8-22-2020

From emission trade sysytem to carbon offset: status and progress of emission control in shipping industry

Zhili Yao

WORLD MARITIME UNIVERSITY

Malmö, Sweden

FROM EMISSION TRADE SYSYTEM TO CARBON OFFSET: STATUS AND PROGRESS OF EMISSION CONTROL IN SHIPPING INDUSTRY

by

YAO ZHILI

A dissertation submitted to the World Maritime University in partial

Fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

In

MARITIME AFFAIRS

(INTERNATIONAL TRANSPORTATION AND LOGISTICS)

2020

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

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

(Signature): ……..

(Date): ……..

Supervised by: ……..

Supervisor's affiliation: ……

Title of Dissertation:	**From Emission Trade System to Carbon Offset: Status and Progress of Emission Control in Shipping Industry**
Degree:	**Master of Science**

With the development of global economic integration, the shipping industry is also developing rapidly, and it also causes a lot of energy consumption and carbon emissions. The carbon emissions of the shipping industry have reached 3.3% of global carbon emissions. In order to control carbon emissions, the world has taken various measures, such as carbon trading and carbon offsets.

However, the existing carbon trading has not formed a global market. Whether carbon trading can effectively reduce carbon emissions and whether it is suitable for the shipping industry is still unknown.

Here we study the characteristics of carbon emissions from the shipping industry, analyze the impact of China's carbon trading pilots on carbon emission reduction. The advantages and limitations of carbon trading and carbon offsets on shipping carbon emission control are discussed in conjunction with relevant literature.

It is recommended to improve the formulation of relevant regulations on shipping carbon trading and attempts to offset carbon emissions in the shipping industry as soon as possible.

We anticipate providing reference and support for China and the global shipping industry to reduce carbon emissions.

KEYWORDS: Shipping industry, Carbon trade system, Carbon offset, Carbon emission control

Contents

1 Introduction

1.1 Background

Since the first industrial revolution started in Britain in the 1860s, human science and technology and production technology have developed rapidly, and human's ability to transform nature has been increasing. Since the Industrial Revolution, carbon emissions in the atmosphere have risen sharply due to human activities, increasing by about 25% -30%. The increase of these greenhouse gases has caused the greenhouse effect to continue to increase, with serious consequences such as global warming, extreme Natural disasters such as extreme weather, species extinction, and typhoon and drought, the consequences of these are unbearable for humans. Therefore, protecting the environment and controlling carbon emissions are urgent.

The history of human beings using ships as tools to transport by water is almost as long as the history of human civilization. Because of the irreplaceable advantages of ship transportation in terms of volume and distance, even today, aviation and railway transportation have matured, and shipping still carries about 90% of the world's trade transportation volume. With the continuous development of the shipping industry in recent years, the increase in the number of ships and the development of large-scale ships, the pollution caused by ship transportation has also increased the pressure on the atmospheric environment. The shipping industry will continue to grow in the future. If the carbon emissions restriction measures are not in place, the shipping industry's greenhouse gas emissions will increase significantly. Therefore, in recent years, the IMO and the European Union have adopted a series of measures to control the carbon emissions of ships.

Facing the severe carbon emission reduction situation, the World Maritime Organization (IMO) and various countries have also issued corresponding policies to reduce greenhouse gas emissions. IMO proposed the Ship Energy Efficiency Design Index (EEDI) for the ship design and construction industry to estimate the carbon dioxide generated by the volume of freight per unit of ships, aiming to increase the volume of ships and reduce the amount of carbon dioxide emissions during the ship design phase. At the same time, relevant organizations have also started to design emission reduction targets for carbon dioxide emissions. For example, the IPCC's emission reduction target is "by 2050, marine carbon emissions will be 15% -50% lower than current levels." After the European Union proposed to impose a carbon tax on the aviation industry, it also proposed to impose a "maritime carbon tax" on ships entering and leaving the EU.

