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World Maritime University
Malmö, Sweden



**Analysis of the influence of Ningbo-Zhoushan
Port Development on Regional economy**

By
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China

A dissertation submitted to the World Maritime University in Partial Fulfilment of the
requirements for the award of the degree of

MASTER OF SCIENCE
IN
INTERNATIOANL TRANSPORTATION AND LOGISTICS

2019

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature: Li Manxi

Date: 2019.07.02

Supervised by: Professor Zhao Gang

Supervisor's affiliation: Shanghai Maritime University

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Time flies, the graduate study is close to the end. In this year's study life, I not only got the care and help of teachers and classmates, but also learned a lot of knowledge and skills. Here, I want to express my inner gratitude.

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ABSTRACT

Title of Dissertation: Analysis of the influence of Ningbo-Zhoushan Port Development on Regional economy

Degree: Master of Science

Under the environment of economic globalization and rapid development of international trade, the port has become the growth pole of regional economic development. Taking Ningbo-Zhoushan Port as a specific research object, this paper makes positive progress in building Ningbo into a modern international port city in the process of deepening the strategy of "promoting the city by port and promoting the port by city". This article first elaborates the relevant theories and gives an overview of the development history of Ningbo-Zhoushan Port and the current status quo. Then it makes a qualitative analysis of the impact of Ningbo-Zhoushan Port on regional economic development. Next, based on the data from Ningbo Bureau of Statistics, a regression model was set up, together with econometric analysis, and the elastic relation formula was used to analyze the contribution of port throughput to the GDP and industry. Secondly, it puts forward the difficulties that Ningbo-Zhoushan Port and the regional economy are facing nowadays, and draws lessons from the experiences of the international advanced ports to put forward the suggestion to the common development of the port and the region so as to promote their common progress.

KEY WORDS: Ningbo-zhoushan Port, Regional economy, Regression model, Elastic relationship

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1. Introduction

1.1 Research Background and Significance

As the process of global economic integration accelerates, trade demand is constantly rising at an unimaginable rate on a global scale. As a major transportation hub for international trade, the port has become more and more important under this demand. Throughout the ages, ports have played a vital role in promoting the development of the regional economy. Around the globe, many economically developed cities have one thing in common: connecting to ports through inland waterways or owning ports. Since the initiative of “the Belt and Road” came out, the public has once again focused on the importance of port development. As an important connecting node, the port plays an important role in promoting the national economic development while China is deeply integrated into the global economy. At the same time, some port policies are constantly being adjusted and changed, and they also promote the development of ports.

Ningbo Port and Zhoushan Port have been merged since 2006 and the rapid development of the port is the remarkable feature in recent years. Ningbo-Zhoushan Port is the world's first large port with a throughput of more than 900 million tons. As the busiest port in China, it has brought a large number of goods from all over the world into China. At the same time, countless “Made in China” products have also been transported to more than 100 countries and regions through the port, which has built a shipping trade network in the world. Ningbo-Zhoushan Port, as the biggest engine for stimulating the entire region's economy in Ningbo, is actively grasping the good opportunities brought by the initiative of “the Belt and Road” and accelerating the development of modern logistics services such as sea-rail combined transportation.

Ningbo is known for its four business cards, the first and the most important business card is Ningbo Port. The economic development of the port can affect the national

economic development in both positive and negative angles. Among them, the most significant influence caused by the port will be the surrounding cities of the port. Ningbo-Zhoushan Port can be said to be the biggest advantage of Ningbo. It has a special status in the national economy of Ningbo and even in Zhejiang Province. It is really a veritable engine of Ningbo's economic development.

1.2 Research status

1) Port development

Regarding the development of the port, Yang Mingjun, Lin Jian and Li Yancheng (2010) pointed out that the geographical conditions affecting port development include navigation conditions, berthing conditions, port construction conditions and hinterland conditions, especially in the hinterland, which is the basis for the rise and fall of the port. Ren Meijun and others believe that the main factors affecting port development are natural conditions, hinterland, container transportation development and collection and transportation conditions, fresh water resources, port service systems and other factors, including port construction conditions, hinterland construction conditions and collection and distribution conditions. It is regarded as the three core elements of port development.

2) The relationship between port and city

The concept of "large ports and large cities" defined by Jung (2011) is based on the view that the final result of the integration of ports and cities is the formation of a complete port city or city port, that is, the port and the city have been integrated.

Liu Bingzhen (2002) analyzes the mechanism of the relationship between the port and the city, and considers that the port is the best region to attract and gather modern industry, and has a very important leading role and driving role in urban development.

Xu Zhibin (2004) studied the "port-city integration" strategy, specifically analyzing the complementary symbiotic relationship between ports and cities, and the "internalization" of transaction costs and negative externalities in port and urban construction.

Li Zengjun (2002) deeply analyzed the complementary relationship between the port and the city and the different levels of the port and the vast hinterland. He believed that the promotion of the port's economy to the city is the most direct reflection of the economic impact of the port on the hinterland, and the development of the city provides support and protection for the development of the port.

Gao Zongqi (2009) summarized the development history of different port cities and found that the development of ports and the development of port cities do not necessarily maintain a unified pace. It is believed that the sustainable development of port cities should be the result of interaction between port functions and socio-economic development in the hinterland.

Li Jing and Liang Jing (2012) proposed the spatial impact of ports on the regional economy. Studies have shown that ports can affect the distribution of regional production factors and gather related industries to port cities to achieve economic growth.

In the study of Fred (2001), it is believed that the role of the port in promoting the economy is more achieved through the role of the port. He believes that the port undertakes the role of regional foreign exchange, and the port can enhance the degree of openness of the city, thereby promoting the development of the city and related regions.

In the study of Jung Duk Lim (2005), it is believed that there should be an interactive relationship between the port and the regional economy. In the interaction between each other, the port not only promotes regional economic growth, but also regional economic growth has further promoted the development of the port.

The conclusion of Darren Prokop (2006) is consistent with the conclusions of Fred et al. However, he believes that in addition to the role of the “link” of the port, the port has obvious industrial agglomeration in promoting regional economic growth. The modern port is no longer a traditional logistics center, but an industrial cluster center. The development of the port industry is the core driving force for the development of modern regional economy.

Tom (2013) analyzed the role of port and shipping management systems in different countries and regions in the interaction between ports and regional economies. Based on the demonstrations of Barcelona and Rotterdam, he pointed out that the legal system related to the sound development of ports and the economy is sustainable for the port city and port area. The important role of the port management organization is to transform from a single sub-industry management to a unified management of the port area.

3) The relationship between the port and the region

For the relationship between the port and its economic hinterland, scholars have explained through empirical analysis and other methods.

Among them, Hu Binbin and Hu Liang (2010) concluded through empirical analysis: from the long-term relationship: there is a unique cointegration relationship between GDP and port throughput, that is, there is a long-term stable equilibrium relationship between them, and the port throughput obviously promotes the growth of GDP. From the short-term relationship: port development not only directly promotes the development of import and export trade, but also promotes the development of port-based industries. Port development not only directly promotes the development of import and export trade, but also promotes the development of port-based industries, thereby promoting regional economic development; The development will strengthen the construction of the bonded area, promote the standardization of the port industry, and continuously improve the service infrastructure of the port, thereby improving the

external environment for port development, thereby enhancing the competitiveness of the port and promoting port development.

Zhong Zheng (2013) studied the development mechanism of inland ports to promote regional economic development, and analyzed the developmental effects of regional economy from several aspects such as industrial transformation, technological progress, population employment, and ecological environmental protection.

Song Min (2015) used the port input-output table to analyze the impact of seaport business activities on the direct economic hinterland. The results show that the port transportation and transportation service industry has the greatest impact on the economic hinterland, followed by the seaport service industry. The lowest impact is harbor construction industry.

Tukan (2012) used the econometric model to study the relationship between port investment and regional economic growth.

Jin (2016) used the Augmented Solow model for panel data analysis to explore the impact of ports on the Korean regional economy. It was found that container port activities have a positive impact on regional economic growth, and port investment indirectly drives regional economic growth.

Heijman (2017) believe that regional economy plays a key role in the formation and development of port economy, and port is an important growth pole of regional economic development, that is, there is a mutual promotion relationship between port and regional economy.

4) Recommendations for promoting coordinated development of port areas

Liu Dongtao (2017) proposed to realize the coordinated development of ports by means of benefit sharing and information sharing; Wei Lihua (2016) proposed that in order to better promote the integration process of ports, it is necessary to create a cross-regional coordination and cooperation mechanism and build a synergistic division of labor with complementary advantages cooperation system.

Chen Yuanyuan (2017) proposed countermeasures for the transformation and development of Ningbo modern international port city from six aspects: give full play to the advantages of the port, create a “one circle and three centers”; vigorously enhance the city's functions, enhance the nuclear function of Ningbo's central city; accelerate industrial transformation and upgrading To build a modern industrial system; to build a strong cultural city, to lead the transformation and development; to achieve refined social governance, promote urban harmony; accelerate the development of ecological civilization and build a beautiful Ningbo.

In the research of Lee Tsung-Chen, Lee Paul T-W, Chen Tao and others, the core of port development is to strengthen the construction of infrastructure. Only through continuous improvement of port infrastructure construction, efforts to improve the port's service capabilities, and enhance the port's ability to serve the modern economy, can we achieve a harmonious and win-win situation for port and economic growth.

In the study of Bart ff. Wiegman, Erik Louw, it is believed that port development must be based on the reality of regional economic development, and expand its own competitiveness around the modern economic development trends such as the marine economy and port economy. In order to better promote the port to play a role in the development of regional economy.

