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PROBLEMS OF AQUATIC PRODUCTS EXPORT FROM SHANDONG PROVINCE TO BELT AND ROAD INITIATIVE COUNTRIES

PhD dissertation prepared under supervision of

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STRESZCZENIE

PROBLEMY EKSPORTU PRODUKTÓW PRZEMYSŁU POŁOWOWEGO Z PROWINCJI SHANDONG DO KRAJÓW INICJATYWY PASA I SZLAKU

JIAYU RU

W literaturze światowej większość publikacji dotyczących handlu pomiędzy krajami Inicjatywy Pasa i Szlaku koncentruje się na relacjach pomiędzy gospodarkami krajowymi. Brakuje jednak szczegółowych opracowań dotyczących handlu między poszczególnymi chińskimi prowincjami a krajami Inicjatywy Pasa i Szlaku. Niniejsza praca w pewnym zakresie uzupełnia tę lukę badawczą wyjaśniając gospodarczo-polityczne aspekty relacji prowincji Shandong z krajami Inicjatywy Pasa i Szlaku. W oparciu o wyniki badania empirycznego praca przedstawia sugestie dla dalszego rozwoju polityki ekonomicznej w zakresie przemysłu połowowego prowincji Shandong. W niniejszej dysertacji przedstawiono także ocenę implementacji polityki gospodarczej prowincji Shandong omawiając głównie wady prowadzonej polityki i braki we wdrażaniu strategii Pasa i Szlaku oraz ukazano środki i sugestie umożliwiające rozwiązanie tych problemów. Praca ma na celu opisanie handlu produktami przemysłu połowowego między prowincją Shandong a krajami należącymi do Inicjatywy Pasa i Szlaku. Pokazuje także, że eksport produktów przemysłu połowowego z prowincji Shandong jest zależny od wydajności handlowej i technicznej krajów Inicjatywy Pasa i Szlaku. Dla realizacji celu opracowano stochastyczny model grawitacji granicznej (*stochastic frontier gravity model*), który

został zastosowany, by przezwyciężyć wady tradycyjnego modelu grawitacji. Budowa modelu umożliwiła także analizę potencjału i odporności handlu produktami przemysłu połowowego dzięki określeniu optymalnych wartości eksportu do krajów Inicjatywy Pasa i Szlaku. Analizę efektywności handlu produktami przemysłu połowowego pogłębiono także dzięki wykorzystaniu nieparametrycznej metody granicznej analizy danych (*data envelope analysis*). Wyniki analiz wskazują, że istnieje jeszcze znaczący, niewykorzystany potencjał eksportu produktów przemysłu połowowego z prowincji Shandong do państw Inicjatywy Pasa i Szlaku. W pracy przedstawiono także szereg rekomendacji, w jaki sposób można potencjał ten wykorzystać.

Słowa kluczowe: Inicjatywa Pasa i Szlaku, efektywność handlu, przemysł połowowy.

ABSTRACT

PROBLEMS OF AQUATIC PRODUCTS EXPORT FROM SHANDONG PROVINCE TO BELT AND ROAD INITIATIVE COUNTRIES

JIAYU RU

According to existing literature, most studies focus on the trade status between China and the Belt and Road Initiative (BRI) countries on the national level. However, there are no detailed studies concerning trade between major manufacturing provinces in China and countries along the “Belt and Road” routes. As a result of this, this dissertation will firstly explain the policy design and requirements to construct the Belt and Road Initiative from the national perspective, and provide policy suggestions to promote business transactions of aquatic products between China and these countries based on empirical results. Secondly, this dissertation will investigate how Shandong province implements its polices, mainly discussing Shandong’s policy defects and deficiencies in the implementation of the Belt and Road strategies and put forward measures and suggestions to deal with these problems. In short, it aims to describe the trade of aquatic products between Shandong and countries along the Belt and Road route, proving whether the export of aquatic products from Shandong is affected by the trade and technical efficiencies of the BRI countries. Stochastic frontier gravity model is established to overcome the shortcomings of traditional gravity model. Trade resistance is also measured. Measuring the frontier level and the optimal trade level has become a reliable way to investigate trade potential. Therefore, the stochastic frontier gravity model is adopted to study the export potential of aquatic products from Shandong to BRI countries, which is of great theoretical, practical and innovative significance. As a non-parametric analysis method, envelop analysis is effective in calculation without

assuming the specific form of production function in advance. Since the trade environment is a complicated system, this method is appropriate to give a realistic picture of trade efficiencies.

Keywords: *Belt and Road Initiative, Trade efficiency, Aquatic products.*

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I allow myself feeling pain reminds me that everyone has been through the same, and I’m not alone. Vulnerability really connects us ,because we all have been through tough time. it gives us the foundation to trust and support each other. And thank you.

LIST OF PUBLICATIONS

Efficiency evaluation and comparison of Yantai port and the port of Gdansk based on the policy of Belt and Road Initiative

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INTRODUCTION

In the face of the new situation of domestic and foreign affairs, “Silk Road Economic Belt” and “21st Century Maritime Silk Road” were put forward by Xi Jinping, the President of China in September and October, 2013. The Belt and Road Initiative namely the “Silk Road Economic Belt” and “21st Century Maritime Silk Road”, was formally proposed in the “Vision and Actions for Joining the Joint Construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road” [1]released in March 2015. The Belt and Road Initiative is not an entity organization, but a concept and initiative of cooperation and development. In practice, unimpeded trade is one of the important contents of the Belt and Road Initiative, which has greatly promoted the economic and trade cooperation between China and the countries along the Belt and Road routes. Shandong is a major province of aquatic products, and its aquatic products trade occupies an important position in its foreign trade, as significant export products for earning foreign exchange. Thus, the “Belt and Road” strategy gives Shandong a new position, new mission and new goal in the new era of export development of aquatic products.

Most of the existing literature studies the status of trade cooperation between China and the countries along the Belt and Road Initiative on the national level. However, trade issues between major production provinces in China and countries along the “Belt and Road” routes are not detailed. Given this, this dissertation will firstly grasp the policy design and policy requirements of the construction of the Belt and Road Initiative from the national level, and provide policy suggestions for promoting the trade of aquatic products between China and the countries along the Belt and Road Initiative based on empirical results. Secondly, this dissertation will

[1] *Vision and actions on jointly building Belt and Road*， Issued by the National Development and Reform Commission, Ministry of Foreign Affairs, and Ministry of Commerce of the People's Republic of China, with State Council authorization， March 2015.

investigate the policy actions of Shandong province, focusing on the policy defects and deficiencies in the implementation of the Belt and Road strategy in Shandong province, and put forward corresponding countermeasures and suggestions. In short, this dissertation aims to provide a description of the trade of aquatic products between Shandong province and the countries along the Belt and Road routes, and to demonstrate whether the export of aquatic products in Shandong province is affected by the trade efficiency and technical efficiency of the countries along the Belt and Road routes. Stochastic frontier gravity model can overcome the shortcomings that traditional gravity model cannot deal with and measure trade resistance. The measurement of frontier level and optimal trade level has become a reliable method to study trade potential. Therefore, the use of the stochastic frontier gravity model to study the export potential of aquatic products in Shandong province to countries along the Belt and Road Initiative is of great theoretical, practical and innovative significance. Envelope analysis is a non-parametric analysis method, which is simple in calculation and does not need to assume the specific form of production function in advance. Given the fact that the trade environment is a complex system, this method is suitable for the realistic evaluation of trade efficiency.

The size of the market which may be measured by the population, is generally assumed to positively impact the size of trade. However, other studies suggest that population has a negative effect on trade. A large country has a large population, and the huge local market will hinder the occurrence of international trade of such large countries. Small countries have small populations and small local markets, and generally rely on specialized production for international trade. On the one hand, importing countries are more complex. On the other hand, the larger the population, the greater the demand for import. Importing countries may also import substitutes, which hinder international trade.

To identify factors that correlate with value of exports of aquatic products from Shandong province and trade inefficiency two sets of hypothesis were tested in this thesis. First set of hypotheses aims to establish correlations with exports.

$H1_1$: The per capita GDP of importing countries is positively correlated with aquatic

products export of Shandong province.

$H1_{2:}$ The per capita GDP of exporting countries is positively correlated with aquatic products export of Shandong province.

$H1_{3:}$ The total population of importing countries is positively correlated with aquatic products export of Shandong province.

$H1_{4:}$ The total population of exporting countries is positively correlated with aquatic products export of Shandong province.

$H1_{5:}$ Distance is negatively correlated with aquatic products export of Shandong province.

The second set of hypothesis aims for identification of factors that may be affecting trade inefficiency. Trade inefficiency is the main factor that affects the trade potential and the actual trade difference. TAF (Tariff and other import duties as a percentage of tax revenue) reflects the tariff level of the importing country, INF (Trade and Transport Infrastructure Index) measures the development level of regional logistics industry data, SHP (Liner Shipping Connectivity Index) assesses how closely the importing country is connected to the global transport network from the UNCTAD report, MON (Degree of currency freedom) reflects the inflation rate and price control of importing countries and FIN (The degree of financial freedom) reflects the degree of market openness, which is based on the Global Heritage Foundation Index of Economic Freedom.

$H2_{1,}$ Tariff's share of national tax is positively correlated with trade inefficiency.

$H2_{2}$:Country's membership in the WTO is negatively correlated with trade inefficiency.

$H2_{3:}$ Degree of currency freedom is positively correlated with trade inefficiency.

$H2_{4}$:Liner Shipping Connectivity Index is negatively correlated with trade inefficiency.

$H2_{5:}$ The degree of financial freedom is negatively correlated with trade inefficiency.

To achieve its goals, of this dissertation it has been divided into 6 sections.

Chapter 1 raises questions by revealing the background of the full-text thematic study. On this basis, combined with the literature review, a comprehensive analysis

framework for the export potential of aquatic products in Shandong province is proposed. Meanwhile, based on the intra-provincial trade database and other information, the aquatic product trade between Shandong province and the countries along the Belt and Road routes are sorted out and statistically analyzed.

Chapter 2 describes the trade situation among the major countries along the Belt and Road routes, and further analyzes it based on the Trade Competitiveness (TC) Index and foreign trade openness. In this section, the import and export amounts between Shandong province and the major countries along the Belt and Road routes reflect the trade status of aquatic products between the two sides.

Chapter 3 elaborates the trade potential research based on the Stochastic Frontier Gravitation Model (SFGM), and analyzes the export potential of aquatic products between Shandong province and countries along the Belt and Road routes.

Chapter 4 explores the trade potential mechanism and countermeasure research, by examining the influencing factors of trade potential from qualitative variables and traditional factors.

Chapter 5 analyzes the influencing factors of trade efficiency between Shandong province and countries along the Belt and Road routes. In general, the research on export and economic growth is widely concerned, so this dissertation selects the export variables of aquatic products and the variables of GDP for quantitative analysis. However, few studies examine trade and technological progress, especially exports and technological progress. Therefore, the Data envelopment analysis model is used to further analyze the trade efficiency and technology relationship of the 31 countries along the Belt and Road routes.

Chapter 6 summarizes the conclusions and suggestions in the context of the Belt and Road Initiative. This chapter outlines some of the main findings of this study. Based on the conclusions of the previous chapters, some suggestions are provided. Finally, the shortcomings of this study are pointed out. The data and information of this paper mainly come from the official documents, reports and other materials published by Shandong Statistical Yearbook. The tables and figures presented in this study are based on statistics recently released by the Shandong Provincial Department

of Commerce. Besides, other publications on this topic (OECD, WTO, IMF) and Internet resources also provide some information and data.

CHAPTER 1. THEORETICAL FRAMEWORK OF THE BELT AND ROAD INITIATIVE

1.1. The origins and concept of Belt and Road Initiative

Over the past eight years, the Belt and Road Initiative strategic deployment has been effectively implemented and achieved gratifying results.

The Third Plenary Session of the 18th CPC Central Committee in November 2013 put forth the main content of the comprehensive deepening of reform as a major decision.“ Comprehensively deepening reform ” means the reform will be more systematic, integrated and coordinated. The CPC will speed up the development of a socialist market economy, democracy, cultural development, social harmony and ecological progress.

In December 2014 the Central Committee and the State Council devised and enacted the strategic plan for the construction of the Silk Road Economic Belt and the 21st century Maritime Silk Road, completing the national top-level design and pointing out the direction for local implementation. The Silk Road Fund Co Ltd, a company signed a memorandum with the China Three Gorges Corp and the Pakistan Private Power and Infrastructure Board to inject capital to construct the Karot Hydropower Project on the Jhelum River, with an initial investment of 1.65 billion USD[2].

In March 2015, with the authorization of the State Council and the National Development and Reform Commission, the Ministry of Foreign Affairs and the Ministry of Commerce jointly issued the Program of Action to jointly build the Silk Road Economic Belt and the 21st Century, which could fully define China's plans and convey its sincerity[3]. In December of the same year, the Asian Infrastructure Investment Bank (AIIB) was formally established, and became the first multilateral

[2] CCTV news, http://news.cctv.com/2019/04/25/ARTII6vbjmjRC99qzfC1Rb8i190425.html（accessed: 2022.07.03)

[3] Xin Jin, *Analysis of Comparative advantages of tea trade between China and Countries along the "Belt and Road Initiative",* " IOP Conference Series: Earth and Environmental Science ", 2019, P.12-14.

financial institution proposed by China in the world[4].

1.1.1 The historical origin of the Belt and Road Initiative

The “Silk Road” could broadly be divided into the “Land Silk Road” and “Sea Silk Road”. This dissertation focuses on discussing the land silk road, which came into being in the Han Dynasty with a history of more than two thousand years. It is an ancient land trade route connecting Asia, Middle East and Europe. Its initial role was to transport silk, porcelains and other commodities produced in ancient China. Later on, it became the main channel for commercial trade between the East and the West in many fields, such as economy, politics and culture. The Silk Road on land refers to the land trade corridor opened by Zhang Qian in the western region of China under the order of the emperor of Han Dynasty. It started from Chang'an, the capital city, and Luoyang, the capital city of the Eastern Han Dynasty, and reached to the Mediterranean by connecting Liangzhou, Jiuquan, Guazhou, Dunhuang, Afghanistan, Iran, Iraq, Syria and ending in Rome, covering an area of 6440 kilometers[5]. A network of road is thought to be the junction of ancient Eastern civilization and Western civilization on the Eurasian continent, with silk being the most representative luxury goods of high value.

The Maritime Silk Road refers to the maritime channel through which ancient China traded with other regions of the world in economic and cultural exchanges. More than 2000 years ago, a maritime Silk Road starting from ports such as Xuwen Port in China (now Xuwen County in Zhanjiang) and Hepu Port (now Hepu County in Guangxi) created a world-wide trade network. In the Tang Dynasty, the sea route formed along the Southeast coast, Guangzhou Tonghai Yidao, which was the earliest title of the maritime Silk Road in China. The ancient Maritime Silk Road from the southeast coast of China connected the central and southern peninsula and the South China Sea countries, across the Indian Ocean, the Red Sea, East Africa and Europe, and became the sea gateway for the trade and cultural exchanges between China and foreign countries to promote prosperity along the route. The commodities exported by

[4] Xin Hua News, http://www.xinhuanet.com/politics/2015-12/26/c_128568650.html (accessed 2022.07.03)
[5] Liu Huaqin, *New Eurasian Board for the Belt for land [C]*, China Business Press, 2015, p.31-35.

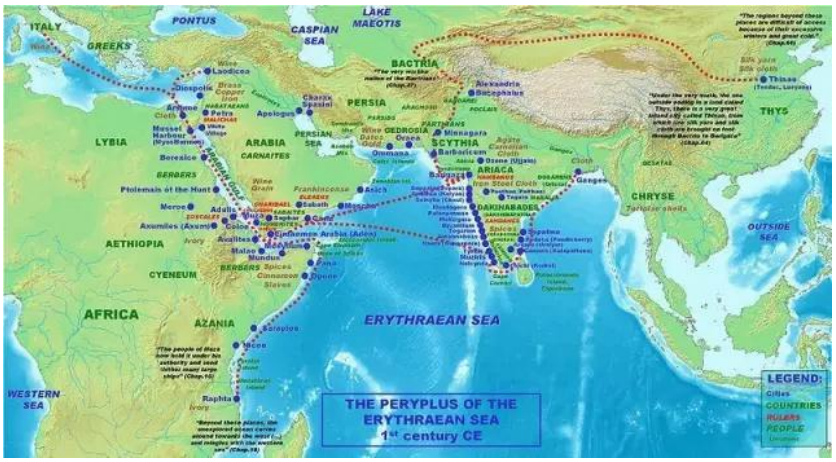
China were mostly silk, ceramic and tea. Then eastern civilization continued to influence the world. During the Song and Yuan Dynasty, great progress was made in China's shipbuilding and navigation technologies. The wide application of compass in navigation enabled merchant ships to sail further, and folk maritime trade was developed. During that period, China had direct "Maritime silk road" trade contacts with more than 60 countries in the world, opening up a glorious maritime era in which the western world could have a glimpse of the Oriental civilization[6]. The success of Zheng He's voyage to the Western Seas in the Ming Dynasty marked the heyday of the Maritime Silk Road. In addition to the Land Silk Road and the Maritime Silk Road, the desert Silk Road and the steppe Silk Road to Central Asia should be noted. The Desert Silk Road runs through Yunnan-Guizhou to the "Tea Horse Ancient Road" in South Asia, connecting Xinjiang with Central Asia, West Asia, the Persian Gulf and the Mediterranean Sea. The "Prairie Silk Road" started from the Central Plains in the north, passing through the ancient Yinshan Mountains (today's Daqing Mountains), the Mongolian Plateau, Central Asia and the northern part of West Asia, and reaching the Mediterranean Sea in the northwest[7]. Desert Silk Road and Grassland Silk Road also play key roles in trade. Their formation, development and prosperity represent a glorious period in China’s history. "Land Silk Road", "Maritime Silk Road", "Desert Silk Road" and "Grassland Silk Road" reflected the spirits of peace, cooperation, openness, inclusiveness, mutual learning and mutual benefit along the way.

For the countries along the ancient silk road, it has cultural and economic significance. As the ancient silk road across Asia and Europe's famous trade channels were on the road, it is the bridge between eastern and western culture to let Chinese culture, Indian culture, Persian culture and Arab culture, the ancient Greek culture and Roman culture intertwine with each other. The road played a very important role in promoting the cultural exchanges between the East and the West. Moreover, the significance of religion and nationality should be mentioned. The initial Silk Road Economic Belt was conducive to expanding the economic expansion of western China, promoting the development of social economy, and maintaining the expansion of ancient Chinese power and the active national commerce. The political, cultural and economic exchanges between the East and the West in Asia and Europe were spread

[6] Lu Fanghua, *From the Silk Road to the Belt and Road: Historical Inheritance and Chinese Strategies*, 2017, University of Nanchang, p.23-35.
[7] Liao Yiwei. *Motivation analysis and Challenge discussion on "One Belt and One Road" [J],* 2017, “ Technology and Market ”, p.42-46.

along the sides of the ancient Silk Road. The Western civilization brought by the Han Dynasty also promoted national prosperity, and served as an important channel of communication between China and the West.

Picture 1.1 The Belt and Road Maritime Silk Road map



Source: Sina Net , http://blog.sina.com.cn/s/blog_558ca8c70102z8ut.html (accessed:2019.08.10)

1.1.2. The concept of Belt and Road Initiative

The Belt and Road strategy is a concrete interpretation of the five-sphere integrated development concepts, including innovation, coordination, green development, openness and sharing are integrated. These elements can exist at the same time and are equally important guidelines for action. The Belt and Road Initiative covers more than 60 countries and regions in Europe, Asia and Africa. Five provinces in Northwest China, four provinces in Southwest China and five provinces in East China are covered in the strategy. However, the administrative areas radiated by any strategy to promote the formation and development of economic zones will not completely coincide with the geographical category demarcated by the state, and a possibility of dynamic change is allowed. Therefore, it is more objective to view the economic zone from the perspective of the Belt and Road. These economic zones involve similar levels of economic development and are at the similar height of the economic zones, which are expected to develop economies within the framework of the strategy and to serve China's economy together with the Beijing-Tianjin-Hebei

Cooperation Zone and the Yangtze River Economic Belt.[8].

The main contents of the Belt and Road Initiative are to enhance policy coordination, road connectivity, unimpeded trade, currency circulation and people-to-people bonds. These "five links" are closely associated and mutually promoting. They exhibit strong correlation and coupling capabilities. Among these links, road connection, unimpeded trade and currency circulation are closely associated with the development of the logistics industry, which may provide a great opportunity for the cluster-type "going out" development of the domestic logistics industry.

Vision and Action to Promote the Construction of the Silk Road Economic Belt in the 21st Century.

The ambition revealed in the Three Commission (Ministry of Foreign Affairs, Ministry of Commerce, National Development and Reform Commission) points out that there are "3+2" roads in the "Belt and Road". "Belt" refers to the "Silk Road Economic Belt", and is the land-based economic corridor. The first two routes run from China to the Baltic Sea and the Mediterranean Sea via Central Asia. The third focuses on the area of Southeast Asia. "The Road" refers to "the 21st Century Maritime Silk Road", a maritime economic corridor that goes in two directions: one goes to the South China Sea, and the other goes through the Indian Ocean to Southeast Asia, and then through the Mediterranean Sea to Europe[9].

The main idea and task arrangement at the central level is more concentrated in the Vision and Action of promoting the Silk Road Economic Belt and the Maritime Silk Road of 21st Century (hereinafter referred to as Vision and Action) and the proposal of the Central Committee of the CPC to formulate the Thirteenth Five-year plan for national economic and social development. In these two documents, Belt and Road Initiative, and the basic framework and development direction are put forward. Meanwhile, the detailed policy implementation was elaborated by the ministries and commissions.

After the strategy of Belt and Road Initiative was put forward, China's policies and plans for developing competitive advantages in foreign trade, international production capacity and manufacturing industry were introduced successively. To

[8] Dou Jin, *Forecasting and Empirical Research on Logistics Demand of Gansu province under "One Belt And One Road" Strategy*, Lanzhou University of Finance and Economics, 2017, p.12-23.
[9] Government official website of the People's Republic of China , http://www.gov.cn/xinwen/2015-03/28/content_2839723.html (accessed:2019.08.12)

accelerate the transformation of China from a giant manufacturing power to a strong manufacturing power, Prime Minister Li Keqiang advanced the concept of "Made in China 2025" in his Government Work Report to the top legislature on May 8, 2015. The report defined three stages of the transformation that will take about three decades. "Made in China 2025" is the guideline for the first decade to lay a solid foundation for the next two stages. In the current stage of globalization, although the club of “developed countries” is still dominating financial and technological investment around the world, a large amount of foreign investment has been flowing to China. The industrial policy of “Made in China 2025” focuses on innovation and the “Belt and Road Initiative” is to fulfill a clear vision: a more ambitious standard of profitability. With China's GDP rate of growth being declined, the two national strategies of Belt and Road and "Made in China 2025" should be effectively connected. Made in China 2025[10] is the program of action for the implementation of the strong manufacturing strategy in the first decade. Under the guidance of the "Belt and Road Initiative" strategy, the implementation of the strategy will surely promote the international competitiveness of manufacturing enterprises, especially multinational companies. Secondly, the implementation of the “Made in China 2025” plan will provide a solid support for the implementation of the Belt and Road strategy to deepen China’s industrial international cooperation.

On May 16, 2015, the State Council issued Several Opinions on Accelerating the Cultivation of New Advantages in Foreign Trade Competition, proposing to improve economic and trade cooperation with "Belt and Road Initiative" countries along the routes, mainly via deepening trade cooperation, expanding industrial investment in the countries, and optimizing the economic and trade development pattern of countries along the routes[11]. The State Council promoted the international production and equipment manufacturing cooperation guidance, putting forward to promote international cooperation in production and equipment manufacturing, foreign cooperation, advantage of capacity to create the new economic growth point in China. It promotes enterprises to improve technology, quality and service level, elevates the overall quality and core competitiveness[12]. In the key areas of the Belt and Road

[10] Government official website of the People's Republic of China, http://www.gov.cn/zhuanti/2016/MadeinChina2025-plan/index.html (accessed:2022.07.03)
[11] Wang Baomin, *Research on countermeasures of foreign trade in Shandong Province under the background of “The Belt And Road", “*Jinan Daily ”, 2018, P. 24-35.
[12] Government official website of the People's Republic of China,

Initiative, the “Made in China 2025” plan and the Belt and Road Initiative strategies are seamlessly aligned to press forward the Two Centenary Goals and to fulfill the Chinese Dream of national revitalization.

1.1.3. The scope of Belt and Road Initiative idea

The scope of the Silk Road Economic Belt can be interpreted from a narrow \a middle sense and a general perspective[13]. In the narrow sense, it is based on the core area or hub area of the ancient Silk Road, including China and the five Central Asian countries, and is the starting point of the construction of the Silk Road. In the middle sense, the Silk Road is connected by the modern Silk Road Eurasian land bridge to spans Asia and Europe, covering major countries along the line while excluding 28 EU countries. From East to West, China, Mongolia, Myanmar, Bangladesh, India, Pakistan, Afghanistan, five Central Asian countries, Iran, Iraq, Syria, Jordan, Israel, Azerbaijan, Georgia, Armenia, Russia, Ukraine and Belarus all belong to this economic zone. In November 2013, the Third Plenary Session of the 18th CPC Central Committee adopted the Decision of the CPC Central Committee on Some Major Issues on Comprehensively Deepening Reform, promoting the construction of the Silk Road Economic Belt and the Maritime Silk Road to form a new pattern of all-round opening-up. Therefore, the construction of "Silk Road Economic Belt" has been established as a major national strategy for China to realize the next stage of development in both domestic and foreign affairs. This is also the prioritized task in the construction of the Silk Road Economic Belt, which mainly relies on the Second Eurasian Land Bridge International Economic Corridor and the International Energy Corridor. This economic cooperation zone between China and West Asian countries coincides with the scope of the ancient Silk Road. The construction of the Silk Road Economic Belt will profoundly impact on the world economy favorably. In a nutshell, One Belt and One Road is the two Silk Roads that cover five northwest provinces and

http://www.gov.cn/english/content/2015-05-16/content 9771.html (accessed:2019.08.07)

[13] Xiang Hong Li Xiangqian, *A New Dream for the New Silk Road: A Reader on the Belt and RoadStrategy[M],* Beijing Red Flag Press, 2020, p. 35-41.

regions, including Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Chongqing, Sichuan, Yunnan and Guangxi. The New Silk Road Economic Belt, which connects the Asia-Pacific Economic Circle with the developed European Economic Circle, is regarded as "the longest economic corridor with the most development potential in the world"[14]. As an "economic belt", it reflects the idea of centralized and coordinated development of cities along the economic belt starting from China and passing through the five Central Asian countries, Russia, Western Europe and the Mediterranean coast. Geographically speaking, it can be divided into four regions: (1) five Central Asian countries; (2) Afghanistan, Pakistan and India; (3) Iran, Iraq, Syria, Turkey and Russia south of the Caucasus; and (4) Europe.

The Maritime Silk Road starts from China's coastal ports, which extend to Japan and the Republic of Korea to the east, and to 11 Southeast Asian countries to the south, including Philippines, Indonesia and Thailand. Its Indian Ocean route starts from the east coast of China and goes through the Strait of Malacca to the east coast of India, Pakistan and Africa, and passes through the Strait of Holmes to the Persian Gulf. Its Atlantic route starts from the east coast of China and enters the Indian Ocean, reaching European countries via the Mediterranean Sea through the Strait of Mandeb and the Suez Canal. The central government put forward and implemented a programmatic document called "Belt and Road Initiative". The programmatic document refers to the provisions or summaries of the principles, regulations, opinions and lessons that are formally expressed, strictly believed and adhered to. Governments, political parties, and associations set their goals and action plans according to their tasks within a certain period of time[15].

The strategic positioning of "Belt and Road Initiative" has to deal with three problems. First, China's goal is to seek world peace, development, common prosperity and cooperation. Second, China will open up international transport routes on land, support key cities along the routes, and jointly build transport routes with key economic and trade industrial parks by using cooperation platforms and key ports as

[14] Government official website of the People's Republic of China, http://www.gov.cn/english/content/2015-05-12/content 9735.html (accessed:2019.08.07)
[15] Huanqiu news, https://china.huanqiu.com/article/9CaKrnJJkZH (accessed:2019.08.12)

the maritime platforms. Third, all the nations of the world can be masters of builders, and they will not submit to any other power that seeks dominance.

More specifically, the document can be understood from four aspects. The basic concept of "Vision and Action"[16] emphasizes the need to adhere to the four working concepts, which are peace and cooperation, openness and inclusiveness, mutual learning and mutual benefit, and promote common development, realization and prosperity. To be specific, peace and cooperation are the mainstream spirit of modern world, and the rejuvenation of the Chinese nation cannot be achieved without a peaceful and friendly external environment. Openness and inclusiveness are sufficient to meet the principles and methods in international exchanges. Only by applying an open and inclusive attitude can we achieve peaceful coexistence of all countries and all ethnic groups. Mutual learning is an effective way for the Chinese nation and other nations to grow and to bring out the best in each other. Reciprocity is the primary purpose and objective. The joint construction of "Belt and Road Initiative" should not be realized without damaging the interests of any one party[17].

The Chinese central government's unyielding support of the "Belt and Road Initiative" construction is not merely reflected in its words, but in action. During the summit, all sorts of bilateral or multilateral agreements have put forth that investment from the Chinese government public funds will be spent on the strategy. Meanwhile, the other funds provided by investment banks, through the BRICS bank, will guide the flow of social capita in the areas along the way. China's remarkable achievements are the result of the hard work of the Chinese people and an external peaceful environment, which ensures the win-win cooperation. As an important engine of global development, China is ready to make use of its development experience to provide solutions by contributing Chinese wisdom and strength to the current world economy, which now manifests sluggish growth, unbalanced development and polarization of wealth. The "Belt and Road Initiative" is part of China's plan and a

[16] Ministry of Commerce of the People's Republic of China, *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*, State Council authorization, 2015, p.10-15.
[17] Dong Guo, *Study on three problems of strategic positioning of "One Belt And One Road",* Yan Bian University 2007, p.34-42.

great vision for the benefit of mankind. China has taken its responsibilities as a major world's power, holding high the banner of economic globalization and free trade, and actively participating in world and regional issues. This strategy will boost the economic development of the countries along the Belt and Road and inspired the world. The new drivers of economic growth have contributed to the establishment and improvement of a new world governance and are constantly injecting energy into the pursuit of interconnected development[18].

1.2. Shandong province and its role in the Belt and Road Initiative

The premise of effective implementation of policy is reasonable positioning and conformity with reality. The construction of " Belt and Road Initiative" involves a variety of factors, such as industrial and agricultural foundation, social development level, transportation and logistics conditions, policy design. These factors must be matched and connected with each other. Given the actual situation of Shandong province, geographical location, transportation and logistics, industrial base are the predominant factors that are worthy of in-depth examination.

Geography is a fundamental consideration in any trade strategy. For example, some of China's border provinces in the northwest and southwest are adjacent to countries along the Belt and Road, thereby posing natural advantages to develop foreign trade and providing valuable opportunities for international exchanges and cooperation. Shandong province is enriched with economic resources and cultural population in the east coast of China. Its greatest advantage is the unimpeded sea channel of 3,000-kilometer coastline, the second largest China. Its coastline is dotted with many excellent ports. Moreover, Shandong province is near the edge of Beijing and Tianjin in the north, and the Yangtze River Economic Circle in the south. It is located in the overlapping area between the two major economic regions. This factor is of great help to the development of export-oriented economy and to the

[18] Xinhua news, http://www.xinhuanet.com/comments/2017-05/22/c_1121016023.htm (accessed:2019.08.12)

strengthening of cooperation of domestically-oriented industries[19].

Shandong's traffic and logistics exhibit three characteristics. The first is the coverage of land transport networks. The railways and expressways are well developed in Shandong, covering a total 16 cities in the province. Highway infrastructure is well, and land transportation is convenient. The second is its air traffic. The province has created "east China first-class" air traffic management service has made a great contribution. By 2018, the number of civil airports in the province had reached 9, ranking the first place in China, and run more than 300 domestic and foreign air routes. Thirdly, its maritime traffic is highly developed. The vast ocean is the greatest advantage and the most distinctive feature of Shandong's transportation system. Qingdao, Yantai, Weihai, Rizhao and other port cities are densely distributed. China has opened more than 180 sea lanes to cover the whole world. In general, although Shandong province is far away from the national border, its geographical position is inferior to that of some border provinces. However, its convenient and efficient transportation and logistics system could make up for such deficiency.

Shandong is one of the largest economies in China, ranking the third in 2018. Its agriculture, industry and marine economy are well developed with complete categories. To be specific, the scale of traditional industries of Shandong is huge. For "Belt and Road Initiative", coal and steel are Shandong's two biggest asset industries[20]. Some industries have reached the international average level, with complementary resources and technologies with some countries along the Belt and Road. Moreover, its sound foundation for agriculture makes it possible for the export of agricultural products to occupy an important position in the whole country[21]. The trade of primary agricultural products and the in-depth development of agricultural resources in the countries along the Belt and Road sheds light on a broad prospect for promoting

[19] Li Jidong. *Pan-pearl River Delta Economic Circle and China's Southward Geostrategy -- geoeconomic Analysis of pan-Pearl River Delta Economic Circle* [J]. " Economic geography ", 2008, p.250-254.

