics, Wireless Network, Regional economic contribution differences

## 1 Introduction

At present, the process of economic globalization is accelerating and the trend of regional economic integration is increasing. This has already shown the situation of global, national and regional development [1, 2]. The strengthening of regional economic integration, cross-regional logistics, business flow, information flow, and capital flow are also increasingly frequent, which makes the market competition between regions become more intense, and the logistics supply chain has become a key link of competition [3]. Therefore, the modern logistics industry has received more and more attention in countries around the world and has become an emerging industry with broad market prospects. The logistics industry has played a huge role in reducing the consumption of materials, improving the productivity of enterprises and promoting economic development [4]. Its level of development is often used as a measure of the

overall economic strength and modernization of a country or region. And e-commerce has become an effective means for enterprises to reduce costs, improve efficiency, open up markets, and innovate operations [5]. This is also an important way for regional economic transformation and development, improving the quality of economic operations and enhancing international competitiveness. It plays an important role in the sustainable development of society, optimizing the industrial structure, supporting the development of strategic emerging industries, and forming new economic growth points. Due to the influence of economic, social and geographical factors, there is a significant imbalance in the development of e-commerce in various regions [6]. On the one hand, the level of e-commerce is the result of the development of regional economic, social and geographical factors. On the other hand, e-commerce has become a new force driving regional economic growth [7].

At present, in the urban economic circle, which is called “center of gravity” and “growth pole” in China, it is generally considered that there are three. That is, the Pearl River Delta urban economic circle consisting of Guangzhou, Shenzhen, Zhuhai, and other cities [8]. The Beijing-Tianjin-Hebei urban economic circle consists of Beijing, Tianjin, and Hebei. The three economic circles play an important role in China’s economic growth. As the logistics industry and e-commerce become important factors in promoting regional economic growth. How to understand the economics of logistics industry and e-commerce in the region and the contribution of logistics industry and e-commerce to regional economic growth, so as to develop a positive and appropriate logistics industry policy, has gradually become an important topic of regional economic research [9]. As one of the most developed regions in China, the region has achieved certain achievements in the development of regional logistics industry and e-commerce and plays an important role in the process of regional integration [10].

Wireless sensor networks have a very wide range of application prospects [11–13]. It has great application value in traditional and emerging fields such as industry, agriculture, military, environment, medical care, digital home, green energy saving, and intelligent transportation [14–16]. Wireless sensor networks will be ubiquitous and fully integrated into our lives. With the rapid development of sensor technology and wireless communication technology, the application of wireless sensor networks is becoming more and more extensive. However, to make wireless sensor networks truly widely used, how to efficiently obtain data from sensor networks and satisfy user queries has become a key issue for the current wireless sensor networks from research to practical application [17–19].

The rapid development of e-commerce has greatly promoted the development of the modern logistics industry. The application level of e-commerce and the application status of modern logistics largely determine the development of regional economic structure in a region [20]. Under this circumstance, it is particularly important to comprehensively strengthen the research and analysis of the impact of e-commerce and modern logistics on the regional economic structure and scope, and promote the coordinated development between each other. Therefore, this paper analyses the development status of the logistics industry and its contribution to regional economic growth as the model region [21]. On this basis, it puts forward the countermeasures to further increase the contribution of the logistics industry and e-commerce to the economic

growth, so as to provide reference for the construction of a coordinated regional logistics-e-commerce system and the realization of regional economic integration.

The main research contributions of this paper are as follows:

1. Taking the network area economy as the research object, discussed the economic growth and development in the wireless network area
2. Obtain relevant regional logistics nodes and e-commerce information through wireless network. Based on the information acquisition, an empirical analysis of the development status of logistics industry and e-commerce is proposed.
3. Proposed related wireless network technology to further improve logistics and increase the application range of wireless network technology

The rest of this paper is organized as follows: Section 2 gives some related work. In Section 3, we propose our network economic integration method. Section 4 presents the performance analysis for our method. Finally, we give the conclusion and future work in Section 5.