1.3 Main contents

The paper is divided into six chapters, the main contents of each chapter are as follows:

Chapter 1: Introduction

Starting from the research background, the research significance, research content and research methods are emphasized.

Chapter 2: The relevant theory of port and regional economy

It elaborates the relevant theories of port and regional economy. This chapter will separately describe the meaning of port economy and the meaning of regional economy. Based on the theory of regional economy, it analyzes the interrelationship between port economy and regional economy.

Chapter 3: Qualitative Analysis of the influence of the Ningbo-Zhoushan Port on regional economy

It first gives a general overview of the basic situation of Ningbo-Zhoushan Port, and then analyzes the development history and current situation of Ningbo. Then the qualitative analysis of overall impact of the Ningbo-Zhoushan port economy on the regional economy is given, and based on this, model assumption is proposed.

Chapter 4: Quantitative analysis of the influence of the Ningbo-Zhoushan Port on regional economic development

It undertakes the above model hypothesis, collects relevant indicator data, establishes a regression model, and makes an econometric analysis for the regression results of the model.

Chapter 5: Suggestions for the coordinated development of Ningbo-Zhoushan Port and the regional economy

It further analyzes the impact of the port on the regional economy by learning from the experience of well-known ports. Therefore, policy opinions are proposed to realize the coordinated development of the port and regional economy, and actively play the role of the port in the regional economy.

Chapter 6: Summary and outlook of the full paper

It summarizes the research content of the full paper.

1.4 Research method

In the research process, this paper mainly uses the following methods:

1) Literature research method:

Through a large amount of information, I learned about the role of ports in regional economic development. Besides, a large amount of data was collected to analyze the impact of Ningbo-Zhoushan Port on regional economic impact.

2) Qualitative analysis:

By analyzing the development status of the port and regional economy, the internal relationship between port development and urban economic development is obtained.

3) Quantitative analysis;

The linear regression model is used to analyze the impact of the port on the regional economy and analyze the specific impact mechanism of Ningbo-Zhoushan Port on the regional economy.

2. The relevant theory and experience of port and regional economy

2.1 Theoretical basis of port and regional economy

2.1.1 Concept definition of port and regional economy

The port, which is a transportation hub, has certain water and land transportation equipment and conditions, and it can provide in and out port service and docking service for ships. Specifically, the port economy is an open economy. As the name suggests, it is centered on the port. At the same time, it is based on the port city and supported by its related port industries. Through the integrated transportation system which can be seen as its arteries, regional economy is further promoted to be contributed to the regional prosperity.

From the perspective of logistics, the port economy is a comprehensive cycle, which interweaves the logistics chain and the transportation hub and related service industries.

From the perspective of resource allocation, the port economy can play its two major roles through the port: agglomeration and radiation. It has a hinterland in both inland and overseas directions. Under certain market conditions, it can make an integration of resources among goods, technology and so others and can help achieve optimal configuration and communication.

From the perspective of economies of scale, it is well known that the transportation cost of the maritime industry is the lowest compared with other kind of transportation. With the deepening of the global economy, this feature can be said to be a distinct advantage, which can make port cities form economies of scale.

Russia's Economic Zoning Commission has defined the concept of a region, and they defined that a region should be a special economically intact region of the country. And they believe that this area will become a link in the national economic chain because of its natural characteristics, past cultural accumulation and the combination of residents and their productive activities. Talking about the regional economy, it

refers to the comprehensive product of internal factors and external conditions that affect economic development in a certain region. The regional economy not only covers a geographical concept, but also an economic phenomenon more importantly. The material basis of the regional economy depends on a certain area, which is its geographical attribute. As far as the level of economic phenomena is concerned, the regional economy reflects the objective laws of economic development in different regions and is the fundamental trend of economic integration development.

2.1.2 Theoretical basis of port economy

After a long period of historical development, the port has become an important meeting point, including the integration of economy, trade and culture. The port not only has the function of transporting goods and picking up passengers, but also has a variety of functions in trade, commerce and industry. Modern ports have evolved from a pure transportation center that integrates transportation, transshipment and storage to a distribution center, which includes transportation, transshipment, storage, storage management, loading and unloading and processing services, and finally become a popular integrated logistics center in the eyes of the public, including transportation, transshipment, storage, warehouse management, loading and unloading, processing and information processing services.

With the development of port transportation functions, the commercial and trade functions of modern ports are also developing correspondingly. At the same time, the improvement of commercial functions and trade functions further promotes the development of port transportation functions. The trade function of modern ports can better provide resources for shipping and ports. Then On the basis of this function, the yard financing of some ports has gradually formed and developed, which has brought opportunities for economic growth.

What's more, the port's service functions and industrial functions have emerged. In

addition to the booming industries that served for people, some other auxiliary function of shipping trade such as agency, insurance, shipping transaction and so on also have developed. These auxiliary functions not only enable the port area to accelerate the process of urbanization, but also promote the port to develop into a multi-functional, multi-level and multi-faceted system. More importantly, the industrial function of the port cannot be ignored. As we all know, transportation costs account for a certain proportion of the cost of goods, and the use of ships for large-scale transportation can help reduce unit costs. Establishing industry in port cities can not only make full use of the advantages of large-ship transportation, but also save transportation costs. It can also take advantage of the contact with international market information, and make timely adjustments to the types and structures of the products based on the latest news and actively respond to market changes.

2.1.3 Theory of regional economic development

The theory of balanced growth, the theory of non-equilibrium growth and the theory of new growth are all theories that explain regional economic growth. The equilibrium growth theory has a large gap with the reality due to excessive emphasis on the balance between production and consumption. Although the theory of non-equilibrium growth has a good role in industrial optimization and selection, it is difficult to explain why the level of development in different countries is so different. It pointed out that it is difficult to concentrate resources in all industries due to limited production factors in any country or region. Therefore, we need to allocate resources and elements to those industries with comparative advantages through comparative advantage analysis, in order to promote the rapid development of the economy. The birth of the new growth theory is due to the development of science and technology. More and more scholars recognize the importance of science and technology in economic development. The theory emphasizes that technology is the driving force for economic

growth. In the view of the new economic geography school, with the development of the intellectual society, they believe that people are the core elements determining economic development, and the influence of other natural resource elements is declining. Some scholars regard the population as a separate element or combine with technology. Under the background that modern science and technology profoundly affects social development, more and more scholars have affirmed the status of technology as the first force of economic development.

In general, regional economic growth is based on regional comparative advantages and is based on the allocation of unbalanced resources. Through the interpretation of modern regional economics, there are many factors that influence regional economic growth, mainly including natural elements and technological elements. The geographical distribution and the reserve status of resources are the most important natural factors. Generally speaking, in the development of many cities, coastal cities have a large first-mover advantage. From the perspective of the whole world, economically developed areas are mainly concentrated along rivers or coastal areas, such as the New York Economic Belt and the London River Economic Zone, the Yangtze River Delta, the Pearl River Delta, and the Bohai Rim Economic Zone, which can reflect the importance of the port for economic development in fact.

2.2 Research on the relationship between port and regional economy

2.2.1 Port economy promotes regional economic development

The port has unique advantages and is able to directly participate in international division of labor and trade through land and sea transportation. The superior geographical location and large-scale distribution function can promote the

economies of scale and the benefits of agglomeration, and then guide the population, enterprises, and industries to gather in the port area, making the city's economic aggregate rise rapidly.

The promotion of the port to the economic development of the city is mainly manifested in three aspects. The first one is that the port can directly create regional GDP, tax revenue and numerous employment opportunities. The second one is that from an industrial perspective, ports have a correlation effect, including forward linkage and backward linkage. It mainly refers to the port can provide loading, unloading, storage and other related services, and the port will directly consume the products and services of the local industry, trade and other industries to a certain extent. The third one is that due to the geographical location, the inducing, generating and agglomeration functions of the port industry play an important role in economic development and bring huge benefits to the city. Ports and related industries can provide a large number of jobs for a city. From another perspective, it also helps the government to establish a good image and reduce the pressure on the government. As a hub, the port is more closely integrated with the city when it plays its transportation function, forming a city impression. Moreover, due to the portal image of the port opening to the outside world, it can further promote economic and cultural exchanges between the city and other regions, making the city image widely known.

1) The port accelerates the expansion of urban form

At the beginning, the estuary port city is generally formed in the upper section of the estuary because of the convenience of transportation. Gradually, with the development of the economy, the scale of the port will be expanded and the urban land will be expanded accordingly. The development of the port will be accompanied by the development of large-scale ships and transportation technologies. Coupled with the increase of restrictions in the old port area, the port will be retired to the lower reaches of the river, moving from the estuary along the coast or moving towards the

island. At this time, the urban land will also be moved outwards accordingly, gradually developing in the direction of the estuary and coastal islands, forming a city shape that matches the function of the port.

2) Port development promotes urban construction

The port can serve as a catalyst for regional economic development and continuously promote the development of port cities.

Urban infrastructure is a general term for a class of equipment that is built to carry out various economic activities and other activities in society. The port itself is the transportation infrastructure. As the most basic important transportation infrastructure of the port city, it plays a vital role in foreign exchanges. It is the responsibility of the government to strengthen the city's infrastructure and provide citizens with a better production and living environment. For a port-centric city, the port is the source of funding for the city's infrastructure. The exchange of goods and services can be motivated through the port, which can bring the increase of the income of the city and thus become part of the fiscal revenue to improve the infrastructure. The improvement of infrastructure is conducive to the further expansion of the port scale and the development of the port industry, which will generate more income, form a virtuous circle. While providing funding, it continues to enrich the functions of the city.