[20] Jiemian news, https://www.jiemian.com/article/1008637.html (accessed:2019.08.13)

[21] Zuo Peiting. *Research on development Countermeasures of Linyi City based on Silk Road Economic Belt Strategy [J]*. " Journal of Shandong University of Administration ", 2014, p.42-45, 55.

international agricultural industrialization. Its advantages of contracting projects and foreign labor service cooperation enable more and more enterprises in Shandong province to "go out", by making use of rich experience in foreign contracting projects and foreign labor cooperation. This is conducive to promoting the transfer of supporting production capacity and service industry on the basis of project contracting. Development offers opportunities.

Shandong province started to open to the outside world at an early age. Yantai is the first open city in the country[22]. It has a long history and a good foundation for foreign economic and trade cooperation. Over the past 40 years of reform and opening- up, Shandong has made remarkable achievement in its open-ended economic development, with foreign trade related indicators ranking among the top in the country. In particular, a large number of foreign cooperation platforms and carriers have been established in Shandong province. The number of economic development zones above the provincial level and the number of overseas economic and trade cooperation zones at the national level rank first in the country, providing a vital platform and carrier support for reform and opening-up.

Overall, Shandong province has many advantages and good basic conditions. It is expected to play a constructive role in the process of implementing the Belt and Road Initiative, promoting the balanced and coordinated development of various regions in China[23].

[22] Da Xiao news, http://www.ytcutv.com/html/twnews/rd/2018-05-25/957267.html (accessed:2022.0.03)
[23] Shandong Provincial People's Government manages the open net, http://www.sdwht. Gov. cn/html/2016/szf_0722/_html (accessed:2019.08.08)

1.3. Implementation of the Belt and Road Initiative by Shandong province

1.3.1. Shandong provincial policy structure system

Since the implementation of "Vision and Action for Promoting the Joint Construction of the Silk Road Economic Belt and the Maritime Silk Road in the 21st Century", the Shandong provincial Party Committee and the provincial government have actively participated in program and made it the prioritized task of open economic work. The provincial Party Committee and the provincial government have set up a leading group for coordinating and promoting the Belt and Road Initiative construction to formulate the Implementation Plan. The strategic positioning, spatial layout, work objectives and key areas of Shandong's participation in the Belt and Road construction are clearly defined, and a systematic policy structure system for the implementation has initially been formed. Its is composed of leading agencies, work objectives, supporting policies and promoting projects.

The Shandong provincial Party Committee and the provincial government have set up a leading group for coordinating and advancing the construction work of Belt and Road Initiative. The Office of the leading group is located in the provincial Development and Reform Commission. The member units include the Publicity Department of the provincial Party Committee, the Taiwan Affair Office, the Development and Reform Commission, business, finance, taxation, entry and exit inspection and quarantine, and environmental protection. Under the guidance of provincial leadership organizations, municipalities at all levels have also set up working organizations to undertake the tasks issued at the provincial level and to devise overall plans for related businesses. The leading group is a cross-departmental organization consisting of more than 20 departments. Its main mode of operation should be sufficient to review and coordinate the work of the provincial party committee and the poor planning of the government[24]. It is responsible for the

[24] Shan Dian news, https://baijiahao.baidu.com/s?id=1664572095668399326&wfr=spider&for=pc

guidance and coordination of provincial Belt and Road Initiative construction.

1.3.2. Project construction in Shandong province under the Belt and Road Initiative

Based on the practices of local governments at all levels in recent years, project construction is a significant way for local governments to develop economy and run policy mechanisms. In practice, projects generally have two meanings in local governments, namely, economic activities (referring to the object of investment), and management mode, (referring to the operation mechanism of "project-based" management). Specifically, the former is to promote regional economic development by attracting investment and implementing economic projects, which poses a direct significance for promoting regional gross national product and solving labor employment. In the Belt and Road Initiative, the implementation of a series of projects in the eight key areas of Shandong province is equipped with global significance, playing a leading and radiating role. The latter is to ensure the implementation of major policies and economic activities through "project-oriented" management, including clarifying the responsibilities of all parties, implementing grade-by-level year-end assessments, etc. In general, the two are often integrated in practice. The implementation of policies is reflected in projects, while the realization of goals is guaranteed by “project-based” management.

Table 1.1. Summary of the first priority projects in Shandong province

Project Category	Number of projects	Country	Investment amount (Units: 100 million RMB)
Infrastructure	75	Pakistan, Russia, Cambodia, etc.	2861
Capacity cooperation	81	Indonesia, Cambodia, India, etc.	1214

(accessed:2022.07.03)

Energy resources	15	Mongolia, Indonesia, Cambodia, etc.	97
Communication	5	Uzbekistan Maldives, Russia, etc.	213
Financial cooperation	5	Singapore, Ukraine, Indonesia, etc.	91
Eco-environmental protection	4	Vietnam, Philippines, Pakistan, etc	18
Other	5		9.6
Total	270		4500

Source: self-compiled on the basis of local web set, https://www.sohu.com/a/71827972_115512 (accessed:2019.09.10)

At present, Shandong province has established the first batch of key project construction for the "Belt and Road" Initiative, with a total investment of 450 billion RMB in 210 projects of 7 categories. As can be seen from Table 1.1, there are 156 projects in infrastructure and capacity cooperation, accounting for 74% of the total number of projects. The total investment in infrastructure and capacity cooperation is 407.5 billion RMB, accounting for 90.5% of the total investment. This fully reflects the special importance of these two fields, as the basis for the key construction, in the construction of the Belt and Road Initiative in Shandong province, which is consistent with the recent construction and energy cooperation goals[25].

In the integration of Shandong province into the Belt and Road strategy, geography and location play an absolute advantage. From the perspective of the world as a whole, Shandong province is located at the intersection of the Belt and Road Initiative, bordering the Bohai Sea and the Yellow Sea, with convenient transportation. On land, the New Eurasian Land Bridge runs through the Eurasian continent, passing through Mongolia and Russia, Central Asia, Central and Eastern Europe, West Asia and the Middle East. Besides, the sea transportation in Shandong province is also very convenient, with direct access to Southeast Asia and South Asia. Its geographical

[25] Shandong Provincial People's Government manages the open net, http://www.sdwht.Gov.cn/html/2016/szf_0722/html (accessed:2019.08.08.10)

location at the intersection of land and sea is conducive to exchanges and cooperation between the land economy and the marine economy, and the development of an open economy. Domestically, Shandong province, located at the junction of Beijing-Tianjin-Hebei region and the Yangtze River Delta, ranks third in terms of economic aggregate, which is conducive to regional economic exchanges and cooperation[26]. The location and transportation advantages are more conducive to giving full play to the geographical advantages, providing favorable conditions for Shandong to integrate into the Belt and Road Initiative. In addition, Shandong province is located in the eastern coastal area of China and belongs to the coastal economic belt. Owing to this advantage, Shandong province can easily benefit from the radiation effect and influence of international economy, finance, trade, technology, information and talents, and then transmit this influence to the mainland and hinterland of China.

1.4. Participation of cities in Shandong province in the Belt and Road Initiative

Motivated by the integration into Belt and Road Initiative in Shandong province, cities in the province have formulated their own development ideas and measures. Among the 16 cities in Shandong province, Qingdao and Yantai are listed as important coastal node cities, while Jinan and Qingdao have been identified as the key cities. In view of the special status and role of Jinan, Qingdao and Yantai in the construction of Belt and Road Initiative, the thesis briefly summarizes the ideas and practices of these cities in this strategy.

Jinan is a city with profound historical background and humanistic feelings, and sound industrial system. These are conducive to the economic and cultural integration between Jinan and other countries along the Belt and Road Initiative. Jinan should

[26] Chen Guang, *Shandong should play a leading role in the "Belt and Road Construction [N]*. " Guangming Daily ", 2015-05-20007.

strengthen the construction of external corridors. As the capital of Shandong province, Jinan plays a leading role in the overall economic structure[27]. Jinan strives to build a platform for foreign economic and trade cooperation. Jinan has strong economic strength in Shandong province after annexing the city of Laiwu, with its economic scale, number of market players leading the other cities in the province. However, its geographical location makes a certain disadvantage in comparison with Qingdao and Yantai in terms of "export" in foreign trade cooperation. Specifically, in recent years, Jinan has actively promoted the opening of the "Jinan New Europe" railway freight queue and international logistics channels. Meanwhile, the construction of electronic ports and barrier-free cross-border e-commerce has been intensified. By taking advantage of the natural advantages of the provincial capital, Jinan can be transformed from the political center to the logistics center. Jinan proposed that by 2020, it will become an important core city of Belt and Road Initiative and an important platform for two-way opening up and international regional cooperation.

The integration of Jinan into the Belt and Road Initiative is to speed up the replication of the pilot free trade zone innovation system model, and to actively contribute to synergistic effect of pilot free trade zone. In terms of industrial development, eligible industrial parks should apply for the elevation into national overseas economic and trade cooperation zones to strengthen construction planning and layout, and to improve the cultivation mechanism[28].

The advantages of Shandong's integration into the Belt and Road strategy also lie in its convenient maritime transportation and superior port conditions, especially Qingdao, Yantai and Binzhou. As a major ocean province in China, Shandong's coastline accounts for about 1/6 of the total length of the country. In 2020, the throughput of ports in Shandong accounted for more than 10 percent of the total of China, amounting to 1.11 billion tons[29].

[27] Dong Yiling, *The Strategy of "One Belt and One Road" from the perspective of regional economy -- Also on Shandong's integration strategy [J]*. "Review of Economics and Management", 2015, p.155-161.
[28] Jinan Daily, http://www.jnsw.gov.cn/content/topnews/content-87-17895-1.html (accessed:2019.09.13)
[29] China Shandong Net, https://baijiahao.baidu.com/s?id=1677236392709845056&wfr=spider&for=pc

As the starting point of the northern route of ancient Maritime Silk Road, Qingdao has been an important hub since ancient times. In 2014, Qingdao was designated as the "Major Node City of the New Eurasian Land Bridge Economic Corridor" and the "Strategic Fulcrum of Maritime Cooperation" to involve in the two major strategies of "One Belt" and "One Road"[30]. Qingdao has made great efforts to promote maritime development. In the Belt and Road planning and construction, Qingdao is positioned as the main node of the new Eurasian Land Bridge Economic Corridor and the fulcrum city of maritime cooperation strategy. Consistent with the actual situation of Qingdao[31], it not only has strong strength in the province, but is also a leading city in foreign trade in China. Its position and function are irreplaceable. At present, Qingdao has established sister city relations with 67 overseas cities, covering more than 30 countries and regions on six continents. Therefore, Qingdao's maritime construction not only has location advantage, but has a promising prospect to realize such a strategic fulcrum. Leading by the economic cooperation projects, Qingdao plays the role of "building an integrated whole and driving an integrated whole". According to media reports, Qingdao increased policy input in project construction, and offered preferential policy support to key projects through financial subsidies. Economic and trade cooperation key project database has been built in Qingdao to collect more than 100 outstanding development projects, 11 of which have entered the national support level. Qingdao ranked the first place in Shandong province.

Qingdao proposed itself in the Vision and Action as a coastal city port in need of key construction. Founded in 1892, Qingdao port has a history of 130 years, and is the seventh largest port in the world and the third largest trading port in China. Its foreign trade throughput ranks second in China. At present, Qingdao port has maintained trade contacts with more than 700 ports in more than 180 countries and regions in the

(accessed:2022.07.03)

[30] Sohu net, https://www.sohu.com/a/146493904_522922 (accessed:2019.19.13)

[31] Zhang Jianping. *The " Belt and Road" local development orientation and Shandong countermeasures [N]*. “ Guangming Daily ”, 2015-05-20007.

world[32]. The container handling efficiency has maintained the first place in the world for four consecutive years, and has formed a global network to facilitate trade exchanges and cooperation between Shandong province and the Belt and Road region. As the outlet of Shandong's economy, Qingdao port serves inland regions such as Henan, Hebei, Shanxi, Shaanxi and Xinjiang, and is an important center of trade, energy and raw material exchange and transportation in inland regions. The other huge advantage of Qingdao in the Belt and Road Initiative is the construction of "Blue Silicon Valley"[33], which will make Qingdao the leading city to surpass other six coastal cities as the hinterland. It focuses on the joint expansion of the ocean and is the fulcrum of the Belt and Road maritime cooperation. Meanwhile, Qingdao Port has also made outstanding achievements in deepening cooperation with 15 ports along the "21st Century Maritime Silk Road".

The special geographical location and historical origin have brought up the long-standing cooperation between Yantai and the countries along the Belt and Road Initiative. As early as the Qin and Han Dynasties, China's first maritime "opening to the outside world" started from Yantai, known as Dengzhou in ancient times. As the starting place of the "Oriental Maritime Silk Road", Yantai played an important role in the formation and development of historical trade. Yantai is located at the intersection of the Pacific Rim Economic Circle and the Northeast Asian Economic Circle, and is an important juncture of the Maritime Silk Road and the Overland Silk Road Economic Belt. Yantai will focus on building overseas economic and trade cooperation groups. Compared with Jinan, Yantai has a better manufacturing base and a larger gross industrial product, but its growth has been lagged behind in recent years. However, the unique geographical location of Yantai is obviously better than that of Jinan The construction of corridors is not the most important for Yantai. Although Yantai is one of the first open cities, its foreign trade and economic development have been slower in recent years and has been completely surpassed by Qingdao. Therefore,

[32] Jing Hong,*Highlights of Qingdao's foreign Investment [N]*. " China Information News ", 2015-08-04003, p.1-2.
[33] Qing Dao News, https://www.qingdaonews.com/content/2012-03/16/content_9236807.htm (accessed:2022.07.03)

Yantai decided to take an alternative path, focusing on the overseas economic layout to create overseas economic and trade cooperation zones. It also encourages and supports superior enterprises and special enterprises to the countries along the Belt and Road with rich resources and broad cooperation prospects. It actively establishes industrial parks, economic and trade cooperation zones and builds industrial cooperation platforms with production and processing, and makes merger and acquisition the starting point. Yantai will actively cultivate an international enterprise group to server internationalization of industries, markets, enterprises, parks and cities. According to media reports, more than 30 domestic and international enterprises, such as Jereh Group, CIMC RAFFELES, Wanhua Chemicals have been nurtured, and 127 projects have been invested in 27 countries along the line, including Russia, Indonesia and Pakistan. The Sino-Hungarian Sino-German Economic and Trade Cooperation Zone and Sino-Russian Timber Industry and Trade Cooperation Zone initiated by Yantai City have been jointly designated as the national-level overseas economic and trade cooperation zones by the State Ministry of Commerce and the Ministry of Finance. Hungary-China BorsodchemZrt Economic and Trade Cooperation Zone is by far the largest investment project of China in Central and Eastern Europe[34]. Irradiating Japan,The Republic of Korea and the new Eurasian land bridge, Yantai Port has exchanges and cooperation with more than 100 ports in more than 70 countries and regions. Since China put forward the Belt and Road strategy, Yantai Port Group has gone abroad to invest, build and operate dock projects in Africa, and has made prominent progress. Moreover, Yantai Port focuses on the urbanization and transformation of Zhifu Bay Port area and the construction of the West Port area, continuously accelerating the construction of six bases including energy import, ore distribution, container transfer, coal drainage, fertilizer export, and import and export to Africa, providing backbone support for cargo circulation and trade of the Belt and Road.

[34] Yin Hong, *Research on the Development of Cultural Industry in the Construction of Silk Road Economic Belt [J]*. " Academic Forum ", 2015, p.55-60.

1.5. Economic characteristics of Shandong province

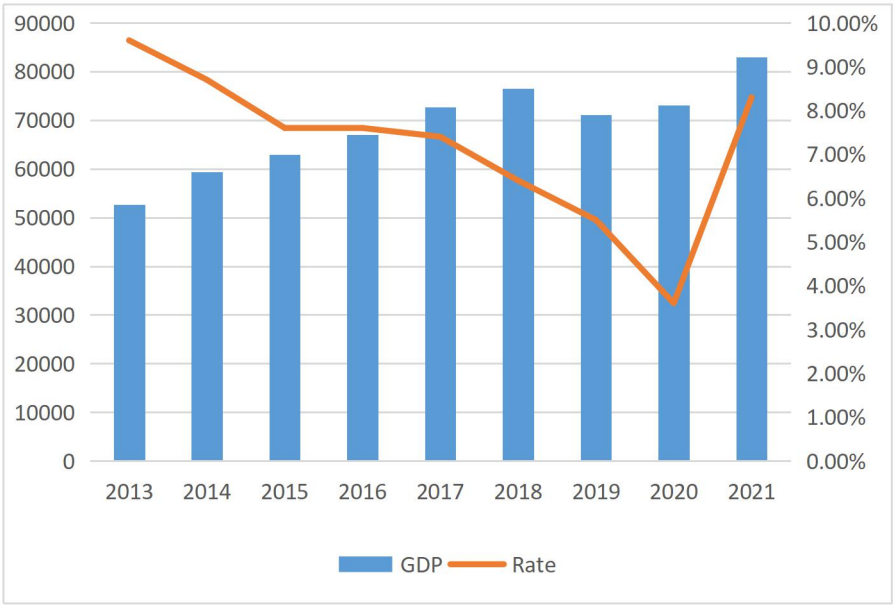
Shandong province is a coastal province with a large economic volume and a high level of economic development under the comprehensive regional development strategy. The current regional development strategy of "two districts, one circle and one belt" in Shandong province includes national development strategy and provincial development strategy, which have both priority development plans and protective development plans. The strategy is rich in connotation and clear in layers, covers the whole region with various forms of strategies, which is very conducive to Shandong province's integration into the Belt and Road strategy. Specifically, "two districts" refers to the Shandong Peninsula Blue Economic Zone and the Yellow River Delta High-Efficiency Ecological Economic Zone. The Shandong Peninsula Blue Economic Zone, led by Qingdao, adheres to the coordination of sea and land, and the interaction between city and sea, and vigorously promotes the integration of regional energy, transportation, communications and other infrastructure, thereby supporting the development of the Belt and Road strategy. The main goal of the Yellow River Delta high-efficiency ecological economic zone is to become a new growth pole in the Bohai Economic circle, thereby driving the development of cities and towns. Coastal cities such as Dongying and Binzhou are selected as key cultivation cities in the district, which are more conducive to the construction of the 21st Century Maritime Silk Road. "One circle" refers to the economic circle of the provincial capital Jinan city group, centered on Jinan's transportation network and infrastructure network, aiming to make the internal communication and transportation of Shandong province comprehensive, three-dimensional and informational, so as to give play to the advantages of "'regional strategy". “One belt” is an area developed and constructed based on the economic uplift belt in the west of Shandong province, aiming to build a new economic growth pole in the east area of the Eurasian Continental Bridge and connect the Silk Road Economic Belt, financial trade, transportation infrastructure, etc. As a result, extensive exchanges and cooperation can be carried out with the regions along the Eurasian Continental Bridge Economic Belt along the Silk Road,

which has an obvious supporting role for the local economy[35].

Shandong province has a large population and abundant labor resources. By 2020, Shandong's population has reached 100.96 million. As a province that opened to the outside world earlier, Shandong province, located at the mouth of the Yellow River with convenient transportation, has unique advantages in the field of foreign trade. In addition, industries such as industry, agriculture, and service industries in Shandong province have grown steadily in recent years. This chapter mainly analyzes the structure of foreign trade import and export commodities in Shandong province and its foreign trade development potential through foreign trade competitiveness index and foreign trade dependence degree[36].

Figure 1.1. Changes in local economic growth rates of Shandong province

GDP Unit: billion RMB



Source: https://baijiahao.baidu.com/s?id=1623986192607090268&wfr=spider&for=pc

(accessed: 2022.05.06)

Shandong province is rich in marine and mineral resources, with a solid foundation of agriculture, a continuously developing industry and a rapidly rising

[35] LI Jiaojiao, *Study on Shandong Province's integration into "The Belt and Road" Strategy from the perspective of geo-economy,* Shandong Normal University, 2016, p.17-23.

[36] China Business Net, https://baijiahao.baidu.com/s?id=1623986192607090268&wfr=spider&for=pc

(accessed: 2019.08.03)

service industry. Especially after China's accession to the WTO, the economic aggregate of Shandong province has been growing rapidly every year. Since then, Shandong province has continued to accelerate the pace of reform, by adjusting the industrial structure and improving the independent innovation capabilities of enterprises (such as high-tech industries and equipment manufacturing). In addition, Shandong province proposed the National Strategies of Bohai Rim Strategy and the Yellow River Delta to play a radiating and driving role in the overall economic growth of Shandong province, thus contributing to the national economic growth.

As can be seen from Figure 1.1, the economic growth rate of Shandong province has always been at a relatively high level, which has played a crucial role in the growth of the national economy. In 2021, Shandong province achieved a GDP of 8,309.590 billion RMB, an increase of 8.3% over the previous year and an average growth rate of 5.9% over the past two years. Of this, the added value of the primary industry was 602.903 billion RMB, a year-on-year increase of 7.5% and an average increase of 5.1% over the past two years. The added value of the secondary industry was 3,318.716 billion RMB, a year-on-year increase of 7.2% and an average increase of 5.2% over the past two years. The added value of the tertiary industry was 4.3879.71 trillion RMB, a year-on-year increase of 9.2% and an average increase of 6.5% over the past two years.

Table 1.2. Main economic indicators of Shandong province in 2021

Gross Domestic (local) Product (Q1-Q4) (Unit: 100 million RMB)					
		First quarter	Second quarter	Third quarter	Fourth quarter
Gross regional product	Cumulative absolute amount(100 million USD)	18055.51	38906.35	60439.2	83095.9
	Cumulative growth rate (%)	18	12.8	9.9	8.3

The primary industry	Cumulative absolute amount (100 million USD)	679.19	2653.44	2653.44	6029.03
	Cumulative growth rate (%)	4	7.38	7.7	7.5
The secondary industry	Cumulative absolute amount (100 million USD)	6911.02 3688.0	15076.31 18297.03	23653.2 27011.33	33187.16 28310.92
	Cumulative growth rate (%)	16.9	11.82	8.9	7.2
The tertiary industry	Cumulative absolute amount (100 million USD)	10465.3	21176.6	32656.1	43879.71
	Cumulative growth rate (%)	18	14.2	10.9	9.2

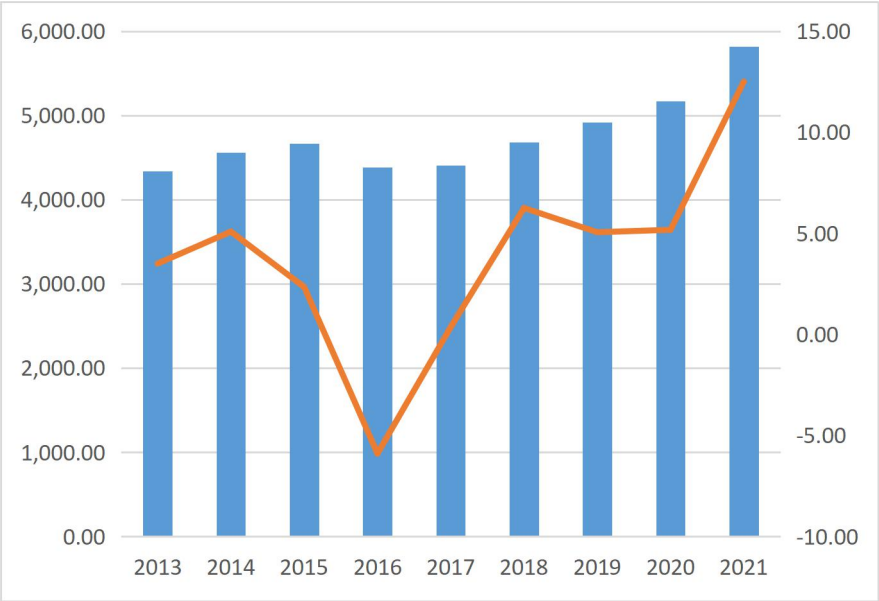
Source: Local Data, http://old.stats-sd.gov.cn/stats/site/search/searchdetail.jsp (accessed:2022.25.06)

According to Table 1.2, the cumulative growth rate of the cumulative absolute GDP in Shandong province in the four quarters is basically stable, with the largest in the fourth quarter and the least in the first quarter. In detail, the cumulative absolute amount of the primary industry shows a significant growth trend, while the secondary and tertiary industries show a slow growth[37].

As shown in Figure 1.2, since 2013, the industrial added value of Shandong province has increased steadily, from 2,257.146 billion RMB in 2013 to 3,787.7 billion RMB in 2018. From 2018 to 2021, the industrial added value showed a continuous upward trend, and its growth rate reached 12.5% in 2021.

[37] Local Data, http://old.stats-sd.gov.cn/stats/site/search/searchdetail.jsp (accessed:2019.08.03)

Figure 1.2. Statistics of industrial value added of Shandong province from 2013 to 2021

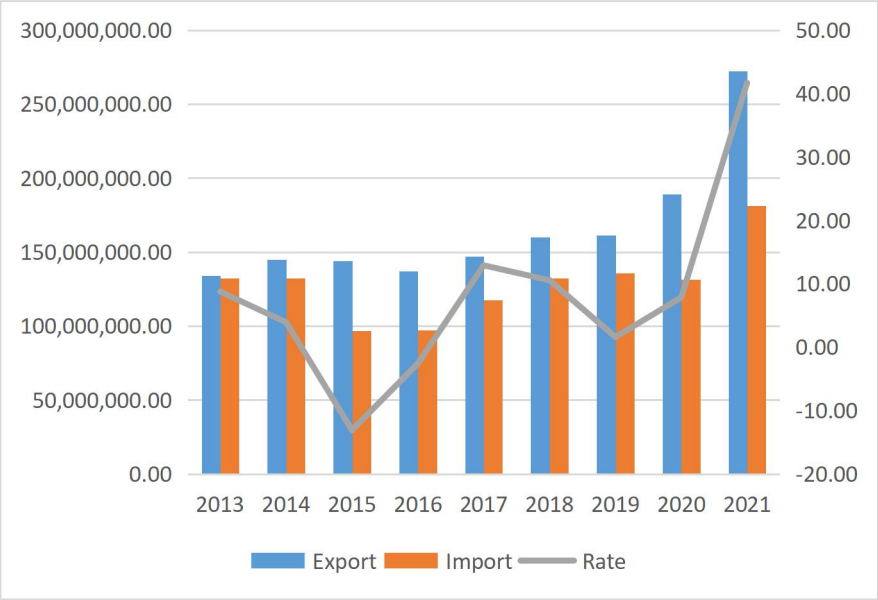


Source: Local Data,

http://data.chinabaogao.com/hgshj/2019/09644G002019.html (accessed:2022.25.06)

As can be seen from Figure 1.3, the total export value of Shandong province showed a downward trend from 2013 to 2016, and a fluctuating upward trend from 2017 to 2021. While, the total import value of Shandong province showed a downward trend from 2013 to 2017, and a fluctuating upward trend from 2018 to 2021. In general, the growth rates of imports and exports in Shandong province both showed a fluctuating upward trend.

Figure 1.3. Statistics of the total imports and exports of Shandong province from 2013 to 2021



Source: Hua Jing network, https://www.huaon.com/story/416331?from=groupmessage (accessed:2019.08.10)

Table 1.3. Statistics of total import and export of Shandong province by nature of enterprises in 2010-2018.

	Total import and export volume (100 million RMB)			
	Wholly foreign-owned enterprises in Shandong province	Sino-foreign cooperative enterprises in Shandong province	Sino-foreign joint ventures in Shandong province	Foreign-funded enterprises in Shandong province
2010	50.5	0.67	45.1	96.3
2011	55.4	0.78	51.4	107.5
2012	54.8	0.88	46.4	102.0
2013	53.7	0.86	46.9	101.4
2014	56.1	0.79	50.2	107.1
2015	50.2	0.65	42.5	93.5
2016	44.7	0.51	37.2	82.5
2017	47.3	0.62	36.2	84.2
2018	48.9	0.63	36.3	85.8

Source: Hua Jing net, https://www.huaon.com/story/416331?from=groupmessag(accessed:2019.08.10)

As shown in Table 1.3, in 2018, the total import and export volume of wholly foreign-owned enterprises in Shandong province was 48.9 billion RMB, that of

Sino-foreign cooperative enterprises was 0.63 billion RMB, that of Sino-foreign joint ventures was 36.3 billion RMB, and that of foreign-funded enterprises was 85.8 RMB[38]. After reaching 5.61 billion RMB in 2014, the total import and export volume of foreign-funded enterprises in Shandong province decreased year by year, and rebounded again in 2018, showing a slight fluctuation trend in general. After reaching a peak in 2012, the total import and export volume of Sino-foreign cooperative enterprises in Shandong province had been declining year by year since 2013, with the largest decline in 2016, and began to grow slowly in 2017. The total import and export volume of Sino-foreign joint ventures and foreign-funded enterprises in Shandong province has decreased year by year since 2014, while that of foreign-funded enterprises returned to a growth trend from 2016 to 2018.

1.6. Analysis of trade relations between Shandong province and countries along the Belt and Road routes

As a major economic province in China, Shandong province has shown a rapid, sustainable and healthy development trend since the reform and opening up, with a significant improvement in economic level and a more reasonable industrial structure. Shandong province's GDP reached 8 trillion RMB in 2021, a year-on-year increase of 8.3%, second only to Guangdong and Jiangsu provinces. In terms of industrial structure, its tertiary industry grew the fastest, with an increase of 4,387.971 billion RMB, a year-on-year increase of 9.2%. The added value of the secondary industry was 3.318716 billion RMB, up 7.2%, and that of primary industry was 602.903 billion RMB, an increase of 7.5%. Correspondingly, the per capita GDP of Shandong province was 81,707 RMB, a year-on-year increase of 6.5%.

In 2019, Shandong's total foreign trade exceeded 2 trillion RMB for the first time, reaching 2.04 trillion RMB, an increase of 5.8% over 2018, of which exports

[38] Hua Jing Net,https://www.huaon.com/story/416331?from=groupmessage (accessed:2019.08.10)

accounted for 1.11 trillion RMB, an increase of 5.3%, and imports were 929.06 billion RMB, an increase of 6.4%. Meanwhile, in 2019, Shandong's total import and export volume ranked sixth in China, accounting for 6.5% of the total import and export volume, an increase of 0.15% over 2018. Among the top six provinces and cities in foreign trade, Shandong's import growth rate ranks first. Its export growth rate is second only to Zhejiang and Beijing[39].

Table 1.4. Total value of the top 19 major commodities exported by Shandong province in 2021

Commodity	Export	
	Amount (100 million RMB)	Year-on-year growth
Electromechanical products	7585.6	35.8%
High-tech products	1312.9	23.7%
Cultural products	1240.8	74.2%
Agricultural products	1238.4	-1.5%
Clothing and clothing accessories	1224.4	25.1%
Auto parts	1086.4	18.6%
Garment yarns, fabrics and their products	831.6	-2.3%
Steel	827.8	72.1%
Rubber tire	679.6	15.5%
Basic organic chemistry	602	55.3%
Plastic products	549.4	44.6%
Game consoles and accessories	518.7	50.7%
Electronic components	435.4	41.1%
Electrical equipment	402.8	40.8%
Household appliances	401.2	21.3%
Toy	323.1	101.8%
Aquatic products	285.9	-3.6%
General machinery and equipment	278.3	34%
Computer and communication technology	668.3	14.1%

Source: Qingdao customs District P.R.CHINA,

[39] China Shandong Net, https://baijiahao.baidu.com/s?id=1655783611759790116&wfr=spider&for=pc (accessed:2019.09.10)

http://guiyang.customs.gov.cn/qingdao_customs/406535/fdzdgknr30/406514/406515/4132093/index.html (accessed:2022.25.06)

As shown in Table 1.4, the export value of electromechanical products, agricultural products, cultural products, clothing and clothing accessories and high-tech products is in the forefront, but agricultural products show a negative year-on-year growth. In addition, among the top 19 export commodities in Shandong province, textile yarn, fabric and its products, and aquatic products all show negative growth. In contrast, the demand for steel, unforged aluminum and aluminum materials and containers increases relatively, with a significant year-on-year growth.