Since China's reform and opening up, along with the rapid development of its economic strength, the environmental costs it has paid cannot be underestimated. As the world's second largest economy, China emits more than 6 billion tons of carbon dioxide each year, becoming the country with the largest carbon dioxide emissions in the world. It has an inescapable responsibility for global climate change and air pollution. As a large country, at the Copenhagen World Climate Conference in 2009, the Chinese government set a reduction target of “40% -45% reduction in carbon emissions intensity per unit GDP by 2020 compared to 2005”. China has also promulgated a series of rules and regulations and amended the corresponding laws to meet the carbon emission reduction target.

There are three main types of carbon emission reduction measures: command, fiscal, and market. Among them, market-based carbon emission reduction measures are the most effective and sustainable measures. At present, market-based carbon emission reduction measures are mainly carbon trading and carbon offset. Compared with other emission reduction systems, the carbon emissions trading system consumes less socioeconomic costs and the system is more mature. It

realizes the optimal allocation of resources through the price mechanism, and it also has an incentive role for emission participants to actively participate in carbon emission reduction activities. At present, the carbon emission trading mechanism has become one of the important policy tools in the process of managing global environmental problems. Many countries, such as Germany, the United States, and Canada, have matured their carbon emission trading systems in the power, industrial, and forestry industries. The Kyoto Protocol specifies three carbon emissions trading mechanisms: international emissions trading, joint implementation, and the Clean Development Mechanism. The shipping industry has also gradually heard the establishment of a shipping carbon emission trading mechanism, but due to the particularity of the shipping industry, a complete and clear shipping carbon trading system and supporting laws and regulations have not yet formed.

Carbon offset refers to the total amount of greenhouse gas emissions directly or indirectly measured by a company, group or individual within a certain period of time. Through tree planting, energy conservation and emission reduction, etc., to offset the carbon dioxide emissions generated by itself, and achieve "zero emissions of carbon dioxide". In the air transport industry, at the 75th annual meeting of the International Air Transport Association (IATA), participating airlines voted to call on governments to continue to carry out important work to ensure that the United Nations International Civil Aviation Organization (ICAO) has established the global air transport industry carbon offset plan and CORSIA have been fully implemented. In the shipping industry, carbon offset is still in the planning stage. Global shipping business AP Moller-Maersk has set a goal of achieving “carbon offset” by 2050. Maersk said that to achieve its goals, carbon-neutral ships need to be commercially viable by 2030. Compared with carbon emissions trading, carbon offset has more development prospects, especially under the trend that carbon emission rights are increasingly oversupplied, carbon

neutralization will be a better carbon emission reduction scheme.

1.2 Research questions

1.2.1 Is there any problem in China's shipping industry using carbon trading to reduce emissions?

Since China formally proposed to implement a carbon emission trading system in 2010, China's carbon emission trading market is still in the stage of exploration and improvement. There are still many problems: low participation in the international carbon market, imperfect legal system, and carbon trading price mechanism Absent, etc. China's shipping industry has a large amount of carbon emissions and will continue to rise in the future. Will the carbon emission market quotas exceed supply? Can the implementation of carbon emissions trading play a role in controlling carbon emissions? These issues deserve further analysis.

1.2.2 Is China's current shipping emission reduction policy effective?

After the Ministry of Transport of China issued the "Implementation Plan for the Ship's Air Pollutant Emission Control Zone" on November 30, 2018, it has been implemented for more than a year. Has the implementation of this policy effectively achieved the ship's emission reduction expectations? Is there a need and sustainability for continued implementation? Does it fit the actual situation?

1.2.3 Can carbon offset be an effective measure of reducing carbon emissions from shipping?

The rise of carbon neutrality and carbon offset represents a new way to control carbon emissions. Maersk Group's plan to achieve zero net carbon emissions in 2050 has sparked heated discussions in the industry. Can carbon offset be one of the means

to effectively control carbon emissions from shipping?