At the same time, the development of ports and related industries is also a catalyst for urban development. In addition to providing a source of funds for the city, it also provides a large number of employment opportunities for the city, which is conducive to social stability. As an important transportation infrastructure, the port has a clustering function, which can gather production factors and attract investment to create greater economic benefits.

2.2.2 The region is the hinterland of port economic development

The region is the hinterland of port economic development. The policy mechanism,

cultural atmosphere and management service functions in the region can provide environmental protection for the development of the port economy and promote the function of the port.

Throughout the ages, the port and the port city are closely related. The development of the port is closely related to the economic situation of the hinterland. There is a relationship of symbiosis and prosperity between them. The port city is the most direct economic hinterland. The economic development of a region can be reflected in the output of goods. The expansion of the economic scale of the hinterland means that the hinterland has a large foreign economy and a large demand for transportation. At this time, a large amount of transportation demand will promote the expansion of the port and the evolution of the structure. Specifically, the industrial development in the region and the improvement of the competitiveness of industrial products will bring some changes to the goods. It will make the types of goods change constantly and become so various that the types and quantity of the transported goods will increase. The cargo throughput of the port will also increase accordingly. More importantly, the bulk dry bulk cargo will gradually replace the original general bulk cargo. It will then also develop in the direction of container specialization, which will significantly improve the port's economic efficiency.

Another point worth mentioning is that the development of the port requires a certain software and hardware environment, which must be based on the city. In the region, not only can the port provide land, collect and transport, human resources and other hardware conditions, but also provide an indispensable financial and trade environment. Policy support is also needed when the port undergoes structural evolution and scale expansion. For example, positioning the port's layout and functions, and promoting a more open economic policy to help the port progress.

2.3 Interactive development experience

Yokohama Port is one of the earliest ports open to the outside world in Japan. As early as the 1950s and 1960s, the first industrial upgrade from the light industry of the traditional textile industry to the heavy industry was realized in Yokohama. By utilizing its port advantages, it has developed the port industry, and with its excellent harbor conditions, it has finally developed into one of the world's leading international trading ports and a famous coastal tourist city.

Yokohama Port is located on the coast of Kanagawa Prefecture, surrounded by hills on the west, south and north. It is on the west bank of the Tokyo Bay and has a deep-water channel to the Pacific Ocean to the east. The coastline is extremely tortuous. The harbor is about 5 kilometers deep in the mainland. The water depth is wide and the port is rarely affected by the Pacific winds. So it is a natural excellent port in Japan and is famous for its "Japanese sea porch". Yokohama Port is a symbol of Yokohama City. The throughput of Yokohama Port has been continuously improved with the development of international trade. The most prominent feature of Yokohama Port is its export business. It is known to all that Japan is a processing trade country. Although Yokohama Port's cargo throughput ranks third behind Kobe Port and Chiba Port, its total trade volume ranks first in Japan and is the largest international trading port in Japan.

Since its operation, Yokohama Port has been able to adapt to changes in world economic and trade to contribute to the construction and development. Its goal is to become a comprehensive port and give full play to its positive role in contributing to the economy of Yokohama and the world economy. In Yokohama Port, we attach great importance to the construction of port transportation facilities. The local area has a perfect transportation network. There are railways, highways, water and land exchanges, and railways and highways are connected between terminals, warehouses and ports. With the development of the port, the industry has been

induced and cohesive. For decades, refining, electrical, mechanical, steel, chemical and other industries have been established in Yokohama, which has become a unique model of industrial construction. Through comprehensive planning, we have determined the focus and direction of industrial development in Yokohama that keeps pace with the times, and the industrial layout is constantly improving. With the construction and development of the port, the industrial upgrading of urban industry was promoted. Before the Second World War, the ratio of light industry was much higher than that of heavy industry. In the 1950s and 1960s, the first industrial upgrading in Yokohama was carried out, thus heavy industry was rapidly developed and expanded, surpassing the proportion of light industry. In 1963, the Yokohama City Government proposed the industrial zone to promote the productivity of SMEs, adjust the urban layout, and improve environmental protection in order to further develop the city. The oil crisis in 1973 caused a large number of high-energy products to lose their competitive advantage. The Yokohama municipal government took the initiative to adjust the industrial structure once again, adding technology-intensive products with high processing capacity and low energy consumption, such as electrical appliances, computers, automobiles, etc. It realized the transformation of Yokohama port industry from heavy chemical industry to technology capital-intensive industry. During this period, the container terminals were also established, which provided good conditions for the transformation of the industry.

After decades of development and changes, an industrial belt near the sea has been built gradually in Yokohama, which industrial output ranks third in Japan, making it an important international port of Tokyo-Yokohama Industrial Belt in Japan.

3. Qualitative Analysis of the interplay between Ningbo-Zhoushan Port and Regional Economy

3.1 Overview of the basic situation of Ningbo-Zhoushan Port

3.1.1 Ningbo-Zhoushan Port geographical analysis

Ningbo-Zhoushan Port is located on the eastern coast of Zhejiang. The five port areas of Ningbo, Beilun, Zhenhai, Chuanshan and Daxie are its main port areas. The Ningbo-Zhoushan Port has a prominent position and it is an indispensable maritime hub for foreign trade in the history of China. More importantly, it is one of the four international deep-water ports of transshipment, which is currently under the development and construction in China. What is not to be underestimated is its locational conditions, shoreline resources, waterway depth, land support and development potential, which have great advantages.

In terms of the location of Ningbo-Zhoushan Port, it is located in the middle of the Chinese mainland coastline and is located at the hub of the “Belt and Road Economic Belt” and the “Maritime Silk Road”. It is closely adjacent to the busiest international main channel in the world. With obvious advantages, wide and convenient radiation, it is an ideal port for transporting goods from coastal areas in China to the major ports in the world. By the end of 2015, 235 trade routes linked between Ningbo-Zhoushan Port with more than 600 ports in more than 100 countries and regions have been established. The routes can be extended westward to the Yangtze River region, which currently has the highest level of economic development and is the most dynamic economic belt in China. What’s more, the routes to the east can radiate the entire East Asia and Pacific area and can radiate coastal economic belt of China to the north and south, thus forming a more comprehensive route network.

What is more noteworthy is that Ningbo-Zhoushan Port is a rare deep-water well-developed port in the world. It has excellent shipping conditions and is an ice-free port that can be navigable throughout the year. It can reach more than 350 days of

operation throughout the year. The water depth of the approach channel is above 18.2 meters and the 300,000-ton-class giant ships have the free access to enter and exit the port. It is the port with the largest number of ships with a capacity exceeding 100,000 tons in China. The 19 port areas form the entire Ningbo-Zhoushan Port. The port has 150 large-scale deep-water berths of over 10,000 tons, including 89 large-scale and extra-large deep-water berths of 50,000-ton or above, which is the port with the largest number of large and extra-large deep water berths in the mainland of China. In addition, there is no need to build other breakwaters because of the small waves in the Ningbo-Zhoushan Port, which highlights the advantages of Ningbo-Zhoushan Port. It has the advantages of investment and high efficiency, and its deep water coastline is more than 120 kilometers and can be well developed. The land area behind these deep water coastlines is flat and open, which is extremely conducive to the development of inventory storage services in the port and contributes to the development of the port industry. It really has excellent development prospects.

3.1.2 The development history and current situation of Ningbo-Zhoushan Port

The earliest port in Ningbo can be traced back to 473 BC. After the successful elimination of Wu, Goujian established a Juzhang port in the Yong River Basin. The Juzhang port gradually declined after the Wei and Jin Dynasties, and the port was forced to move to the “three-river-junction”, which is the port of Mingzhou in Tang Dynasty, which is the area where Ningbo is today. Ningbo-Zhoushan Port is located in the Yangtze River Delta in the east of China. It is backed by some high-developed urban agglomerations, such as Shanghai, Hangzhou, Ningbo and other urban agglomerations. It is one of the most active and developed regions in China. The predecessor of the Ningbo-Zhoushan Port was Ningbo Port, the second largest port in China, and the Zhoushan Port, a natural deep-water port. Although the two ports use the same channel and are located in the same sea area, the resources are not

reasonably allocated in planning, construction, management, etc., resulting in serious waste of port resources and failure to achieve optimal allocation of resources. With the approval of the Ministry of Transport of the People's Republic of China, since January 1, 2006, the two pillar ports in Zhejiang Province have been merged, and the "Ningbo-Zhoushan Port" has been officially adopted to replace the previous two ports. On September 29, 2015, with the unveiling of the Ningbo-Zhoushan Port Group, the integration process of Ningbo-Zhoushan Port has achieved substantial asset integration.