Table 1.5. Total value of imports and exports by trade type in Shandong province in 2021

Type of trade	Import and export		Import		Export	
	Total value (100 million RMB)	Year-on-year growth	Total value (100 million RMB)	Year-on-year growth	Total value (100 million RMB)	Year-on-year growth
General trade	19487.71	28.1%	12650.96	32.3%	6836.75	21.1%
Processed food	3918.28	19.1%	2754.68	15.1%	1163.6	29.9%
Goods entering and leaving the bonded premises	2796.23	52.6%	13.56	64.6%	2582.67	51.7%
Special supervision of regional logistics goods by customs	1271.35	65.9%	446.01	134.9%	825.35	43.2%
Other trades	1131.51	184.9%	1096.37	205.3%	35.14	-7.7%
Trades of processing with customer's material	608.81	11.4%	353.83	2.7%	254.97	26.3%

Contracted projects	62.25	5.4%	65.25	5.4%	-	-
Equipment of special supervision areas	11.18	68.5%	-	-	11.18	68.5%
Leasing trade	6.38	-17.5%	0.36	-60.8%	6.02	-11.6%
Equipment imported by foreign-funded enterprises	3.90	-25.8%	-	-	3.9	-25.8%
International Aid (official)	1.51	-35.6%	1.48	-36.8%	0.03	-
Processing trade import equipment	1.49	-21.5%	-	-	1.49	-21.5%
Export processing trade	0.4	1313.4%	0.14	1250.8%	0.26	1349.3%
Duty free	0.02	-37.7%	-	-	0.02	-37.7%
Barter trade	0.01	-	0.01	-	-	-
Small border trade	0.01	-9.9%	0.01	-9.9%	-	-

Source: Jinan Customs District R.P.CHINA, http://xian.customs.gov.cn/jinan_customs/zfxxgk93/3014222/3014291/500344/4132806/index.html (accessed:2022.25.06)

As can be seen from Table 1.5, the total import and export value of general trade is 1,948.771 billion RMB, accounting for the largest proportion of the total import and export, and its exports exceed imports, showing an increasing trend in the same year. Import and export goods in bonded areas, logistics goods under special customs supervision, processing and assembly trade with supplied materials all show an increasing trend. General trade refers to the unilateral import and export conducted by enterprises with import and export rights within the territory of China. That is, the goods imported and exported in accordance with the general trade transaction method are general trade goods. The import of general trade goods can go through customs formalities in accordance with the general import and export supervision system,

which belong to general import and export goods. Besides, they can also enjoy special preferential treatment of tax reduction or exemption according to the special tax reduction and exemption supervision system. In this case, they can enjoy specific tax reduction or exemption, which can also be approved for bonded by customs, and go through customs formalities in accordance with the bonded supervision system. As a result, these can be recognized as bonded goods[40].

Table 1.6. Total value of the imports and exports of Shandong province with major trading countries in 2021

Country/Region	Export and Import		Export		Import	
	Total Value (100 million RMB)	Year-on-year growth	Total Value (100 million RMB)	Year-on-year growth	Total Value (100 million RMB)	Year-on-year growth
Countries along the "Belt and Road" routes	9375.97	40.8%	5418.38	39.7%	3957.59	42.2%
ASEAN	4308.82	42.7%	2415.54	33.1%	1893.28	57.2%
U.S.A	3339.33	37.3%	2722.68	36.4%	616.64	41.2%
E.U (excluding UK)	2887.57	24.3%	2214.59	26.7%	672.98	17.1%
Korea	2695.51	29.7%	1746.78	31%	948.73	27.2%
Japan	1821.46	16.5%	1396.23	16.1%	425.24	17.9%
Brazil	1598.12	16.8%	260.81	45.4%	1337.31	12.5
Australia	1334	33.8%	393.53	33.4%	940.47	34%
Russia	1272.25	33.1%	477.05	76.5%	795.21	16%

[40] Zhu Qirong, *Comparative analysis of the influence of general trade and processing trade on China's economic growth,* "University of International Business and Economics", 2006, p.21-28.

Taiwan, China	698.1	38.1%	200.96	36.3%	497.14	38.9%
Hongkong, China	621.54	75%	615.24	77.4%	6.3	-23.8
India	608.59	47.8%	460.98	57.5%	147.61	23.9%
U.K	555.68	17.6%	469.04	11.5%	86.64	67.3%
United Arab Emirates	534.8	60.4%	253.47	53.9%	281.33	66.7%
Canada	488.86	9.6%	343.63	24.7%	145.23	-14.9%
Chile	432.17	44.3%	140.1	68.5%	292.08	35.1%
Mexico	414.51	38.9%	377.17	43.7%	37.35	4%
Oman	372.51	116.2%	27.3	6.8%	345.22	135.2%
Norway	338.95	25.2%	29.28	-0.2%	309.66	28.3%
Angola	323.3	22.4%	15.55	56.3%	307.75	21.1%

Source: Jinan Customs District R.P.CHINA, http://xian.customs.gov.cn/jinan_customs/zfxxgk93/3014222/3014291/500344/4132806/index.html (accessed:2022.26.06)

According to customs statistics, the import and export value of Shandong province in 2021 reached 2.93 trillion RMB, a record high for the sixth consecutive year since 2016, an increase of 32.4% than that of 2020 and 43.1% than 2019, accounting for 7.5% of the total value of China's foreign trade compared with 6.9% in 2020. As shown in Table 1.6, exports to major markets other than Norway continued to grow, with significant increases to Russia, Brazil, Hong Kong, India, Chile, Mexico and Angola. In 2021, Shandong's exports to ASEAN, the European Union,The Republic of Korea Japan and Brazil increased, while its imports and exports to the United States decreased. In 2021, ASEAN, the United States, the European Union,The Republic of Korea Japan and Brazil were the top six trade markets in Shandong province. Shandong’s imports and exports to these countries reached 430.88 billion RMB, 333.93 billion RMB, 288.76 billion RMB, 269.55 billion RMB, 182.15 billion RMB and 159.81 billion RMB respectively, with the growth rate of 42.7%, 37.3%, 24.3%, 29.7%, 16.5% and 16.8% accordingly. In total, these markets accounted for 56.8% of Shandong's total foreign trade value. During the same period, Shandong's imports and exports to the countries along the Belt and Road routes reached 937.06 billion RMB, an increase of 40.8%, accounting for 32.0% of the total import and

export value of Shandong province[41].

Since the 18th National Congress of the Communist Party of China, Chinese President Xi Jinping has issued instructions on Shandong's opening up many times, requiring Shandong to implement a more proactive opening-up strategy and reshape the new advantages of an open economy. During the inspection in June 2018, Xi required Shandong to actively integrate into the overall situation of China's opening up, expand high-quality investment promotion, and deeply integrate into the construction of the “Belt and Road” Initiative. Governments at all levels have strictly implemented the spirit of Xi’s instruction, making Shandong’s opening up even wider[42].

In this context, the awareness of opening up the market economy in Shandong province has become increasingly stronger. Although there are some gaps between Shandong and the developed provinces in the south, the local people are relatively open to emancipating their minds, with a strong ability to accept and adapt to novelties. Over the years, the Shandong government has made great efforts for the construction of the Belt and Road Initiative and the introduction of foreign capital. Shandong province is equipped with a good economic foundation, large industrial and agricultural demand, as well as high consumption level and purchasing power of urban and rural residents. In 2021, the per capita disposable income of Shandong residents was 35,705 RMB, a year-on-year increase of 8.6% (7.3% in real terms after deducting price factors). Of this amount, the per capita disposable income of urban residents was 47,066 RMB, an increase of 7.6% (6.2% in real terms after adjusting for inflation). The per capita disposable income of rural residents was 20,794 RMB, up 10.9% (9.8% in real terms after adjusting for inflation). In 2021, the per capita consumption expenditure of Shandong residents was 22,821 RMB, a year-on-year increase of 9.0%. Of this, the per capita consumption expenditure of urban residents was 29,314 RMB, up 7.4%. The per capita consumption expenditure of rural residents

[41] Hai Bao news, *https://baijiahao.baidu.com/s?id=1722185636134836686&wfr=spider&for=pc*（accessed:2022.25.06）

[42] Shandong Provincial Government, https://baijiahao.baidu.com/s?id=1681780536428521763&wfr=spider&for=pc (accessed:2021.06.13)

was 14,299 RMB, up 12.9%[43].

Moreover, Shandong province is a major fishery province in China, with significant location and technological advantages. Shandong aquaculture production and export volume have been at the forefront of the country for many years. From 2007 to 2016, the trade surplus of aquatic products in Shandong province exceeded 1 billion USD, and the trade surplus showed an overall upward trend. By 2012, China's trade exports had been the first in China until it was surpassed by Fujian province for the first time in 2013. Since 2013, the export of aquatic products in Shandong province has maintained the second place in China. In 2016, Shandong's trade exports were 4.685 billion USD, accounting for 23% of China's total exports, and the trade surplus of aquatic products was 2.211 billion USD. In recent years, the proportion of Shandong's aquatic product imports and exports in China has been declining year by year, but the Belt and Road strategy has brought new opportunities for Shandong's aquatic product export. Furthermore, Shandong's aquatic product trade still faces internal and external challenges, such as exchange rate fluctuations, water pollution, and the Sino-US trade war. Therefore, the study of Shandong's export is particularly important, which will be elaborated in the second chapter.

[43] Shandong Provincial Bureau of Statistics, http://tjj.shandong.gov.cn/ (accessed:2022.03.07)

CHAPTER 2. DEVELOPMENT AND TRADE OF AQUATIC PRODUCTS IN SHANDONG PROVINCE

2.1. Aquatic production in China

Aquatic products are one of the important industries in China, playing a very significant role in agricultural development, agricultural economics, and farmers' income increase. As the world's largest exporter of aquatic products, the international competitiveness of China's aquatic products is the key to its market share. However, facts show that China has long relied on resource-consuming production models and low-price competition. With the increasing trade barriers set by major trading partners on aquatic products, the international image of China's aquatic products exports has been seriously damaged. Many traders take temporary maintenance with new labels on imported aquatic products from China, which makes Chinese aquatic products gradually lose the resource advantages in international trade[44]. Therefore, Chinese aquatic products must change the concept of low-price competition, and turn resource advantages into competitive advantages to deal with international market competitors, through the restructuring of aquaculture industry. In addition, China should pay attention to both economic and ecological benefits, with a focus on improving its international competitiveness.

According to the statistics of the report of the "State of the World Fisheries and Aquaculture"[45] of the United Nations, China is a large country in aquaculture and the only country in the world where the amount of aquaculture is greater than that of fishing, accounting for 76.12% and 23.88%, respectively. The production of seawater

[44] Feng Xiaoshan, *Research on the Export International Competitiveness of Aquatic Product in China*, University of Suzhou, 2019, p. 31-42.
[45] *State of the World Fisheries and Aquaculture Report 2020,* ISSN 2410-5902, Food and Agriculture Organization of the United Nations.

and freshwater aquaculture in 2019 reached 200.7 million tons and 25.4098 million tons respectively, a year-on-year increase of 4.46% and 0.95%. In marine aquaculture, the production of shellfish reached 14.4371 million tons, far exceeding that of crustaceans and fish. The production of freshwater aquaculture reached 250.4098 million tons, of which the production of crustaceans and shellfish was much lower than that of fish. Overall, fish, shellfish and crustaceans are the main farming species[46].

Regarding fish farming, grass carp and catfish are the main cultured species in freshwater aquaculture, while large yellow croaker, perch and grouper are the main cultured species in marine aquaculture. At present, large yellow croaker, tilapia, shrimp and shellfish have become the main export species, accounting for 1.37%, 7.92%, 12.23% and 8.41% of the total export volume of general trade respectively. Fishery trade accounts for a relatively small proportion in China's foreign trade, among which these four types of aquatic products are the main categories of aquatic products exported by China. The general trade here refers to the trade of aquatic products. Table 2.1 does not imply that all products are exported in the same year. The production of marine products was 11.1242 million tons, down 6.30% from the previous year, of which the production of fish, crustaceans and shellfish were 7.6522 million tons, 2.0706 million tons and 442.9 thousand tons respectively. The production of freshwater fishing was 5.6351 million tons, an increase of 8.97% over the previous year, of which the production of algae, fish and crustaceans reached 3.73 million tons, 1.6158 million tons and 289,300 tons respectively.

Table 2.1. Production of China's aquatic products in 2019

Unit: 10,000 tons

Breeding	Amount (10,000 tons)	Fishing	Amount (10,000 tons)
Seawater	**2135.31**	**Seawater**	**1154.36**
Shellfish	1516.27	Shellfish	793.5
Crustaceans	158.58	Crustaceans	218.97

[46] *China Fishery Statistical Yearbook Report 2020,* ISBN 978-7-109-26847-0, Fishery administration of Ministry of Agriculture and Rural Affairs.

Fish	160.42	Fish	46.31
Freshwater	**3234.64**	**Freshwater**	**579.42**
Fish	2697.27	Fish	385.6
Crustaceans	341.97	Crustaceans	162.59
Shellfish	21.48	Shellfish	28.93

Source: China Fishery Statistical Yearbook Report 2020, ISBN 978-7-109-26847-0, Fishery administration of Ministry of Agriculture and Rural Affairs.

2.2. Exports of Chinese aquatic products

Compared with other industries such as vegetables, China's aquatic products participate in international competition much more than other agricultural products, which ranks first in the total export value of agricultural products.

Table 2.2. The export value and volume of Chinese aquatic products from 2013 to 2018

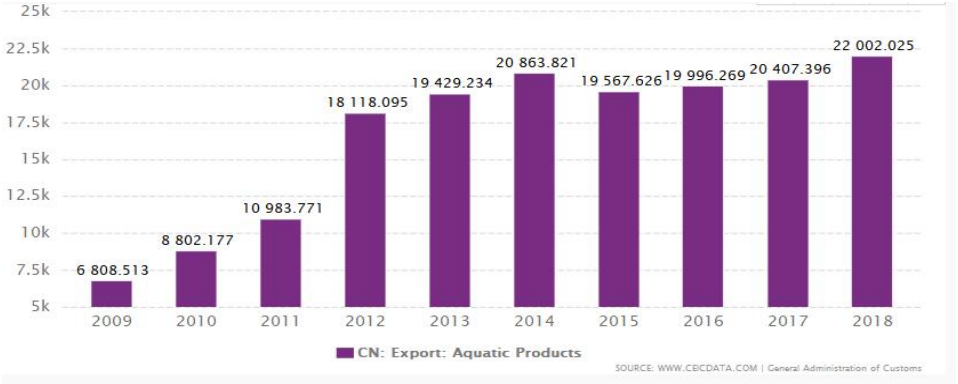
Period	Total value (USD)	Qty Unit (10,000 tons)
2013	1090350	603, 602
2014	1344017	740, 010
2015	998401	457, 556
2016	1359962	617, 038
2017	44744256	77, 589, 500
2018	1400082	665, 322

Source: China Aquatic Products Industry Analysis Report, 2019, Hangzhou zhongjing market research Co. LTD, p.12-14.

As can be seen from Table 2.2, the export volume of aquatic products showed an unstable trend from 2013 to 2018. Exports increased in 2014 compared with 2013, but dropped significantly in 2015, then peaked in 2017, and declined again in 2018 due to the Sino-US trade war.

Figure 2.1. China's aquatic product exports between 2009 and 2018

Unit: USD mn

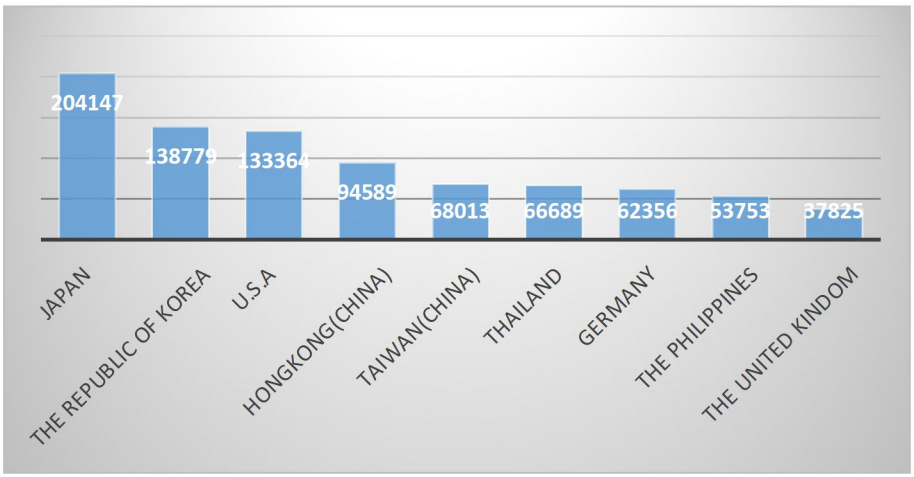


Source: Research report on market prospect and investment opportunity of Chinese aquatic product industry 2010-2019, Database of China Commercial Industry Research Institute

Figure 2.1 clearly shows that fish exports have suffered significantly since the onset of the 2009 financial crisis. However, from 2010 to 2014, the export volume showed a significant growth trend year by year, reaching its peak in 2014. In contrast, 2015 was a difficult year for China's aquatic product exports, but the export volume increased in 2016, with an improving trend. From 2015 to 2017, the export volume of aquatic products increased steadily. Until 2018, the export volume of aquatic products increased significantly again.

Figure 2.2. Major import countries of Chinese aquatic products in 2019

Unit:Ten Billion



Source: United Nations Trade Statistics Database,

https://unstats.un.org/unsd/trade/default.asp. (accessed 22.06.07)

As can be seen from Figure 2.2, China's aquatic product exports in 2019 were mainly concentrated in Asia, especially Japan and The Republic of Korea. However, the continuous strengthening of trade regulations in the United States, Japan and other countries in recent years has led to restrictions on the export of Chinese aquatic products. According to the WTO, the United States is China's third-largest exporter of aquatic products. Affected by the Sino-US trade war, China's aquatic product exports have been affected to a certain extent, which is being resolved in an orderly manner. Thus, China still maintains the international competitive advantage of aquatic products, with Japan, the United States, Germany, Hong Kong and The Republic of Korea as the main export target markets. In 2019, owing to the influence of the preferential policies of the Belt and Road initiative and the easing of diplomatic relations between China, Japan and The Republic of Korea China's exports to Japan and The Republic of Korea showed a positive trend. Against the backdrop of trade frictions between Japan and the ROK and between China and the US, the construction of the China-Japan-ROK Free Trade Zone has become one of the important factors in the trade cooperation between China, Japan and The Republic of Korea which is also a critical variable affecting the future direction of China-Japan-Korea relations. In this case, the Belt and Road initiative plays a vital role in the construction of free trade zones. Since the initiative pointed out that countries should actively use the existing bilateral and multilateral cooperation mechanisms to promote regional cooperation and development.

Table 2.3. Main export provinces in 2019

Coastal	Export amount (Unit:10000 RMB)	Year-on- year increase or decrease	Export volume (Unit: 10000 tons)	Year-on-year increase or decrease
Liaoning	1149317.68	-2.44	33.57	-1.86
Zhejiang	873389.01	-0.09	32.43	-1.52
Fujian	1341558.18	-1.41	48.83	-7.61

Shandong	1016553.07	-4.67	36.42	-1.75
Guangdong	1362590.5	2.8	39.71	1.36
Inland	Export amount (Unit:10000 RMB)	Year-on- year increase or decrease	Export volume (Unit: 10000 tons)	Year-on- year increase or decrease
Jiangxi	697763.99	0.36	23.44	0.43
Hubei	56288.64	-0.75	18.27	-0.57
Jilin	1232989.7	-0.57	37.27	-0.76

Source: China Fishery Statistical Yearbook Report 2020, ISBN 978-7-109-26847-0, Fishery administration of Ministry of Agriculture and Rural Affairs.

At present, China's major aquatic products exporting provinces are mainly concentrated in the eastern coastal areas. In 2019, Shandong, Fujian, and Guangdong were the main exporting provinces in China, with similar export volume and output, but different aquaculture species. Specifically, Shandong's export value was 10.165 billion RMB, accounting for 50% of China's total aquatic product exports. Fujian's export amount and export volume decreased by -1.41% and -7.61% respectively in 2019, mainly due to lower exports to Taiwan and Hong Kong. However, Fujian has China's largest distribution center for distant-water fisheries in Dongshan, with developed processing industry and broad prospects for export of aquatic products.

Among the inland provinces, the proportion of freshwater aquaculture in Jiangxi, Hubei and Jilin is lower than the total export. Affected by the recession of the international eel market, Jiangxi's export amount and export volume only increased by 0.36% and 0.43% year-on-year respectively. The export volume of aquatic products from Hubei and Jilin is also affected by the international aquatic product market. The export amount and export volume of aquatic products in Hubei and Jilin are also affected by the international aquatic products market. Specifically, the export amount and export volume of aquatic products in Hubei decreased by 0.75% and 0.57% respectively, while those of Jilin decreased by 0.57% and 0.76%. In practice, aquaculture in inland provinces accounts for a very small share of China’s total exports, which therefore has little impact on China's total aquatic product exports.

2.3. Aquatic products export structure and major export markets

According to the statistics of the Ministry of Agriculture, the main export species of China's general exports are cephalopods, shrimp, shellfish, tilapia, crab, eel, mackerel, algae, yellow croaker and freshwater lobster. Based on the United Nations Trade Statistics Database, the HS (Harmonized System) of aquatic product quantile codes are as follows: 0301 (fresh fish), 0302 (fresh or frozen fish), 0303 (frozen fish), 0304 (fish, fish fillets and surimi products), 0305 (marinated and smoked fish products), 0306 (crustacean products), 0307 (invertebrate and invertebrate soft fish), 0308 (crustacean and invertebrate soft fish), 1504 (fish and marine mammalian fat and fish oil products), 1604 (fish eggs and caviar products), and 1605 (crustaceans and invertebrate mollusks made or stored)[47].

Affected by the decline in the import demand of aquatic products in the global market, the trade situation of aquatic products in the international market has become severe. In 2019, the import volume of major Chinese exporters such as Norway, the United States, Canada, India, and Chile all showed a downward trend. Under the circumstance that the export volume and export value of the target market countries have declined, China's aquatic product exports to ASEAN and Taiwan have maintained a certain growth. In 2019, China's total imports and exports of aquatic products reached 10.533 million tons, with a total value of 39.36 billion USD, up 10.3% and 5.4% year-on-year respectively. Of this amount, the imports were 6.265 million tons and 18.7 billion USD, an increase of 19.9% and 25.6% respectively. The exports were 4.268 million tons and 20.66 billion USD, down 13.8% and 8.0% year-on-year respectively. As a result, the trade surplus was only 1.96 billion USD, down 74.1% year-on-year.

China’s major export markets have changed. Specifically, exports to Japan, ASEAN, and the European Union increased slightly year-on-year, while exports to Republic of Korea declined slightly. Affected by trade frictions, exports to the US fell

[47] Feng Xiaoshan, *Research on the Export International Competitiveness of Aquatic Product in China,*, 2019, p. 15-23.

by 18.7% year-on-year. With the exception of the United States, import markets over the world generally increased. Imports from ASEAN increased by 39.0% year-on-year, of which imports from Vietnam increased by 59.8% year-on-year, and imports from Indonesia increased by 11.4% year-on-year. Imports from Russia and Peru rose by 6.9% and 5.6%, respectively. In contrast, imports from the United States fell by 11.8% year-on-year[48].

Table 2.4. Main export markets of aquatic products in Shandong province from 2013 to 2019

Year	The total export (Ten thousand tons)	Japan	Republic of Korea	The United States	The European Union	Four major markets	Share of four major markets (%)
2013	111.18	29.0	23.5	12.9	19.2	84.6	76.09
2014	116.95	30.8	21.7	13.4	25.1	91.0	77.81
2015	107.73	30.3	20.3	14.1	25.5	90.2	83.73
2016	111.38	28.4	14.9	12.7	27.6	83.6	75.06
2017	109.43	25.4	14.3	12.3	27.6	79.6	72.74
2018	110.36	28.8	13.9	12.7	29.4	84.8	76.84
2019	114.29	15.2	15.2	13.5	30.2	94.6	82.77

Source: China aquatic products trade statistical yearbook 2014-2020, Statistics Publishing House, the author is the Department of Foreign Trade statistics, National Bureau of Statistics.

It can be seen from Table 2.4 that Japan, The Republic of Korea the United States and the European Union are the main export markets of aquatic products in Shandong province. Overall, the export volume of aquatic products from Shandong province to the four major markets showed an upward trend, from 84.6 ten thousand tons in 2013 to 94 ten thousand tons in 2019, an increase of 100,000 tons. The average share of the four major export markets is 73.42%. Among them, the export volume to the EU showed a significant growth trend from 2013 to 2019. The export volume to Japan showed a trend of fluctuating growth, with a slight decline in both 2016 and 2017. Exports to Republic of Korea increased from 235,000 tons in 2013 to 152,000 tons in 2019, showing a large decrease. The export volume to the United States increased

[48] Weihai Blue News, http://www.china-cfa.org/xwzx/xydt/2021/0528/596.html (accessed:2022.07.03)

steadily until 2015, but began to decrease, and gradually rose again in 2018. In general, the export of aquatic products in Shandong province occupies a relatively high proportion in the four major markets, with a strong advantage.

2.4. Exports of aquatic products in Shandong province

Since 2007, the national economy of Shandong province has grown substantially, with significantly enhanced economic strength. According to the statistics of the National Bureau of Statistics, the GDP of Shandong province was initially calculated to be 70.675 billion RMB, an increase of 5.5% over the previous year in terms of comparable prices. The added value of the primary industry was 511.64 billion RMB, an increase of 1.1%; the added value of the secondary industry was 2831.09 billion RMB, an increase of 2.6%; the added value of the tertiary industry was 37640.2 billion RMB, an increase of 8.7%. The per capita GDP value of Shandong province is always higher than China's overall level, and the gap shows an increasing trend year by year.

In addition, Shandong province's economic growth rate has been consistently higher than the national average. In 2010, Shandong's economic growth rate reached 9.76%, 5 percentage points higher than the national rate, which was the peak of Shandong's economic growth in the past decade. In 2007, under the influence of the international financial crisis, the world economy faced downward pressure, and the Chinese economy entered a new normal. Affected by COVID-19 in 2020, the economic growth rate of Shandong province began to slow down year by year. By 2021, Shandong's economic growth had slowed to 8.3%[49].

[49] Xiao Xiang News, https://baijiahao.baidu.com/s?id=1722461423498732306&wfr=spider&for=pc (accessed:2022.07.03)

Table 2.5. Major economic situation of Shandong province from 2009-2019

Year	SHANDONG			
	Total GDP (100 million RMB)	GDP per capita (RMB)	Shandong GDP as a share of China's GDP	Total ranking (As a share of China's GDP)
2009	33896.65	35894	9.94%	3
2010	39169.92	41106	9.76%	3
2011	45361.85	47335	9.59%	3
2012	50013.24	51768	9.63%	3
2013	55230.32	56885	9.71%	3
2014	59426.59	60879	9.3%	3
2015	63002.33	64168	9.14%	3
2016	67008.19	67706	9.0%	3
2017	72678.18	72851	8.79%	3
2018	76469.7	76300	8.95%	3
2019	71067.5	70000	8.29%	3

Source: Statistical Yearbook of Shandong province 2007-2019, China Statistical Yearbook 2007-2019, Shandong Survey Team, National Bureau of Statistics, China Statistics Press

As shown in Figure 2.5, the main economic indicators of Shandong province from 2009 to 2019 show that GDP and GDP per capita were on the rise, but Shandong's share of national GDP declined slightly.

Shandong borders the Bohai Sea and the East China Sea, facing Republic of Korea and Japan across the sea. Shandong province has a vast coastal area with 326 islands covering an area of more than 500 square meters, which results in marine land resources equal to land area. Shandong province is located in temperate and subtropical coastal waters, and belongs to the edge of the mid-latitude temperate water.

Affected by the continental climate and the inflow of rivers into the sea, the temperature and salinity of its seawater have obvious seasonal changes. As a result, the diversity of marine animal and plant species composition, the number of floristic characteristics and the distribution characteristics of marine life migration characteristics are highlighted here. Sufficient sunshine and fertile water quality are suitable for the growth and reproduction of fish and aquatic organisms. There are more than 400 kinds of aquatic biological resources with economic value in the intertidal zone and subtidal zone. The production of sea cucumbers, abalone, prawns, scallops and other marine treasures is world-renowned. In addition, Shandong has a variety of important aquatic organisms in China, such as small yellow croaker, hairtail, silver pompano, yellow drum, red snapper, cod, flounder, red nipper, Oriental pure, herring, mackerel, blue point mackerel, prawn, shrimp, swimming crab, mantis shrimps, squid, jellyfish breeding farm, etc. Along the coast, there are numbers of fishing grounds such as the Yellow River Estuary, Laizhou Bay, Yanwei, Shidao, Rushan, Jiaozhou Bay and Haizhou Bay. Relying on its resource advantages, Shandong province has ranked first in the country for many years in terms of total aquatic product output and marine product output.

Picture 2.1. Map of Shandong province

Source: Guidebook tourists, http://treehouseguide.net/go/zh-cn/node/213, (accessed:2022.28.06)

2.4.1. Overview of aquatic products in Shandong province

Shandong is the main province of aquaculture and export, where aquaculture has always been the leading industry of Shandong's export. The export of aquatic products, as the pillar industry of Shandong with a long history of aquatic products, has greatly increased the income of Shandong's export of foreign exchange. Shandong province has a warm temperate monsoon climate. The annual average temperature is 11°C-14°C, and the annual precipitation is about 550-950 mm. Superior geographical conditions and suitable climate determine the diversity and abundance of aquatic products in Shandong province. Thus, Shandong province has over 200 species of marine fish resources, 100 species of shrimp and crab resources, 260 species of shellfish resources, 120 species of algae resources, 290 species of freshwater fish resources, and 120 species of aquatic plants[50].

Table 2.6. Statistics of aquatic product output in Shandong province in 2019

Index	Amount (Ten thousand tons)
Total output of aquatic products	861.4
Total output of sea water products	736.1
Natural production of sea water products	215.0
Production of artificial cultured seawater products	521.1
Marine fish yield	172.1
Crab yield	38.9
Shellfish production	429.3
Seaweed production	66.7

[50] Han Shuwen,Lu Shuzi, *Shandong Aquaculture* [M] 1st Edition,“ Jinan Shandong Science and Technology ” , 2020. P.5-8.

Output of other sea water products	29.2
Total output of fresh water products	125.3
Natural fresh water production	8.3
Output of fresh water products in artificial culture	117.1
Freshwater fish production	112.3
Yield of freshwater crabs	12.0
Freshwater shellfish yield	0.4
Output of other fresh water products	0.7

Source:Shandong Aquatic Product Output Data Analysis Report 2020, ZJZS-N-30728, China Economic industry Information Research Network.

As shown in Table 2.6, the total output of aquatic products (excluding ocean fisheries) was 8.614 million tons in 2019. Of this, the output of seawater products was 7.631 million tons and that of freshwater products was 1.53 million tons. Among them, the production of artificial aquaculture seawater products and sea shellfish is the highest.

Table 2.7. Total output of aquatic products and its value in Shandong province from 2014 to 2018

Year	Total Aquatic Products (tons)	Total aquatic product values (100 million RMB)
2014	846458	400.9
2015	8722448	432.03
2016	8899622	510.66
2017	8680030	594.7
2018	86140000	645.7

Source:Statistical Yearbook of Shandong province 2015-2020, Shandong Investigation Team, National Bureau of Statistics.

From Table 2.7, we can see that the total output of aquatic products in Shandong

province is on the rise. In 2014, the output value was the smallest, with a total output of 846,458 tons and an output value of 400.9 million RMB. In 2018, the total output was the largest, with 861,400 million tons and 645.7 million RMB.

As shown in Table 2.8, Shandong province exported 1,142,900 tons of aquatic products in 2019, 272,300 tons higher than the second-ranked Fujian province. Its export volume accounted for 6.37% higher than that of Fujian province in China, but its export value was 42.39 million USD lower than that of Fujian province and 2.05% lower than that of Fujian province. In the past decade, Fujian's aquatic product exports have grown steadily and doubled, becoming the strongest domestic competitor of Shandong province.

Table 2.8. Comparison of aquatic product exports between Shandong province and other provinces in China in 2019

Unit:units: ten million tons, billion dollars

province	Export Volume			Import Volume		
	Total	Growth (%)	Share in total Chinese aquatic products exports	Total	Growth (%)	Share in total Chinese aquatic products imports
Shandong	114.38	3.39	26.78	51.29	4.34	24.82
Fujian	87.06	9.25	20.41	55.5	6.56	26.87
Liaoning	83.94	0	19.64	23.31	-1.82	14.19
Guangdong	57.81	3.94	13.55	32.04	4.15	15.51
Zhejiang	48.49	9.37	11.36	18.93	-1.4	9.17
Hainan	15.79	7.14	3.7	4.82	2.65	2.34
Guangxi	4.19	-12.1	0.98	1.92	-1.51	0.93
Jiangsu	4.67	-8.85	1.09	3.65	-1.11	1.77
Hebei	2.85	2.25	0.67	0.16	-26.92	1.16

Source: Statistics yearbook of China's aquatic products import and export, China Society Of Fisheries, 2020.