1.3 Literature review

1.3.1 Carbon emission in shipping industry

Researchers have done many analyses on carbon emission in shipping industry.

In Fang (2015) 's article, we can see that ships bear about 80% of the world's cargo volume, realizing nearly one-third of world trade value, and promoting the development of economic globalization and the rapid expansion of global cargo transportation. As the transportation medium of the shipping industry, the CO_2 emissions generated during the transportation are 3.3% of the total global emissions. The environmental problems caused by this have attracted widespread attention from the international community. However, the factors affecting shipping carbon emissions are complex. Chen (2017) talks about the factors affecting carbon emissions from international shipping. The expansion of international logistics scale is the most direct cause of carbon emissions from international shipping by sea. The improvement of energy efficiency and optimization of the energy structure can suppress carbon emissions, but the adjustment efforts have not been adapted to the growth of logistics scale. The development of energy-saving technologies can curb the carbon emission. That can also be found in the article of Yin (2015), it believes that the larger the ship, the lower its unit carbon emissions, but the reduction effect of shipbuilding and large-scale measures has declined over time; large-scale fleets can significantly reduce shipping carbon emissions, and large-scale ships Whether the team's competitiveness is in the early, middle or long term, the competitive advantage is obvious.

1.3.2 Emission control policies

In recent years, the IMO and the European Union have adopted a series of measures to control the carbon emissions of ships. Zhou (2015) 's article analyses IMO's policies on emission control. In 1997, at the Conference of the States Parties to the International Convention for the Prevention of Pollution from Ships (MARPOL), the IMO passed a resolution cooperating with the United Nations Framework Convention on Climate Change (UNFCCC) to study the issue of carbon dioxide emissions from ships. In September 2010, the IMO approved the draft amendment circular to the International Convention for the Prevention of Pollution from Ships (MARPOL) of the International Convention on the Prevention of Pollution from Ships (MARDI) on the Energy Efficiency Design Index for New Ships (EEDI) and Ship Energy Efficiency Management Scheme (EEMP). MEPC was approved at the 62nd meeting in July, and will take effect by default on January 1, 2013. Zhao (2015) point out that the European Union successively proposed to impose an aviation carbon tax and a maritime carbon tax in 2012. Both have been boycotted by countries around the world. Therefore, like Mellin et al. (2011) said, it seem to support that ports with a more comprehensive environmental approach are more positive towards a mandatory regulation of shipping's CO_2 emissions.

So does Liu (2016), he figures out that in June 2013, the EU formulated a shipping industry emission policy, and announces that the shipping industry's emission reduction policy will take three steps: (1) Establish a shipping "Monitoring, Reporting and Verification (MRV, Measurement, Reporting and Verification) Provide the necessary data basis for shipping greenhouse gas emission reduction; (2) set greenhouse gas emission reduction targets for the shipping industry; (3) implement market based measures (MBMs) in the medium and long term.

In the article of Giziakis et al. (2012), they point out the implementation of some policies. A large part of the Greek shipping industry is familiar with the EEOI for

ships, which demonstrates an advanced level of regulatory awareness concerning the reduction of GHG emissions from ships. Moreover, many of the participant companies have a positive view on the development of an EEOI for ships and consider that the use of such an index is probably necessary for the adoption of an effective policy instrument for the reduction of GHG emissions from ships.

As a major shipping country, China is actively taking responsibility for reducing carbon emissions from shipping. Shi (2018)'s showed that on June 15, 2016, China Classification Society was recognized by the Danish National Accreditation Agency (DANAK) as an EU MRV certification body. It can carry out the verification of the carbon dioxide emissions monitoring plan and monitoring report of ships sailing in EU waters in accordance with the requirements of the EU Maritime MRV Regulation jobs. To date, CCS has implemented carbon emission MRV monitoring plan verification and approval for more than 500 ships.