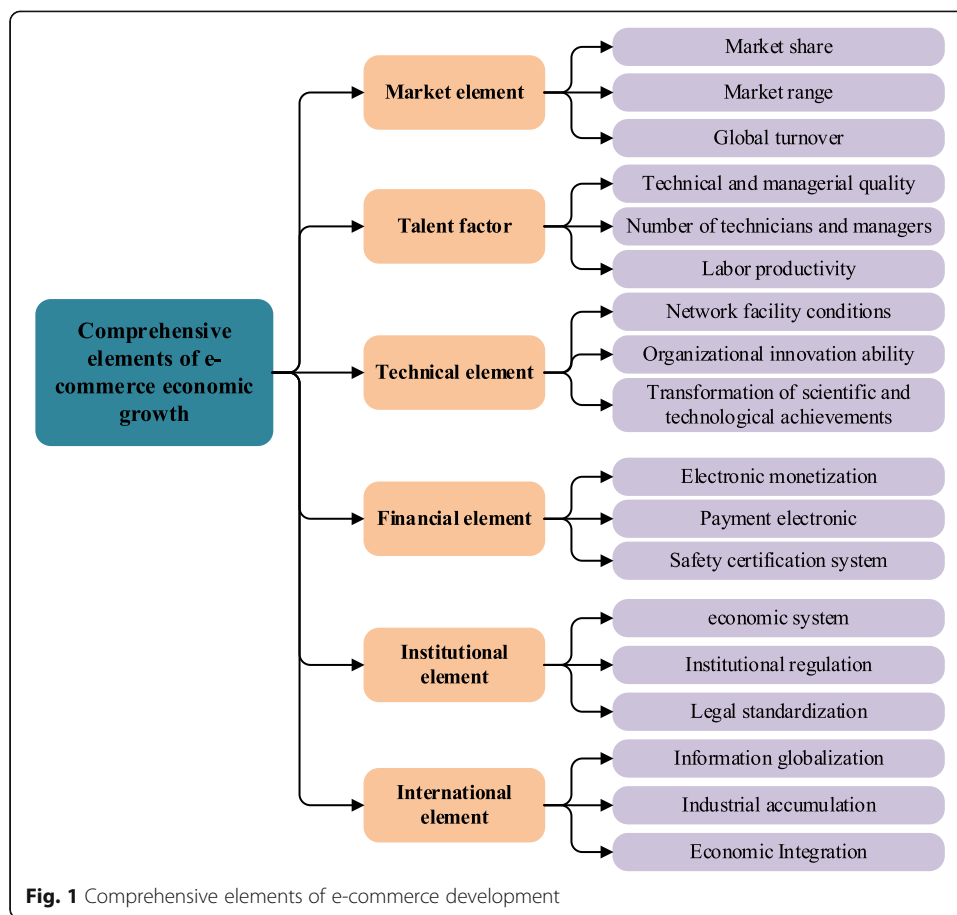
## 2 Related work

Before analyzing the interaction between e-commerce and modern logistics and economic growth, we should first make a brief understanding of the relevant concepts of modern logistics and e-commerce and related theories of economic growth [22, 23]. On this basis, the research literature on the relationship between e-commerce and modern logistics and economic growth is analyzed and summarized, and the interaction mechanism between e-commerce and modern logistics and economic growth is obtained. In turn, it can more accurately analyze the contribution of e-commerce and modern logistics to the regional economy. Inductively form the statistical indicators as shown in Fig. 1.

The contribution of e-commerce to economic growth is reflected in the transaction process under different modes, which is the increase of economic benefits driven by transaction costs—commerce transaction costs include the total cost of software and hardware configuration, learning and use, information acquisition, online payment, information security, logistics and delivery, and after-sales service [24, 25].

Because of the different levels of economic growth, the role of e-commerce development has different effects on economic growth. Therefore, the influencing factors of different stages of e-commerce are also different. In the initial stage of e-commerce development, factors such as enterprise information flow, capital flow, and material flow directly affect the development level of e-commerce technology development and market application balance. The core element of e-commerce application development is demand [26].

The combination of the supply of information flow, capital flow, and material flow to a certain level after the development of the market economy reaches a certain level is to improve the efficiency through the development of e-commerce. In the development stage of e-commerce development, the contribution to regional economic growth is positive. The influencing factors are mainly the elements outside the e-commerce system. Elements outside the national economic system are also very important. Such as the international competitive environment, the country's open market economy,



political and humanities, and business operating environment are crucial. Due to their role, the speed and efficiency of e-commerce development will vary greatly [27, 28]. According to China's practical experience, the market, talent, technology, finance, and international and institutional environment elements of e-commerce development are all important factors at this stage.