Table 2.9. Export share of major aquatic product export markets of Shandong province and other coastal cities in 2019

province	Total (ten million tons)	Japan	The Republic of Korea	USA	EU

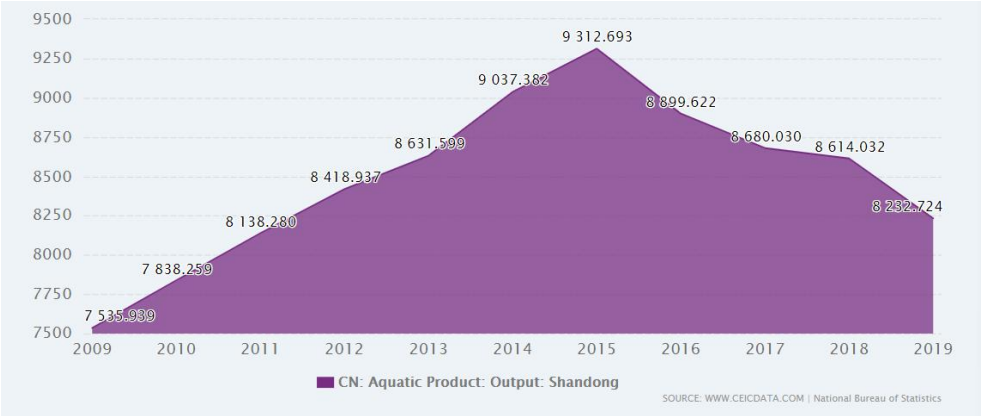
Tianjin	18.98	4.29	3.69	3.63	4.97
Liaoning	33.57	8.28	7.12	7.31	9.64
Hebei	7.42	1.79	1.53	1.33	2.04
Shandong	36.42	9.05	7.07	10.17	9.2
Shanghai	23.1	5.18	4.45	4.95	6.41
Jiangsu	36.25	8.03	7.9	8.07	9.34
Zhejiang	32.34	7.18	7.31	8.37	8.17
Guangdong	39.71	8.91	7.66	9.18	10.37
Guangxi	10.53	2.47	2.11	1.95	2.83
Hainan	26.69	6.69	5.12	5.77	6.92
Fujian	48.83	12.32	9.16	12.35	11.69

Source:Statistics yearbook of China's aquatic products import and export, China Society Of Fisheries, 2020.

As can be seen from Table 2.9, the coastal provinces are the main export areas of China's aquatic products, and the export markets of aquatic products are mainly Japan,The Republic of Korea the United States and the European Union. The main exporters of the coastal provinces are Japan and The Republic of Korea and the share of exports to Japan and Republic of Korea accounts for more than half of the total exports. Shandong, Guangdong, Jiangsu and Fujian have the highest export volume, of which Shandong exported 36.42 million tons. The United States imported the most, with 10.17 million tons, accounting for nearly 30% of Shandong's total exports.

Figure 2.3. Export value of aquatic products in Shandong province from 2009 to 2019

Unit:Million dollar



Source: CEIC Database, https://www.ceicdata.com (accessed:10/10/2022)

As shown in Figure 2.3, the export of aquatic products in Shandong province has increased significantly. The export of aquatic products in Shandong province peaked in 2015 at 9312.693 million USD, but since 2016, the export of aquatic products has dropped significantly.

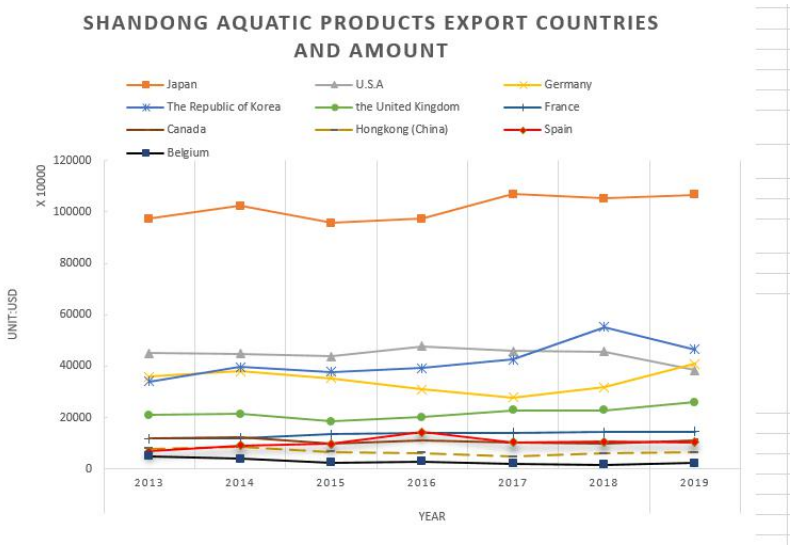
Global trade in aquatic products declined in 2015 due to the slow recovery of the global economy and shrinking aquatic product consumption. China's aquatic product trade has not been spared, facing the most serious situation in nearly 20 years. According to customs data, in 2015, the total import and export of aquatic products in China was 81.415 million tons, and the total import and export value was 29.314 billion USD, a year-on-year decrease of 35.9% and 58.08% respectively[51]. Specifically, China exported 40.06 million tons, worth 20.333 billion USD, down 24.8% and 69% year-on-year, respectively; imported 40.813 million tons, worth 89.82 billion USD, down 46.6% and 22% year-on-year. As a result, the trade surplus was 11.151 billion USD, a decrease of 1.161 billion USD from the previous year. However, China's status as the world's largest exporter of aquatic products has not been shaken. On the basis of maintaining Taiwan's market advantages, Fujian province has given full play to its regional advantages and vigorously expanded the ASEAN market. Since 2013, China has been the world's largest exporter for three consecutive years, with increasing market share year by year. In 2015, despite the generally sluggish global situation, China's export volume increased steadily and slightly. Shandong and Liaoning are major import and export provinces. With the increase of labor cost, the competitive advantage of import and processing trade decreases year by year. While, in 2015, both Shandong and Liaoning aquatic product exports fell sharply. Affected by the falling prices of eel and tilapia, the growth rate of Guangdong's exports declined. The output of Hainan and Guangxi, the main exporters of tilapia, also fell almost in half. The export of marine fish and shrimp, the main export species of Zhejiang province, dropped significantly, and the export volume of the whole

[51] The Ministry of Agriculture statistics RPC, http://www.moa.gov.cn/ztzl/nybrl/rlxx/201604/t20160412_5090837.htm (accessed:2022.07.03)

province declined. In addition, Hebei province has vigorously developed coastal advantageous industrial areas and achieved stable export growth, surpassing Hainan and Guangxi to become the sixth largest exporting province in China. The ranking of China's inland provinces was unchanged, with Jiangxi, Hubei and Jilin still in the top three, but the gap was gradually narrowing. Among them, exports from Jiangxi and Hubei dropped significantly. With the help of regional advantages and the development of Hunchun port trade, Jilin province has achieved great growth in exports.

Figure 2.4. Shandong aquatic product exports by countries and amount

Unit: USD



Source: Shandong Oceanic Bureau Database, http://hyj.shandong.gov.cn/ (accessed: 2020.13.11)

As shown in Figure 2.4, from 2013 to 2019, Shandong's aquatic product exporting countries were mainly Japan, the United States, Germany, The Republic of Korea the United Kingdom, France, Canada, Hong Kong, Spain and Belgium. Japan is the largest importer of aquatic products among these 10 countries, and its import volume ranks first for six consecutive years. The rankings of the remaining nine countries changed slightly over those years, but not much.

Table 2.10. Total value of aquatic product exports by export modes in Shandong province in 2018

Mode of export	Total imports and exports		Export	
	Amount (USD 100 million)	Year-on-year growth (%)	Amount (USD 100 million)	Year-on-year growth (%)
Total	17483.7	7.4	9594.0	6.6
General trading	11793.6	11.9	6621.2	15.2
Improvement and repair trade	3975.9	8.0	2725.5	8.0
Special customs supervision area	1570.7	24.0	14101	-9.1
Other trades	72.7	17.5	58.7	18.4
Foreign contracted outsourcing	15.2	11.3	15.2	11.3

Source: Qingdao Customs District P.R.CHINA Database, http://qingdao.customs.gov.cn/, (accessed: 2019.23.12)

The export mode of aquatic products in Shandong province is dominated by processing trade, supplemented by general trade, which accounts for a large proportion of exports. However, affected by its own conditions and the domestic environment of the importing country, general trade and processing trade have changed year by year, with a decrease compared with the previous year. Table 2.10 shows that under the export mode, Shandong province takes general trade as the main export mode. In 2018, general trade accounted for more than 60%, up 15.2% year-on-year.

2.4.2. Characteristics of aquatic product exports in Shandong province

At present, the export of aquatic products in Shandong province is mainly concentrated in the export of seawater products, such as fish, shrimp and crab. Fish products include octopus, yellow croaker, red fish fillets, frozen fish fillets, etc.

Shellfish products include red shellfish meat, scallops, etc. In 2019, frozen fish and frozen fillets were the main species exported. Specifically, Shandong exported 591,000 tons of frozen fish and frozen fish fillets, accounting for 54%, of which frozen fish and frozen fish were both above 100,000 tons, ranking first and second. The export cities of aquatic products (especially seawater products) are mainly concentrated in the four port cities of Weihai, Yantai, Qingdao and Rizhao. In 2019, these four cities exported 2.95 billion USD, accounting for 92.8% of the province's aquatic product exports. Among them, the export of aquatic products in Yantai was 1.09 billion USD, a year-on-year increase of 15.6%, accounting for more than 1/3 of the province's aquatic product exports, becoming the province's largest export market. Qingdao exported 1.07 billion USD, an increase of 28.5% over last year; Weihai exported 520 million USD, a year-on-year increase of 1.3%; Rizhao exported 270 million USD, a year-on-year increase of 13.2%[52].

There are 40 leading fishery industrialization enterprises in Shandong province, which are market-oriented and economical-centered to form an industrial cluster of specialized production and large-scale operation. In 2016, there were 736 aquatic product exporting enterprises in Shandong province, of which 337 were exporting more than 1 million USD and 91 were exporting more than 10 million USD, with an export value of US$2.16 billion, accounting for 67.9% of the total export value. Moreover, seven companies exported more than 5 million USD. Shandong Jinxuan Textile Co., Ltd., Penglai Huiyang Food Co., Ltd. and Qingdao Longyuan Aquatic Products Co., Ltd. ranked the top three exporters, with exports of 11.36 million USD, 75.43 million USD and 7.42 million USD respectively[53]. As a result, these aquatic product exporters have played an important role in promoting the quality improvement of aquatic products and the research and development of deep-processed products in Shandong province.

In 2019, the top five aquatic products exported to the countries along the "Belt

[52] Fan Yang,*The significance of promoting fishery industrialization and countermeasure,* Nanjing University*, 2020, p.14-23.*
[53] China Industry Information Research Network Database, http://www.cniir.com/ (accessed:2019.23.12)

and Road" routes in Shandong province were squid and frozen squid, frozen cod fillet and other frozen fish fillets, and fish (whole or sliced) not listed for production or preservation. In 2019, frozen cod, frozen pollock, other frozen salmon, other frozen northern prawns and other unnamed frozen fish were the top five imported aquatic products from the countries along the Belt and Road routes in Shandong province[54].

The long coastline and vast beach area provide an irreplaceable comparative advantage for Shandong province to develop aquatic product production and trade. Therefore, the leading products, including squid, cod, salmon and shrimp, that are suitable for Shandong province's water conditions, have become the main products for developing aquatic products trade between Shandong province and the countries along the Belt and Road routes.

2.5. Problems in the export of aquatic products from Shandong province

Export markets are concentrated to withstand risks and the export industry features poor self-discipline. The backward detection system needs improvement. The export mainly comes from the green trade barrier, with only one export variety and low added value.

To deal with the risk of too centralized export markets, certain measure should be taken. For example, the aquatic products export market in Shandong province should be diversified further. Under the guidance of the Belt and Road Initiative, the scale of export target countries has been greatly expanded, yet more than 80% of the exports are concentrated in four international markets: Japan, the European Union, the United States and Republic of Korea. The narrowed export market leads to trade friction with these traditional markets and reduce the anti-risk ability caused by the adverse changes in the market. In that case, the export of Shandong province's aquatic products will be severely damaged.

[54] Zhou Xun , *Analysis on market situation and development prospect of aquatic product industry in Shandong Province,*China Research Network, *2020, p.23.*

In regard to strengthening the self-discipline of the export industry, aquatic product is the main exportation of Shandong province. In recent years, more and more enterprises have begun to engage in the trade of aquatic products. However, due to the lack of effective management and industry self-discipline, the market of aquatic products export competition does not have a sound regulatory mechanism[55]. For example, many aquatic product-processing enterprises maliciously bid up the price of imported raw materials in the international market, and thereby increasing the cost of other enterprises to seize the market share. For best-selling products, some enterprises deliberately lowered the price to make it unprofitable for enterprises and even cause foreign anti-dumping sanctions. Therefore, the self-discipline mechanism should be established immediately in the export industry.

As to the third problem of backward detecting system, the quality and safety of aquatic products should be improved. Poor safety of aquatic products has always been an important factor restricting the export of aquatic products in Shandong province.

In recent years, water pollution in Shandong province has been aggravated, and various aquatic organisms have been polluted to a certain extent. Meanwhile, the excessive abuse of fish drugs in aquaculture industry is very serious. Aquaculture workers have a weak sense of quality and safety, they do not follow the prescribed standard medication, or even use banned drugs. In addition, the residues of chemicals such as preservatives that are used can cause quality and safety issues. Water environment is the key to aquaculture, and the issuance of aquaculture license must be controlled strictly. Those who engaged in aquaculture industry must obtain the license. The breeding density of fishes should be strictly controlled, and the activity of over-density should be punished. The use of various drugs and feed additives should be strictly controlled; the use of prohibited drugs should be prohibited to ensure the quality and safety of aquatic products. The existing quality inspection system in Shandong province is yet to be improved, considering that the inspection equipment is backward and is lagging behind by that of developed countries. The more popular

[55] Cai Xin, Chen Yongfu, Chen Jie. *An empirical Analysis of the Influencing Factors of International Competitiveness of Aquatic Products in China [J]*. "Journal of Dalian University of Technology (Social Science Edition) ", 2018, p. 12-14,43.

international system has not yet been formed in Shandong province. Among the numerous aquatic products export enterprises, only a few have obtained the international quality certification, and the rest of the enterprises have not been certified officially[56].

To deal with the low varieties of aquatic products, efforts should be made to increase the added value. However, the export variety of aquatic products in Shandong province is relatively limited. In recent years, the main export varieties of aquatic products are frozen fish fillets, butterflies, croakers, surimi, scallop columns and simulated crab meat. Among them, frozen fish fillet is the dominant export varieties of aquatic products. The single breed makes Shandong province vulnerable to the change of raw material prices in the international market.

For the export barriers caused by green trade barriers, green trade barriers have become the main obstacle in recent years to the export of aquatic products. As the main export markets of aquatic products of Shandong province, the United States, Japan, Republic of Korea and the European Union have set up more green trade barriers to our aquatic products.

The United States also frequently implements green trade barriers to China's aquatic products export. The establishment of the system is necessary for enterprises to export aquatic products to the United States. It is an internationally recognized and accepted food safety guarantee system which mainly controls microorganisms, physical and chemical hazards in food. Chinese aquatic products enterprises must obtain the certificate of the United States, and then pass the U.S. record before they are allowed to export products to the United States. The United States government is strict about the sampling test items of aquatic products in China. At present, only a few of aquatic export enterprises in Shandong province have been certified. After the chloramphenicol incident happened in the European Union in 2002, the United States immediately carried out strict chloramphenicol test on shrimp products imported from China. However, the small lobsters in Shandong province failed to pass the test. In

[56] Wang Hui, Luo Hui, Sun Weijuan, et al. *Analysis of Export Competitiveness of Chinese aquatic products based on diamond Model -- A Case study of Shandong Province [J].* " World Agriculture ", 2016, p. 32-35.

2007, the US imposed automatic deduction and inspection measures on aquatic products imported from China, including shrimp and gill from Shandong province, on the grounds that drug residues exceeded the standard. When dealing with these strict measures, the enterprises in Shandong province is facing more and more daunting challenges[57].

China needs to further formulate laws and regulations on aquatic product quality and safety management, supervision and testing on aquatic products to ensure quality and safety. Lessons from foreign laws and regulations should be learnt to keep the advanced nature of China's aquatic product laws and regulations.

Although Shandong province has made achievements in brand building of aquatic products, these problems cannot be ignored. Overall, the brand building of the aquatic industry in Shandong province is far from perfect, as the brand awareness is weak. First, consumers do not have strong brand awareness, let alone the demand for a specific brand of aquatic products. They do not think that the technical content of primary aquatic products such as fish and shrimp is high, and that the quality can be identified with the naked eye. Secondly, producers and operators do not attach enough importance to the building of brand. On the one hand, the lower brand demand discourages the producers and operators to pay attention to brand construction. They are struggling in price war, yet ignore the construction and promotion of brands. The publicity campaigns of some companies do not focus on brands. On the other hand, most enterprises lack long-term vision, they only focus on the immediate future and are reluctant to spend money on brand building and publicity. Third, the brand awareness of government departments is weak. A considerable number of cadres are do not have brand awareness, and they only pay attention to the output of aquatic products. They believe that the quality of aquatic products are heavily dependent on natural conditions and that the establishment of a particular brand cannot be achieved. Therefore, the relevant government does not provide appropriate support and guidance to the construction of aquatic product brand. These problems have severly

[57] Wang Yongmei. *Analysis on the Effect of green Trade Barrier on aquatic products Export -- A Case study of Zhejiang Province [J].* " International Trade Issues ", 2011, p.21-34.

restricted the brand construction and development of aquatic products in Shandong province.

Therefore, the construction of "sea granary" has become an important fishery economic project in China to drive the growth of export. In the new era, China's aquatic products export faces new situations and tough tasks. On the one hand, the construction of "Marine Granary" is an important channel to integrate into the Belt and Road Initiative strategy, and to expand the export of aquatic products. China should actively promote the transformation of marine economy and fishery development mode, stressing on the development of green ecological fishery. China will promote the transformation of industrial development by providing better services for scientific and technological innovation. On the other hand, the Belt and Road Initiative strategy has now entered the stage of comprehensive practical cooperation. Shandong province is still dealing with the daunting challenge of uncoordinated and inadequate development of ocean and fishery, and it must rely on the construction of "sea granary".

The last problem to be solved is about fishery information technology that can speed up the circulation of aquatic products, optimize the industrial structure of aquatic products, and promote the export of aquatic products. The improvement of fishery informatization can help aquatic exporters to grasp the latest trends of aquatic products trade, supply and demand, and price changes in the international market, and to understand the policies and regulations of importing countries. After obtaining this information, companies can analyze and predict aquatic products export more accurately to circumvent various trade barriers. It is reported that China's information capacity is only 8.6% of that of the United States. The need of information in Shandong province can be imagined. Information asymmetry between aquatic product suppliers has caused huge losses in many aquatic products export enterprises[58]. These companies have missed out on a lot of good opportunities to enter the international market in time. The low level of information in Shandong province is unfavorable to

[58] Lam M E, *Pitcher T J. Fish commoditization: sustainability strategies to protect living fish [J]* Bulletin of Science, " Technology& Society ", 2012, p. 31- 40.

the development of fishery and hinders the export of aquatic products in Shandong province.

CHAPTER 3. STUDY OF SHANDONG PROVINCE'S EXPORT POTENTIAL OF AQUATIC PRODUCTS TO BELT AND ROAD COUNTRIES

3.1. Competitiveness and comparative advantages of Shandong province's aquatic products trade

(1) Trade competitiveness index[59] (TC index) indicates the proportion of difference between import and export of a country's total import and export. TC index is commonly used to analyze international competitive advantage. It reflects the trade balance of an industry in the proportion of the total trade of the industry, and shows the international export competitiveness. The use of TC index can overcome the limitation of MS index for countries with huge disparity in comparative volume, and excludes the influence of inflation and macro factors, thereby making the trade competitiveness of different countries more comparable and better illustrating the international competitive advantage of a certain industry. TC index can be expressed as:

$$TC_{ij}=(X_{ij}-M_{ij})/(X_{ij}+M_{ij}) \quad (1)$$

Where X_{ij} and M_{ij} represent the export and import of *j* industries or products of country *i* during the *t*-period, respectively; *j* refers to the analyzed industry or product.

TC index is an effective tool to analyse the international competitiveness of an industry, and reflect its possible competitive advantage over the peers in the international market. TC index, which takes both export and import factors into account, is calculated as the relative ratio of trade balance to total trade, thus excluding the impact of macroeconomic variables such as economic inflation and inflation. The value of TC index ranges from [-1,1], regardless of the absolute amount

[59] Hou min, *Comparative Advantage and trade Complementarity of Aquatic products in China and the United States [J]*. " Journal of Ocean University of China (Social Science Edition) ", 2013, p.18-25.

of import and export.

When TC index equals -1, the industry has only imports but no exports. The closer the TC index approaches -1, the weaker the international competitiveness. The closer the TC index approaches 0, the closer the international competitiveness approaches the average level. When the TC index equals 1, the industry has only exports but no imports. The closer the TC index approaches 1, the stronger the international competitiveness.

The revealed comparative advantage index (RCA), first introduced by Hungarian economist Bela Balassa in 1965, can reflect the comparative advantage of a country's trade of a product. It is the ratio of the share of an industry or product export to the total world trade. It is expressed as: $$RCA_{ij}=\frac{X_{ij}/\sum_{j=1}^{n}X_{ij}}{\sum_{i=1}^{m}X_{ij}/\sum_{j=1}^{n}\sum_{i=1}^{m}X_{ij}} \quad (2)$$[60]

Where X_{ij} denotes the export amount of *j*-products of country *i*, $\sum_{j=1}^{n}X_{ij}$ denotes the total export amount of goods of country *i*, $\sum_{i=1}^{m}X_{ij}$ denotes the total export amount of *j* products, and $\sum_{j=1}^{n}\sum_{i=1}^{m}X_{ij}$ denotes the total export amount of goods of the world market.

RCA index can better reflect the comparative advantage of a country's industry or product in comparison with the world average level, as it disregards the effects of fluctuations in world economy and the total national economic fluctuations. The general standard indicates: if the RCA index is less than 0.8, the international competitiveness of country *i* on *j* products is weak; if the RCA is between [0.8, 1.25], then country *i* has a moderate comparative advantage on *j* products; if the RCA index is greater than 1.25, then country *j* has a strong international competitive advantage on *j* products.

As seen in Table 3.1, the growth of competitiveness index of Shandong province's aquatic products export remained roughly unchanged from 2013 to 2015; the export of aquatic products in Shandong province declined gradually from 0.24 in

[60] Kang Chengwen. *A review of the Research on the Index of Explicit Comparative Advantage [J]*. " Business Research ", 2014, p.34-37.

2018 to 0.20 in 2019.

Table 3.1. Export competitiveness index of aquatic products in Shandong province

Year	Gross export value (Million USD)	Gross import value (Million USD)	Total imports and exports (Million USD)	TC (Million USD)
2012	33.49	23.75	57.24	0.17
2013	32.59	22.85	55.44	0.18
2014	34.36	24.06	58.42	0.18
2015	32.27	22.21	54.48	0.18
2016	34.13	22.53	56.66	0.20
2017	35.59	24.36	59.95	0.19
2018	40.43	45.37	85.80	0.24
2019	39.76	60.12	99.88	0.20

Source: China fisheries yearbook and statistics calculation of the department of ocean and fisheries in Shandong province in 2013-2020, Institutional knowledge base of Yantai institute.

Table 3.2. Comparative advantage index of aquatic products in Shandong province

Year	Shandong		World	RCA (Shandong) (Million USD)
	Gross export value of aquatic products (Million USD)	Gross export value (Million USD)	Gross export value (Million USD)	
2012	33.49	604.89	18513.1	5.69
2013	32.59	582.39	14030.35	5.08
2014	34.36	622.86	13928.93	4.53
2015	32.27	561.29	16555.7	4.13
2016	34.13	504.82	16043.2	4.11
2017	35.59	1782.39	17737.66	4.03
2018	40.43	1601.39	19468.14	4.05
2019	39.76	1614.40	19014.76	3.96
Average	35.32	984.3	16911.48	4.45

Source: China Fisheries Yearbook and statistics calculation of the department of ocean and fisheries in Shandong province in 2013-2020, Institutional knowledge base of Yantai institute

Table 3.2 shows the comparative advantage index of Shandong province's aquatic product export, which indicates that the export volume of aquatic products has rebounded. The export of aquatic products was on the rise from 2012 to 2014, but was

on a downward trend in 2015. The export volume of aquatic products increased again from 2016 to 2018, and decreased again in 2019. The average RCA index of aquatic products in Shandong province was 4.45, showing a strong competitive advantage. From 2012 to 2019, the RCA index was reduced continuously, from 5.69 to 3.96.

3.2. Belt and Road countries as potential markets for aquatic products exports

By establishing the index system of aquatic product export market segmentation, the clustering analysis method can be used to classify the aquatic product export market of Shandong province and the countries along the Belt and Road to accurately identify the attributes and characteristics of different subdivision markets, and to pinpoint the potential of each country in the market.

In the literature research on the international market segmentation, the indicators cover four aspects: basic economic conditions, market sales potential, market access barriers and national system environment. As a result, 11 secondary indicators under 44 first-level indicators could be summed[61].

Table 3.3. Market segmentation index system of China's export of aquatic products to Belt and Road countries

First class index	Second class index
Basic economic conditions (1)	Growth rate of GDP (1a)
	GDP per capita (1b)
	Population density (1c)
	Aquaculture consumption per capita (2a)
Market Sales Potential (2)	Market share of aquatic products import (2b)
	Proportion of import consumption of aquatic products (2c)
	Import tariff rate for aquatic products (3a)
Barriers to Market Access (3)	Exchange rate change (3b)

[61] Jan'ai, *On the prospect of Agricultural trade between China and Central Asian countries under the background of "One Belt and One Road" [J]*. " Scientific and Technological Economic Market ", 2018, p.76-78.

	Geographic Distance (3c)
National Institutional Environment (4)	Business Facility Index (4a)
	Is it a free trade area (4b)

Source: Liu Qinglin, Wang Mingzhu, *The protection level and structure of China's agricultural market access policy*, "Chinese Economic Research"No.7,2014, p.34-42.

The statistics in this chapter were collected from USDA (United States Department of Agriculture), UN Comtrade (International Trade Statistics Database), FAOSTAT (FAO Statistical database), World Bank (World Bank Open Data), WITS database, WDI (World Bank WDI World Development Indicators Database) and IMF data.

37 Belt and Road countries included in this section are Russia, The The Republic of Korea Singapore, Malaysia, Cambodia, Indonesia, Vietnam, Brunei, Thailand, Philippines, Azerbaijan, Turkey, Bahrain, Egypt, Oman, Qatar, Jordan, Armenia, Lebanon, Iran, Israel, United Arab Emirates, Georgia, Kuwait, Saudi Arabia, Afghanistan, Pakistan, Maldives, Sri Lanka, Kazakhstan, Croatia, Ukraine, Lithuania, Slovakia, Bulgaria, Romania, Poland.

Table 3.4. Distribution of aquatic product exports to countries

Region	Country
Russia (1)	Russia
East Asia (1)	The Republic of Korea
ASEAN (8)	Singapore,Malaysia, Cambodia, Indonesia, Vietnam, Brunei, Thailand, Philippines
West Asia and Middle East (15)	Azerbaijan, Turkey, Bahrain, Egypt, Oman, Qatar, Jordan, Armenia, Lebanon, Iran, Israel, United Arab Emirates, Georgia, Kuwait, Saudi Arabia
South Asia (4)	Afghanistan, Pakistan, Maldives, Sri Lanka
Central Asia (1)	Kazakhstan
Central and Eastern Europe (7)	Slovakia, Romania, Bulgaria, Lithuania, Croatia, Ukraine, Poland

Source: Guo Shuke, Study on trade Flow and trade potential of Aquatic products between China and countries along the Belt and Road[J]. World Agriculture, 2017, p.106-112.

After sorting out and calculating the obtained statistics, we can apprehend the basic economic condition index values of these 37 countries in terms of GDP growth rate, GDP per capita and population density.

Table 3.5. Selected data of the Belt and Road countries in 2019

Country	GDP growth rate (%)	GDP per capita (US dollar)	Population density
Russia	1.3	17000	8.9
The Republic of Korea	2	31750	506
Singapore	0.7	65233	7797
Malaysia	4.3	11432	96
Cambodia	7.6	1683	87
Indonesia	5.02	4175	145.7
Vietnam	5.3	2700	283
Brunei	1.82	23734	80.3
Thailand	2.4	8000	133
Philippines	5.9	3300	352
Azerbaijan	2.1	4851	119
Turkey	0.9	9100	105
Bahrain	2.1	23500	651
Egypt	4.9	3020	96.1
Oman	0.5	15330	15
Qatar	-0.18	68325	234
Jordan	3.6	4156	106
Armenia	7.6	4212	103.7
Lebanon	-5.64	7784.32	665
Iran	-9.45	6037	49
Israel	3.51	43290	399
United Arab Emirates	0.33	23100	133
Georgia	5.1	4769	65
Kuwait	0.4	32000	227
Saudi Arabia	0.33	20201	15
Afghanistan	2.9	581	55
Pakistan	3.3	2876	262
Maldives	5.22	10600	1654
Sri Lanka	3.8	3853	315.8
Kazakhstan	3.8	9731	6
Slovakia	4.4	20132	113
Romania	4.1	12630	85
Bulgaria	3.4	9578	65

Lithuania	1.1	19655	45
Croatia	2.94	14853	73
Ukraine	3.2	3700	77.4
Poland	4.1	15400	124

Source: Kuai Yi Database, https://www.kylc.com/stats (accessed:2019.24.11)

1) GDP growth rate

GDP growth rate of 2019 was calculated based on the GDP value of 2018. The economic development of Belt and Road countries in recent years would certainly impact on aquatic product export. As seen in Table 3.5, GDP growth rates vary widely among the Belt and Road countries: those in ASEAN, South Asia, Central and Western Asia and Central and Eastern Europe showed a faster growing of GDP. Cambodia, Indonesia, Vietnam, Philippines, Armenia, Georgia and Maldives had a growth rate of over 5%. These countries have developed well economically and have a broad market for aquatic products. Apart from South and Central Asia, Lebanon and Iran and Qatar, with negative GDP growth rates, reflected poor economic development and low demand for aquatic export.

2) GDP per capita index

As can be seen in table 3.5, the differences in GDP per capita among the Belt and Road countries were quite large. Countries in West Asia generally had higher GDP per capita, as opposed to countries in Central Asia generally with lower GDP per capita. Specifically, 18 countries with per capita GDP of more than USD10,000 are Singapore, Russia, The Republic of Korea , Malaysia，Brunei, Bahrain, Oman, Qatar, Israel, the United Arab Emirates, Kuwait, Saudi Arabia, Maldives, Croatia, Slovakia, Lithuania, Croatia and Poland. Among them Singapore has the highest per capita GDP of USD 65,223, followed by Qatar of USD 68,325. These countries have a better level of economic development. Afghanistan's GDP per capita being less than USD1,000 indicates that the country is underdeveloped.

3) Population density index

Population density refers to the number of people per square kilometer of land area. The higher the population density, the greater the demand for aquatic products

consumption. According to the general criteria, population density can be divided into four levels: densely populated areas (>100 people/km2), moderately densely populated areas (25-100 people/km2), sparsely populated areas (1-25 people/km2) and extremely sparsely populated areas (<1 person/km2). Therefore, the population types of Belt and Road countries can also be subdivided, as seen in Table 3.6.

Table 3.6. National population density of the Belt and Road countries

Rank	Country
Densely populated areas (>100 people/sq km)	The Republic of Korea , Singapore, Indonesia, Vietnam, Thailand, Philippines, Azerbaijan, Turkey, Bahrain, Qatar, Jordan, Armenia, Lebanon, Israel, United Arab Emirates, Kuwait, Maldives, Pakistan, Sri Lanka, Slovakia, Poland
Medium Population Areas (25-100 people/sq km)	Malaysia, Cambodia, Brunei, Egypt, Iran, Georgia, Romania, Bulgaria, Lithuania, Croatia, Ukraine
sparsely populated area (1-25 people/sq km)	Russia, Kazakhstan,Afghanistan,Oman

Source: Wind Database, https://www.wind.com.cn/en/edb.html (accessed: 2022. 14.07)

Countries along the Belt and Road routes have different levels of economic development. Russia, for example, has a high population density, but its economy is growing fast, while Afghanistan has a high population density. Most countries have stable and orderly economic growth and most countries have a high population density. For example: The Republic of Korea, Singapore, Indonesia, Vietnam, Thailand, Philippines, Azerbaijan, Turkey, Bahrain, Qatar, Jordan, Armenia, Lebanon, Israel, United Arab Emirates, Kuwait, Maldives, Pakistan, Sri Lanka, Slovakia, Poland.

3.3. National institutional environment

This subsection analyzes three indicators, including aquatic product import tariff rate, exchange rate fluctuation and geographic distance to reflect the access status of the aquatic products of Belt and Road countries.

Import tariff rate of aquatic products represents a trade barrier reflecting the difficulty of market access to Belt and Road countries. As seen in Table 3.7, the tariff rates of aquatic products trade between China and different Belt and Road countries are quite different. Aquatic products import tariff rates are generally lower for those have signed free trade agreements, most of FTA countries have 0 tariff rate. ASEAN countries have lower import tariff rates for aquatic products, and most ASEAN countries have 0 tariff rate. However, the import tariff rates of aquatic products in West Asia and Middle East are relatively high, with Lebanon having the highest tariff rate of 70%, followed by Turkey of 54%. This reflects the higher barriers to aquatic products trade in these countries, and the great difficulty of entry into their consumer markets.