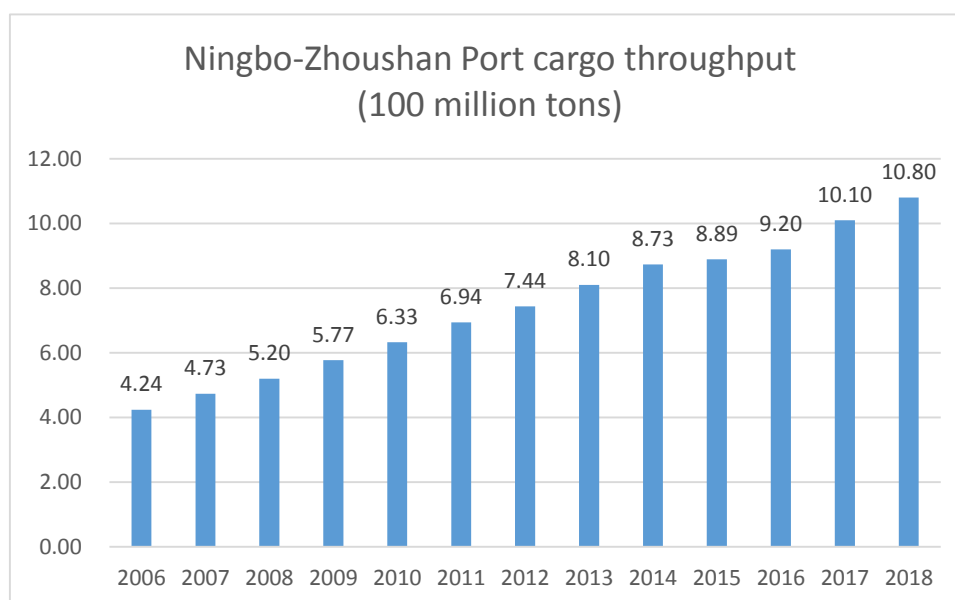


Figure 1: Overview of cargo throughput in Ningbo-Zhoushan Port

According to the data of Ningbo Municipal Bureau of Statistics, a histogram is made. As shown in Figure 1, the throughput of Ningbo-Zhoushan Port is increasing year by year. The throughput in 2007 was 473 million tons. After that, it increases every year until 2015, Ningbo-Zhoushan Port has reached 889 million tons of cargo throughput, ranking first in the world for seven consecutive years, and has maintained an upward trend in the following years. In the end, the throughput in 2018 reached 1080 million

tons. From this we can see that the port has played an increasingly important role. From another perspective, this phenomenon also shows that since China joined the WTO, international trade activities have become more and more active. With the establishment of Ningbo-Zhoushan Port Group, the resource allocation of the two ports can be more optimized. After dividing the different functions of each area, the logistics and transportation functions can be fully realized. All the processes can be operated like the assembly line, not only fast but also efficiently, thus actively accelerating the development of the regional economy.

From the port industry, the coastal port industrial belt has basically formed, accounting for two-thirds of the city's industry. At present, three pillar industries have formed in Ningbo: chemical industry, textile and garment industry and machinery industry. The chemical industry mainly focuses on the production of chemical raw materials, petrochemicals, rubber and plastics, concentrated in Zhenhai District and Beilun District. The textile service industry has a relatively high degree of regional concentration, and its production scale ranks high in the mainland. The machinery industry is second only to the petrochemical industry and it has leading enterprises such as Shanghai Volkswagen and Zhejiang Shipbuilding Co., Ltd.

3.2 Analysis of the impact of Ningbo-Zhoushan port economy on regional economy

3.2.1 Change the industrial structure of the region and promote employment

Relying on the advantages of the port, Ningbo has made rapid progress in recent years and has become the marine economic center of Zhejiang Province. With the advantages of Ningbo-Zhoushan Port and the vast hinterland, a large number of

industries have been created in Ningbo, among which its logistics, manufacturing, foreign trade and other industries have been evolved into Ningbo's pillar industries.

Table 1: List of economic conditions in Ningbo

Year	GDP	Speed of growth (%)	Ranking in the country
2006	2864.50	13.60	12
2007	3433.10	14.70	12
2008	3964.10	10.30	14
2009	4214.60	8.90	15
2010	5125.82	12.50	16
2011	6010.48	10.00	16
2012	6524.70	7.80	16
2013	7128.90	8.10	17
2014	7602.51	7.60	17
2015	8011.50	8.00	16
2016	8541.11	7.10	16
2017	9846.90	7.90	17
2018	10746.00	7.00	16

(Source: Ningbo Municipal Bureau of Statistics)

It can be seen from the table that in 2006, when the two ports are first merged, Ningbo created a total GDP of 286.45 billion yuan in the whole year. As of 2018, it increased to 10746 billion yuan. From this, we find that the economic aggregate has risen significantly, largely due to the foreign trade advantage brought by Ningbo-Zhoushan Port. However, due to the large proportion of Ningbo's export-oriented economy, the economic crisis in 2008 has caused tremendous impact on the financial system in many regions, which has severely hit the economies of many developed countries such as Europe and the United States. Therefore, in this context, Ningbo is also affected by a relatively deep degree. In 2009, Ningbo's GDP growth rate was significantly affected. This was due to the fact that many foreign trade factories had

fewer orders or many factories were closed down, which caused by the poor capital turnover. Although the growth rate of GDP began to improve in 2011, in general, the ranking of Ningbo's economic aggregate in the country also fell from the 12th in 2006 to the 17th in 2014. After 2015, the completion of new cities such as Hangzhou Bay New City also brought the emergence of emerging industries. The economic transformation of Ningbo has achieved initial results. From the perspective of GDP growth, it has also improved from the previous year.

Table 2: The proportion of the three major industries in Ningbo

Year	The proportion of the primary industry	The proportion of the secondary industry	The proportion of the tertiary industry
2006	5.40%	54.83%	39.77%
2007	4.85%	54.99%	40.16%
2008	4.41%	55.41%	40.18%
2009	4.23%	55.51%	40.26%
2010	4.24%	54.56%	41.20%
2011	4.24%	55.60%	40.16%
2012	4.21%	55.28%	40.51%
2013	4.08%	53.43%	42.49%
2014	3.88%	52.49%	43.63%
2015	3.60%	49.00%	47.40%
2016	3.60%	49.60%	46.80%
2017	3.20%	51.80%	45.00%
2018	2.80%	51.30%	45.90%

(Source: Ningbo Municipal Bureau of Statistics)

Industrial structure has been actively transformed in Ningbo in recent years. It can be seen from Table 2, the largest proportion of the industrial structure of Ningbo is the second industry. Over the years, the proportion of the secondary industry, which ranks

first in the three major industries, has declined from 54.83% in 2006 to 51.30% in 2018. At the same time, the proportion of the tertiary industry has gradually increased from 39.77% in 2006 to 45.9% in 2018. This shows that the economic restructuring and upgrading of Ningbo in recent years has achieved remarkable results, and the industrial structure has been continuously optimized. At the same time, it can also explain the role of the port in the regional economy, which can change the industrial structure of the region. The economic transformation of the city will correspondingly improve the cargo structure of the port and provide a continuous source of power for the development of the port. In addition, the expansion and construction of the port area have injected new vitality into the regional economy. As a result, many highly staffed industries are rushing into new urban areas, such as catering, commerce, property & finance, insurance and port services. These industries have brought a large number of employment opportunities to the region, which can improve employment problems to a certain extent and make the society develop harmoniously.

3.2.2 Promote regional port industry clustering

The superior natural location is intertwined with a good policy environment, which has accelerated the process of industrial clustering in the port. The port area has attracted many group companies. For example, Beilun District of Ningbo has six major port industries, and most of them have formed industrial clusters, and the economic benefits are considerable.

The first one, which has to be mentioned, is the energy industry. It has formed the energy industry group with major energy projects and cogeneration enterprises between Beilun Power Plant, LNG, Donghai Oil and Gas Field Landing Project, etc.

The second one is petrochemical industry, which has formed a petrochemical industrial chain mainly consisting of Formosa Petrochemical, Mitsubishi Rayon Acrylic Fiber, Yisheng Chemical and Pacific Chemical. The industrial chain covers the upper,

middle and lower reaches of the industry and is relatively complete.

The third one is a steel industry, which has formed a steel production base in the development, with Baoxin Stainless Steel, Ningbo Iron and Steel, Huaguang Stainless Steel as the main body.

The fourth one is the automobile and spare parts industry, and the automobile and spare parts industry also has an industrial cluster, which has independent intellectual property rights. The main body of the industry cluster is Geely Automobile, Tuopu, Xintai and many other automobile and auto parts production enterprises.

The fifth is the shipbuilding industry, which has formed a shipbuilding industry cluster with Samsung Heavy Industries and Hengfu Shipbuilding as the main body and with the whole ship and ship spare parts as the core products.

In the end, it is the paper industry, which has formed the largest papermaking industry base in Asia with Ningbo Zhonghua Paper Company as the main leader.

In general, the port promotes the concentration of industries, making these enterprises concentrated into industrial clusters. In addition, making full use of the advantages of the port can reduce unit costs and achieve better benefits.

3.2.3 Promote the establishment of transport networks within the region

The geographical location is located at the “T”-shaped junction of the eastern coastal economic belt and the Yangtze River Economic Belt. Numerous deep-water ports and abundant inland waterway resources benefit the region, making the region a unique port with fantastic shipping resources. These are the most prominent location advantages and resource advantages. In order to better connect with the port and develop the intermodal transportation, considering the numerous rivers in Zhejiang and the dense water network, in recent years, in the inland rivers, the container transportation channel mainly consisting of three-level navigation channels has been built, and the key waterway projects has been built. The waterway project finally

completed the Hangyong Canal, the first modern artificial excavation canal in China, and the Huzhou section of the Hujishen Line, the first 1,000-ton inland waterway in the province, which basically formed the a channel pattern that penetrated the north and south with 20 key waterway channel covering more than 1800 kilometres. The navigation effect of the 500-ton class navigation channel of the Hangyong Canal has been initially shown. In 2016, the transportation volume of bulk cargo of the river-sea combined transport exceeded 1.3 million tons. At the same time, the Zhejiang Inland Waterway Rehabilitation Plan is gradually being realized and the revival of the shipping project in the middle and upper reaches of the Qiantang River has also started.