1.3.3 Emission trade system and carbon-offset

The "Kyoto Protocol" is the first legal document in history to quantify emission reduction targets in the form of international law and involves the international greenhouse gas emissions trading system. Dales (1968) was the first to introduce the concept of property right to research into environment regulation to curb pollution, laying a solid theoretical foundation for emission trade studies.

Yan et al. (2020) affirmes that ETS has produced ideal air pollution control results in practice. The collaborative control of the environment by virtue of ETS is both a system innovation and new market-based environment regulation instrument. However, Hermeling et al. (2015) have different perspective. They suggest that the attempt to implement an EUMETS runs into a dilemma. It is impossible to design a scheme that achieves the goal of emission reductions in a cost efficient manner and is compatible with international law. Although the effects of such a global maritime ETS remains to be studied in detail, policy makers should

continue working on an international agreement to reduce maritime emissions instead of resorting to regional schemes.

China is stepping up efforts to trade in carbon emissions markets. China has made pilot carbon trading a key task in controlling greenhouse gas emissions during the 12th Five-Year Plan period. Gan et al. (2013), through the analysis of the shipping industry in China, point out that the number of domestic ships is huge, which has a broad market basis for ship energy conservation and emission reduction.

Carbon offset is another market measure for carbon emission reduction. The carbon offset for the forestry sector is well established and is traded under both compliance and voluntary carbon markets. Salt marshes, mangroves, and seagrass meadows are the major coastal wetland and aquatic habitats that provide various ecosystem services including carbon sequestration and storage of this “blue” carbon. Sapkota et al. (2020) believe that Several efforts have been made to bring the blue carbon offset into the carbon market including the development of wetland carbon offset methodologies. Blue carbon system could potentially benefit by generating offsets in the growing voluntary and compliance carbon markets.

Gong et al. (2012) analyzes the potential benefits of carbon offsets. Carbon offsets have potential synergies, can promote the sustainable development of developing countries, can offset the achievable economic benefits of all parties in the transaction, and promote technological innovation.

Liu (2015) finds two problems in the analysis: difficulties in assigning responsibilities to countries under the carbon offset mechanism and inconsistent selection of emission units in the carbon offset mechanism.

1.3.4 Weaknesses in the existing literature

1.3.4.1 Lack of analysis of possible problems in implementing carbon trading in China's shipping industry

Since China formally proposed to implement a carbon emission trading system in 2010, China's carbon emission trading market is still in the stage of exploration and improvement. There are still many problems: low participation in the international carbon market, imperfect legal system, and carbon trading price mechanism Absent, etc. China's shipping industry has a large amount of carbon emissions and will continue to rise in the future. Will the carbon emission market quotas exceed supply? Can the implementation of carbon emissions trading play a role in controlling carbon emissions? These issues deserve further analysis.

1.3.4.2 Lack of analysis of the effect of China's current shipping emission reduction policy before and after implementation

After the Ministry of Transport of China issued the "Implementation Plan for the Ship's Air Pollutant Emission Control Zone" on November 30, 2018, it has been implemented for more than a year. Has the implementation of this policy effectively achieved the ship's emission reduction expectations? Is there a need and sustainability for continued implementation? Does it fit the actual situation?

1.3.4.3 Lack of analysis of the application prospects of carbon offset in the shipping industry

The rise of carbon neutrality and carbon offset represents a new way to control carbon emissions. Maersk Group's plan to achieve zero net carbon emissions in 2050 has sparked heated discussions in the industry. Can carbon offset be one of the measure to effectively control carbon emissions from shipping?

1.3.5 Amendments

In accordance with existing problems we have talked above. I would like to make following amendments

1.3.5.1 Analyze possible problems facing carbon trading in China's shipping industry

By analyzing the current status and problems of carbon emissions trading markets in China and internationally, and discussing the actual situation of China's national shipping industry and the carbon emissions of China's shipping industry, discuss whether it is of practical significance for China's shipping industry to achieve carbon emission control through carbon trading .