The application of e-commerce has a great impact on the development of regional economy, mainly in three aspects. First, the development of e-commerce enhances regional economic efficiency, reduces overall costs, expands the scope of regional economic development, and increases the total demand for goods and services in a particular region. Second, it can reduce the development cost of enterprises and optimize the production conditions of enterprises. Third, the rapid expansion of market sales and demand, the development of e-commerce can greatly meet the needs of consumers, to provide customers with more personalized services. Lower transaction costs in the development of the company can increase operating profit. Whether for consumers or enterprises, the development of e-commerce can effectively improve information efficiency and reduce transaction costs [29, 30]. The application of e-commerce under the regional economic development model can effectively promote the expansion and development of enterprises in the region. In addition, the development of e-commerce reduces corporate social transaction costs, including credit costs, time costs, and logistics costs. Commercial credit plays a role as a lubricant in the commodity

economy. The improvement of the information system can effectively save capital costs, reduce unnecessary logistics expenses in enterprise development, and improve business operation efficiency. For the construction of some specialized e-commerce logistics platforms, the reduction of logistics costs makes the business development form more flexible. For consumers, it is possible to search for products that meet individual needs in a short period of time, while reducing transaction time costs, which is much more efficient than traditional trading methods.

### **3 Our proposed network economic integration method**

Research on the related role of modern logistics and economic growth, relevant literature at home and abroad, shows that the main focus is on the following three aspects: The analysis of the role of modern logistics in economic growth mainly refers to the analysis of the premise guarantee and promotion effect of the improvement of modern logistics supply capacity on economic growth, research on the impact of economic growth on the development of modern logistics, and analysis of the interaction mechanism between modern logistics and social economy.

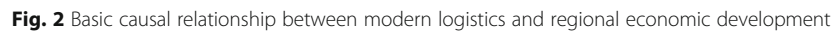
#### **3.1 The impact of regional economic growth on the development of modern logistics**

Modern logistics is considered to be a product of economic development to a certain stage. The impact of economic development on modern logistics is reflected in the fact that the substantial growth of the economy will lead to an increase in demand for logistics, and the increase in logistics demand can promote the development of modern logistics. On the other hand, the level of economic development determines the level of development of modern logistics. The substantial economic growth will inevitably lead to the flow of huge materials and products, which will inevitably lead to an increase in the flow of goods. This is an inevitable law of economic development and an inevitable law of logistics development.

#### **3.2 The interaction mechanism between modern logistics and regional economic growth**

Modern logistics and regional economic growth are interdependent entities. Modern logistics is the main component of regional economic growth and a leading force in the formation and development of economic systems. Modern logistics has a dual function in economic development, namely, subordinate function and guiding function (i.e., basic role and promotion role). At the same time, the faster the regional economic growth, the higher the demand for logistics and the greater the dependence of the economy on logistics. Logistics is becoming more and more important in regional economic growth, and the greater the role of the economy in promoting logistics development [31]. The interaction between modern logistics and economic growth can be described by the causal diagram in Fig. 2.

The impact of modern logistics on the regional economic scope is mainly reflected in the regional economic radiation range. The larger the scope of modern logistics outward radiation, the more it can promote the expansion of the regional economic scope. In addition, the efficiency of modern logistics is affected by the speed of physical logistics, which limits the speed of modern logistics and the outward radiation, which limits the scope of outward radiation of products, thus limiting the expansion of regional



economic scope. When the product circulates beyond the single-point radiation range, another adjacent product outlet continues to radiate outward [32]. The wider the single-point radiation range and the higher the degree of modern logistics, the smaller the network points required under the same coverage area, which can effectively reduce the operating costs of enterprises, optimize the operating environment of enterprises, and improve the comprehensive competitiveness of enterprises. In the process of development, the regional economy not only needs the interaction of various factors in the region, but also pays attention to the interaction between production and circulation and production factors. In a large regional economic market, there may be frequent economic constraints and trade barriers, as well as frequent exchanges of production factors and products. Under the combined influence of external factors and internal factors, such activities may solve two problems. One is the issue of object ownership [33]. The second is the issue of physical circulation, which is often referred to as logistics. The development of inter-regional logistics activities can promote the growth effects of demand and supply.