3.3 Analysis of the impact of regional economy on Ningbo-Zhoushan port economy

3.3.1 The mechanism of urban economic development on ports

It can be seen from Figure 2 that the mechanism of urban development on the port is as follows:

The economic development of the city is bound to promote the development of the three major industries of the city. The development of urban economy is inseparable from the construction of urban infrastructure, and under a good economic situation, a better urban infrastructure will be built. At the same time, urban economic development will bring a lot of information flow, and the service level of the city will be further improved. As a city with a relatively developed water transport system, Ningbo has a large amount of cargo demand covering the cargo resources of the port logistics of Ningbo-Zhoushan Port. The port's cargo resources are the source of port

development, thus promoting the development of port logistics. While the three major industries are developing in Ningbo, they will also form competition among enterprises in the industry and in the whole industry.

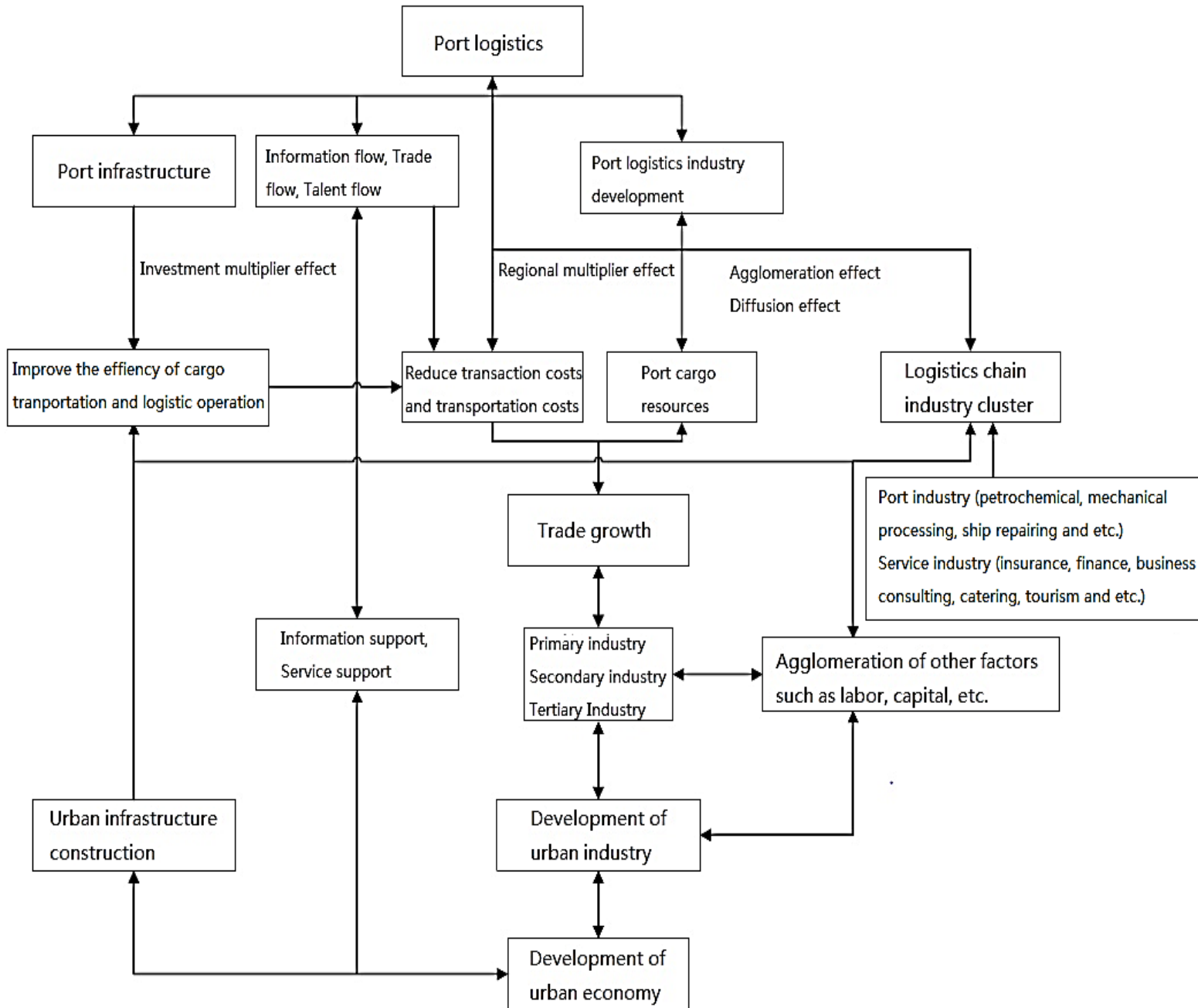


Figure 2: Mechanism of Port and Urban Economic Development

Under the dual role of development and competition, it is bound to put forward higher

requirements for the efficiency of logistics operations to adapt to its development. At the same time, improved urban infrastructure will also improve transportation efficiency and logistic operation efficiency. The improvement of logistics efficiency under the influence of multiple parties will effectively reduce transportation costs and logistics costs, thus promoting the development of port logistics of Ningbo-Zhoushan Port. The information support and service support brought by urban economic development will bring a lot of information flow, trade flow and talent flow to the city. Multi-stream intertwined can reduce the cost of logistics operation and promote the development of port logistics.

3.3.2 The role of urban economy in promoting ports

The types of goods entering and leaving the port will change with the changes of the city's economy, and the economic development of the city can guide the port's development strategy and guide the port's functional responsibilities and service areas. With the economic development of the city, the production characteristics of the port will continue to change accordingly. The types of goods in international trade are increasing day by day, the total volume of trade is increasing, and the volume of goods in ports is gradually increasing. The goods transported through ports are developing in the direction of bulk cargo and container specialization. The degree of development of the port is directly dependent on the urban economy. The economic activities and economic scale of the city are the support of the port. The economic development will inevitably increase the cargo throughput of the port and promote the development of the port. In general, the promotion of the port by the urban economy is mainly reflected in the following three aspects:

The first is that the city provides cargo transportation needs for the port. The development of cities requires a large amount of materials. Due to the uneven distribution of resources, it provides requirements for the transfer of goods. Through

port logistics, it can provide transportation and other related services for the development of urban economy. The development of urban economy, the structure of three main industries and the situation of international trade directly affects the demand for goods, which in turn has an important impact on the flow of goods in the port.

The second is that urban economic development can provide space guarantee for the development of the port. The infrastructure in the surrounding areas of the port can directly affect the port logistics. According to the analysis of the impact of the urban economy on the port above, the city can provide hardware and software support for the development of the port. In terms of hardware, the city can provide a resource base for the construction of the port sea-land multimodal transport system to meet the transit needs of inbound and outbound cargo. Therefore, the development of urban economics can affect the healthy development of the port, and can provide the necessary space guarantee for the port's integrated logistics and the healthy development of the land and sea transportation system.

The third is that urban economic development can provide relevant services for port logistics. The information support, business activities and talent needs required for the development of the port are all provided by the city. The development of the urban economy directly determines whether the region is attractive and whether it can attract sufficient capital flow, business flow, logistics flow and talent flow for the region. These resources are all necessary resources for port development. The flow of goods in the port is based on them. At the same time, the development of the information industry, transportation and circulation industry, trade industry and logistics industry and other industries in the city can determine the development efficiency and service quality of port logistics. In summary, the development of urban economy can bring capital and material support for the development of the port, and the development of port logistics is inevitably subject to the development of urban economy.

4. Quantitative analysis of Ningbo Port and regional economic development

4.1 Ningbo-Zhoushan Port and Regional Economic Regression Model

Hypothesis

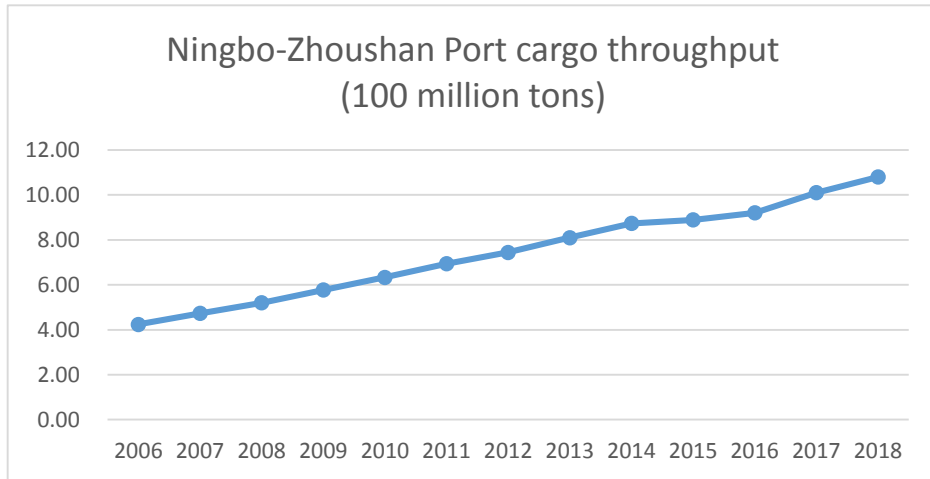


Figure 3: Ningbo-Zhoushan Port cargo throughput statistics

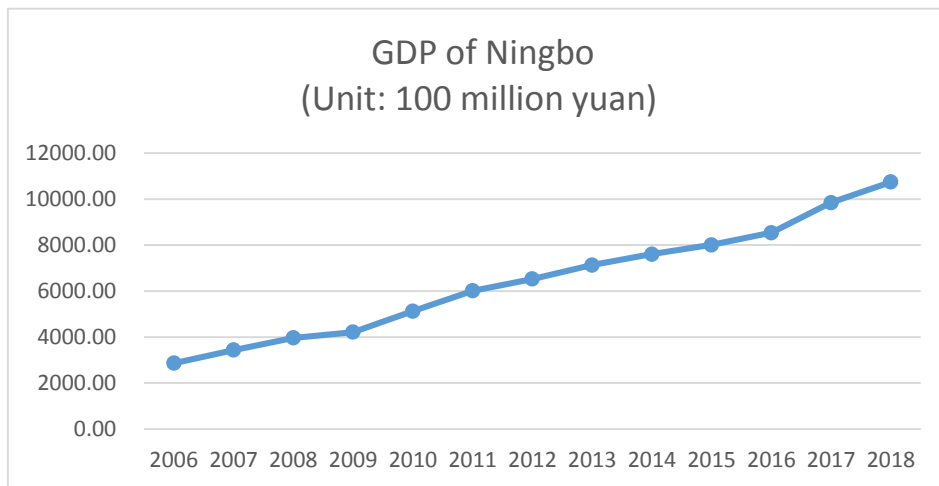


Figure 4: Ningbo GDP Statistics

There are many industries involved in the port, and some industries will involve non-port economy, so it is impossible to do statistics from the economic aggregate. However, according to the definition of port economy, we can know that the port economy is a compound economy, including the port directly or indirectly related to