Table 3.7. Market access indicators of the Belt and Road countries in 2019

Country	Import tariff of aquatic products(%)	Exchange rate fluctuation(%)
Russia	5	-19.44
The Republic of Korea	0	-19.44
Singapore	0	-3.29
Malaysia	0	-7.56
Cambodia	5	-0.46
Indonesia	0	-11.32
Vietnam	2.5	-1.53
Brunei	0	-3.31
Thailand	0	-3.33
Philippines	0	-2.62
Azerbaijan	15	-8.1
Turkey	54	-12.97
Bahrain	0	-0.17
Egypt	20	-7.73
Oman	0	-0.17
Qatar	0	-0.17
Jordan	27.5	-0.17
Armenia	5	-5.72
Lebanon	70	-0.17
Iran	42.5	-24.45
Israel	37.5	-0.35
Unites Arab Emirates	0	-0.17

Georgia	12	-9.88
Kuwait	0	-2.56
Saudi Arabia	0	-0.17
Afghanistan	12.5	-6.05
Pakistan	0	-3.2
Maldives	15	-0.17
Sri Lanka	25	-2.25
Kazakhstan	13.8	-12.34
Slovakia	5	-3.85
Romania	5	-2.65
Bulgaria	5	-3.95
Lithuania	5	-2.18
Croatia	7.5	-5.1
Ukraine	0	-26.53
Poland	5.4	-0.99

Source: IMF database, https://www.imf.org/en/Data (accessed: 2019.24.11)

The exchange rate is calculated by using the direct pricing method; the exchange rate fluctuation for Belt and Road countries is based on the comparison with that of 2019. It can be seen that exchange rate fluctuation of each country is negative, which reflects the relative devaluated currency to RMB, and the international competitiveness of China's aquatic products is relatively weakened. The barriers to the Belt and Road countries should be noted.

Geographical distance between Shandong province and the capitals of Belt and Road countries is calculated. For the trade of aquatic products, geographic distance can reflect the cost and risk of trade to a certain extent, considering that the products are prone to deteriorate. The farther the geographic distance, the higher the cost in transportation and the greater the potential trade risk. China is geographically closer to Russia, ASEAN countries, South Asian countries and Central Asian countries, but is distant from Western countries, the Middle East, Central and Eastern Europe. This shows that the cost of trade with these countries will be higher.

3.4. Standardization of indicators and reliability analysis

This section selects the Ease of Doing Business Index and the membership of FTA to measure the institutional environment of Belt and Road countries. The ease of doing business index was collected from World Bank's (WB) database of business environment projects ranking countries based on the conduciveness of the legal system of the involved county conducive to trade activities. The higher the country ranks, the more favorable the legal system for trade activities. 1 indicates that the legal system has the most beneficial business activities.

Free trade area is selected to show the institutional environment of Belt and Road countries

Those have signed free trade agreements with China will be denoted as 1 for this indicator, otherwise the indicator will be denoted as 0. The signing of free trade agreements can directly promote China's international competitiveness in the FTA countries, enhance bilateral trade relations and increase the volume of trade.

Table 3.8. Trade environment elements in Belt and Road countries

Country	Ease of doing business	Free trade area
Russia	28	0
The Republic of Korea	5	1
Singapore	2	1
Malaysia	12	1
Cambodia	144	1
Indonesia	73	1
Vietnam	70	1
Brunei	66	1
Thailand	21	1
Philippines	95	1
Azerbaijan	34	0
Turkey	33	0

Bahrain	43	0
Egypt	114	0
Oman	68	0
Qatar	77	0
Jordan	75	0
Armenia	47	0
Lebanon	143	0
Iran	127	0
Israel	35	0
United Arab Emirates	11	0
Georgia	7	0
Kuwait	83	0
Saudi Arabia	62	0
Afghanistan	173	0
Pakistan	108	1
Maldives	147	0
Sri Lanka	99	0
Kazakhstan	25	0
Slovakia	45	0
Romania	55	0
Bulgaria	61	0
Lithuania	11	0
Croatia	102	0
Ukraine	64	0
Poland	40	0

Source: World bank Database, https://data.worldbank.org/ (accessed:2019.24.11)

Among the selected Belt and Road countries, business environment index shows that less than 37 countries, including Russia,The Republic of Korea, Singapore, Cambodia,Malaysia, Thailand, Turkey, Brunei, Armenia, Azerbaijan, Israel, The United Arab Emirates, Georgia, Kazakhstan, Slovakia, Lithuania, Poland and other 16 countries, are suitable for doing business, thanks to their good business environment and high conduciveness to aquatic products. However, Myanmar, Egypt, Lebanon, Iran, Afghanistan, Pakistan, Maldives and Croatia ranked 144, 114, 143, 127, 173, 108, 147, and 102 in terms of business convenience index. Their poor business

environments are not conducive to trade.

Nine ASEAN countries have signed FTAs with China, that is, Singapore, Malaysia, Cambodia, Indonesia, Vietnam, Myanmar, Brunei, Thailand and Pakistan. This shows that China's aquatic products will be more competitive in these markets.

3.4.1. Standardization of indicators

The disparities in the different index values obtained in this chapter could be attributable to the inconsistent measurement units of each index variable. To avoid over-representativeness of indexes with larger values and under-representativeness the of other indexes with smaller values, the original index data should be standardized before making aquatic product market segmentation.

Standardization[62] of data refers to the procedure of scaling the data to a smaller, and specific interval, thereby removing the unit of data measurement to convert it into pure values without dimensions. In so doing, the comparison and weighing of data between different units or magnitudes of indicators become easier. The process of standardizing data is also known as dimensionless processing.

There are mainly four methods to standardize data, including sum standardization, standard deviation standardization, maximum standardization and range standardization. This chapter uses the method of range standardization to process the original index data without dimension. The new data have a maximum value of 1, a minimum value of 0. Naturally, the rest of the values are between 0 and 1.

The specific calculation formula is as follows:

$$y_{ij} = \frac{x_{ij} - \min_i \{x_{ij}\}}{\max_i \{x_{ij}\} - \min_i \{x_{ij}\}} \quad (1)$$

Where y_{ij} is the new datum obtained by standardization, x_{ij} is the original index data,

[62] Yu Miaozhi, Liang Yinfeng, Gao Ying. *Research on the Relationship between China and South Asia's Agricultural trade [J].* " Issues in agricultural economy ", 2016, p. 83-94,112.

$\min_i \{x_{ij}\}$ is the minimum value of index *i*, $\max_i \{x_{ij}\}$ is the maximum value of index *i* (i=1,2,3,...M, m is the number of indicators, J = 1,2,3,..., n, n is the sample size of the index).

Reliability refers to the consistency of results obtained when repeated measurements are made on the same subject using the same method[63]. It is conducted to test the reliability and stability of sample index data. The indicators of reliability analysis are represented by correlation coefficients, which could be roughly divided into three categories: stability coefficient, equivalence coefficient and internal consistency coefficient. Four methods of reliability analysis include retest reliability, half-fold reliability, replica reliability and α reliability coefficient. This chapter uses α reliability coefficient method to analyze the reliability of sample index data. The specific calculation formula is as follows:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} \sigma_{Y_i}^{\ 2}}{\sigma_x^{\ 2}}\right) \quad (2)$$

Where K is the number of indicators, $\sigma_{Y_i}^{\ 2}$ is the variance value of the sample data of the first indicator, and $\sigma_x^{\ 2}$ is the variance value of the total sample. Apparently, α reliability coefficient represents the internal consistency of the sample data of each index and belongs to the internal consistency coefficient. The value of α reliability factor is usually between 0 and 1. The numerical reference for the reliability test is shown below:

Table 3.9. Reference table of reliability analysis

Reference standard	[0,0.6)	[0.6,0.7)	[0.7,0.8)	[0.8,0.9)

[63] Fu Minghui. *Market segmentation of agricultural products export between China and "One Belt and One Road" countries: concept and method of trade continuum [D]*. Huazhong Agricultural University, 2017, p. 21-36.

Test results	Insufficient reliability	Basic acceptability	Quite good acceptability	Excellent acceptability

SPSS software was used to test the reliability of 8 sample indexes of the export market segmentation of Shandong province and 37 Belt and Road countries. The reliability of the original index data and the standardized index data were tested at the same time. The alpha reliability coefficients of the original index data and of the non-dimensional index data was 0.359 and 0.718, respectively. It demonstrated that the insufficient reliability of original index data was enhanced after a very poor standardization, as the reliability and stability of the index data were quite good. The next step can be proceeded.

3.4.2. Market segmentation method: cluster analysis

This section uses cluster analysis method to subdivide the aquatic product export markets of Shandong province and the Belt and Road countries.

Clustering is the grouping of index data into multiple clusters[64] to make objects within the same category have a high degree of similarity but a large difference for objects between different categories. There are two methods for cluster analysis from a statistically defined distance angle, namely hierarchical method and partition method. Although the partition method is simpler and more efficient in operation, it requires that the number of classes be divided at first to create an initial partition. Then, the iteration principle could be applied by moving objects between the classes. The method of classifying the number of classes in advance is not meaningful for the exploration in this dissertation, therefore we applied the hierarchical method for cluster analysis. Hierarchical methods, also known as system clustering, are based on the principle that each subject is initially a separate group, so that the objects can be merged according to the principle of similarity and exclusion until all the

[64] Guo Shuke. *Research on trade flow and trade potential of aquatic products between China and countries along the Belt and Road[J]*. " World Agriculture ", 2017, p.106-112.

combinations are merged into a single category[65].

Distance is the basis of systematic cluster analysis and the measurement of differences between disciplines. The farther the distance, the greater the difference, and the smaller the similarity. In this thesis, Euclidean distance[66] is used for measurement, and the specific calculation formula is as follows:

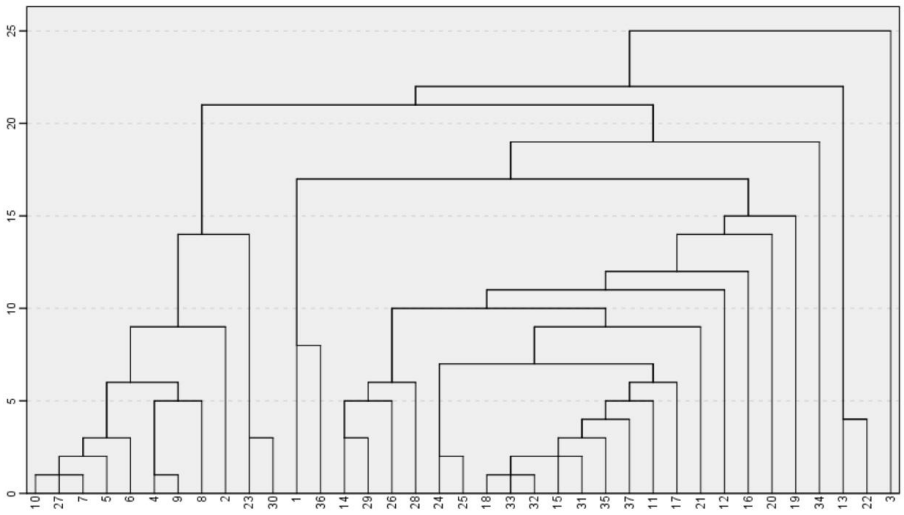
$$D_{ij} = \sqrt{\sum_{k=1}^{n} (X_{ik} - X_{ik})^2} \quad (3)$$

Where D_{ij} is the distance between the subjects, X_{ik} is the value of the object I on the index k, X_{jk} is the value of the object j on the index K (i, j = 1, 2, 3,..., m, m as the index sample size, k = 1,2,3,..., n, n is the number of indicators).

3.4.3. Segmentation results of aquaculture export market

SPSS software was used to cluster eight indicators of 37 Belt and Road countries by means of systematic clustering. The clustering map is shown in the figure 3.1.

Figure 3.1. Cluster map for segmentation of aquatic export markets



Source: SPSSAU automatically selects clustering methods based on the data type.

[65] Gao Jintian. *Current situation and countermeasure research of aquatic products export in Shandong Province.* " Science and technology information development and economy", 2002, p.17-23.

[66] Smith,W R. *Product Differentiation and Market Segmentation as Alternative Marketing Strategies [M].* " Journal of Marketing ", 1956,21-(1), p. 3-8.

Cluster analysis is a method to study the classification of individuals according to their characteristics. The principle of cluster analysis is that the individuals in the same category have great similarity while the individuals in different categories have great differences. The clustering tree diagram shows the specific process of clustering by using graphical method. The number on the top line is a scale unit that represents the relative distance, and a node represents a focusing process. By drawing a straight line drawn vertically, we can have four points of intersection with this pedigree. Hence, these 37 countries can be divided into four categories:

Category 1:

Philippines, Pakistan, Vietnam, Cambodia, Indonesia, Malaysia, Thailand, Brunei, The Republic of Korea, Georgia,Singapore

Category 2:

Kazakhstan, Russia, Ukraine, Egypt ,Sri Lanka, Maldives Kuwait, Saudi Arabia, Armenia, Bulgaria, Romania, Oman, Slovakia, Croatia, Poland ,Azerbaijan, Jordan, Israel, Turkey, Qatar, Iran , Lebanon, Lithuania

Category 3: Bahrain, United Arab Emirates

Category 4: Afghanistan,

The first group features a good economic development, a high population density, a great potential for market sales of aquatic products, a good national environment for aquatic products trade, and few barriers to access. It can be regarded as the trading partners for Shandong province. Those in Category 2 are Central Asia, West Asia and Europe countries, which have signed free trade agreements with China and are geographically close to China. They are more suitable for aquatic products trade and can be regarded as secondary exporters of aquatic products. Categories 3 and 4 are composed of those countries with minimal potential for aquatic products trade.

3.5. Research summary

In this chapter, the aquatic products export market segmentation index system is constructed, and the aquatic products export market of countries along the Belt and Road in Shandong province is classified by using systematic cluster analysis. The attributes and basic characteristics of different market segments are accurately assessed to come up with the following conclusions:

(1) Countries differ greatly in basic economic conditions, and countries along the Belt and Road have different levels of economic development. Growth in most of the countries is relatively slow. West Asian countries generally have higher per capita GDP, while Central Asian countries have lower per capita GDP. Most of these countries have high population densities.

(2) Chinese trade tariff rate of aquatic products is quite different from that of Belt and Road countries. Aquatic products import tariff rate is 0 for most FTA countries, which are geographically closer to Russia. For ASEAN countries, South Asian countries and Central Asian countries, the tariffs are less diversified within the geographical proximity. In contrast, the tariffs are more diversified within West, Middle East and CEE countries.

(3) A good business environment can only be found in a minority of the countries along the Belt and Road. However, the worse business environment indicates that the trade potential is greater, but is not conducive to the short-term trade of aquatic products. Singapore, Philippines, Pakistan, Vietnam, Cambodia, Indonesia, Malaysia, Thailand, Brunei, The The Republic of Korea Georgia, Kazakhstan, Russia, Ukraine, Egypt, Sri Lanka, Afghanistan, Maldives ,Kuwait, Saudi Arabia, Armenia, Bulgaria, Romania, Oman, Slovakia, Croatia, Poland, Azerbaijan, Jordan, Israel, Turkey, Qatar, Iran, Lebanon, Lithuania have good business environment, which is more conducive to aquatic products trade, while Afghanistan has a poor business environment not conducive to aquatic products trade.

(4) The aquatic products export market segmentation index system shows that trade countries along the Belt and Road can be divided into four parts, for which

different export strategies should be adopted specifically.

CHAPTER 4. TRADE POTENTIAL MEASUREMENT AND STOCHASTIC FRONTIER GRAVITATION MODEL (SFGM)

4.1. The concept of stochastic frontier gravitation model

Potential can be defined as the inner strength or hidden ability, and the potential in economics mostly stem from technological innovation. Production potential refers to the optimal output of economic production unit under the constraint of existing technical level and maximum input. However, the optimal output level cannot be reached due to the influence of inefficiency factors. The certain gap between actual output and production potential indicates that the actual production efficiency has not reached the maximum production efficiency under the ideal situation, with a certain degree of efficiency loss. By using stochastic forward-edge method, we can estimate the frontier production function and measure the contribution of technological efficiency, technological progress, factor input and total factor productivity for economic growth.

Trade potential refers to the maximum flow of trade that can be achieved without resistance and free trade condition. Export potential represents the maximum value of export under the circumstance of increased export under the condition of constant input of trade. Trade potential is mainly determined by technological progress and improvement of trade environment. It is the optimal value of a given input. If other conditions remain the same, the innovation of science and technology will reduce production cost and improve the output level, thereby improving the trade profit. On the other hand, trade potential is determined by the institutional arrangements between the trading partners. If the bilateral trade environment is conducive to free trade and the reduction of trade barriers, trade exports will increase and trade potential will be unleashed.

At present, gravity model is the mainstream approach to analyze trade cooperation between the two countries. The gravity model was introduced by Tinbergen Jan for the first time in physics to explore international trade issues. He likened the two countries to two objects, and the degree of the trade relationship between the two countries is directly proportional to the total economic volume but is inversely proportional to the distance between the two countries. This pattern is similar to the gravity between the two objects[67]. Linnemann innovated the traditional gravity model by introducing two new explanatory variables, population and trade policy, initiating the innovative development of gravity model[68]. Subsequently, the gravity model was widely used in measuring trade potential, identifying the effect of trade blocs, analyzing trade patterns and estimating the boundary cost of trade barriers[69]. It has become an important empirical tool for studying international bilateral cooperation issues.

However, the traditional gravity model has many defects in analyzing the influencing factors and measuring the potential of trade. First of all, the trade potential calculated empirically by the traditional model only reflects a comprehensive analysis under the influence of explanatory variables in the model, but is not the optimal level. Secondly, the traditional model cannot analyze the trade barriers and non-barriers influencing factors between the two countries, as most of the factors are classified into the random disturbance item. Therefore, the results of traditional trade gravity model based on the analysis of fixed influence factors have large room of errors. In this context, stochastic frontier analysis is applied in the traditional trade gravity model. At first, stochastic frontier method is used to analyze production efficiency and its influencing factors, and to calculate the maximum output after eliminating the influencing factors. In fact, the export potential of a country can be regarded as the

[67] Tinbergen Jan. *Shaping the World Economy: Suggestions for an International Economic Policy[M]*. " New York: The Twentieth Century Fund ", 1962, p. 9-14.

[68] Linnemann H. *An Econometric Study in International Trade Flows[M]*. North-Holland Publishing Co, Amsterdam, 1966.

[69] Sheng Bin, Liao Mingzhong. *China's Trade Flow and Export potential: A Study of gravity Model [J]*. " World Economy ", 2004, p. 3-12.

maximum trade scale excluding influential factors. it is consistent with the purpose of stochastic frontier method. Therefore, the random frontier analysis method is added in the traditional gravity model to forming the random frontier gravity model analysis method.

In economic research, the concept of technological efficiency has been put forth for a long time. Koopmans[70] believes that under certain technological conditions, no output can be increased without reducing other outputs, or no input can be reduced without increasing other inputs. He calls this input-output technologically effective. Farrell[71] proposed the frontier measurement method of technical efficiency for the first time, which has been widely accepted by the theoretical circles to become the basis of efficiency measurement. In practice, the technological frontier needs to be determined.

There are two methods to determine the frontier production function. The first is to estimate the parameters of the frontier production function in an econometric model, which is called the "statistical method" or "parameter method" of efficiency evaluation. The second is to determine the frontier of production by solving a linear programming problem to determine the technical efficiency. This method is called "mathematical programming method" or "non-linear programming method". The selection of production functions is critical to the feasibility of parameter methods. Common production functions include Cobb-Douglas production function, Translog production function, and so on. The development of parametric methods has undergone two phases: the stochastic frontier model and the deterministic frontier model[72].

The deterministic frontier model can be used to measure all the random factors that impact as technical inefficiencies to make the results of technical efficiency calculation deviate from the actual level. To eliminate the flaw in this frontier model,

[70] Tjalling C. Koopmans,*An Analysis of production as an Efficient Combination of Activities*. Cowles Commission Monograph No.13. , 1951, p.33-97.

[71] Farrell R, Grosskopf S, Lovell, CAK.*The measurement of efficiency of production*, Kluwer-Nijhoff Publish, Boston, 1985, p. 21-42.

[72] Anderson, J. E.& Wincoop, E. V. *Gravity with Gravitas: A solution to the border puzzle[J]*. " The American Economic Review ", 2003, p. 11-14.

Meeusen and Van den Broeck[73], Aigner, Lovell, and Schmidt[74], Battese, and Corra[75] proposed a stochastic frontier gravitation model that can distinguish the error items in the model and improve the accuracy of technical efficiency measurement. They believe that the deviation between the actual output of a production unit and the "frontier" of production is not entirely under the control of the production unit. Within the analysis framework of deterministic production frontier, some external events, such as production equipment failures or even severe weather, may be attributable to technical inefficiencies. Any deterministic frontier model setting error or measurement error of these variables will also increase the technical invalidity of the calculation, hence accounting for disadvantage of any deterministic frontier setting. Forsund & Jansen[76] discussed the average and optimal frontier functions within the framework of the stochastic frontier model analysis, and suggested that a particular production unit is faced with a specific production frontier that can incorporate a random item to capture the random factors, thus making it difficult to control the production unit[77].

Stochastic frontier gravity model can overcome the shortcoming of traditional gravity model being unable to measure trade resistance. Meanwhile, the measurement of frontier level and optimal trade level becomes a reliable method to study trade potential. In this case, the use of stochastic frontier gravity model to study the export potential of aquatic products in Shandong province to countries along the Belt and Road Initiative is of important theoretical, practical and innovative significance.

[73] Meeusen W. and J. van den Broeck, *Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error* , International Economic Review,1977, p.435-444

[74] Aigner, D.J., Lovell CAK, and SchmidtP., *Formulation and Estimation of Stochastic Frontier Production FunctionModels ,* "Journal of Econometrics", 1977, p. 21-37.

[75] Battese, G.E and Corra, G.S., *Estimation of a Production Function Model with Application to the Pastoral Zone of Eastern Australia*, " *Australian Journal of Agricultural Economics ",* 1977, p.169-179.

[76] Forsund, Finn R & Jansen, Eilev S, *On Estimating Average and Best Practice Homothetic Production Functions via Cost Functions*, "International Economic Review, Department of Economics*"* , University of Pennsylvania and Osaka University Institute of Social and Economic Research Association, 1977, 18(2), p. 463-476.

[77] Battese, G. E.& CoeUi, T. J. *A model for technical inefficiency effects in a stochastic frontier production function for panel data[J]*. " Empirical Economics ",1995, p.3-8.

4.2. Improvement of random frontier method in measuring trade potential

The traditional trade gravity model and its extended form and the improved model based on the new trade theory can be used to measure the trade potential and can well fit the real data in practice. However, the traditional gravity model has a large defect in the empirical analysis of trade potential and its influencing factors. Random frontier methods can be used to estimate each parameter value via maximum likelihood. The conditional expectation of the technical inefficiency term can reflect the technical efficiency value. By using the stochastic frontier method, the information of each sample is taken into account to make the calculation results more stable and solid.

First, the results of traditional trade gravity models are averaged under the influence of multiple trade factors, hence the estimation of trade potential is not the "best possible value" that "potential" literally represents, according to Armstong[78]. Second, traditional gravity models only introduce a small fraction of many objective factors that impede trade (such as trade barriers), but disregard most that are difficult to measure. Kang and Fratianni argued that Drysdale and Garnaut's categorization of objective trade resistance into random interference factors will inevitably result in bias in trade potential estimation[79]. In addition, some subjective factors that vary with time have been ignored in traditional gravitational models. Random frontier function is often used to measure the production potential of producers under a certain effective input vector, while the foreign trade potential reflects the optimal level of trade under certain economic environment, policy system, natural environment, and so on. Therefore, a stochastic frontier gravitation model can be used to analyze the

[78] Armstong S, *Measuring Trade and Trade Potential: A Survey[J]*. Asia Pacific Economic dissertation, 2007, p.1-15.

[79] Fratianni, M. & Kang, H. *International terrorism, international trade, and borders.*" Research in Global Strategic Management*"*, 2006, p. 203-223.

inter-country trade potential, according to Sun Yimeng[80]. The stochastic frontier gravitation model improves the performance of traditional gravitational model in the following aspects.

First, the traditional gravity model assumes that uncontrollable factors with a mean value of 0. There also exists also a random disturbance item with a mean of 0 in the Stochastic frontier gravitation model, which is used to measure unobservable natural factors of trade. However, one of the fundamental differences is that the stochastic frontier gravity model considers the negative impacts of these uncontrollable factors on trade potential.

Second, the stochastic frontier gravity model can estimate the optimal level of trade for each country with the fixed trade environment factors. It postulates that free trade between countries can be obtained on the frontier under the influence of only natural determinants, which corresponds to the potential self-explanations and economic efficiency-based representation. The model can also be used to observe trade efficiency and to assess the effectiveness of existing policies. Given that the observable human factors that hinder bilateral trade are concentrated in trade inefficiencies, the non-negative asymmetric nature will prevent the scale of trade from reaching the theoretical frontier. Therefore, the actual trade value calculated from the stochastic frontier method will not break through the trade potential, and no conclusion can be reached as to the occurrence of excessive trade when the traditional gravitational model is used to measure the potential[81].

4.3. Theoretical model used for stochastic frontier gravitation

When using the method, the factors in the traditional random disturbance term are divided into two independent parts: the random error term V represents the

[80] Sun Yimeng, *Study on the influence of Arctic Route on China's foreign trade potential*, Daliann Maritime University, 2014, p. 33-49.

[81] Battese, G. E.& Corra, G. S. *Estimation of a production frontier model: with application to the pastoral zone of eastern Australia[J]*. “Australia Journal of Agricultural Economics ”, 1977, p. 169-179.

random impact in the production, the non-negative technical inefficiency term u represents the non-observable non-efficiency factor, and the estimated u to observe the production efficiency. Trade volume can be viewed as a function of variables such as economic size and distance. It is similar to the production function, so the stochastic frontier method can also be used to measure trade efficiency and trade potential.

Random frontier models for panel data can be represented as:

$$Y_{ijt} = f(x_{ijt}, \beta)\exp(-\mu)\exp(v_{ijt),}u_{ijt} \geq 0$$

$$Y_{ijt}^{*} = f(x_{ijt}, \beta)\exp(v_{ijt})$$

$$TE = \frac{Y_{ijt}}{Y_{ijt}^{*}} = \exp(-u_{ijt})$$

$$InY_{ijt} = Inf(x_{ijt}, \beta) + v_{ijt} - u_{ijt}$$

Where Y_{ijt} represents the actual level of trade between country *i* and country *j* in the *t*-period; Y_{ijt} represents the trade potential, the maximum possible trade value of country I to country j. For example, the volume of trade at the frontier level is the best trade in a frictionless state, and the trade inefficiency is zero at this time. TE represents trade efficiency, a ratio of actual trade level to trade potential, and an exponential function of trade inefficiencies. When u = 0, the trade potential is the same as the actual trade level. When U > 0, the actual trade level will be smaller than the trade potential due to trade inefficiency.

Because of the difference between the concepts of trade potential in the traditional gravity model is close to the averaged actual level of trade, the trade potential of the random frontier will be no less than the actual level of trade, and there will be no "over trade".

4.4. Source of data used for stochastic frontier gravitation

This section studies the trade of aquatic products between Shandong province and the countries along the Belt and Road, including Russia, Singapore, Malaysia, Cambodia, Indonesia, Vietnam, Brunei, Thailand, Philippines, Azerbaijan, Turkey, Bahrain, Egypt, Oman, Qatar, Jordan, Lebanon, Iran, Israel, United Arab Emirates, Georgia, Kuwait, Saudi Arabia, Afghanistan, Pakistan, Maldives, Sri Lanka, Kazakhstan, Ukraine, Lithuania, Slovakia, Bulgaria, Romania, and Poland. In the data of the national panel data from 2012 to 2019, some are reasonably processed by using interpolation (Due to the lack of statistics, Afghanistan, Maldives and Bulgaria are excluded)

The export data of aquatic products in Shandong province were collected from the Customs database, Ocean and Fishery Department and China Fishery Statistics Yearbook. PGDP and POP data were collected from the World Bank WDI. DIS data were based on the geographic distance between the economic centers of the two countries. Languages and boundaries were derived from tables of CEPII distance and geographic information statistics. WTO is a virtual variable. The data show that if China and the importing country join WTO at the same time, they are represented as 1, otherwise, they are represented as 0. TAF (Tariff and other import duties as a percentage of tax revenue) reflects the tariff level of the importing country, INF (Trade and Transport Infrastructure Index) measures the development level of regional logistics industry data, SHP (Liner Shipping Connectivity Index) assesses how closely the importing country is connected to the global transport network from the UNCTAD report, MON (Degree of currency freedom) reflects the inflation rate and price control of importing countries and FIN (The degree of financial freedom) reflects the degree of market openness, which is based on the Global Heritage Foundation Index of Economic Freedom.

4.5. Empirical analysis for stochastic frontier gravitation

4.5.1. Testing results for hypothesis of stochastic frontier gravitation model

Armstrong[82] proposed that only a few core variables, such as economic size, distance, boundaries, and language, that will not change in the short term should be used in estimating trade frontiers. These are called natural factors. Variable factors, such as trade agreements and financial systems, are taken into the account of inefficiency. Based on the above ideas, this section builds a time-varying Stochastic frontier gravitation model to measure the trade potential of Shandong province to countries along Belt and Road Initiative. The equations are as follows:

$$InEXP_{ijt} = \beta_0 + \beta_1 InPGDP_{it} + \beta_2 InPGDP_{jt} + \beta_3 InPOP_{it} + \beta_4 \mathrm{In}POP_{jt} + \beta_5 InDIS_{ij} + \beta_6 X_{ij} + V_{ijt} - u_{ijt}$$

where EXP_{ijt} is the explanatory variable that represents the export volume of country i to country j during the t period. For each explanatory variable in the classical trade gravity model, $PGDP_{\mathrm{it}}$ and $PGDP_{\mathrm{jt}}$ represent the per capita GDP of exporting and importing countries respectively during the t-period, which can reflect the level of economic development, demand level and factor endowment ratio of a certain country, according to Bergstrand[83]. The many factors may cause inconsistent results of empirical analysis. However, it is generally assumed that POP_{it} and POP_{jt} are positively associated with export. Population of the period, which represents the size of the domestic market, is generally assumed to promote trade. However, other studies suggest that a larger population can exert a negative effect on trade, because the huge local market will hinder the occurrence of international trade among large countries. In contrast, countries have small populations and small local markets generally rely on specialized production for international trade. On the one hand, importing countries are more complex. The larger the population, the greater the demand for

[82] Armstong S, *Measuring Trade and Trade Potential: A Survey[J]*. Asia Pacific Economic dissertation, 2007, p.1-15.

[83] Bergstrand, J.H. *The Generalized Gravity Equation, Monopolistic Competition, and the Factor Proportions Theory in International Trade*. "Review of Economics and Statistics", 1989, p.143-153.

import. Importing countries may also import substitutes, which hinder international trade. DIS_{ij} represents the distance between countries *i* and *j*, typically the distance between capitals or major economic centers. It reflects the transportation costs between the two countries and usually has a negative impact on trade. The other factors, including boundary and language, will be examined according to the importance of equation form in stochastic frontier models. Likelihood ratio test will be run to determine whether these factors should be included in the equation.

Table 4.1. Test results of the stochastic frontier gravitation model (SFGM) hypothesis

Model test results

Original hypothesis	H0	H1	LR	1%critical value	Test conclusion
No inefficiency	-287.03	-112.38	349.3	11.34	reject
Time-invariance	-258.71	-258.32	0.79	9.21	accept
Unnecessary to introduce boundary	-114.64	-112.37	4.54	3.84	accept

The stochastic frontier gravitation model is highly dependent on the functional form of the model, so this study uses likelihood ratios in the estimation to test the applicability and form of the model. As shown in Table 4.1, this chapter conducts hypothesis tests on the model settings: (1) Existence test of trade inefficiency; (2) Existence test of time-varying; (3) Test on the introduction of boundary variables. The likelihood ratio test results show that: (1) The hypothesis that there is no trade inefficiency is rejected at the 1% significance level, indicating that there is trade inefficiency, and it is appropriate to use the stochastic frontier gravity model to estimate the gravity model; (2) Due to the limited data and insufficient time span of this study, it is impossible to judge whether the trade inefficiency changes with time, assuming that the time remains unchanged; (3) It is acceptable not to introduce boundary variables. The possible reason is that the selected sample countries have inconvenient land and sea transportation, and it is difficult to enjoy the convenience of

land and sea borders. This variable will be excluded from the model.

Therefore, the estimated equation for the tested stochastic frontier gravitation model is:

$$InEXP_{ijt} = \beta_0 + \beta_1 InPGDP_{it} + \beta_2 InPGDP_{jt} + \beta_3 InPOP_{it} + \beta_4 InPOP_{jt} + \beta_5 \mathrm{In}DIS_{ij} + V_{ijt} - u_{ijt}$$

4.5.2. Estimation results of time-varying stochastic frontier gravitation model

After defining the function form, this dissertation analyzes the products exported by Shandong province to the countries along "Belt and Road" routes from 2012 to 2019 based on the stochastic frontier gravitation model. Earlier stochastic frontier models assumed that the trade inefficiency item *u* does not change with time, but the assumption of short time dimension is reasonable. Therefore, a time-invariant model is used for estimation.