## 4 Performance analysis

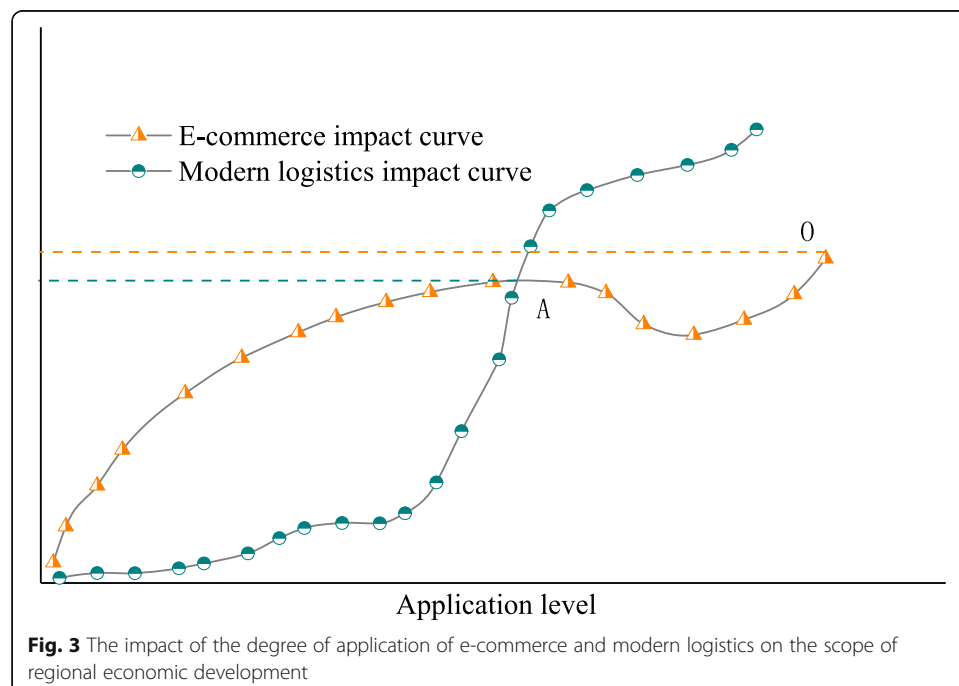
### 4.1 Basic setting

E-commerce and modern logistics will have a greater impact on the regional economic structure and scope. The impact is mainly from the aspect of industrial structure, which in turn affects the trend of regional economic scope. This paper sets the regional economic scope as the ordinate, takes the application of modern logistics and e-commerce as the abscissa, and obtains the influence curve of e-commerce and modern

logistics application degree on the regional economic development range, as shown in Fig. 3.

Among them, the e-commerce impact curve shows that with the increase of the degree of e-commerce application, the regional economic scope presents a power function curve with a power exponent greater than 1 (e.g.,  $y = x^2$ ), and there is no limit. This is determined by the characteristics of e-commerce. For non-physical goods or services, such as information services and music downloads, they are not affected by regional restrictions and radiate to the world. The modern logistics impact curve shows that with the improvement of modern logistics, the regional economic range shows a certain limit function curve (such as  $y = C(1 - e^{-x})$ ). Among them,  $C$  and  $e$  are constant 1 trend growth, when modern logistics is raised to a certain extent, it will not be able to pass the restriction of logistics speed.

To achieve a certain limit efficiency, the product radiation range is limited, thus controlling the regional economic range to a certain limit [34]. In the figure, the regional economic range value corresponding to the focus  $A$  of the two curves indicates that there is a most reasonable single-point radiation range for the product under the joint action of e-commerce and modern logistics. This range of radiation ultimately leads to a reasonable regional economic range. In other words, in the case of single-point radiation of products, a reasonable regional economic range is equal to the single-point radiation range of the product. In this reasonable regional economy, the links between industries are sufficiently close, coordinated, and consistent. Natural resources, human resources, and transportation resources are fully utilized without excessive abuse. The effective service range of the product is just right, the efficiency of matching e-commerce and modern logistics is used to the extreme, and the user's timely demand for goods is maximized [35]. If you go beyond this reasonable area to develop a regional economy, everything will be counterproductive.



As one of the important indicators to measure the economic development of a region, the development of e-commerce and modern logistics will make a great contribution to the development of regional economy and play a decisive role in the economic development of a region.

## 4.2 Results

As an emerging industry, e-commerce and modern logistics industry are an important part of the regional economy, and there is a strong correlation between the two. On the one hand, the development of e-commerce and modern logistics has a significant contribution to the economic development of a region. On the other hand, the development of regional economy can promote the development of e-commerce and modern logistics industry and ultimately determine the development level of e-commerce and modern logistics [36]. Freight volume is the most important indicator of logistics demand, which can reflect the scale of logistics market demand from the totaled-commerce transaction volume as an input factor of economic growth, the change in e-commerce transaction volume will be reflected in the change in freight volume.

As one of the most developed regions in China, the development of the e-commerce industry and the modern logistics industry, the Pearl River Delta and the Beijing-Tianjin-Hebei urban economic circle has already reached a certain scale and level. The development of e-commerce industry and modern logistics also contributes to the economic growth of these regions. This chapter will analyze the contribution of e-commerce and modern logistics development region to its economic growth.