various industries linked to the port, in fact, we can think that the port economy is ultimately reflected by the processing capacity of port throughput. Therefore, the degree of port economic development is mainly measured through the cargo throughput data of the port in this paper. GDP is generally recognized as an indicator of the most economically measurable state. It refers to the value of all final products and services produced in the economy of a country or region within a certain period of time. As a result, the main development of the regional economy is measured through the total GDP of Ningbo.

Table 3: Ningbo-Zhoushan Port Throughput and Ningbo's GDP Statistics

Year	Throughput (00 million ton)	GDP (00 million yuan)
2006	4.24	2864.50
2007	4.73	3433.10
2008	5.20	3964.10
2009	5.77	4214.60
2010	6.33	5125.82
2011	6.94	6010.48
2012	7.44	6524.70
2013	8.10	7128.90
2014	8.73	7602.51
2015	8.89	8011.50
2016	9.20	8541.11
2017	10.10	9846.90
2018	10.80	10746.00

(Source: Ningbo Municipal Bureau of Statistics)

The data span is in units of years and the data is mainly based on the statistics of the Ningbo Municipal Bureau of Statistics. The selected research period is from 2006 to 2018. Through the two line graphs, we find that the throughput of Ningbo-Zhoushan Port and Ningbo's GDP both show an upward trend and have a strong correlation. In

order to know how much the throughput of Ningbo-zhoushan Port can influence the regional economy, it is assumed that the throughput of Ningbo-Zhoushan Port has a direct impact on Ningbo's GDP. Through linear regression analysis, the paper contains an analysis of the contribution of port economy to regional economy, mainly based on throughput and regional GDP. The data from Ningbo Municipal Bureau of Statistics is selected. The data from the Ningbo Municipal Bureau of Statistics, which is used to analyze the impact of throughput on regional GDP is selected and shown in the above table.

4.2 Model establishment and regression results display

In the previous article, we have come to the conclusion that the port economy can promote regional economic development through various aspects of analysis. To this end, we have established the following econometric model:

$$Y = a + bx + u$$

The meanings of the letters are as follows:

Y: Gross Domestic Product of Ningbo, used to measure the development of regional economy in Ningbo

x: Throughput of Ningbo-Zhoushan Port, used to measure the development of port economy

b: The average impact of port throughput on GDP

U: random error

Using the least squares method, the data is entered into the Stata software for parameter estimation, and the regression results are as follows

. reg Y x

Source	SS	df	MS			
Model	73157498.7	1	73157498.7	Number of obs =	13	
Residual	521601.094	11	47418.2812	F(1, 11) =	1542.81	
Total	73679099.8	12	6139924.98	Prob > F =	0.0000	
				R-squared =	0.9929	
				Adj R-squared =	0.9923	
				Root MSE =	217.76	

Y	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
x	1180.086	30.04396	39.28	0.000	1113.96	1246.213
_cons	-2294.515	230.9848	-9.93	0.000	-2802.909	-1786.121

From this we can get the measurement model as follows:

$$Y = -2294.515 + 1180.086x$$

$$Se = 230.9848 \quad 30.04396$$

$$t = -9.93 \quad 39.28$$

$$p = 0.000 \quad 0.000$$

4.3 Econometric analysis of Ningbo-Zhoushan Port and regional economy

1) Economic significance test

The port throughput is positively correlated with the city's regional GDP. The port economy can promote the upward development of the regional economy. The above shows that the model can be tested by economic significance.

2) Goodness of fit test

It can be seen from the model that the determinable coefficient R^2 and the modified determinable coefficient Adjusted R^2 are 0.9929 and 0.9923 respectively, indicating that the model fits the data well, since the established model has only one explanatory variable, it is impossible to have the problem with multiple collinearity, so the next step

can be tested.

3) Significance test of regression equation

As can be seen from the above, $\text{Prob}>F=0.0000$, it can be indicated that the regression equation is significant.

4) Significance test of regression parameters

As can be seen from the above figure, the value of $p>|t|$ is 0.000, it is obviously that the P value is less than 5% of the significant level, so the null hypothesis can be rejected, and the probability of rejecting the null hypothesis is zero, indicating that the throughput of Ningbo-Zhoushan Port has an obvious impact on the regional GDP of Ningbo, so the next step can be tested.

5) White test

The original model was tested for heteroscedasticity and the results were as follows:

```
. . imtest ,white

White's test for Ho: homoskedasticity
    against Ha: unrestricted heteroskedasticity

    chi2(2)      =      1.62
    Prob > chi2  =      0.4444
```

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	1.62	2	0.4444
Skewness	1.71	1	0.1907
Kurtosis	0.72	1	0.3977
Total	4.05	4	0.3993

The results show that the corresponding P value is 0.4444, which is greater than 0.05. It proves that the original hypothesis that the original equation has no

heteroscedasticity cannot be rejected. Therefore, it can be determined that the regression model does not have heteroscedasticity, and the test can be passed.

4.4 Research on the contribution of ports to regional GDP

By establishing a regression model, we can see the relationship between the throughput of the port and the GDP of Ningbo City, but no concrete conclusion of how much the impact of the Ningbo-Zhoushan Port throughput will have on the regional economy can be drawn. Therefore, the elasticity coefficient is used to measure the contribution of the port to the regional economy. The elasticity coefficient indicates the dependency of the growth rate of one economic variable on the growth rate of another variable. It refers to the ratio of the growth rate of two economic variables that are related to each other in a certain period of time, that is, the sensitivity of the dependent variable to the response of the independent variable.

Here, X still represents the independent variable, the throughput of the Ningbo-Zhoushan Port, and Y represents the dependent variable, the GDP of Ningbo.

According to the elastic formula: $E = \frac{dy}{dx} \cdot \frac{X}{Y}$

We can conclude that the elastic relationship between the two is: $E = 1180.086 \cdot \frac{X}{Y}$

Bringing the historical data into the formula above, we can get the results as shown in the following table. From the table, we can see that the annual elastic coefficient is greater than 1, which indicates that the change in the throughput of Ningbo-Zhoushan Port will bring about the same direction of change in the GDP of Ningbo, and after taking the average value, the average value of the elastic coefficient from 2006 to 2018 is 1.413442, which is also greater than 1, so we believe that every one

percentage increase of the throughput of Ningbo-Zhoushan Port can boost the growth of the GDP of Ningbo by 1.4134% and the port has a multiplier effect of 1.4134 times.

Table 4: The elasticity coefficient of Ningbo-Zhoushan Port and Ningbo's GDP

Year	Throughput (billion tons)	GDP of Ningbo (billion Yuan)	Elasticity coefficient	Average elasticity coefficient
2006	4.24	2864.50	1.746750	1.413442
2007	4.73	3433.10	1.625879	
2008	5.20	3964.10	1.548005	
2009	5.77	4214.60	1.615597	
2010	6.33	5125.82	1.457317	
2011	6.94	6010.48	1.362586	
2012	7.44	6524.70	1.345631	
2013	8.10	7128.90	1.340838	
2014	8.73	7602.51	1.355099	
2015	8.89	8011.5	1.309488	
2016	9.20	8541.11	1.271122	
2017	10.1	9846.90	1.210418	
2018	10.8	10746.00	1.186016	

4.5 Analysis of the contribution of the port to the three major industries

It was elaborated that port development can promote the industrial structure of the region. In the previous section, we studied the contribution of port throughput to the total GDP of the region. In order to further study the specific impact on the three industries, 2006 to 2018 were selected. The added value of the three major industries in the year, the data is as follows:

Table 5: Ningbo-Zhoushan Port Throughput and Ningbo's Three Major Industry Statistics

Year	Throughput (billion tons)	Value added in the primary industry (billion Yuan)	Value added in the secondary industry (billion Yuan)	Value added in the tertiary industry (billion Yuan)
2006	4.24	139.50	1575.90	1149.10
2007	4.73	153.60	1888.70	1390.80
2008	5.20	167.40	2196.70	1600.00
2009	5.77	183.80	2247.80	1783.00
2010	6.33	218.43	2848.23	2059.16
2011	6.94	255.76	3335.37	2419.35
2012	7.44	270.00	3516.70	2738.00
2013	8.10	276.40	3741.70	3110.80
2014	8.73	275.18	3935.57	3391.76
2015	8.89	285.20	3924.50	3801.80
2016	9.20	304.60	4239.60	3996.90
2017	10.10	314.10	5105.50	4427.30
2018	10.80	306.00	5508.00	4932.00