Table 4.2. Gravity model regression results

	TIVM		
Variable	coefficient	Standard error	t-value
Constant	9.3994866***	2.6556	3.5395
$PGDP_{it}$	0.3407	0.2043	1.6676
$PGDP_{jt}$	0.62113428***	0.1907	3.2574
POP_{it}	-0.1279	0.2666	-0.4798
POP_{jt}	0.91521308***	2.1837	25.2266
DIS_{ij}	-0.1585	0.2791	-0.5680
σ^2	4.9385308**	2.0743	2.3808
γ	0.91112863***	0.0377	24.1445
μ	2.2073915**	0.9427	2.3415
η	–	–	–
Log Likelihood		-258.7144	

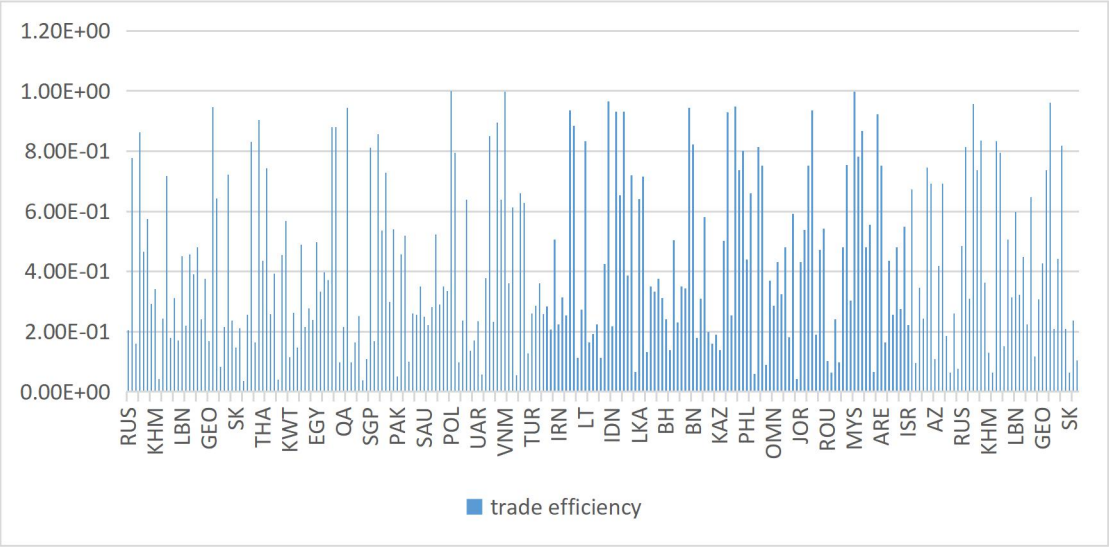
LR	273.5785

Note: *, **, *** represent 10%, 5%, and 1% significant levels, respectively.

The time-invariant model is shown in Table 4.2, σ^2 represents standard deviation, γ is the percentage of total random error in non-trade efficiency terms. As it accounts for 91% in the charts, the data are meaningful to study. As μ is 2.2073915. 0, 0 does not fit the model, and η doesn't exist, the trade efficiency of export aquatic products for countries along Belt and Road Initiative does not increase with time. Such finding proves again that the time-invariant model is more applicable than the time-varying model.

Stochastic frontier gravitation model of estimation shows that the per capita GDP of importing countries play a significant role in promoting the export of aquatic products trade, and that the level of economic development of Shandong province has a significantly greater role in promoting trade than that of trading partners. The total population of the importing country is significantly positively correlated with the export of aquatic products, which conforms to the hypothesis that the larger the market size of the importing country, the better the export will be. Distance (DIS) exerts a significantly negative effect on the export of aquatic products (=-0.1585), indicating that transportation cost is an important factor that hinders trade efficiency.

Figure 4.1. Export efficiency of aquatic products trade between Shandong province and countries along Belt and Road Initiative (2012-2019)



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2020

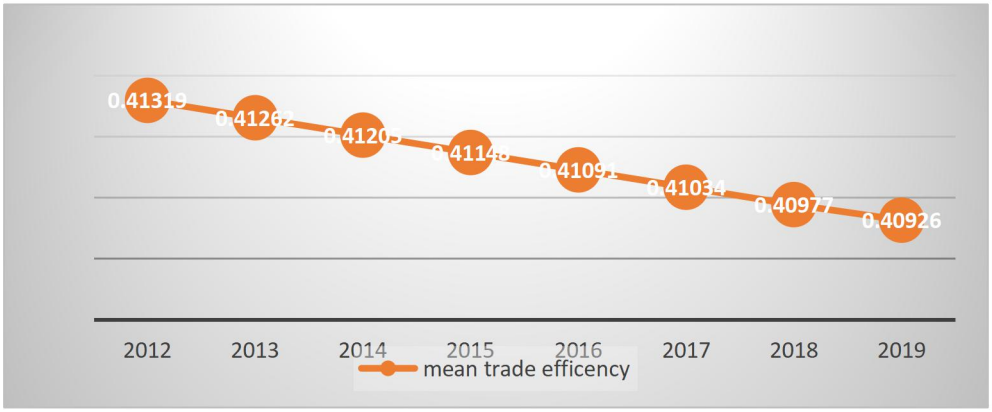
Own calculations of the author.

Export efficiency $TE = \exp(-\mu_{ujt})$ is the exponential function of base e of $-\mu_{ijt}$. since $\mu_{ijt} \geq 0$, and the value of export efficiency is between 0 and 1, a larger μ means a greater trade resistance, and vice versa. By using "one-step method" in the stochastic frontier gravity model, we could obtain the export efficiency of aquatic products of Shandong province to 31 countries along the Belt and Road from 2012 to 2019.

Figure 4.1 shows the average efficiency of the export of aquatic products to the involved countries. Apparently, Shandong province maintains a high trade efficiency with Poland, Singapore, Malaysia, Brunei, Vietnam, United Arab Emirates, Lithuania, Kazakhstan, Sri Lanka, and Egypt. Among them, the trade efficiency with Thailand is the highest. Since the establishment of the Sino-Thai strategic cooperation partnership, high-level exchanges have been frequent, and bilateral economic and trade cooperation has been run on a stable legal basis. It is no surprise to find that trade efficiency is high under the economic and trade cooperation mechanism. Shandong maintained a long-term friendly economic and trade contact with Bahrain and Armenia, thanks to the trade convenience. Brunei, Indonesia and other Southeast

Asian countries exhibited impediments to aquatic products export due to their geographic location. On the contrary, the Middle East countries have a remote geographic location from China.

Figure 4.2. Mean export efficiency of aquatic products of Shandong province to 31 Belt and Road countries from 2012 to 2019



Source: Shandong province Statistical Yearbook,Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2020

Figure 4.2 shows the decreasing export efficiency of aquatic products of Shandong province to 31 Belt and Road countries from 2012 to 2019. In terms of absolute value, the annual average export efficiency remained at about 0.4, and the difference between the maximum value and minimum value was only 0.03. In the past 8 years, the mean efficiency remained unchanged. An average export efficiency of 0.41 indicated the current efficiency to area all the way along the country's aquatic products export was still on the low level, and had been declining for eight years. The financial crisis in 2018, the low market consumption in 2019, the fluctuated trade exchange rate, and foreign trade protection policies jointly led to resistance to the export of Shandong province. Shandong province should improve export efficiency in the future by narrowing the gap between actual export and export potential to release the potential.

4.6. Measurement of aquatic products export potential

Trade efficiency can indirectly reflect export potential, and the degree of trade resistance. The absolute value of trade potential is derived from the trade between actual trade value and trade efficiency. Herein, export potential refers to the maximum export scale of aquatic products of Shandong province to the trading parties under the influences of natural factors, such as GDP, population size, and geographical distance, devoid of trade resistance. Export efficiency can be calculated by using empirical results, and export potential = actual export/export potential.

Table 4.3. Trade potential of aquatic products between Shandong province and the countries along the Belt and Road routes in 2019

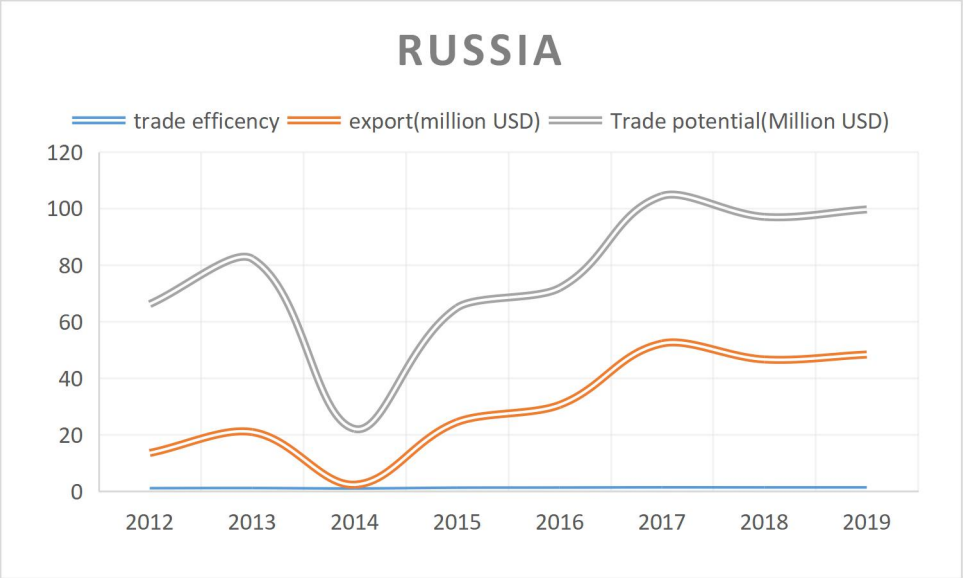
Country	Trade efficiency	Export (Million USD）	Export potential (Million USD)
Russia	0.48542204	48.381026	99.66796316
Singapore	0.81350119	10.525431	12.93843344
Indonesia	0.30993438	5.680722	18.32878947
Malaysia	0.95763049	35.7943	37.37798699
Thailand	0.7375652	33.732588	45.73505908
Vietnam	0.83439568	13.823077	16.56657307
Philippines	0.36322815	5.089144	14.01087443
Cambodia	0.12891751	0.027443	0.212872557
Pakistan	0.06295702	0.0414	0.657591481
Sri Lanka	0.83379464	3.341547	4.0076379
The United Arab Emirates	0.7953573	11.851917	14.90137451
Kuwait	0.15116434	0.075698	0.500766252
Turkey	0.50529836	10.183892	20.15421542
Oman	0.3139395	0.28486	0.90737228
Lebanon	0.59828648	0.796676	1.331596195
Saudi Arabia	0.32325663	3.295008	10.19316448
Bahrain	0.44846976	0.246358	0.549330238
Israel	0.22402558	0.593455	2.649050167
Egypt	0.64794746	7.711624	11.90161931

Iran	0.11779519	0.131353	1.115096465
Jordan	0.30664244	0.154716	0.504548555
Georgia	0.42671844	0.116376	0.272723157
Poland	0.73704218	17.031207	23.10750655
Brunei	0.96164301	0.444935	0.462682092
Azerbaijan	0.2090714	0.071368	0.341357067
Qatar	0.44240095	1.103474	2.494284879
Lithuania	0.81885495	1.322628	1.615216468
Romania	0.20806894	0.361406	1.736953146
Slovakia	0.063162251	0.008311	0.131581758
Ukraine	0.23596789	3.076727	13.03875286
Kazakhstan	0.10393188	0.105084	1.011085338

Source:Shandong province Statistical Yearbook,Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2019.

The stochastic frontier gravity model shows that trade efficiency between Shandong province and countries along Belt and Road Initiative can be derived. As shown in table 4.3, trade potential from the original trade efficiency can be deduced to analyze the changing trend of trade potential and trade efficiency between Shandong province and other countries. Export potential shows that the top ten countries for aquatic products export are Singapore, Malaysia, Vietnam, The United Arab Emirates, Poland, Brunei, Lithuania, Kazakhstan, Sri Lanka, Egypt. Among 31 Belt and Road countries, Russia, Thailand, Malaysia, Poland and Turkey were the five countries with the highest potential. The largest untapped export potentials are Slovakia, Georgia, Cambodia, Azerbaijan and Brunei. By comparing the two categories of countries, we found that the two do not completely overlap with each other, because export potential depends not only on export efficiency, but also on the existing export value. Therefore, it is necessary to combine export efficiency with actual export volume to ensure a comprehensive discussion. Some countries have high absolute export potential, yet the actual export to this country is close to the export potential due to high export efficiency. In this way, there is no room for tapping, and the untapped export potential is not large. Singapore and Sri Lanka are the examples.

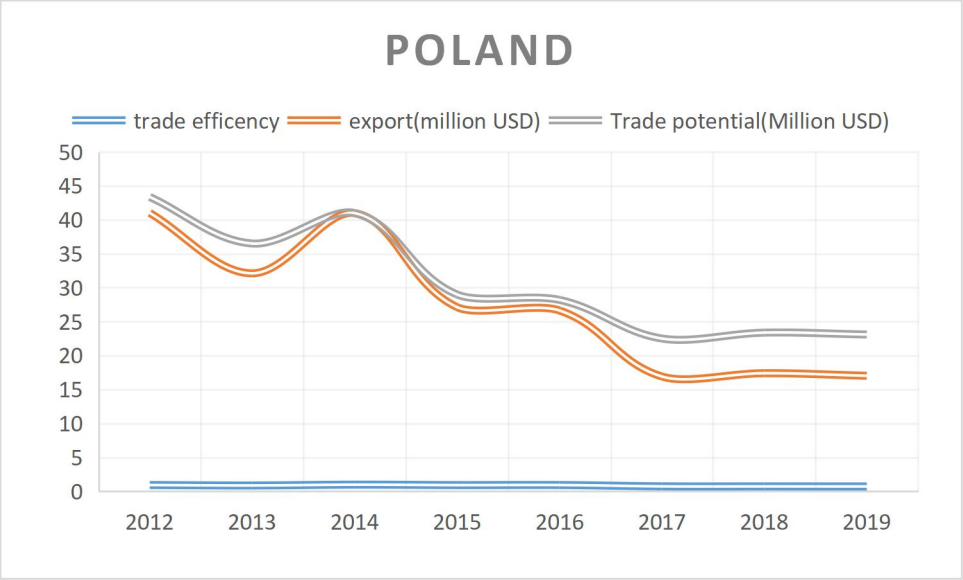
Figure 4.3. Measurement of aquatic products export potential between Shandong province and Russia



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2019

As shown in Figure 4.3, the export relationship of aquatic products between Shandong province and Russia remained, by far and large, stable. The actual export value was correlated with the export potential, and the trade efficiency was at 0.48 from 2016 to 2019. However, the slow recovery of global economy and the shrinking consumption of aquatic products contributed to a significant downward trend in 2014. In 2015, global aquatic product trade was on the rise; The efficiency of Shandong's export with Russia was elevated and stabilized to 0.48 since then. The two curves of export potential and actual export value being highly similar indicated that the trade between Shandong province and Russia was quite stable.

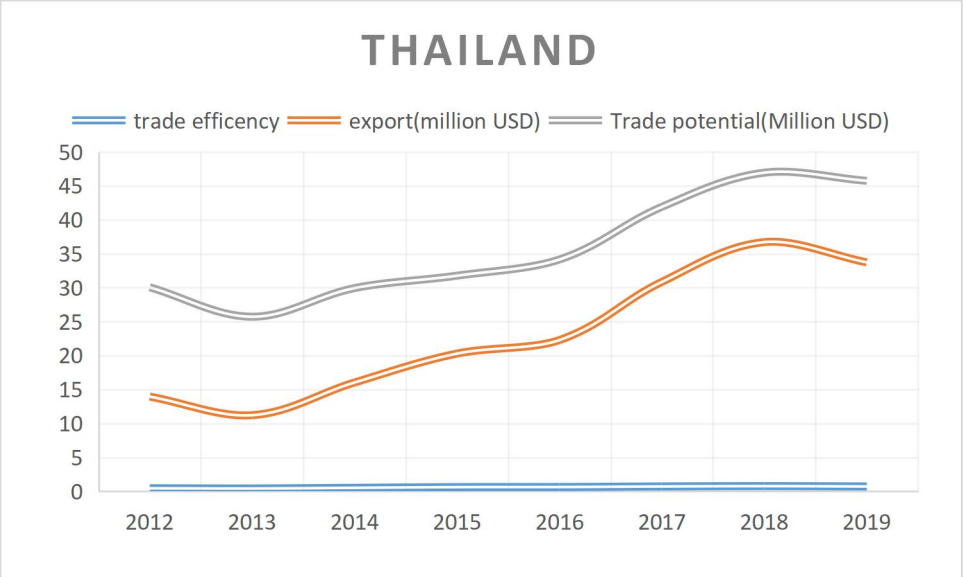
Figure 4.4. Measurement of aquatic products export potential between Shandong province and Poland



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2019

No abrupt fluctuation in the export efficiency of the aquatic products during the sampling period was observed, however, a clear downward trend from 0.945 in 2012 to 0.737 in 2019 should be noted. The trade potential and the actual trade volume showed a synchronizing effect, indicating that the trade potential of the two countries have a large space. Considering the huge trade volume between the two countries, the overall trade potential has been raised. However, the current trade efficiency experienced a large degree of decline that should be dealt with by the relevant departments. The overall export efficiency being greater than 0.6 indicated that a large export space and a good trade foundation of Poland. If the export resistance was reduced, Poland should become the prioritized partner for trade development.

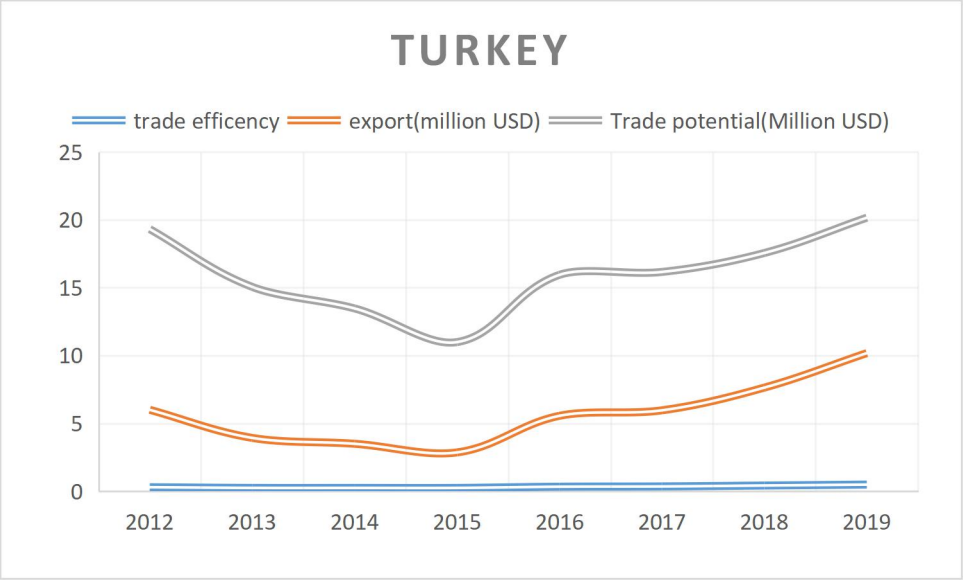
Figure 4.5. Potential measurement of aquatic products export between Shandong province and Thailand



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2019

The trade efficiency of aquatic products between Shandong province and Thailand has been stable, as shown in figure 4.5. Trade potential has improved in recent years, with a significant upward trend since 2016. Actual exports are positively correlated with trade potential. In 2019, trade potential declined due to the impact of the Covid-19 epidemic. Diversified development strategies should be adopted for different types of countries. For Thailand with a mature trade market, it is necessary to deepen, consolidate and expand the market share on the basis of maintaining stability. Overall, the trade potential of Thailand is still large with a big growth space.

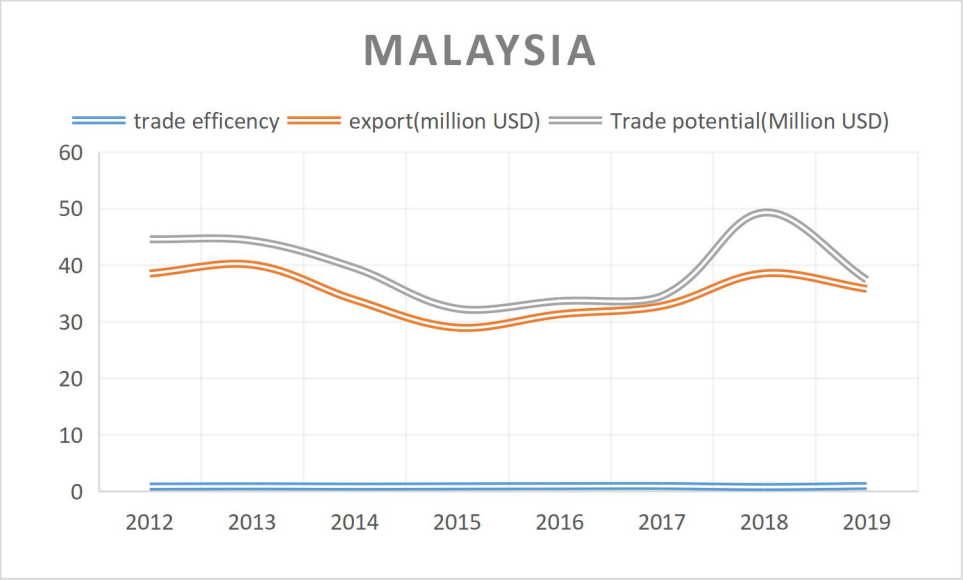
Figure 4.6. Measurement of aquatic products export potential between Shandong province and Turkey



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2019

As shown in figure 4.6, the overall trade efficiency of the export of aquatic products in Shandong province and Turkey showed a downward trend from 2012 to 2015, and rebounded to show an upward trend from 2016 to 2019. This finding indicated that the export of aquatic products to Turkey was relatively stable. Turkey has a medium development potential, low export efficiency on the whole, and high development difficulty. Therefore, it is difficult to achieve satisfactory results in the short term. Long-term exchanges, cooperation and trade should be established with Turkey. In the worst scenario, the market of Turkey can be downsized in the case of limited resources.

Figure 4.7. Measurement of aquatic products export potential between Shandong province and Malaysia



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2019

The export efficiency of aquatic products between Shandong province and Malaysia from 2012 to 2019 showed a relatively stable trend, which could be attributed to the measures taken by the two countries to improve trade facilitation. The efficiency of trade has been greatly improved, and the actual volume of trade has also increased. The trade potential of Malaysia to Shandong province has risen sharply, ranking top five in export potential value of the countries along the Belt and Road routes. The huge import potential of Malaysia's aquatic products suggests a great room for improvement in the future.

4.6.1 Analysis of factors affecting trade inefficiency

Trade inefficiency is the main factor that affects the trade potential and the actual trade difference. The influencing factors of trade inefficiency items of countries along Belt and RoadInitiative in Shandong province could be examined by using the following formula:

$$u_{ijt} = \alpha_0 + \alpha_1 TAF_{jt} + \alpha_2 MON_{jt} + \alpha_3 FIN_{jt} + \alpha_4 SHP_{jt} + \alpha_5 WTO_{ijt} + \varepsilon_{ijt}$$

The explanatory variables consider the following:

(1) Tariff's share of national tax (TAF_{jt}) is used to measure the tariff barriers of a country. A high tariff level results in lower trade efficiency and is positively correlated with trade inefficiencies.

(2) Whether or not to join the World Trade Organization (WTO_{ijt}), the establishment of a global multilateral trade system, especially an effective trade dispute resolution mechanism, will help the two sides to develop trade steadily. It has a negative correlation between expectations and inefficiencies.

(3) Liner Shipping Connectivity Index (SHP_{jt}) evaluates the close relationship between importing countries and global shipping networks. Since the vast majority of modes of transport in international trade are maritime transport. The investigation of SHP could help understand the extent to which maritime efficiency affects trade, and is expected to be negatively correlated with trade inefficiency.

(4) Degree of currency freedom (MON_{jt}) reflects factors, such as price stability and price management efficiency in importing countries. A higher score indicates that domestic price stability is strongly influenced by supply and demand. Price is determined by the market, and is positively associated with inefficiencies.

(5) The degree of financial freedom (FIN_{jt}) indicates the efficiency of financial institutions and the independence of the state's administrative capacity. The higher the evaluation score, the less it subjects to financial control, and the higher the level of independent operation of the market. It is negatively correlated with expectations and inefficiencies.

Table 4.4. Results of stochastic frontier gravitation model estimation

Variable	Coefficient	Standard error	T-value
Constant	0.2430	1.0022	0.2424
TAF_{jt}	0.1026	0.1051	0.9762
MON_{jt}	0.063365994**	0.0313	2.0259

FIN_{jt}	-0.0396	0.0344	-1.1528
SHP_{jt}	-0.051836057***	0.0156	-3.3267
WTO_{ijt}	-1.9004766*	1.1357	-1.6733
σ^2	6.4964375***	1.0753	6.0415
γ	0.99999999***	0.0120	83.4903
Log Likelihood	-365.5858		
LR	59.8358		

Note: *, **, *** represent 10%, 5%, and 1% significant levels, respectively.

As shown in Table 4.4., tariff levels are positively related to trade inefficiencies, however the data did not pass the significance statistical test. It shows that after China's entry into the World Trade Organization and the implementation of tariff policies, tariff has gradually become the main factor that hinders the development of aquatic products trade. The membership of the WTO is significantly correlated with trade inefficiencies, indicating that participating in the multilateral trade system can promote the export of products. The large coefficient also indicates that the general principles of the World Trade Organization should be upheld to expand international trade. Liner Shipping Connectivity Index (SHP) is significantly negatively related to trade inefficiencies, because more than 70% of international trade is by sea transport. Efficiency improvement of international ocean transport plays a key role in affecting the future trade of aquatic products with countries along the Belt and Road through the sea. The degree of financial freedom (FIN) has a significant negative impact on the inefficiency of trade. The higher this index by importing countries, the better the export of aquatic products of Shandong province.

4.6.2 Research conclusions and suggestions

This chapter analyses the status quo of aquatic products export between Shandong province and the Belt and Road countries, establishes the index system for

the subdivision of the export market by using the stochastic frontier gravitation model The following conclusions are drawn:

First, the statistics of the agricultural products trade of the countries showed that the aquatic products trade between Shandong province and the countries along Belt and Road Initiative has developed rapidly since China's entry to the World Trade Organization. Although the financial crisis exerted a huge impact on trade, the export has mostly got rid of the quagmire. Russia, Poland, Southeast Asian countries and the Middle East countries remain the largest trading partners for aquatic products of Shandong province on Belt and Road Initiative.

Second, the trade inefficiency item model shows that the participation in the multilateral trade system is an important factor to promote the export of aquatic products trade. The per capita GDP of Shandong province and importing countries are significantly positively related to the trading volume of agricultural products, indicating that a higher economic development level leads to more demand for aquatic products. The market size of importing countries has a significant positive correlation with the export of aquatic products, while the distance between the two sides indicates a negative correlation. As the infrastructure of Belt and Road Initiative will be greatly improved, the influence of geographic distance may gradually diminish in the future. Degrees of monetary freedom and financial freedom play a vital role in promoting trade. Countries with higher degree of monetary freedom and financial freedom are regarded as the preferential trading partners of Shandong. Land transport and maritime transport of trading countries should be developed at the same time.

Estimations of trade efficiency and trade potential between Shandong province and Belt and Road Initiative are obtained from the model. The results show that Shandong province has great export potential of trade with Russia, Thailand, Malaysia, Turkey, Poland, Ukraine, Egypt, Saudi Arabia, United Arab Emirates, Vietnam, Indonesia, Singapore, and Philippines.

CHAPTER 5. DATA ENVELOPMENT ANALYSIS MODEL AND VARIABLE SELECTION

5.1. Literature review on trade efficiency

Inspired by Ricardo's comparative advantage theory, the Swedish school proposed the theory of characteristic resource advantage in the 1930s and explained the formation of comparative advantage under the same production function. After World War II, New Ricardism believed that trade was not only caused by different advantage in resources, but also by differences in comparative advantage in a broad sense. This theory shows that production factors, technical level, economic scale, market size and system environment could affect trade efficiency.

Adam Smith proposed the concept of urban commercial transaction efficiency. Carl, Weber, Marshall analyzed the impact of transportation efficiency on business transactions, industrial layout and industrial geographic distribution from the perspective of transportation efficiency. When allocating economic activities, Krugman argued that businesses can choose geographic locations to minimize transportation costs, and proposed the concept of transaction efficiency. Nilsson proposed that trade efficiency refers to the ratio of actual trade volume to trade potential (i.e. the maximum level of trade), which reflects the extent of a country's trade potential[84].

Different economic schools have disparate views on the factors influencing trade efficiency. New Economic Geography relies on the assumptions of incomplete competition and increased returns to scale to explain economic clusters, in which specialization of production will increase demand for trade. The theory emphasizes

[84] Nilsson, L., *Trade integration and the EU economic membership criteria. "* European Journal of Political Economy ", 2000.

the important roles of transport technology, transport equipment and infrastructure in transport costs. In contrast, Emerging Classical Economics stressed political systems, legal rules and their economic impact on transaction efficiency, urbanization and overall economic development. The emerging classical trade theory indicates that an improved transaction efficiency can promote the expansion of market size, and strengthen the trend of market integration. Under such circumstance, the transaction cost will rise. The factors affecting transaction costs should be included in the analysis of factors affecting trade efficiency.

Stochastic frontier gravity models and data envelope analysis (DEA) method are frequently used to evaluate trade efficiency. Kang and Fratianni[85] used a Stochastic frontier gravitation model to analyze trade efficiency of a certain country, and found that Singapore is the most efficient country, and that a high trade efficiency can significantly increase trade flow in an inefficient country. Henry[86] collected statistics of 57 developing countries to build models by using stochastic frontier analysis, so as to assess efficiency levels across countries and to explain why they differ. The study found significant differences over time in efficiency levels between countries and regions between 1970 and 1998 [87].

Chen Guohua[88] used the stochastic frontier gravitation model to evaluate the global trade efficiency, and found that the trade efficiency of countries has been increasing from 1995 to 2012. Zhu Tiantian and Liu Bin[89]evaluated the trade efficiency between China and countries along the Belt and Road by using the

[85] Michele Fratianni & Heejoon Kang, *International Terrorism, International Trade, and Borders*," Working Dissertations " , Indiana University, 2006, p.3-22.

[86] Henry, Michael & Kneller, Richard & Milner, Chris, *Trade, technology transfer and national efficiency in developing countries*, "European Economic Review", 2009, p. 237-254.

[87] Xia Yun, Yu Qitong. *Study on International Trade Efficiency of Provinces Along the Belt and Road[J]. "* Economy and Management ", 2019, p. 23-29.

[88] Chen Guohua,*The Empirical Study on Trade Scale and Structure Potential of CAFTA Based on the Stochastic Frontier Gravity Model,* Huaqiao University,2016, p.32-38.

[89] Zhu Tiantian, Liu Bin, *Analysis on trade efficiency and trade potential between China and Belt and Roadcountries, "*Science & Technology and Economy",2018, p.3-5.

stochastic frontier gravitation model. Zhang Yan and Gao Zhigang[90], Liu Youming and Li Cunpu[91]used the stochastic frontier gravity model to evaluate the trade efficiency of China-Australia, China-America, China-Russia, China and Vietnam. Zhang Mingyu[92]evaluated the trade efficiency of the SCO member countries, and found that the trade efficiency of the SCO member countries is of the same: low and medium levels in a downward trend. The clarified relationship between the increased capital stock and technological progress promoted the level of trade, while the increase of labor force hindered the level of trade of each member country. Li Xuewu[93] analyzed the trade efficiency of the countries along the Belt and Roadand found that the export resistance was increasing while the import resistance was decreasing.

Some Chinese and foreign scholars use data envelope analysis to analyze trade efficiency. Kounetas and Napolitano[94] used bootstrap DEA technique to analyze heterogeneity between regions of Italy before and after it joined the European monetary union (EMU), reporting that EMU integration improved Italian technological efficiency while reduced technical differences. Subsequently, they used a partial least squares model to investigate the technological gaps in each period.

Xuan Jiajie[95] studied the trade and investment environment of nine countries using the DEA method, and found out the difference between DEA effective and

[90] Zhang Yan, Gao Zhigang,*Research on sino-Australia bilateral trade efficiency and potential based on stochastic frontier gravity Model,*" International Economics and Trade Research ", 2015, p.3-8.

[91] Liu Youming, Li Cunpu, *China's direct investment and overcapacity control in Belt and Ro adcountries,* "Inquiry into Economic Issues", 2018, P.5-10.

[92] Zhang Mingyu, *Research on trade potential between China and regions along the belt and Road,* Journal of International Trade, 2017, p.3-8.

[93] Li Xuewu, *Research on China's participation in East Asian economic integration,* University of Nanjing, 2018, P.75-114.