### 4.2.1 General introduction

The convenience of transportation provides the basis and guarantee for the smooth progress of e-commerce transactions. In terms of highways, the inter-regional expressways that have been completed and opened to traffic mainly includes the Shanghai-Nanjing Expressway, Shanghai-Hangzhou Expressway, Human Expressway, Ning nan Expressway, and 104 National Highway connecting Beijing-Jinan-Nanjing-Guangzhou. In terms of railways, the main railway lines are the Shanghai-Nanjing Railway, Shanghai-Hangzhou Railway, Hangzhou-Ningbo Railway, Zhejiang-Jiangxi Railway, Xuan hang Railway, and Mingling Railway. And in the transportation mode of high-speed rail trains, it provides a quick and cheap logistics choice for online trading of some fresh products. In terms of coastal ports, the port is above the seaport. The north wing includes six major inland river ports: Nanjing Port, Zhenjiang Port, Jiangyin Port, Zhangjiagang Port, and Nantong Port. The south wing mainly includes ports such as Ningbo Port and Zhoushan Port. The abovementioned overseas Takahashi Logistics Centre, Shanghai Pudong Airport Logistics Centre, Nanjing Longton Port Integrated Logistics Park, Hangzhou Modern Canal Logistics Park, and other logistics centers provide the foundation for the vigorous development of modern logistics.

### 4.2.2 Contribution analysis

Increasing the volume of e-commerce transactions, increasing the volume of freight, and accelerating the turnover rate of logistics are the key to improving the speed and quality of regional economic operations as a whole. Therefore, we can reflect the

development trend of e-commerce and logistics industry by establishing a trend model of e-commerce transaction volume and freight volume. Using the least squares method (Eq. 1), establish a trend model for e-commerce transaction volume and freight volume:

$$\begin{aligned} X &= f(t) \\ Y &= f(t) \end{aligned} \quad (1)$$

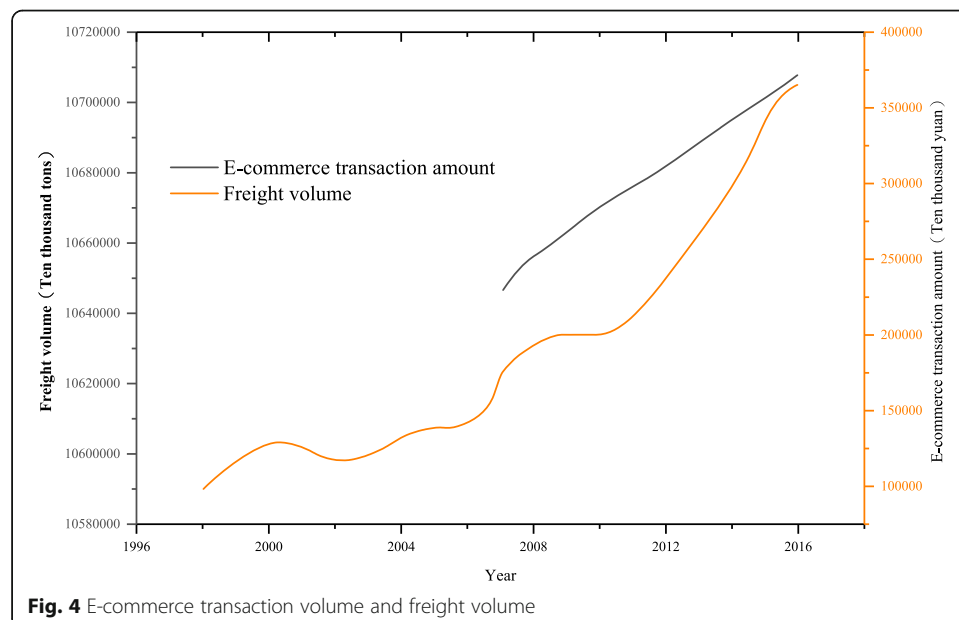
in which  $X$  is the e-commerce transaction amount,  $Y$  is the freight volume, and  $t$  is the year.

As shown in Fig. 4, the freight volume showed a clear upward trend over time. According to the data of freight volume, using SPSS19.0 to establish a linear regression model, we can get the regression equation of freight volume and e-commerce transaction volume:

$$\begin{aligned} X &= 3742.533 + 5281.3827(t + 1996) \\ Y &= 66342.201 + 10221.293(t - 1996) \end{aligned} \quad (2)$$

in which  $X$  is the e-commerce transaction amount,  $Y$  is the freight volume, and  $t$  is the year.