1.3.5.2 Analyze and compare the improvement of carbon emissions before and after the implementation of China's shipping carbon emission reduction policies (preferably before and after data comparison)

A preliminary conclusion is drawn by comparing the data before and after the implementation of the policy. This conclusion helps test the effectiveness of China's current emission reduction policies. Analyzing the results, we can come up with some methods that can help improve shipping carbon emission reduction policies.

1.3.5.3 Analysis of the possibility of carbon neutrality in the shipping industry

Analyze the implementation effect and current status of carbon neutrality in other industries, compare the actual situation of carbon emissions in the shipping industry, and explore the possibility of applying carbon neutrality in the shipping

industry in various aspects. If the effect of carbon neutrality on controlling shipping carbon emissions is not significant, are there other ways to achieve the goal of reducing shipping carbon emissions?

In conclusion, when we talk about emission control in shipping industry, there are still some areas for us to explore deeply inside. Researches on the policies and measures of emission control is still far from complete.

1.4 Research framework

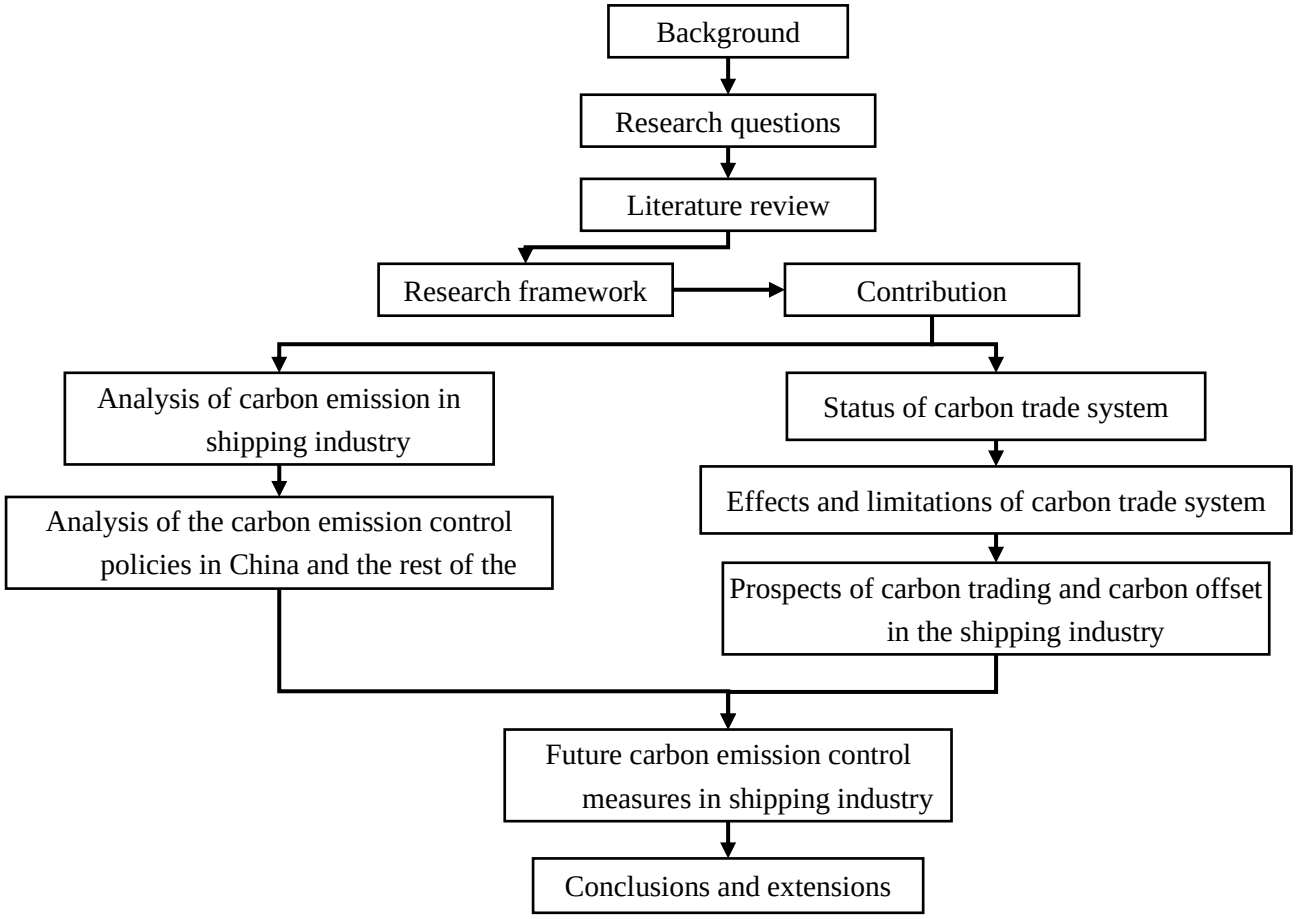

Figure 1 Research Framework

Shipping to maintain the flow of world trade is an important part of world economic development, but at the same time, the pressure to reduce carbon emissions is also

very large. Now that greenhouse gas emissions have caused serious consequences, studying the current status and development direction of carbon trading and carbon emissions is of great significance for controlling the carbon emissions of the shipping industry.

By analyzing the carbon emission characteristics of the shipping industry, this paper finds the obstacles to the difficulties of shipping carbon emission reduction; by analyzing the existing global carbon emission reduction policies, it has guiding significance for the formulation of reasonable shipping carbon emission reduction; Carbon trading market data and carbon emission data, to study the impact of carbon trading on carbon emission reduction, has reference significance for the selection of more effective carbon emission reduction methods.

2 Carbon emission in shipping industry

2.1 Characteristics of carbon emission in shipping industry