According to the same treatment as before, the model of port throughput for the three major industries are established:

$$Y_1 = a_1 + b_1x_1 + u_1$$

$$Y_2 = a_2 + b_2x_2 + u_2$$

$$Y_3 = a_3 + b_3x_3 + u_3$$

The meanings of the letters are as follows:

Y_1 、 Y_2 、 Y_3 —— the added value of the primary, secondary and tertiary industries in Ningbo

x_1 、 x_2 、 x_3 ——The throughput of Ningbo-Zhoushan Port

b_1 、 b_2 、 b_3 ——the average impact of port throughput on valued added in the primary industry, secondary industry and tertiary industry

u_1 、 u_2 、 u_3 —— random error

Using the least squares method, the data is separately recorded into the Stata software for parameter estimation, and the regression results are as follows:

```
. reg y1 x1
```

Source	SS	df	MS			
Model	42623.2203	1	42623.2203	Number of obs =	13	
Residual	3541.34374	11	321.94034	F(1, 11) =	132.39	
Total	46164.564	12	3847.047	Prob > F =	0.0000	
				R-squared =	0.9233	
				Adj R-squared =	0.9163	
				Root MSE =	17.943	

y1	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
x1	28.48442	2.475552	11.51	0.000	23.03577	33.93308
_cons	30.92904	19.0326	1.63	0.132	-10.96143	72.81951

Here is the model of port throughput and the primary industry:

$$Y_1 = 30.929 + 28.484x_1$$

$$t = 1.63 \quad 11.51$$

$$p = 0.132 \quad 0.000$$

It can be seen from the model that the determinable coefficient R^2 and the modified determinable coefficient $Adj R^2$ are 0.9233 and 0.9163 respectively, indicating that the model fits the data well. As can be seen from the figure, $Prob>F=0.0000$, It shows that the regression equation is significant and the value of $p>|t|$ is 0.000, obviously the P value is less than 5% of the significant level, so the null hypothesis can be rejected, and the probability of rejecting the null hypothesis is zero. So it can be indicated that the throughput of Ningbo-Zhoushan Port has obvious impact on the primary industry.

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. reg y2 x2
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Source	SS	df	MS			
Model	17096298.7	1	17096298.7	Number of obs =	13	
Residual	347411.534	11	31582.8668	F(1, 11) =	541.32	
Total	17443710.2	12	1453642.52	Prob > F =	0.0000	
				R-squared =	0.9801	
				Adj R-squared =	0.9783	
				Root MSE =	177.72	

y2	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
x2	570.4734	24.51941	23.27	0.000	516.5065	624.4402
_cons	-843.7919	188.5108	-4.48	0.001	-1258.701	-428.8825

Here is the model of port throughput and the secondary industry:

$$Y_2 = -843.7919 + 570.4734x_2$$

$$t = \quad -4.48 \quad 23.27$$

$$p = \quad 0.001 \quad 0.000$$

It can be seen from the model that the determinable coefficient R^2 and the modified determinable coefficient Adjusted R^2 are 0.9801 and 0.9783 respectively, indicating that the model fits the data well. As can be seen from the figure, Prob>F=0.0000, It shows that the regression equation is significant, and the value of $p>|t|$ is 0.000, which can reject the null hypothesis, indicating that the throughput of Ningbo-Zhoushan Port has a significant impact on the secondary industry.

. reg y3 x3

Source	SS	df	MS			
Model	17740877.4	1	17740877.4	Number of obs =	13	
Residual	206481.441	11	18771.0401	F(1, 11) =	945.12	
Total	17947358.9	12	1495613.24	Prob > F	= 0.0000	
				R-squared	= 0.9885	
				Adj R-squared	= 0.9874	
				Root MSE	= 137.01	

y3	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
x3	581.1281	18.9029	30.74	0.000	539.5231	622.7331
_cons	-1481.651	145.3298	-10.20	0.000	-1801.519	-1161.782

Here is the model of port throughput and the tertiary industry:

$$Y_3 = -1481.651 + 581.1281x_3$$

$$t = \quad -10.20 \quad 30.74$$

$$p = \quad 0.000 \quad 0.000$$

It can be seen from the model that the determinable coefficient R^2 and the modified determinable coefficient Adj R^2 are 0.9885 and 0.9874, respectively, indicating that the model fits the data well. It can be seen from the figure that Prob>F=0.0000, indicating that the regression equation is significant, and the value of $p>|t|$ is 0.000, which can reject the null hypothesis, indicating that the throughput of Ningbo-

Zhoushan Port has a significant impact on the tertiary industry. .

The above three regression equations are processed, and according to the elastic formula, the respective elastic relations are obtained as follows:

$$E_1 = 28.484 \cdot \frac{X_1}{Y_1}$$

$$E_2 = 570.4734 \cdot \frac{X_2}{Y_2}$$

$$E_3 = 581.1281 \cdot \frac{X_3}{Y_3}$$

Substituting the original data into the elastic formula and taking the average value, the result is as follows:

Table 6: The elasticity coefficient of Ningbo-Zhoushan Port and three industries

Year	Elasticity coefficient of the primary industry	Elasticity coefficient of the secondary industry	Elasticity coefficient of the tertiary industry
2006	0.865750251	1.534873543	2.144272164
2007	0.87714401	1.428675376	1.976370372
2008	0.884807646	1.350417299	1.888666325
2009	0.894193036	1.464379179	1.880599628
2010	0.825453097	1.267838841	1.786427899
2011	0.772908039	1.187000362	1.666988660
2012	0.784892444	1.206904796	1.579106305
2013	0.834733719	1.234955913	1.513159833
2014	0.903646050	1.265441291	1.495756868
2015	0.887877840	1.292268703	1.358890212
2016	0.860317794	1.237936428	1.337631294
2017	0.915913403	1.128543990	1.325727601
2018	1.005317647	1.118575294	1.272543285
Average E	0.870227306	1.285985463	1.632780034

From Table 6, we can see that the average elasticity coefficient of the primary industry is less than 1, indicating lack of flexibility, and it means that the change in the value added of the primary industry is less sensitive to changes in port throughput. The average elasticity coefficient of the second and third industries is greater than 1, which indicates that the change in the added value of the secondary industry and the tertiary industry in Ningbo is sensitive to the change in the throughput of Ningbo-Zhoushan Port, and the tertiary industry Value added is relatively more sensitive. In general, Ningbo-Zhoushan Port plays an active role in regional economic development, which is undeniable. It has greatly promoted the growth of GDP in urban areas, and the impact on the secondary and tertiary industries is particularly significant. Every one percentage point increase in the throughput of Ningbo-Zhoushan Port will bring an increase of 1.2860 percentage points to the added value of the secondary industry and an increase of 1.6328 percentage points to the added value of the tertiary industry. These data not only confirm the qualitative argumentation of the previous article, but also provide a basis for the planning and layout of the port industry and lay the foundation for development.

5. Suggestions for the coordinated development of Ningbo-Zhoushan Port and the regional economy

5.1 Difficulties in the joint development of Ningbo-Zhoushan Port and the regional economy

The construction of a modern international port city is an ambitious goal since the reform and opening up of Ningbo. Then there are some long-term and cumulative problems in the construction of a modern international port city. There are still gaps with the goal and the difficulties are here as follows:

The development of service economy is relatively lagging behind. The industrialization of port cities objectively requires the service economy to become its dominant economy. Compared with international advanced cities such as Hong Kong, Yokohama and Singapore, the gap between Ningbo's service economy development and theirs is still quite significant. As far as Hong Kong is concerned, as early as 2014, the service industry's contribution to GDP in Hong Kong has reached 92.7%. However, according to the report of Ningbo Development and Reform Commission, in 2018, the growth rate of service industry in Ningbo increased by 8.1%. %, an increase of 1 percentage point over the previous year, but accounting for only 46.8% of the total GDP, far lower than Hong Kong.

For labor-intensive manufacturing industries dominated by exports, the transition is more difficult. For a long time, the industrial characteristics of many manufacturing industries have been export-oriented, forcing many companies to require OEM production, and thus relying excessively on cheap labor and lacking the ability to innovate independently. In addition, coupled with the lack of financial support, technical support, talent and other factors, the process of innovation and transformation is very difficult.

Strategic emerging industries are still not strong enough at the moment. In recent years, although strategic emerging industries are vigorously developed in Ningbo ,

and following the “Several Opinions on Accelerating the Cultivation and Development of Strategic Emerging Industries” in 2012, 155 strategic emerging industry special projects have been completed and put into production and the 20 sub-divisions industries have begun to take shape in the past four years. In the process of industrial transformation, upgrading and transformation, strategic emerging industries have a crucial leading role, but because the overall scale of the current emerging industries is not very strong, there is still a gap between the reality and the requirements of the construction of innovative cities and advanced manufacturing industries.

The contradiction between ecological improvement and industrial development is constrained. Ningbo is an important heavy chemical industry base and energy raw material base in China. The scale of the port industry is relatively large. In the entire social energy consumption of Ningbo, the proportion of fossil energy accounts for more than 98% of the total. The port industry, especially the heavy chemical industry, has the characteristics of “three wastes” with large emissions and high energy consumption. At the same time, the industry has brought a lot of pollution emissions to the city, which has forced the region to face the high pressure of various ecological indicators under the ecological environment. To put it in another way, the constraints of the ecological environment also affect the development of the large-scale port industry, which makes the government have to consider how the large-scale port industry should develop in Ningbo and develop in what direction.