We need to test the above model. From the regression results, the sample correlation coefficient  $R = 0.965$ , the fitting coefficient  $R^2 = 0.993$ , the degree of fitting is very high, and the representativeness of the regression equation is strong. In addition, since the sum of squared residuals (the sum of the squares of the differences between the sample values and the predicted values) and the sum of the squares of the regressions (the sum of the squared values of the predicted values and the mean values) are independent of each other, the sum of the squares of the total deviations is given under given sample conditions. The sum of the squares of the difference between the sample value and the mean value is fixed. The larger the square of the regression is, the larger the value of the  $F$  statistic used in the test is, and the larger the value of the  $F$  statistic used for the



test, the amount of freight, and the amount of e-commerce transaction and time, the more linear the correlation is. After calculation, the value of the  $F$  statistic used in the test is 228.942, and the associated probability value  $P = 0.001 < 0.05$  indicates that the regression model established under the condition of the significance level of 0.05 is significant, that is, the linear regression model is reasonable. From the regression equation, the regression coefficients of the regression model are 5281.3827 and 10,221.293, which indicates that the freight volume is increasing by an average of 1,021,293,300 tons per year, and the e-commerce transaction volume is increasing at an average annual rate of 528,138,770 yuan.

Here, this study selects GDP as the explanatory variable, representing the level of economic development. Taking freight volume as an explanatory variable, it represents the development level of the logistics industry. By establishing a regression model of GDP to freight volume and e-commerce transaction volume, it reflects the contribution of regional logistics and e-commerce to the economic growth.

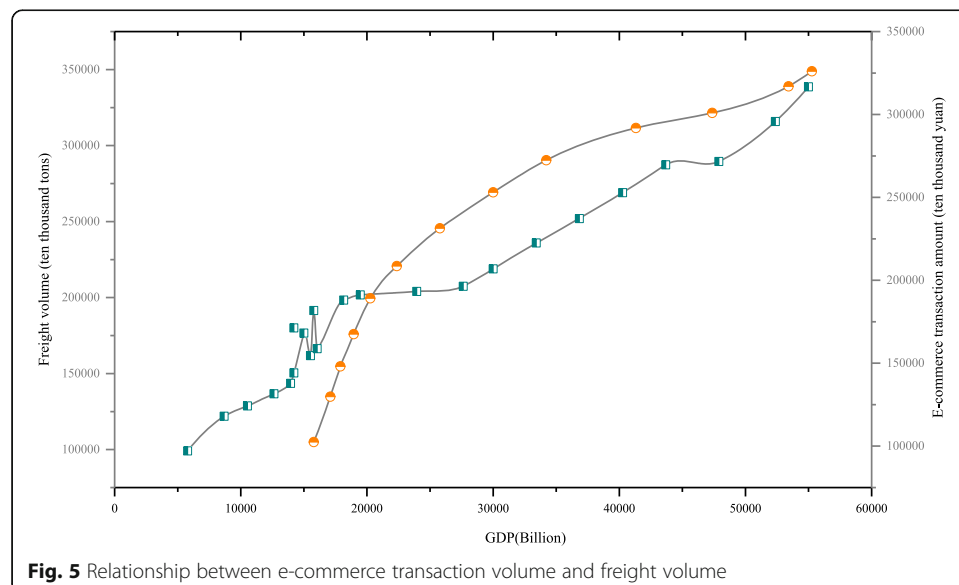
$$\delta = g(x) + g(y) \quad (3)$$

in which  $\delta$  is GDP,  $x$  is the e-commerce transaction amount, and  $y$  is the freight volume.

The relationship between e-commerce transaction volume and freight volume is shown in Fig. 5.

As can be seen from Fig. 5, there is a significant positive correlation between GDP and freight volume and e-commerce transaction volume. This shows that increasing the volume of goods and e-commerce in the whole society and carrying out regional logistics activities and e-commerce activities will contribute to the economic development. According to the data of freight volume, using SPSS19.0 to establish a linear regression model, we can get the regression equation of GDP region as:

$$\delta = 553.119 \times 1.00023^x + 230.122 \times 2.10283^y \quad (4)$$



in which  $\delta$  is GDP,  $x$  is the e-commerce transaction amount, and  $y$  is the freight volume.

The above model is tested. From the regression results, the sample correlation coefficient  $R = 0.979$ , the fitting coefficient  $R^2 = 0.993$ , and the degree of fitting are very high. In addition, the value of the  $F$  statistic used for the calculation test is 116.394, accompanied by the probability value  $P = 0.000 < 0.05$ , indicating that the established regression model is reasonable under the condition that the significance level is 0.05. It can be seen from Eq. 4 that increasing the freight volume and e-commerce business and vigorously developing the regional logistics industry and e-commerce will contribute to the national economic growth. Through the above two models, we can see that because the located in the eastern coastal areas of China, it has obvious geographical advantages and economic development advantages. Therefore, the development of the logistics industry region has been developed earlier and has formed a certain scale, which has a certain contribution to the economic development of the region. Especially in recent years, the development of the logistics industry region has played an important role in the rapid development of the regional economy.