Shipping transportation is a mode of transportation in which ships are the main means of transportation, ports or ports are used as transportation bases, and waters including oceans, rivers, and lakes are used as the scope of transportation activities. Shipping transportation is the earliest and longest history transportation method among the current major transportation methods. Its technical and economic characteristics are large load capacity, low cost and low investment, but it has little flexibility and poor continuity. It is more suitable for carrying medium- and long-distance transportation of bulk, low value, bulky and various bulk cargoes, especially sea transportation, and is more suitable for bearing the import and export transportation of various foreign trade cargoes.

The long cycle and large volume of maritime transportation also means that the ship has a long sailing time, and also needs a lot of power to carry and promote the

ship's sailing. The energy consumption of the ship is very large, resulting in a very large carbon emission. Especially with the globalization of international trade, supply chain networks are often spread all over the world, and international shipping routes are becoming more and more abundant. Maritime transportation not only meets long-distance transportation, but also sometimes meets certain time constraints. The faster the ship travels, the more fuel it consumes.

Shipping is a low-cost mode of transportation. How can this low freight rate be achieved? The fuel price of the ship must be low. Most ocean-going ships that open water channels between countries all over the world are powered by fuel oil, because fuel oil is easier to store and transport than coal, and the price is cheaper. However, the carbon emission coefficient of fuel oil is very high among various main fuels. If you want to use a fuel with a lower carbon emission coefficient, cleaner and more efficient fuel (such as liquefied natural gas) as the fuel oil for ships, the fuel cost of marine transportation will increase significantly, and it is difficult to transform all the working ship was transformed into a ship using clean energy.

Another characteristic of maritime transportation is mobility, and it is not only moving on domestic waterways, but also cross-regional and cross-national, so its carbon emissions are also unbounded. In fact, this feature is unfavorable for controlling carbon emissions, because it will be very controversial in the final determination and attribution of responsibility. These controversies will hinder various measures to reduce carbon emissions.