5.2 Suggestions for promoting the coordinated development between Ningbo-Zhoushan Port and regional economy

5.2.1 Accelerate structural optimization and promote transformation and upgrading

First of all, it is necessary to optimize the internal structure of the industry, improve

resource allocation, actively cooperate with the “One Belt and One Road” strategy in response to the country, achieve diversified development, promote industrial transformation and upgrading, and accelerate the development of advanced manufacturing. Ningbo is a big manufacturing city. Although the manufacturing industry has formed a relatively good development foundation, and even some industries have leading advantages in the country and the world, for the moment, Ningbo's economic development is still in the period of industrialization transition from medium to late development. For a long time, the manufacturing industry is still the focus and pillar of Ningbo's industrial development. Its industrialization process still takes a long way. In many port-based industries, it is necessary to select excellent industries to take the lead in development, and introduce guidance to strengthen industrial standardization and rectification, and make every effort to build a world-class petrochemical industrial base with high industrial structure, ecological development and production recycling. We should focus on developing the port-oriented manufacturing industry with high output efficiency, good market prospects and low environmental pollution. What's more, transforming traditional enterprises, and raising the industrial level and international competitiveness as the core concept to promote the transformation of traditional economy into modern industrial clusters. We should also close, stop and transform polluting enterprises, speed up the elimination of backward production capacity and enterprises, accelerate the pace of scientific and technological progress in order to focus on the development of energy-saving, efficient, and environmentally-friendly cash manufacturing industries. At the same time, continuously improving the production quality of manufacturing products, broadening the functions of the products and prolonging the service life of the products enables the products to be produced more and better, thereby enhancing the competitiveness of the products and providing them with a strong material guarantee for the development of the service industry.

One of the important characteristics of the modern economy is whether the service industry is thriving. Developing the modern service industry and upgrading the level and quality of modern services are the top priorities for optimizing the industrial structure and increasing competitiveness for the industry. At the same time, it is also the key approach to transforming the mode of economic development. The relationship between the modern service industry and the port-based industry should be correctly handled, and the development of modern logistics, modern commerce, international trade and other advantageous service industries, as well as business services, service outsourcing, and scientific and technological information services, and other emerging service formats should be promoted to contribute to the development of standardized modern service industry. We can actively introduce foreign capital and vigorously develop shipping financial services industry. For example. We can develop private equity funds and trust funds in shipping industry and encourage provident funds and securities funds to invest in shipping and create opportunities for shipping finance industry. In addition, relying on the advantages of the port and industry, it is also necessary to pay full attention to the productive service industry at both ends of the “smile curve”. We should actively develop those modern service industries with local characteristics of Ningbo and key industries with strong driving force, such as green processing manufacturing industry and industrial design industry, gradually increase the added value of manufacturing industry, and let the producer service industry naturally promote life service industry. As a result, it will gradually build a high-end service industry with the advantages of port and foster a group of leading enterprises.

5.2.2 Strengthen technology introduction and encourage independent research and development

Ningbo is one of the cities in China that identified strategic development of emerging

industries in the early stage. During the construction of the goal of smart city, a large number of smart industries are booming and the high-tech industries and strategic emerging industries are also developing rapidly and actively in Ningbo. We should take emerging industries such as new energy and marine high technology as important breakthroughs and actively play the important role of emerging industries as a “multiplier” for economic growth, which is of great significance for enhancing the competitiveness of Ningbo. It is necessary to make full use of the advantages in Ningbo, accelerate the integration of emerging industries and traditional industries through existing resources, focus on developing innovative capabilities, and cultivate a number of leading industries. One of the difficulties in the development of the port economy has always been the weakness of independent innovation. This is not only the focus of an industry, but also the need for the country and the government to support and help. First, the government should improve the development mechanism, improve the policy environment and strengthen the guidance of enterprises. The government can formulate relevant policies to support what mentioned above. For example, establishing a relatively sound innovative technology training program, setting up a special innovation research group and providing certain financial support to fully support and encourage enterprises to participate in independent research and development and innovation. After that, the government can invite some experts at home and abroad to attend formal academic seminars to communicate and exchange information, which can promote mutual information exchange and realize resource sharing and intercommunication. Finally, enterprises should actively introduce advanced technology equipment at home and abroad and learn to explore the advanced point when in use, drawing on their research and development spirit, to improve their own independent innovation capabilities.

5.2.3 Strengthen enterprise management and cultivate talents

Although the development of the port-based industry has created a large number of employment opportunities, enterprise management and personnel training are indispensable to better develop the enterprise and obtain better economic benefits.

In the aspect of enterprise management, it is necessary to break the old-fashioned management mode. We should improve the management quality of the enterprise by establishing a sound enterprise management system to optimize the management structure of the enterprise, and improve the business norms and product inspection of the enterprise.

In terms of personnel training, regular training of in-service employees is indispensable. Enterprises can not only contact well-known technical talents in the industry to conduct exchanges so that the internal professional skills can be improved, and well-known teachers from the relevant maritime colleges can also be invited regularly to teach and bring the latest information in the shipping industry. In addition, we can strengthen the connection with relevant institutions, provide managers and technicians with the opportunity to visit and learn, and communicate with the management experience and technical guidance to cultivate talents with high professional quality and high-tech content.

5.2.4 Strengthen the construction of ecological civilization and reduce the contradiction between industry and ecological environment

We should accelerate the industrial cycle development and ecological transformation in order to jointly alleviate ecological pressure. Promoting the construction of ecological civilization is conducive to alleviating the pressure on the ecological environment caused by industrial development and maintaining a healthy and orderly development of the economy. Ningbo can optimize and adjust the energy structure around the low-carbon industry and low-carbon energy, expand the scale of non-fossil energy utilization to further strengthen industrial energy conservation. For the port-based industry, we will implement more stringent technology and environmental

protection access, and severely crack down on eliminating backward production capacity and expanding new energy. At the same time, it is possible to promote the action of clean the ocean, strictly control the pollutant discharge of the port industry, and strengthen the monitoring of the ecological environment of the ocean.

6. Summary and Outlook

6.1 Summary of the full paper

With the development of global trade, the importance of logistics for regional economic development has been continuously improved. In recent years, scholars have been discussing the relationship between logistics and regional economic development. As the most important part of modern logistics, the port is an important carrier for a region to open to the outside world. Around the globe, most economically developed cities are port cities or have direct access to ports. Ningbo-Zhoushan Port is an important industrial port in the whole country and has played a prominent role in the economic development of Ningbo and even the economic development of the Yangtze River Delta. In order to further understand the relationship between port economy and regional economic development, this paper mainly makes a qualitative and quantitative analysis of the impact of Ningbo-Zhoushan Port on regional economic development, aiming to provide useful suggestions for the coordinated development of Ningbo-Zhoushan Port and regional economy. The main findings of this paper are as follows:

- 1) The development of Ningbo-Zhoushan Port has changed the industrial structure of the region, making the logistics industry, manufacturing industry, foreign trade and other industries become the pillar industries of Ningbo. The expansion and construction of the port area has injected new activities into the regional economy, and also provided employment opportunities to some extent, alleviating employment pressure.
- 2) The development of Ningbo-Zhoushan Port has promoted the formation and development of regional port-based industries, formed a port-based industrial cluster and industrial base, and utilized the advantages of the port to reduce the unit cost for the enterprise and achieved better economic benefits.
- 3) The development of Ningbo-Zhoushan Port promotes the establishment of a

transportation network within the region. In order to better docking the port transportation service, the development of inland navigation is promoted and the inland navigation pattern is gradually improved.

4) Using the regression model and the elastic coefficient for metrological analysis, the contribution of the development of Ningbo-Zhoushan Port to the economic development of Ningbo City is obtained. For every 1% increase in the throughput of Ningbo-Zhoushan Port, the production in Ningbo can be promoted. With a total value of 1.4134%, the port has exerted a multiplier effect of 1.4134 times on the region. For the three major industries, the impact of Ningbo-Zhoushan Port on the secondary and tertiary industries is particularly significant. Every one percentage point increase in the throughput of the port will bring an increase of 1.2860 percentage points to the added value of the secondary industry and an increase of 1.6328 percentage points to the added value of the tertiary industry.

Finally, in order to better realize the consistent development goals of Ningbo-Zhoushan Port, and at the same time realize the coordinated development of the port and regional economy, some useful suggestions are provided in the paper. In view of the current difficulties encountered: the service economy is relatively lagging, and the export-oriented labor-intensive manufacturing industry is difficult to transform, the strategic emerging industries are not strong enough and the ecological improvement and industrial development are mutually constrained, some corresponding countermeasures are raised as follows: accelerating structural optimization, promoting transformation and upgrading; strengthening technology introduction, encouraging independent research and development; strengthening enterprise management, cultivating talents; and strengthening ecological civilization construction, and easing the contradiction between industrial development and ecological environment.

6.2 Research outlook

Due to factors such as research time, research perspective and personal ability, this study still has certain deficiencies. The biggest shortcoming is that only the port throughput and regional GDP are taken in the quantitative analysis. Two types of data are used in the paper. The port throughput reflects the development level of a port, and GDP is used to reflect the economic development level of a city. In fact, this has great limitations, and there are many factors affecting the economic development level of a region. It is not comprehensive enough to use the GDP value of the region alone, and since Ningbo-Zhoushan Port was merged in 2006, as of this year, the data adoption period is from 2006 to 2019, and the sample capacity is only 14, which is a certain defect. In addition, there is no unified concept for the regional economy. Therefore, for the convenience of calculation and the convenience of data acquisition, the data of Ningbo directly in the hinterland is taken as model data, and there is no quantitative analysis of the indirect hinterland, which is not comprehensive enough.

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