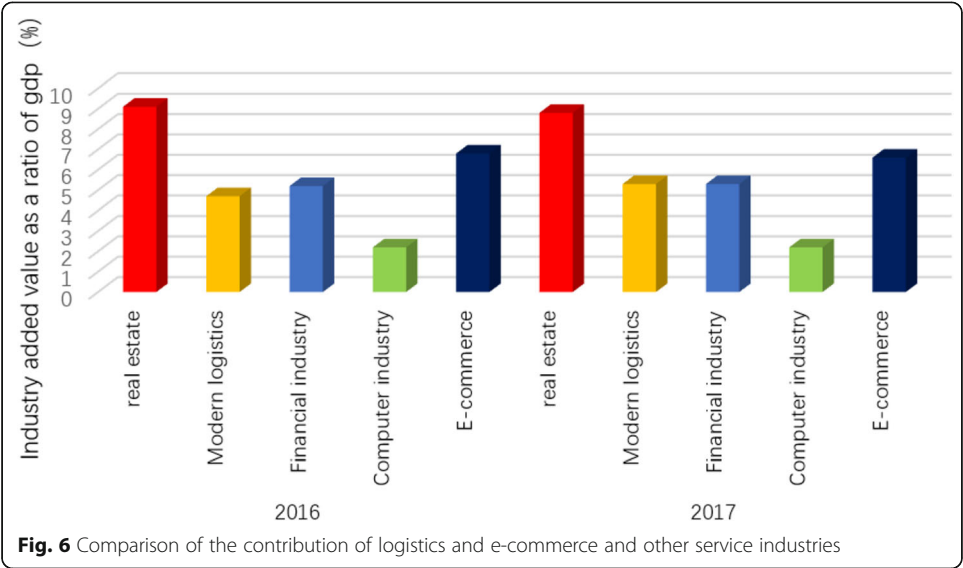
#### 4.2.3 Analysis of the differences in regional logistics and e-commerce contribution to economic growth

At present, the development of the logistics industry region has achieved certain achievements and has contributed to the growth of GDP. According to the “13th Five-Year Plan for the Development of Shanghai Modern Logistics Industry,” “Jiangsu Province Modern Logistics Industry Development Plan,” “Working Situation of Zhejiang Logistics Office in 2017,” “China Logistics Development Report (2016–2017),” Calculation of relevant data of Shanghai Statistical Yearbook (2017), Jiangsu Statistical Yearbook (2017), Zhejiang Statistical Yearbook (2017), and 2016–2017 China E-Commerce Development Index Report. A comparison chart of the contribution regional logistics and e-commerce and other service industries to GDP growth is shown in Fig. 6.

It can be seen from Fig. 6 that from the perspective of the added value of the logistics industry and e-commerce business as a percentage of GDP, regional logistics, and e-commerce have contributed to the growth of GDP and greatly exceeded other service industries. In addition, we can calculate the contribution rate of logistics industry and e-commerce to GDP growth. Assume that the combined effect of the growth of the various sectors of the national economy and the result is the growth of GDP in the whole society. The impact of various sectors on GDP is directly proportional to the proportion of GDP in the sector to the GDP of the whole society. Then, define the contribution rate of the logistics industry to GDP growth as shown in Eq. 5:

$$P = \frac{\text{Modern logistics and electronic commerce GDP growth rate}}{\text{All society GDP growth rate}} \times \text{Buddhist occupation society GDP weight} \quad (5)$$