[94] Kostas Kounetas, Oreste Napolitano, *Modeling the incidence of international trade on Italian regional productive efficiency using a meta-frontier DEA approach,* Economic Modelling,*2018, p.45-58.*

[95] Xuan Jiajie, *Evaluation of relative efficiency of industrial system in Shandong Province, "*Journal of Shandong Institute of Building Materials ",1994, P. 2-5.

non-DEA effective in each country. Chen Landong[96] selected 52 countries along the "Belt and Road" routes to construct 50 second-level indicators from four aspects, including macroeconomic factors, legal factors, infrastructure factors, technical and cultural factors. Principal component analysis was conducted to investigate these indicators, showing that the principal component score of China's trade environment competitiveness index is 0.54. subsequently, the principal component score was used as the input index of DEA model, and the output index of export volume was used to evaluate the efficiency of the national feature market along the "Belt and Road". These researchers applied data envelope analysis method to analyze the trade efficiency at the national level[97].

Cai Wenhao[98] used factor analysis and DEA method to find that the trade environment of Gansu province was falling behind that of other provinces in the western region. Peng Xiaojun[99]used DEA model to evaluate the trade efficiency of agricultural products from six perspectives: industrial development level, government governance performance, education level, transportation capacity, communication capacity, and the improvement of financial system. The input index was selected, and the ratio of trade to GDP was taken as the output index. The study reported a low efficiency of China's agricultural trade. Lu Huifen[100] selected indicators from four aspects, including port infrastructure, regional (hinterland) economic level, transportation facilities and port throughput to perform principal component analysis. The first three principal component scores were used as the input indicators of DEA model, and port throughput was divided into cargo throughput and container

[96] Chen Landong, *China's comprehensive evaluation of OFDI efficiency in key countries of the Belt and RoadInitiative,* He Hai University, 2015,p. 34-47.

[97] Zhai jingfan,*Research on Trade Efficiency of Major Countries along the Belt and Road,* Inner Mongolia University of science and technology, 2018, p.78-84.

[98] Cai Wenhao, *Evaluation and analysis of trade environment in Gansu province*, Journal of Gansu economy, 2007, P.1-5.

[99] Peng Xiaojun, *Research on agricultural problems based on DEA model*, University of Jilin, 2011, p.23-36.

[100] Lu Huifen, *Research on evaluation Index System of low-carbon passenger Transport system in big cities,* Beijing Jiaotong University, 2011, P.43-59.

throughput as the output indicators of DEA model to analyze the competitiveness and efficiency of ports in Liaoning coastal economic zone. Liu Xiaomeng[101] selected input-oriented and output-oriented DEA models, total import and export of goods, exchange rate, international crude oil price and export container throughput as the input indicators of DEA models to evaluate the efficiency of shipping service trade of powerful shipping countries. It was found that the efficiency of China's maritime service trade was low, and that the main factors affecting trade efficiency were port container throughput and exchange rate. These researchers used data envelope analysis method to analyze the trade efficiency of agricultural products and port trade.

Other researchers have established mathematical models to analyze trade efficiency. Chen Ying[102] evaluated the trade efficiency of countries along the Central European Banks by establishing a mathematical model, dividing the national trade efficiency into domestic and international trade efficiency. Trade technical efficiency, such as transportation, information, education and trade efficiency, and trade system efficiency, such as market, credit and credit, were used as indicators of domestic trade efficiency. Import and export of goods and services, degree of openness to the outside world and trade competitiveness index were used as indicators of international trade efficiency. The study revealed that the efficiency of domestic trade and international trade is manifested as high efficiency in central Asia, low efficiency in Europe, and an opposite pattern when it comes to domestic trade efficiency. By analyzing the influencing factors of trade efficiency, the researchers found that the influencing factors of trade efficiency exerted different degrees of impact on each country.

Although most of these literature uses stochastic frontier gravity models in analyzing national trade efficiency, DEA models are needed to evaluate multiple output efficiency. The evaluation method of trade efficiency should be determined before the selection of the symbolic variables of trade efficiency.

[101] Liu Xiaomeng, *Evaluation of China's export relative efficiency from the perspective of sustainable development, "*Journal of Industrial Economy",2015, p.1-5.

[102] Chen Ying, *Evaluation and Comparative study on trade efficiency of Countries along the China-Europe Express Line,* Sichuan International Studies University,2018, P.28-40.

Yan Shaojun pointed out that the Belt and Road initiative is an international trade practice that conforms to the current world development trend, an objective requirement of the global economic trade growth pattern, an inevitable requirement of the international division of labor and the development of the global value chain. It conforms to the new trend of the international trade industry and development mode, and the Belt and Road initiative should be promoted along the line from the perspective of international trade theory. National trade should be considered in terms of trade facilitation, infrastructure, trade investment business environment and border management.

Improving trade facilitation, World Trade Organization (WTO), Asia Pacific Economic Cooperation (APEC), Organization for World Economic Cooperation and Development (OECD), and World Customs Organization (WCO) have basically the same definition of trade promotion. These organizations include all measures to accelerate the flow of goods in the process of international trade, including the simplification of border management, the improvement of infrastructure and the coordination of systems. Kong Qingfeng and Dong Hongyu[103] confirmed that the level of trade facilitation plays the most important role in promoting international trade. In choosing the variables that represent trade convenience, these methods are often used and some sub-indicators are changed accordingly.

Mastromacro and Ghosh[104]found that international trade and foreign direct investment can improve efficiency, so can human capital accumulation. With the support of human capital improvements, migration can increase efficiency and contribute to productivity improvements.

Ning Lin[105] used the adjusted gravity models to analyze the impact of asymmetric trade flows of agricultural products on agricultural competitiveness,

[103] Kong Qingfeng, Dong Hongyu, *Research on trade facilitation level and trade potential of Belt and Roadcountries, "*Journal of International Trade", 2015, p.4-10.

[104] Mastromacro, C. and Ghosh,S. *Foreign Capital,Human Capital,and Efficiency: A Stochastic Frontier Analysis for Developing Countries*, "World Development" , 2013.

[105] Ning Lin, *Research on the dynamic efficiency of main ports of China's Maritime Silk Road under the New economic normal,* Journal of Guangxi University of Finance and Economics, 2016, p. 2-8.

export infrastructure efficiency, and net import openness, reporting that the trade flow of agricultural products is closely related to the degree of net opening up of imports, but is weakly related to agricultural competitiveness. Agricultural competitiveness is mainly related to the advantages of land. Economic development can improve the efficiency of the export of agricultural products. Michael Danquah[106]used trade and machinery imports, human capital and Research and development (R&D) inputs in the Random frontier analysis to study the effects of technology transfer and technology absorption, explain the differences in national trade efficiency between 1970 and 2010 in sub-Saharan Africa. The results show that sub-Saharan African countries with higher levels of education and R&D investment have higher trade efficiency.

A high trade efficiency of countries along the Belt and Road will promote the process of trade integration. Ravishankar and Stack[107] used a stochastic frontier gravity model to evaluate the efficiency of the trade integration process between Eastern European countries and the neighboring Western countries, demonstrating that the degree of trade integration between East and West reached two-thirds of the trade frontier in 1994-2007. Such result indicated that the trade resistance between East and West countries was relatively small.

Xuan and Duc[108] analyzed Vietnam's bilateral trade between 2000 and 2015 to assess its utilization of trade efficiency before and after the entry into the free trade agreement between China and India by using random frontier estimation techniques in the structural gravity model. The results show that the ASEAN-India Free Trade Agreement has a positive impact on Vietnam's bilateral trade flow. However, when the ASEAN-China Free Trade Agreement came into force, Vietnam's export was

[106] Michael Danquah, *Technology transfer, adoption of technology and the efficiency of nations: Empirical evidence from sub Saharan Africa,* "Technological Forecasting and Social Change" , 2018, p.175-182.

[107] Geetha Ravishankar, *The Gravity Model and Trade Efficiency: A Stochastic Frontier Analysis of Eastern European Countries' Potential Trade, "*The World Economy", 2014, p. 690-704,

[108] Cuong Duc Pham, Quan Xuan Tran, Lan Thi Ngoc Nguyen, *Effects of Internal Factors on Financial Performance of Listed Construction-Material Companies: The Case of Vietnam*, "Research Journal of Finance and Accounting", 2018, p.7.

negatively impacted.

In light of above literature, we conclude that scholars mainly use stochastic frontier gravitation model analysis method and data envelope analysis method in the analysis of trade efficiency. Envelope analysis is a non-parametric method because it is simple to calculate and does not assume the specific form of production function in advance. Because the environment of trade is a complex system, this chapter selects data envelope analysis method to make a more realistic evaluation of trade efficiency.

There is no uniform standard for the selection of indicators that affect trade efficiency, and the settings of index weights vary. Therefore, the results of the study are under the influence of different indicators and weight settings. The evaluation index system in this study is constructed based on the data published by the Global Trade Promotion Report and the Global Competitiveness Report, to reflect a complete picture of the overall impact on trade efficiency. However, given the possible correlation among multiple indicators, principal component analysis is used to reduce the dimension and eliminate the collinearity between indicators. To sum up, this chapter chooses the data envelope analysis method to make an empirical analysis of trade efficiency between the major countries along the Belt and Road, so as to advance the understanding of the scenarios.

5.2. Principle and model of DEA

Data Envelopment Analysis (DEA) is a method that evaluates the relative efficiency of Decision Making Units (DMU) units and can deal with the problem of multiple inputs and multiple outputs. As a non-parametric evaluation model, it does not need to set parameters artificially or the form of production function in advance. The larger the value between (0, 1), the higher the relative efficiency in the DMU unit evaluated. If the efficiency value of a DMU unit is 1, the DMU unit is valid. However, this does not mean that the DMU unit has no room for improvement. Instead, it means the DMU unit has achieved the best relative efficiency among all the DMU units evaluated.

Common DEA evaluation model belong to the category of CCR model (CCR is an abbreviation of the names of three operations researchers: A. Charnes & W. W. Cooper & E. Rhodes[109]) and BCC model (BCC is an abbreviation of three operations researchers: Banker R.D.A.& A.Charness& W.W. Cooper[110]). The CCR model assumes that the return on scale is constant. The BCC model is based on the CCR model and assumes variable return on scale. Considering that most decision-making units are in a variable scale reward state, this dissertation applies BCC model to evaluate trade efficiency. The BCC model divides technical efficiency into pure technical efficiency and scale efficiency. Researchers generally focus on the study of export and economic growth, while disregard export and technological progress. Therefore, we select export and GDP of aquatic products as the variables for quantitative analysis.

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\sum_{j=1}^{n} \lambda_j Y_j \geq Y_0$$

$$\sum_{j=1}^{n} \lambda_j X_j \leq \theta X_0$$

Where n=31 is the number of countries along the Belt and Road selected in this thesis. X_0 represents the input of the decision unit, Y_0 represents the output of the decision unit.

Comprehensive efficiency = pure technical efficiency * scale efficiency. Therefore, when comprehensive efficiency equals to pure technical efficiency, the scale efficiency of the decision-making unit is 1, and the production reaches the best state. If scale efficiency is not 1, then the scale efficiency of the decision-making unit has a loss, it is either too large or too small. The comprehensive efficiency is the index to measure the resource allocation capacity and resource utilization efficiency. Pure

[109] A. Charnes, W. W. Cooper and E. Rhodes. *Measuring the efficiency of decision making units*. European Journal of Operational Research, 1978, p. 429-444.

[110] Banker, R.D.A, A.Charness and W.W.Cooper, *Some models for estimating technical and scale inefficiencies in Data Envelopment analysis[J]*. Management science, 1984, p. 1078-1092.

technical efficiency reflects the level of each country's technical level. Scale efficiency is the index to evaluate the rationality of input scale. This dissertation chooses output-oriented DEA-BCC model to analyze the trade efficiency of the major countries along the Belt and Road.

5.3. Variable selection

The use of different evaluation index systems will yield different results. In order to make the evaluation results more convincing, we need to ensure that the evaluation index system is objective and effective. Considering the subjectivity of the qualitative evaluation method, this thesis chooses the quantitative evaluation method to build the evaluation index system.

The principles of index construction are as follows:

(1) The authoritativeness of data: data publishing agencies need to be authoritative, and data published by authoritative agencies are solid;

(2) The objectivity of data, the evaluation indicators of trade efficiency should be realistic and authentic to truly reflect a country's trade competitiveness;

(3) The operability of data means that the evaluation index should be quantified as much as possible. Unquantifiable indicators need to be quantified to make them operational;

(4) Hierarchy of data: the principle of hierarchy is that when evaluating national trade competitiveness, the selection of indicators should reflect a certain hierarchy. That is to say, high-level indicators contain all low-level indicators, and low-level indicators are merely the differentiation of high-level indicators;

(5) Data integrity: the principle of integrity refers to the construction of a national competitiveness evaluation system that includes as many aspects as possible to reflect trade competitiveness and comprehensive indicators.

In this chapter, trade openness and TC index were used as output indexes of DEA model, and the output oriented DEA-BCC model was selected by using Matlab

software to evaluate the trade efficiency of 31 countries from 2012 to 2019.

Table 5.1. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2012

DUM	2012			
	crste	vrste	scale	R-S
RUS	0.186	0.226	0.822	drs
SGP	1	1	1	-
IDN	0.813	1	0.813	drs
MYS	0.645	1	0.645	drs
THA	0.52	1	0.52	drs
VNM	1	1	1	-
PHL	0.549	1	0.549	drs
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
AE	1	1	1	-
KWT	0.451	0.463	0.976	drs
TUR	0.314	1	0.314	drs
OMN	0.833	1	0.833	drs
LBN	0.542	0.938	0.578	drs
SAU	0.189	0.594	0.318	drs
BH	1	1	1	-
ISR	0.55	0.919	0.599	drs
EGY	1	1	1	-
IRN	0.34	1	0.34	drs
JOR	1	1	1	-
GEO	1	1	1	-
POL	0.3	0.769	0.39	drs
BN	1	1	1	-
AZ	0.567	1	0.567	drs
QA	0.447	0.975	0.459	drs
LT	1	1	1	-
ROU	0.448	0.477	0.94	drs
SK	0.567	1	0.567	drs
UAR	0.614	0.813	0.755	drs
KAZ	0.301	0.436	0.689	drs
mean	0.693	0.894	0.771	

Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of

the People's Republic of China (CD version) edited and published by e-magazine, 2012-2020

As can be seen from Table 5.1, the mean comprehensive efficiency of these 31 countries in 2012 was 0.693, indicating that 30.7% of the input elements were wasted and underutilized. The mean value of scale efficiency was 0.894, indicating that the investment scale of B&R countries is relatively reasonable. The mean value of pure technical efficiency was 0.771, indicating that there is still room for improvement in the configuration of input elements. Comparing the two, the value of pure technical efficiency is greater than that of scale efficiency, indicating that there are higher pure technical efficiency and lower scale efficiency. In order to improve comprehensive efficiency, Singapore, Vietnam, Cambodia, Pakistan, Sri Lanka, the United Arab Emirates, Bahrain, Brunei, Georgia and Lithuania all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 10 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 21 countries is less than 1, indicating that they are DEA invalid units. Among the 21 DEA invalid units, the comprehensive efficiency of Indonesia and Oman is greater than 0.8, indicating that their trade efficiency is relatively high, and the waste of input elements is less than 20%. The pure technical efficiency of Indonesia and Oman is 1, which is greater than their scale efficiency, indicating that the allocation of input elements in these two countries is reasonable. Thus, the reason for the low comprehensive efficiency of both countries is the inefficiency of scale. The scale efficiency of Poland and Lithuania is 1, higher than their pure technical efficiency, indicating that low technical efficiency is the reason for their low comprehensive efficiency. The comprehensive efficiency of Russia, Kuwait, Turkey, Saudi Arabia, Iran, Poland, Qatar and Kazakhstan is all lower than 0.5, indicating that the trade efficiency of these countries is quite low, causing more than half of the input elements to be wasted. Comparing the pure technical efficiency and scale efficiency of these 8 countries, this study finds that the scale efficiency of 4 countries is greater than the pure technical efficiency. That is, the low comprehensive efficiency of these 8 countries is resulted from low technical efficiency. Therefore, these countries are not suitable for blindly expanding

investment, and the improvement of technology and the rational allocation of input elements should be paid attention to.

Table 5.2. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2013

DUM	2013			
	crste	vrste	scale	R-S
RUS	0.181	0.216	0.839	drs
SGP	1	1	1	-
IDN	0.855	1	0.855	drs
MYS	0.646	1	0.646	drs
THA	0.515	1	0.515	drs
VNM	1	1	1	-
PHL	0.586	1	0.586	drs
KHM	1	1	1	-
PAK	1	1	1	-
LKA	0.995	1	0.995	drs
AE	1	1	1	-
KWT	0.361	0.484	0.747	drs
TUR	0.266	1	0.266	drs
OMN	0.769	1	0.769	drs
LBN	0.63	0.812	0.776	drs
SAU	0.197	0.59	0.334	drs
BH	1	1	1	-
ISR	0.54	0.775	0.697	drs
EGY	1	1	1	-
IRN	0.401	1	0.401	drs
JOR	1	1	1	-
GEO	1	1	1	-
POL	0.3	1	0.3	drs
BN	1	1	1	-
AZ	0.577	1	0.577	drs
QA	0.337	1	0.337	drs
LT	1	1	1	-
ROU	0.423	0.456	0.928	drs
SK	0.483	1	0.483	drs
UAR	0.585	0.806	0.725	drs
KAZ	0.291	0.431	0.675	drs
mean	0.686	0.893	0.764	

Source: As in Table 5.1.

As can be seen from Table 5.2, the mean comprehensive efficiency of these countries in 2013 was 0.686, indicating that 31.4% of input elements were wasted and underutilized. The mean scale efficiency was 0.764, higher than half, indicating that the investment scale along the route is relatively reasonable. The mean pure technical efficiency was 0.893, indicating that there is still room for improvement in the allocation of input elements. Comparing the two, the value of pure technical efficiency is greater than that of scale efficiency, indicating that the reason for the lower comprehensive efficiency is caused by lower scale efficiency. This also shows that in order to improve the overall benefits of the countries along the "Belt and Road" routes, efforts should be made to rationally allocate resources and expand the scale of investment. Singapore, Vietnam, Cambodia, Pakistan, the United Arab Emirates, Bahrain, Egypt, Jordan, Georgia, Brunei and Lithuania all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 11 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 20 countries is less than 1, indicating that these countries are DEA invalid units. Among the 20 invalid units of DEA, the comprehensive efficiency of Indonesia, Malaysia, Thailand, Sri Lanka, Oman, Israel, Azerbaijan, Ukraine, Lebanon and Philippines is all greater than 0.5, indicating that the trade efficiency of these countries is relatively high and the waste of input elements is less than 50%. Among these 10 countries, the pure technical efficiency of Indonesia, Malaysia, Thailand, Philippines, Sri Lanka, Oman and Azerbaijan is 1, which is greater than their scale efficiency. Slovakia and Kazakhstan, with the comprehensive efficiency of 0.4, have poor trade efficiency, causing 60% of their input elements to be wasted.

Table 5.3. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2014

DUM	2014			
	crste	vrste	scale	R-S
RUS	0.257	0.269	0.956	drs
SGP	1	1	1	-

IDN	0.943	1	0.943	drs
MYS	0.727	1	0.727	drs
THA	0.663	1	0.663	drs
VNM	1	1	1	-
PHL	0.604	1	0.604	drs
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
AE	0.451	1	0.451	drs
KWT	0.541	0.588	0.921	drs
TUR	0.386	1	0.386	drs
OMN	0.733	0.983	0.746	drs
LBN	0.674	0.804	0.839	drs
SAU	0.215	0.661	0.325	drs
BH	1	1	1	-
ISR	0.537	0.926	0.58	drs
EGY	1	1	1	-
IRN	0.618	1	0.618	drs
JOR	1	1	1	-
GEO	0.895	1	0.895	drs
POL	0.313	0.72	0.435	drs
BN	1	1	1	-
AZ	0.898	1	0.898	drs
QA	0.458	1	0.458	drs
LT	1	1	1	-
ROU	0.421	0.566	0.743	drs
SK	0.614	0.929	0.661	drs
UAR	0.773	1	0.773	drs
KAZ	0.376	0.398	0.945	drs
mean	0.722	0.901	0.799	

Source:As in Table 5.1.

According to Table 5.3, the mean comprehensive efficiency of these 31 countries in 2014 was 0.722, indicating that 34.2% of input elements were wasted and underutilized. The mean scale efficiency was 0.799, higher than 50%, indicating that the investment scale along the route is relatively reasonable. The mean pure technical efficiency was 0.901, indicating that there is still room for improvement in the configuration of input elements. Comparing the two, the value of pure technical efficiency is greater than that of scale efficiency, indicating that the reason for the lower comprehensive efficiency value comes from lower scale efficiency. In order to

improve the overall benefits of countries along the “Belt and Road” routes, efforts should be made to rationally allocate resources and expand the scale of investment. Singapore, Vietnam, Cambodia, Pakistan, Sri Lanka, Bahrain, Egypt, Jordan, Brunei and Lithuania all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 10 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 21 countries is less than 1, indicating that these countries are DEA invalid units. Among the 21 invalid units of DEA, the comprehensive efficiency of Indonesia, Malaysia, Thailand, Kuwait, Oman, Lebanon, Israel, Iran, Georgia, Azerbaijan, Slovakia and Ukraine is above 0.5, indicating that the trade efficiency of these countries is relatively high and the waste of input elements is less than 50%. Among these 21 countries, the pure technical efficiency of Indonesia, Malaysia, Thailand, Iran, Georgia, Azerbaijan, Slovakia and Ukraine is 1, which is greater than their scale efficiency. The comprehensive technical efficiency of Russia, Turkey, Saudi Arabia, Poland and Kazakhstan is lower than 0.4, indicating that the trade efficiency of these countries is poor, resulting in the waste of 60% of the input elements, so there is still a large space for income growth under the existing input conditions.

Table 5.4. Trade efficiency values of the 31 major countries along the “Belt and Road” routes in 2015

DUM	2015			
	crste	vrste	scale	R-S
RUS	0.329	0.332	0.993	irs
SGP	1	1	1	-
IDN	1	1	1	-
MYS	0.794	1	0.794	drs
THA	0.652	1	0.652	drs
VNM	1	1	1	-
PHL	0.614	1	0.614	drs
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
AE	0.442	1	0.442	drs
KWT	0.543	0.578	0.94	drs

TUR	0.388	1	0.388	drs
OMN	0.666	0.961	0.694	drs
LBN	0.535	0.662	0.808	drs
SAU	0.241	0.71	0.34	drs
BH	1	1	1	-
ISR	0.514	1	0.514	drs
EGY	1	1	1	-
IRN	0.594	1	0.594	drs
JOR	0.922	1	0.922	drs
GEO	1	1	1	-
POL	0.335	1	0.335	drs
BN	1	1	1	-
AZ	0.805	1	0.805	drs
QA	0.44	0.96	0.459	drs
LT	1	1	1	-
ROU	0.433	0.477	0.908	drs
SK	0.588	0.953	0.617	drs
UAR	1	1	1	-
KAZ	0.343	0.417	0.821	drs
mean	0.724	0.908	0.801	

Source:As in Table 5.1.

It can be seen from Table 5.4 that in 2015, the mean comprehensive efficiency of these 31 countries was 0.724, indicating that 27.6% of input elements were wasted and underutilized. The mean scale efficiency was 0.801, higher than 50%, indicating that the investment scale along the route is relatively reasonable. The mean pure technical efficiency was 0.908, indicating that there is still room for improvement in the allocation of input elements. Comparing the two, the value of pure technical efficiency is greater than that of scale efficiency, indicating that the reason for the lower comprehensive efficiency value is caused by lower scale efficiency. In order to improve comprehensive efficiency, efforts should be made to promote industrial development in a reasonable scale. Singapore, Indonesia, Vietnam, Cambodia, Pakistan, Sri Lanka, Bahrain, Egypt, Georgia, Brunei, Lithuania and Ukraine all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 12 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 19 countries is less than 1, indicating that these countries are DEA invalid units. Among the 19

invalid units of DEA, the comprehensive efficiency of Malaysia, Philippines, Thailand, Kuwait, Oman, Lebanon, Israel, Iran, Jordan, Azerbaijan and Slovakia is above 0.5, indicating that the trade efficiency of these countries is relatively high and the waste of input elements is less than 50%. Among these 19 countries, the pure technical efficiency of Malaysia, Philippines, Thailand, Israel, Iran, Jordan and Azerbaijan is 1, which is greater than their scale efficiency. The comprehensive efficiency of Russia, United Arab Emirates, Turkey, Saudi Arabia, Poland, Qatar, Romania and Kazakhstan is lower than 0.5, indicating that the trade efficiency of these countries is poor, resulting in the waste of 50% of input elements. By comparing the pure technical efficiency and scale efficiency of these 8 countries, we find that the scale efficiency of Russia, Romania and Kazakhstan are all higher than their pure technical efficiency, indicating that the investment scale should not be expanded blindly, but should pay attention to the improvement of technology and the rational allocation of input elements.

Table 5.5. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2016

DUM	2016			
	crste	vrste	scale	R-S
RUS	0.309	0.318	0.973	irs
SGP	1	1	1	-
IDN	0.971	1	0.971	drs
MYS	0.788	1	0.788	drs
THA	0.625	1	0.625	drs
VNM	1	1	1	-
PHL	0.646	1	0.646	drs
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
AE	0.483	1	0.483	drs
KWT	0.488	0.495	0.986	irs
TUR	0.374	0.5	0.748	drs
OMN	0.775	1	0.775	drs
LBN	0.721	1	0.721	drs
SAU	0.248	0.445	0.556	drs
BH	1	1	1	-

ISR	0.508	1	0.508	drs
EGY	0.998	1	0.998	drs
IRN	0.785	1	0.785	drs
JOR	0.983	1	0.983	drs
GEO	1	1	1	-
POL	0.342	1	0.342	drs
BN	1	1	1	-
AZ	1	1	1	-
QA	0.465	1	0.465	drs
LT	1	1	1	-
ROU	0.411	0.537	0.766	drs
SK	0.572	0.621	0.922	drs
UAR	1	1	1	-
KAZ	0.535	0.669	0.8	drs
mean	0.751	0.893	0.839	

Source:As in Table 5.1.

Table 5.5 shows that in 2016, the mean comprehensive efficiency of these 31 countries was 0.751, indicating that 0.249% of the input elements were wasted and underutilized, and the mean efficiency of the industry still has a large space for growth and improvement. The mean scale efficiency was 0.839, higher than 80%, indicating that the investment scale of the countries along the “Belt and Road” routes is relatively reasonable, but the overall level of regional industrial operation needs to be strengthened. The mean pure technical efficiency was 0.893, indicating that there is still room for improvement in the allocation of input elements. Comparing the two, scale efficiency value is slightly lower than pure technical efficiency. In order to improve comprehensive technical efficiency, efforts should be made to promote a reasonable scale of industrial development. This also shows that the key to improving the comprehensive efficiency lies in the rational allocation and upgrading of technology, rather than blindly expanding the scale. Singapore, Vietnam, Cambodia, Pakistan, Sri Lanka, Bahrain, Georgia, Brunei, Azerbaijan, Lithuania and Ukraine all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 11 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 20 countries is less than 1, indicating that these countries are DEA invalid units. Among the 20 invalid units of DEA, the comprehensive efficiency of 12 countries, including

Indonesia, Malaysia, Thailand, Philippines, Oman, Lebanon, Israel, Egypt, Iran, Jordan, Slovakia and Kazakhstan, is all greater than 0.5, indicating that these countries have relatively high trade efficiency, resulting in less than 50% waste of input elements. However, the overall management level of these industries still needs to be strengthened, and the scale of operation is unreasonable. Among these 12 countries, Indonesia, Malaysia, Thailand, Philippines, Oman, Lebanon, Israel, Egypt, Iran and Jordan have the pure technical efficiency value of 1, which is higher than their scale efficiency. To solve the problems of high pure technical efficiency and low scale efficiency, efforts should be made to promote the rationalization of industrial scale so as to achieve the improvement of comprehensive efficiency.

Table 5.6. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2017

DUM	2017			
	crste	vrste	scale	R-S
RUS	0.264	0.266	0.995	drs
SGP	1	1	1	-
IDN	0.87	1	0.87	drs
MYS	0.712	1	0.712	drs
THA	0.585	1	0.585	drs
VNM	1	1	1	-
PHL	0.685	1	0.685	drs
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
AE	0.484	0.895	0.541	drs
KWT	0.572	0.59	0.97	drs
TUR	0.401	1	0.401	drs
OMN	0.795	1	0.795	drs
LBN	0.697	1	0.697	drs
SAU	0.253	0.577	0.438	drs
BH	1	1	1	-
ISR	0.494	0.812	0.608	drs
EGY	1	1	1	-
IRN	0.55	1	0.55	drs
JOR	0.985	1	0.985	drs
GEO	1	1	1	-

POL	0.334	1	0.334	drs
BN	1	1	1	-
AZ	0.903	1	0.903	drs
QA	0.526	1	0.526	drs
LT	1	1	1	-
ROU	0.399	0.599	0.666	drs
SK	0.618	0.957	0.645	drs
UAR	0.973	1	0.973	drs
KAZ	0.445	0.632	0.703	drs
mean	0.736	0.916	0.799	

Source:As in Table 5.1.

As shown in table 5.6., the mean comprehensive efficiency of these 31 countries in 2017 was 0.736, indicating that 26.4% of the input elements were wasted and underutilized, and there is room for growth to improve the comprehensive efficiency of the industry. The mean scale efficiency was 0.799, greater than 50% but less than 80%, indicating that the investment scale of the countries along the “Belt and Road” routes is relatively reasonable, but the overall level of regional industrial operation needs to be strengthened. The mean pure technical efficiency was 0.916, indicating that there is still room for improvement in the allocation of input elements. Comparing the two, pure technical efficiency is larger than scale efficiency. This also indicates that in order to improve comprehensive technical efficiency, it is necessary to promote the rationalization of industry development scale. Singapore, Vietnam, Cambodia, Pakistan, Sri Lanka, Bahrain, Egypt, Georgia, Brunei and Lithuania all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 10 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 21 countries is less than 1, indicating that these countries are DEA invalid units. Among the 21 invalid units of DEA, Indonesia, Malaysia, Thailand, Philippines, Kuwait, Oman, Qatar, Lebanon, Iran, Jordan, Azerbaijan, Slovakia, Ukraine and other countries have the comprehensive efficiency of all above 0.5, indicating that the trade efficiency is relatively higher in these countries, with Input element waste less than 50%. However, the overall management level of these industries still needs to be strengthened, and the scale of operation is unreasonable. Among the 21 countries, the pure technical

efficiency of Indonesia, Malaysia, Thailand, Philippines, Oman, Lebanon, Iran, Jordan, Azerbaijan, Qatar and Ukraine is 1, which is higher than their scale efficiency. To solve the problems of high pure technical efficiency and low scale efficiency, efforts should be made to promote the rationalization of industrial scale so as to achieve the improvement of comprehensive efficiency.

Table 5.7. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2018

DUM	2018			
	crste	vrste	scale	R-S
RUS	0.186	0.188	0.989	irs
SGP	0.925	1	0.925	drs
IDN	0.111	0.244	0.457	drs
MYS	1	1	1	-
THA	0.298	0.926	0.321	drs
VNM	1	1	1	-
PHL	1	1	1	-
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
ARE	0.255	0.3	0.85	drs
KWT	0.521	0.747	0.697	drs
TUR	0.33	1	0.33	drs
OMN	0.811	1	0.811	drs
LBN	0.961	1	0.961	drs
SAU	0.226	0.991	0.228	drs
BH	0.889	1	0.889	drs
ISR	0.302	1	0.302	drs
EGY	0.675	1	0.675	drs
IRN	0.845	0.847	0.998	drs
JOR	0.957	1	0.957	drs
GEO	1	1	1	-
POL	0.246	1	0.246	drs
BN	1	1	1	-
AZ	1	1	1	-
QA	0.53	1	0.53	drs
LT	1	1	1	-
ROU	0.286	0.468	0.61	drs
SK	1	1	1	-

UAR	0.711	0.737	0.965	irs
KAZ	0.324	0.325	0.997	irs
mean	0.7	0.868	0.804	

Source: As in Table 5.1.

As shown in Table 5.7, the mean comprehensive efficiency of these 31 countries in 2018 was 0.7, indicating that 30% of the input elements were wasted and underutilized, and there is room for growth to improve the comprehensive efficiency of the industry. The mean scale efficiency was 0.804, more than 80%, indicating that the investment scale along the route is relatively reasonable, but the overall level of regional industrial operation needs to be strengthened. The mean pure technical efficiency was 0.868, indicating that there is still some room for improvement in the allocation of input elements. Comparing the two, pure technical efficiency is larger than scale efficiency. This also indicates that in order to improve comprehensive technical efficiency, it is necessary to promote the rationalization of industry development scale. Malaysia, Vietnam, Cambodia, Philippines, Pakistan, Sri Lanka, Georgia, Brunei, Azerbaijan, Lithuania and Slovakia all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 11 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 20 countries is less than 1, indicating that these countries are DEA invalid units. Among the 20 invalid units of DEA, the comprehensive efficiency of Singapore, Kuwait, Oman, Lebanon, Bahrain, Egypt, Iran, Jordan, Qatar, Ukraine and other countries is above 0.5, indicating that the trade efficiency of these countries is high, and the waste of input elements is below 50%. Among the 20 countries, the pure technical efficiency value of Singapore, Oman, Lebanon, Bahrain, Egypt, Iran, Jordan and Qatar is 1, which is higher than their scale efficiency. To solve the problems of high pure technical efficiency and low scale efficiency, efforts should be made to promote the rationalization of industrial scale so as to achieve the improvement of comprehensive efficiency.

Table 5.8. Trade efficiency values of the 31 major countries along the "Belt and Road" routes in 2019

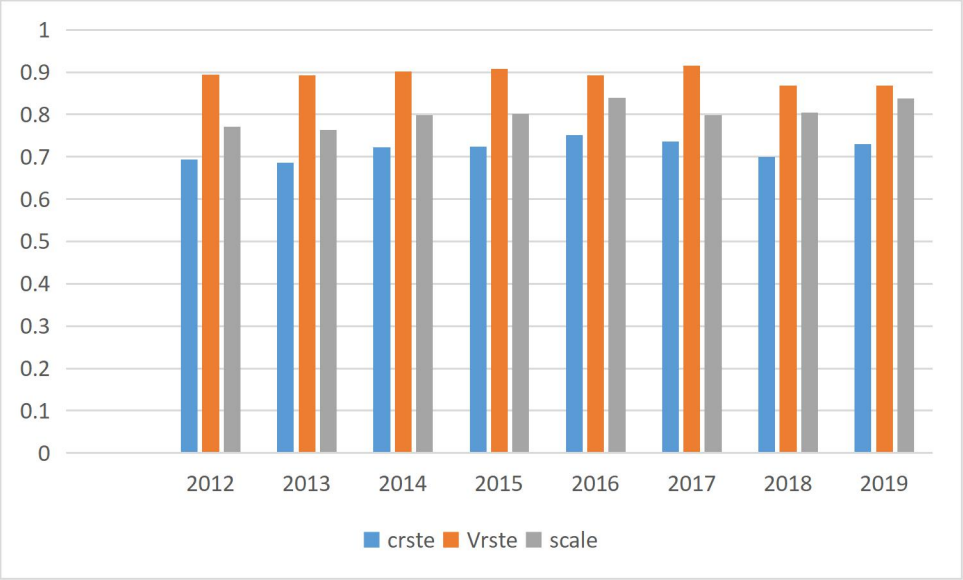
DUM	2019			
	crste	vrste	scale	R-S
RUS	0.251	0.295	0.853	drs
SGP	0.838	1	0.838	drs
IDN	0.94	1	0.94	drs
MYS	0.45	1	0.45	drs
THA	0.429	0.999	0.43	drs
VNM	1	1	1	-
PHL	1	1	1	-
KHM	1	1	1	-
PAK	1	1	1	-
LKA	1	1	1	-
ARE	1	1	1	-
KWT	0.502	0.507	0.991	irs
TUR	0.412	1	0.412	drs
OMN	0.75	1	0.75	drs
LBN	0.616	0.669	0.922	drs
SAU	0.207	0.85	0.244	drs
BH	1	1	1	-
ISR	0.295	0.598	0.494	drs
EGY	1	1	1	-
IRN	1	1	1	-
JOR	1	1	1	-
GEO	0.945	0.958	0.986	drs
POL	0.308	1	0.308	drs
BN	1	1	1	-
AZ	0.828	0.832	0.994	irs
QA	0.453	0.663	0.683	drs
LT	1	1	1	-
ROU	0.376	0.459	0.82	drs
SK	0.511	0.671	0.762	drs
UAR	0.862	0.892	0.967	drs
KAZ	0.38	0.395	0.961	irs
mean	0.73	0.868	0.838	

Source: As in Table 5.1.

As shown in Table 5.9, the mean comprehensive efficiency of these 31 countries was 0.73 in 2019, indicating that 29.7% of the input elements were wasted and underutilized, and that the space for growth is still large to improve the

comprehensive efficiency. The mean scale efficiency being 0.838 indicated that the investment scale of the involved countries is relatively reasonable, and that the overall level of regional industrial operation should be strengthened. The mean pure technical efficiency was 0.868, so the allocation of input elements could be improved. Comparing the two, pure technical efficiency is larger than scale efficiency, which also indicates that a reasonable industry development scale is necessary to improve comprehensive efficiency. Malaysia, Vietnam, Cambodia, Philippines, Pakistan, Sri Lanka, Georgia, Brunei, Azerbaijan, Lithuania and Slovakia all have the comprehensive efficiency, pure technical efficiency and scale efficiency of 1, indicating that these 11 countries are valid units of DEA, whose input scale and input elements are reasonable. The comprehensive efficiency of the remaining 20 countries being less than 1 indicated that they are DEA invalid units. Among these 20 invalid units of DEA, the comprehensive efficiency of Singapore, Indonesia, Kuwait, Oman, Lebanon, Georgia, Slovakia, Ukraine and other countries is above 0.5, indicating a high trade efficiency and that their waste of input elements is below 50%. The overall level of management in these industries should be strengthened and the scale of operations is not reasonable. Among the 20 countries, the pure technical efficiency value of Singapore, Indonesia, Malaysia, Turkey, Oman, Poland is 1, which is higher than their scale efficiency. That is, their pure technical efficiency is high, but their scale efficiency is low. To improve the comprehensive technical efficiency, the rationalization of industrial scale should be enhanced.

Figure 5.1. The mean value of trade efficiency of Shandong and the major countries along the Belt and Road from 2012 to 2019



Source: Shandong province Statistical Yearbook, Shandong province National Bureau of Statistics of the People's Republic of China (CD version) edited and published by e-magazine, 2012-2017

As illustrated in Figure 5.1, the comprehensive efficiency, pure technical efficiency and scale efficiency of the involved countries are relatively stable. As the scale efficiency and pure technical efficiency are around 0.8, the regional industry as a whole management level needs to be strengthened, and operating scale is not reasonable. These countries have higher pure technical efficiency and scale efficiency. In order to improve the efficiency of comprehensive technology, the development of its industry scale should become more reasonable by casting off the traditional inefficient management mode, adopting management innovation, and adjusting the scale of the industry. If return to scale remains unchanged, the increasing input will inevitably elevate industry output in proportion. If these industries expand further, the returns to scale will be reduced. In that case, the waste of resources and a reduction in overall technical efficiency will follow.

5.4.Method of estimating technological progress and data description

5.4.1. Trade and growth based on neoclassic growth theory

Neoclassical growth theory is developed on the framework of neoclassicism, whose core assumption is the setting of production functions to guarantee a good

performance of production functions: linear homogeneity, first derivative being greater than zero, second derivative being less than zero, and paddy field conditions being satisfied. These conditions have extremely rich economic implications: the scale reward of production remains unchanged: the marginal product is greater than zero; the marginal product decreases with greater input of elements; and the paddy field condition guarantees the existence of a stable solution.

Because the marginal product decreases with the increase of factor input and the return on scale remains unchanged, long-term economic growth cannot be accumulated in the event of soaring factor input. The basic conclusion of the neoclassical model is that in the long run, the per capita income and per capita capital will depend on the endogenous or exogenous savings rate. This contradicts the real long-term economic growth. When technological progress is introduced into the neoclassical model, the source of technological progress is not considered. Therefore, technological progress is exogenous. In this way, the neoclassical model can only attribute explain economic growth within its framework to the contribution of exogenous technological progress.

While it partially solves the source of economic growth, it leaves the problem of endogenous technology progress unattended, allowing for the emergence of new growth theory.

Within the framework of neo-classical growth theory, technological progress is exogenous, the effect of trade on promoting growth is generally manifested total economic output. Herein, we can expand the neo-classical production function and add trade variables to the right, including total trade structure trade. In terms of policy and trade system, there are horizontal and differential variables, qualitative and quantitative variables. Technically, the effect of trade on growth is mostly analyzed by using correlation coefficient method or measurement method.

5.4.2. The relationship between trade and technological progress based on the new growth theory

The new growth theory overrides the restrictions of the neoclassical framework, taking several factors such as knowledge accumulation, human capital research and development into the neoclassical production function. The higher returns to scale would shake the groundwork of the neoclassical growth theory. The R&D intermediate product model considers that the expansion of quantity or improvement of quality of intermediate products is the source of technological progress. Meanwhile, it introduces the intermediate product department, whose production input is used for R&D. The products of this department represent technological progress, thereby contributing to the internal biochemical reaction of technological progress and enabling long-term endogenous economic growth. Given the endogenous nature of technology, people begin to consider the contribution of international trade to technological progress. The traditional proposition of trade and growth should be reviewed. In general, technological progress is used as the explanatory variable, and the volume of trade is relatively high. That is to say, the total amount of trade is included, and the contribution of different commodities with different technological content and element content to technological progress can be examined in detail.

Helpman[111] extended the new growth theory to the global scope and created some concise yet profound technology diffusion catching-up models. It is generally believed that technology (knowledge) originates and innovates from a few developed countries, and can flow around the world through various channels, such as trade, foreign investment, conferences, networks, and books, to achieve technology diffusion. The implied Diffusion pathways included international trade and FDI, while the un-implied pathways include conferences, networks, books, and so forth.

Coe & Helpman[112] examined import and technology spillover in developed

[111] Tamim Bayoumi, David T.Coe and Elhanan Helpman, *R&D spillovers and Global Growth,* Journal of International Economics, 1999, p. 399-428.

[112] David T.Coe，Elhanan Helpman, *International R&D spillovers*, “European Economic Review” ,

countries in the empirical research. However, the findings have some drawbacks: the object of study is the relation between developed countries and the volume of trade is selected as the total amount. The research disregarded that the different trade structures may have different degrees of technology diffusion. Moreover, some other factors affecting trade efficiency, such as geographical distance and location, cultural factors between countries, FDI and so on, were not taken into account. To solve these problems, the research object should be expanded to cover both developed countries and developing countries; intermediate products, consumer goods, labor-intensive products, capital-intensive products and other different product types and different trade structures should be examined to better understand geographical location, distance and other factors of the national cultural system. It can be concluded that import can realize technology spillover not only between developed and developing countries, but also between developing countries.

5.4.3. Impacts of export on technological progress

In contrast to the clear relationship between import and technological progress, the research on export and technological progress is relatively imperfect. First, most of the studies are empirical research, and the empirical conclusions vary according to different countries in different time periods. Second, the construction of the theoretical model is not concise or clear. In theory, export may promote technological progress from the following aspects:

1) demand expansion effect;
2) competitive effects;
3) technology dissemination effect;
4) effect of optimal resource allocation.

Export expands the demand for products, thus enabling producers to realize the economies of scale, thereby increasing efficiency and promoting technological

1995, P. 859-887.

progress. Meanwhile, the continuous accumulation of knowledge and experience will facilitate the scale of production expansion and increase the output of production.

The exporters in the international market are dealing with the more intensified competition than that of their domestic peers. Therefore, exporters must reduce costs, continuously improve product quality and efficiency. The external pressure for the manufacturers to continuously develop new products could press forward the making of technological progress.

Exporters in the international market will also compete with higher-level manufacturers. In this process, the advanced management experience, management system and advantages in production and sales of foreign enterprises will be disseminated to the exporters through knowledge spillover effect, thereby achieving technological progress.

In addition to these impacts on individual companies, export can also eliminate the advantages and disadvantages, making it difficult for technologically inferior manufacturers or industries to enter the international market. They are most likely to be squeezed out of the domestic market due to poor management and profit reduction. In that case, resources will be distributed to the technologically advanced ones or enterprises to improve the technical level of the entire industry or the country.

5.4.4. The impact of technological progress on export

The impact of technological progress on export can be considered from two standpoints:

1) comparative advantage;
2) the sunk costs;

Traditional trade theory postulates that a country with different comparative advantages in terms of production elements and technological level will specialize in the production of a certain product, or import/export a certain product.

Manufacturers in the international market face more competition and challenges, and therefore may face higher costs, such as transportation fees. In addition, the

different market rules and traditional international practices in the international market compel the exporters to learn, and hence a higher learning cost will arise. Because of these sunk costs, only those companies with technological progress will be profitable when they enter the international market. Therefore, only units with technological progress can be exported, and technological progress is the root cause of export.

In terms of the impact of export on technological progress, Melitz[113] constructed a very sophisticated theoretical model based on New trade theory). Herein, the detailed introduction of the model was dismissed and we come up with the basic conclusions.

In line with the theoretical basis, the empirical study on export and technological progress should focuses on two issues.

First, an analysis of export and technological progress is necessary. Whether export and technological progress promote or hinder each other, or barely affect each other is the first concern of researchers. If one promotes the other, then it is a positive correlation, otherwise, it is a negative correlation or no correlation. Second, the causal analysis of export and technological progress remains seldom on China's export and technological progress[114].

All the studies postulates that there is a positive correlation between export and technological progress, that being said, the faster the export develops, the greater the technological progress. A causal relationship is uncertain. Some studies conclude that export leads to technological progress to support learning from exporting. Others believe that technological progress leads to export and supports self-selection.

In the study of export and economic growth, the export variables and GDP of aquatic products should be selected for quantitative analysis. However, few studies on trade and technological progress, especially on export and technological progress, have been conducted. The above search and analysis of the theoretical and empirical

[113] Melitz, M. , *The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity*, "Econometrica", 2003, 71(6), p. 1695–1725.
[114] Fu Qiang, *Study on the strategic Mode of enterprise green sustainable Innovation*, Kunming University of Science and Technology, 2003, p.23-45.

literature on export and technological progress are open to various interpretations.

5.5. Introduction of DEA-Tobit and DEA-CLAD index method

DEA-BCC output-oriented model is used to measure the trade efficiency of 31 countries along the belt and Road, meanwhile, the influencing factors of trade efficiency warrant exceptional exploration. Since the trade efficiency value estimated by DEA model is within (0,1), it is an indirect observed variable that meets the application conditions of merge model. In general, Tobit model is used for estimation. However, if the disturbance term does not obey normal distribution or homoscedasticity assumption, the results of Tobit model using Maximum Likelihood Estimate (MLE) estimation method are not robust. Zhang Xiaomin, Zhang Xiaoyun, Chen Xiaoyu[115] believe that CLAD method only requires the disturbance term to be IID, and consistent estimation can be obtained even in the case of non-normal distribution and heteroscedasticity. Matlab software will be used to analyze the influencing factors of trade efficiency. By comparing the results of Tobit model and CLAD method, we can obtain consistency estimation results to make the theoretical basis of policy recommendations more solid.

Tobit model is:

$$y_i^* = \beta x_i^{'} + \varepsilon_i$$

Where, Y_i^* is the potential quantity variable, $X_i^{'}$ is the exogenous variable of K *1, I =1,2... N. ε_i is the model residual.

The probability density is:

$$f(y_i^* | x) = [1 - \varnothing(\frac{\beta x_i^{'}}{\sigma})]^{I(y_i=0)} [\frac{\varnothing}{\sigma}(y_i^* - \beta x_i^{'}) / \sigma]^{I(y_i>0)}$$

Where 1(•) is an indication function. When expressed as true in parentheses, the

[115] Zhang Xiaomin, Zhang Xiaoyun, Chen Xiaoyu, *Research on production efficiency and influencing factors of animal husbandry in main pastoral areas of China,* Journal of China Agricultural University, 2017, p.2-7.

value is 1; otherwise, it is 0.

The merging data model of CLAD method is:

$$y_i = \max(0, \beta x_i^{'} + \varepsilon_i)$$

The objective function is:

$$\min_{\beta} \sum_{i=1}^{n} \left| y_i - \max(0, \beta x_i^{'}) \right|$$

CLAD method requires that the disturbance term should obey iID. If $\beta x_i^{'} + \varepsilon_i > 0$, $Y_i = \beta x_i^{'} + \varepsilon_i$, otherwise $Y_i = 0$.

Among the literature on influencing factors of trade efficiency, the author chooses the data of 31 countries along the Belt and Road country to examine TAF, MON, FIN and SHP as independent variables affecting trade efficiency. Previous trade efficiency values of DEA were taken as dependent variables to establish the Tobit model and CLAD model. The excessive amount of data will make it hard for comparison. Therefore, we selected data from 2014, 2016 and 2019 for analysis. In order to avoid multicollinearity and to form elastic coefficient in the regression, the natural logarithm of the explained variables and explanatory variables was applied in in the model.

The conditional moment test of Tobit model can only be used when the explained variable is left merged data and the merge point is 0. Wooldridge highlighted that if the Tobit model is set correctly, the estimated results of CLAD and Tobit should be similar.[116] Therefore, the CLAD estimation results can be roughly regarded as a hypothesis test of the Tobit model. As shown in Table 5.9. and table 5.10., the comparison of the estimation results of Tobit model and CLAD method in 2012, 2014, 2016 and 2019 found significant differences in the estimation values. Therefore, it can be considered that the setting of the Tobit model is wrong. That is to say, the disturbance term of the model does not conform to normal distribution or

[116] Wooldridge J.M. *Econometric analysis of cross-section and panel data [M]*. The MIT Press, Massachusetts , 2010, p.12-16.

heteroscedasticity hypothesis.

Table 5.9. Tobit results for 2012, 2014, 2016 and 2019

	2012 tobit	2014 tobit	2016 tobit	2019 tobit
TAF(%)	0.0330994(**)	0.0523776(**)	0.0288428	0.0172332(**)
	1.91	2.06	1.44	1.99
MON	0.0138044	0.0065232	0.0076293	-0.0064555
	1.56	0.69	0.80	-0.90
FIN	0.0052123	0.0044023	-0.000371	0.0048605
	1.24	1.06	-0.07	1.17
SHP	0.0021483	-0.0004819	-0.0009737	0.0009448
	0.96	-0.22	-0.50	0.55
	0.53	0.93	0.69	1.17
INF	-0.168303	0.0616165	0.1390123	-0.166528(*)
	-1.13	0.62	1.28	-1.80
_cons	-0.297489	-0.3751526	-0.3363935	1.333974(***)
	-0.39	-0.48	-0.47	3.79

1.96t >T>1.65: indicates passing the 10% significance test

2.58>T>1.96: represents passing the significance test of 5%

T>2.58: represents passing the 1% significance test

Table 5.10. CLAD results for 2012, 2014, 2016 and 2019

	2012	2014	2016	2019
TAF	0.035***	0.066***	0.076***	0.023
	(3.41)	(6.97)	(7.6e+14)	(1.40)
MON	0.032***	-0.009**	0.005***	-0.037*
	(5.21)	(-2.40)	(2.3e+14)	(-1.72)
FIN	0.006***	0.014***	0.006***	0.017
	(3.10)	(5.04)	(5.3e+14)	(1.18)
SHP	-0.002	0.002	-0.008***	0.004
	(-0.75)	(1.42)	(-1.6e+15)	(0.84)
INF	-0.566***	0.138***	0.191***	-0.007
	(-3.49)	(3.52)	(4.1e+14)	(-0.02)
_CONS	-0.276	-0.125	-0.549***	2.304**
	(-0.43)	(-0.45)	(-2.9e+14)	(2.68)
N	31	31	31	31
r2_p	0.41	0.33	0.44	0.36

T or z values are printed in parentheses;*** p<0.01,** p<0.05,* p<0.1

Empirical results in 2012 show that the influence of TAF (Tariff and other import duties as a percentage of tax revenue), MON (The Degree of currency freedom), FIN (The Degree of financial freedom), and INF (Trade and Transport Infrastructure Index) on trade efficiency all passed the test of significance level. Empirical results in 2014 show that the influence of TAF (Tariff and other import duties as a percentage of tax revenue), MON (The Degree of currency freedom), FIN (The Degree of financial freedom), and INF (Trade and Transport Infrastructure Index) on trade efficiency passed the test of significance level. Empirical results in 2016 show that the influence of TAF (Tariff and other import duties as a percentage of tax revenue), MON (The Degree of currency freedom), FIN (The Degree of financial freedom), SHP (Liner Transport Connectivity Index) and INF (Trade and Transport Infrastructure Index) on trade efficiency all passed the test of significance level. While, empirical results in 2019 show that only the influence of MON (The Degree of financial freedom) on trade efficiency passed the test of significance level.

MON (The Degree of currency freedom) had a negative effect on the trade efficiency improvement of the 31 countries along the Belt and Road routes in 2014 and 2019. SHP (Liner Transport Connectivity Index) had a negative effect on the trade efficiency improvement of the 31 Belt and Road countries in 2016. INF (Trade and Transport Infrastructure Index) posed a negative effect on the trade efficiency improvement of the 31 Belt and Road countries in 2012.

An interesting result shows that monetary freedom in 2014 and 2019 had a counter-productive effect on the trade efficiency of the countries along the Belt and Road routes. Monetary freedom is primarily used to examine monetary policy, price stability measures and the main dimensions of price stability, and also to evaluate whether there are price controls. In other words, market index, financialization index and economic index reflect the institutional environment. In 2012 and 2016, monetary freedom and financial freedom had a positive impact on the trade efficiency of the Belt and Road countries. Specifically, monetary freedom belongs to regulatory efficiency, while financial freedom belongs to market openness. Monetary freedom contains two intermediate indicators, namely the weighted average inflation rate over

the past three years and government price controls. Within a reasonable range, the lower the average inflation rate of a country, the less price regulation by the government, the higher the index score, and the more currency and price are affected by the "invisible hand" of the market[117]. Wen Shuhui and Zhang Xin[118] believed that if the prices in importing countries are stable and commodity prices are more determined by the market, the trade volume and trade efficiency can be better promoted. In this case, the government should improve the efficiency of supervision, give play to the role of the market in regulating prices, and provide guarantees for the smooth progress of trade, thereby improving the efficiency of trade. Financial freedom reflects the operational efficiency and independence of banks and other financial institutions. The higher the score on this indicator, the higher the operational efficiency of the country's banks and other financial institutions, with less government intervention and higher operational independence. Wen Shuhui and Zhang Xin believed that financial opening would provide new impetus for deepening economic and trade cooperation among countries and promoting trade cooperation. Open financial markets will provide financial institutions with greater room for development, with more efficient financial services for bilateral trade and investment. Therefore, the government should expand market opening and promote trade between China and the “Belt and Road” countries, thereby improving trade efficiency.

INF (Trade and Transport Infrastructure Index) had a positive impact on trade efficiency in 2014 and 2016. Infrastructure interconnection is the cornerstone of the development of the Belt and Road Initiative, which is conducive to improving trade efficiency and policy communication and non-governmental exchanges with countries along the route. In this way, trade friction can be reduced and the export efficiency of aquatic products can be improved.

[117] Zhou Shudong, Zheng Jian, *Trade efficiency and influencing factors between China and RCEP partners* , Inquiry into Economic Issues , 2018, p.2-7.
[118] Wen Shushui, Zhang Xin, *Trade potential of Indo-China Peninsula and its influencing factors*, Journal of International Trade, 2017, p.4-10.

5.6. Conclusion

Overall, Shandong province has excess exports to Russia, the United Arab Emirates, Turkey, Poland and the Philippines, but there is a lot of room for improvement in aquatic product trade for most countries along the “Belt and Road” routes, especially the neighboring ASEAN countries. Therefore, Shandong province can formulate differentiated trade strategies for various countries according to the actual situation, focusing on cultivating countries with low trade volume and maintaining countries with mature trade.

In a full view of the above chapters, the export growth of aquatic products between Shandong province and the countries along the “Belt and Road” routes is mainly driven by trade potential. Therefore, the growth of Shandong's aquatic product exports is sustainable. Although the trade potential has a great role in promoting trade, it is also inseparable from the contribution of trade input and trade efficiency in Shandong province.

CHAPTER 6. CONCLUSIONS, RECOMMENDATIONS AND FURTHER RESEARCH

6.1. Main research conclusions

Based on the economic and international trade theories, the stochastic frontier methods and the new trade theory, this dissertation establishes the general analysis framework of aquatic products trade between Shandong province and countries along the Belt and Road from the perspective of trade potential. Meanwhile, several key concepts, such as the WTO, the per capita GDP of import and export countries, the degree of trade freedom, the degree of financial freedom, are noted to help evaluate the impact of the Belt and Road initiative on the potential and quality of trade. Finally, in accordance with theoretical research and empirical analysis and the experience of domestic and foreign trade potential promotion, certain policy suggestions are put forth to enhance the trade potential of aquatic products in Shandong province.

1. The following conclusions can be drawn from Chapter One: while the export volume and value of aquatic products in Shandong province were decreasing, they still accounted for a predominant position in comparison with other coastal provinces in China. For a long time, the policies of Shandong province along the Belt and Road have been changing. To adjust the structure of aquatic products with the policies of the Belt and Road Initiative, Shandong provincial government should combine the demand structure of markets and conform to the industrial transformation and upgrading trend of countries along the Belt and Road Initiative. In so doing, it can accelerate the transformation of export development power, and cultivate new export competitive advantages.

2. The following conclusions can be drawn from chapter Two. The aquatic products export to Belt and Road countries have shown trade competitiveness as well

as comparative advantages. The TC index of the export of aquatic products to Belt and Road countries from Shandong province is positive, the RCA index equals to 1 on average, and the values of the two indexes are increasing gradually. “0 < RCA < 1” means a comparative disadvantage for a certain industry or commodity. If the value is closer to 0 than 1, the disadvantage is more distinct. “RCA > 1” indicates an explicit comparative advantage for a certain industry or commodity in this country. The higher the value, the clearer the explicit comparative advantage and the stronger the competitive advantage. These data shows that the aquatic products of Shandong province have certain trade competitiveness and obvious comparative advantages.

3. By constructing the index system of aquatic products export market, this thesis classifies the aquatic products export markets of Shandong province and the Belt and Road countries to find that:

(1) The large differences in the basic economic conditions of each country, and the levels of economic development among the Belt and Road countries. Economic growth in most countries is relatively slow. The countries in West Asia generally have higher per capita GDP, while the countries in Central Asia generally have lower per capita GDP. Most of these countries have a high population density.

(2) The tariff rates of aquatic products trade differ greatly among Belt and Road countries, and is 0 for most FTA countries.

(3) In countries along the Belt and Road, a better business environment indicates the lower the cost of export, the stronger the desire to export, and the larger export scale. A good business environment is more conducive to aquatic products trade in a small number, however, the relatively poor business environment is common in these countries. Naturally, a poor business environment will weaken competitiveness and hinder export, and is not conducive to short-term aquatic products trade. The index system of subdivision of aquatic product export market showed that the aquatic products export markets of Shandong province and the Belt and Road countries can be divided into 4 groups, in which various export strategies should be applied.

(4) In the export of aquatic products in Shandong province, certain problems, such as low added value, potential quality and safety hazards, heavy dependence on

export, narrow export market, poor brand awareness and low degree of information technology, should be solved in no time. The import and export of most countries along Belt and Road belongs to "inadequate trade", with a large growth space for bilateral trade. Therefore, it is necessary for Shandong province to adjust the distribution of import and export markets to fulfill the market potential.

(5) On the basis of segmentation, a stochastic frontier gravity model is constructed to segment the aquatic products market, which can calculate the export potential value to judge aquatic products export potential of Shandong province to these 37 countries along the “Belt and Road” routes. Stochastic frontier gravitation model estimates show that the per capita GDP of importing countries ($H1_1$) has a significant positive correlation role in promoting the export of aquatic products trade, and the level of economic development of exporting Shandong province has a significantly greater role in promoting trade than that of trading partners. The per capita GDP of exporting countries ($H1_2$) is positively correlated with aquatic products export of Shandong province.

The total population of the importing country ($H1_3$) has a significant positive correlation with the export of aquatic products,which conforms to the theoretical hypothesis that the larger the market size of the importing country, the better the export will be. The total population of exporting countries ($H1_4$) is negatively correlated with aquatic products export of Shandong province.

Distance ($H1_5$) has a significant negative effect on the export of aquatic products, reaching -0.1585, indicating that transportation costs are an important factor hindering trade efficiency.

With China's entry into the World Trade Organization and the implementation of related tariff policies, tariff's share of national tax ($H2_1$) is used to measure the tariff barriers of a country. A high tariff level results in lower trade efficiency and is positively correlated with trade inefficiencies.

Whether the trade parties are members of the World Trade Organization ($H2_2$) has a significant negative correlation with trade inefficiencies, which indicates that participating in the multilateral trade system can promote the export of products

between Shandong province and countries along Belt and Road Initiative, and the large coefficient also indicates that we must continue to adhere to the general principles of the World Trade Organization to expand international trade.

Degree of currency freedom ($H2_3$) reflects factors, such as price stability and price management efficiency in importing countries. A higher score indicates that domestic price stability is strongly influenced by supply and demand. Price is determined by the market, and is positively associated with inefficiencies.

Ship Transport Connectivity Index ($H2_4$) is significantly negatively related to trade inefficiencies, because more than 70% of international trade is completed by sea transport, and the efficiency improvement of international ocean transport plays a promoting role in aquatic products trade, indicating that the future trade of Shandong province in aquatic products with countries along the Belt and Road can also vigorously develop through the sea in addition to the Silk Road land route transport completed.

The degree of financial freedom ($H2_5$) has a significant negative impact on the inefficiency of trade, indicating that the liberalization of financial plays a positive role in promoting trade development. The higher the evaluation of this index by importing countries, the better the export of aquatic products of Shandong province.

(6) The export volume of Shandong province to Russia, the United Arab Emirates, Turkey, Poland and Philippines remains excessive, yet the trade of aquatic products is insufficient for most countries along the Belt and all the way, especially for ASEAN countries. Therefore, these regions have more room for trade promotion. It is suggested that Shandong province should apply various methods for different countries in accordance with their respective situation, emphasizing on those with insufficient trade potential and ensuring mature countries with trade potential.

The growth of aquatic products export between Shandong province and each country along the Belt and Road is mainly at the mercy of trade potential. Therefore, the sustainable growth of aquatic products export in Shandong province cannot be separated from the improvement of trade potential. Although trade potential plays a major role in promoting trade, it cannot be separated from the contribution of trade

input and efficiency in Shandong province.

6.2. Recommendations

(1) Shandong province should give full play to its resource advantages with large marine and fishery provinces, using information technology to drive the modernization of aquatic products exportation and promoting sustainable and healthy development of aquatic products export industry. However, the quality of aquatic products directly determines the realization of export potential to the Belt and Road countries. In order to enhance trade competitiveness and comparative advantages of aquatic products, the government should actively guide enterprises to intensively study the aquatic products market access standards of the Belt and Road countries, and encourage enterprises to fully incorporate these market access standards into the breeding, fishing, circulation and processing of products. For enterprises that do not meet the corresponding standards, punishment measures should be conducted to cut off the production and circulation fundamentally and to improve the overall quality of aquatic products in Shandong province.

(2) Optimizing the export structure of aquatic products and widening the export market of aquatic products in an all-round way should be combined with the characteristics of market structure. Industrial transformation and upgrading of the countries along the line could accelerate the transformation of export development power, and cultivate new competitive advantage in export. Local governments and export enterprises should optimize the structure of aquatic products export between Shandong province and the Belt and Road countries. Meanwhile, Shandong province should give full play to the advantage of trade complementarity, fully tap the export potential of aquatic products, expand the export market, and increase the export volume of aquatic products.

(3) Local governments should give full play to their functions and strengthen support for aquatic products export to create a good environmental condition for the

export of aquatic products. To seize the opportunities of infrastructure construction in the countries along the lines, trade exchange through export associations, various industrial parks, e-commerce platforms, and business exhibitions should be established. In so doing, they can grasp the changes in consumption demand of the countries along the lines, provide guidance and suggestions to export enterprises, and promote coordination between export structure and consumption demand.

(4) Improve the efficiency of logistics services.

For most of the developing countries along the Belt and Road, the level and efficiency of logistics services can heavily restrict their international trade. Logistics infrastructure plays an important role in improving trade potential and expanding market scope. The Belt and Road strategy focuses on the interconnection of infrastructure including highways, railways, ports and airports, prioritizing the development of infrastructure areas to solve the actual problems of economic development. This strategy strongly confirms the necessity and accuracy of the implementation, and promotes the involved countries to improve the level and efficiency of logistics services. It is no doubt a win-win strategy to expand the aquatic product trade market by increasing the flow of trade and enhancing the potential of aquatic products business.

(5) Construction drives export growth in the construction of the marine economy.

The development of marine economy is currently a key economic engine in Shandong province to promote the fishery economic projects. On the one hand, the construction of "marine granary" is an important channel in the Belt and Road strategy to expand the export of aquatic products. China should actively promote the conversion of kinetic energy of marine economy and the transformation of fishery development mode, focusing on developing green eco-fishery and promoting the conversion of industrial development connotation by strengthening scientific and technological innovation services. On the other hand, the Belt and Road Initiative has entered the stage of comprehensive and practical cooperation. Shandong province is still facing challenges of inconsistency and inadequacy in the development of oceans and fisheries. The construction of "Marine Granary" will help Shandong province

embark on a new journey of speeding up the establishment of a strong marine province, improving international competitiveness and enhancing the level of economic and trade cooperation under the Belt and Road Initiative. A mutually beneficial and win-win mode of cooperation in aquatic trade could be achieved eventually.

6.3. Limitations and further research

Two methods are used to evaluate trade efficiency: data envelope analysis method and Stochastic frontier gravitation model. The conclusions are more robust and policy recommendations are more feasible.

Due to the lack of statistics in some countries, the empirical analysis in this dissertation could not examine the trade efficiency of all Belt and Road countries. However, follow-up studies should be conducted in the future to track the dynamic changes of the Belt and Road to ensure solidarity of the results.

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