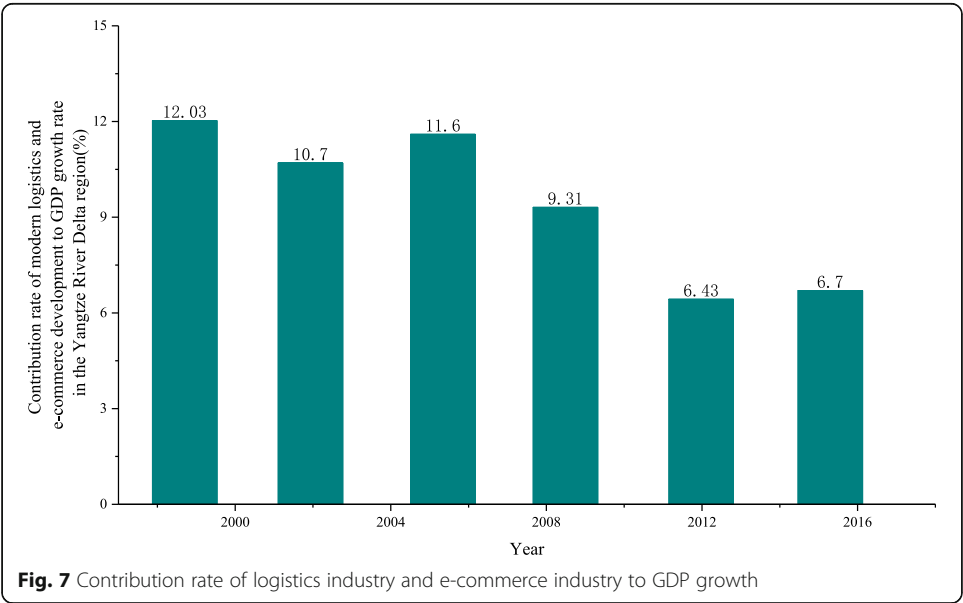
According to the above formula, the GDP of the logistics industry is represented by the GDP of the transportation, warehousing, and postal and telecommunications industries (or by transportation, warehousing and postal services). The GDP of e-commerce transactions represents the GDP of e-commerce. According to the relevant data of 2010–2017 China Statistical Yearbook, Shanghai Statistical Yearbook (2017), Jiangsu



Statistical Yearbook (2017), and Zhejiang Statistical Yearbook (2017), the result is shown in Fig. 7.

In summary, the current logistics industry and e-commerce region have contributed to the growth of GDP, and in terms of the proportion of industrial added value to GDP, its contribution exceeds that of other service industries. The regional logistics industry and e-commerce belong to the service industry in the tertiary industry, and the optimization of industrial structure is measured by the development level of the tertiary industry. Therefore, to examine the proportion of the added value of the logistics industry and e-commerce region in the tertiary industry, we can find out the contribution of regional logistics to optimizing the industrial structure.

From any angle, the role of e-commerce and modern logistics in the development of the economy can be considered significant. As one of the important drivers of



economic growth, the role of investment cannot be ignored. China is currently in a critical period of economic transformation. The role of the other party's openness in regional economic development is also significant. In the absence of domestic demand, the development of China's economy must be integrated into the development of the world economy. Under this circumstance, modern logistics and e-commerce are very important. Trade agreements and trade disputes in different regions of the world have escalated, and vying for the world's markets is an important means of upgrading the country's economy. China has always attached importance to foreign trade, and we cannot do without the positive impact that opening up has brought to our own economic development. Differences in the degree of openness of each other in different regions will affect the level of local economic development. The construction of the e-commerce network is based on the Internet. The original business model is based on the individual's development of the customer group, and establishes business relationships through communication and contact. The openness of e-commerce to the customer base is based on the network, and naturally there are large-scale potential customers. As long as the attention is paid on the Internet platform, the number of customers will be geometrically long. For example, the rise of Haidilao store opened the offline stores to the Internet, which made the original smaller shops face a wider customer base, thus promoting the expansion and development of business scale. The development of e-commerce has automatically led to the development of the offline logistics industry, thus complementing each other, promoting each other, and developing together.

## 5 Conclusion and future work

E-commerce and modern logistics have greatly affected the development of the regional economy. In this case, we will take effective measures to formulate a reasonable development strategy. By actively promoting the development and application of e-commerce, rationally arranging the development of logistics parks, speeding up the construction of transportation infrastructure and freight information network, promoting coordinated development, and promoting the healthy and rapid development of regional economy. Through the analysis of this research, we find that the rapid development of e-commerce and modern logistics has a significant positive impact on regional economic growth. In the economic development of various regions, focusing on promoting e-commerce and using modern logistics play an important role in improving the level of regional economic development.

For the future, we will further conduct research on regional economic development differences in the wireless network and logistics industry including how to understand the economic conditions of the logistics industry and e-commerce in the region and the contribution of the logistics industry and e-commerce to the regional economic growth, so as to formulate an active and appropriate logistics industry policy.

## Abbreviations

GDP: Gross domestic product

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**Authors' contributions**

Xiaodong Tang was responsible for the survey and analysis of the data, and Gangyi Wang was responsible for the writing of the paper. The authors read and approved the final manuscript.

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**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Ethics approval and consent to participate**

This article does not contain any studies with human participants or animals performed by any of the authors. All authors agree to submit this version and claim that no part of this manuscript has been published or submitted elsewhere.

**Competing interests**

Declares that he has no conflict of interest

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