2.2 Factors of carbon emission in shipping industry

Factors of carbon emissions refer to the relevant factors that affect the amount of carbon emissions in the logistics process. According to the research level, they can be generally divided into broad-based influencing factors and narrow-influencing factors. The influencing factors in a broad sense will include the operating factors of shipping companies, the environmental influencing factors of laws and

regulations, and so on ;the influencing factors in a narrow sense mainly focus on direct influencing factors such as energy consumption.

The most significant impact on maritime carbon emissions is energy consumption, which can be subdivided into energy structure and energy efficiency. The energy structure is related to the power source used by the ship, that is, the fuel used by the ship. If you want to control the carbon emissions of a ship, you must adjust the energy structure of the ship to use a cleaner fuel with a lower carbon emission coefficient. Energy efficiency is related to the structure of the ship and shipbuilding technology. Through better technology, improving the utilization of energy and reducing waste of energy to reduce the use of fuel and ultimately achieve the purpose of reducing carbon emissions.

The freight scale and transportation distance of ocean transportation are also important factors that affect the carbon emissions of ocean transportation. The enlargement of ships can not only reduce the economic cost of transportation, but also reduce the carbon emissions per unit of transportation. Through more concentrated and effective transportation schemes and routes, and more timely transportation regulation and allocation, it can play the role of improving energy efficiency, reducing energy waste and reducing carbon emissions.

The impact of international trade on shipping carbon emissions cannot be ignored. If international trade cooperation increases, the demand for international logistics will certainly increase, and the demand for international shipping logistics will also increase. The increasingly close international trade makes the logistics distance required for trade expand. The complex situation of international trade will also make international shipping carbon emissions more serious. Unbalanced trade between countries will cause problems such as empty container transfers, increase transportation costs and carbon emissions.

2.3 Difficulties in controlling carbon emission from shipping

We all want to improve the global environment and reduce carbon emissions in shipping. But due to the characteristics of maritime transportation and the current international economic and trade environment and technical limitations, we still encounter many difficulties.

In the first place, there are conflicts between reducing carbon emissions and international economic and trade development to a certain extent. Today, the globalization of trade makes international transportation and international shipping an indispensable and important mode of transportation. The trend of globalization will also inevitably lead to an increase in international routes and a longer transportation distance. Want to control the carbon emissions of transportation, but cannot restrain international economic and national development as a price. In addition, different countries have different economic and technological levels. The carbon emissions of developed countries may be relatively stable, while the growth of carbon emissions in developing countries is difficult to control. The economic development needs of developing countries and limited shipbuilding technology will conflict with the goal of controlling carbon emissions.

Secondly, the current development of shipbuilding technology is still unable to keep up with economic development. In other words, the development of low-carbon technologies cannot meet the demand for reducing carbon emissions. Changing the energy structure and energy efficiency of ships is much more difficult than turning gasoline-powered cars into electric cars. Although the scale of new energy-powered ships (such as LNG fuel-powered ships) is now expanding, construction and reconstruction costs are high due to factors such as imperfect regulations, lagging infrastructure, equipment supply, and low design and process levels. , Failed to highlight economic advantages. It is still a big problem to achieve large-

scale innovations in marine energy technology.

In addition, because the ship is moving during transportation, and moves across regions or even countries, carbon emissions are also unbounded. This will have different calculation methods and standards and different determinations when measuring ship carbon emissions Criteria for attribution of responsibility. This will lead to the problem of inability to define the responsible person and the inability to supervise the liquidation and handling of carbon emissions. Even with various legal regulations and international regulations, it is still easy to shirk responsibility and weak supervision. In the end, a series of carbon emission control methods have little effect or even cannot be implemented.

3 Analysis of the carbon emission control policies in China and the rest of the world

3.1 Carbon emission control policies in China

In fact, layout of China's policies on carbon emission control is not very smooth from the beginning.

In 1988, the United Nations Environment Program and the World Meteorological Organization established the Intergovernmental Panel on Climate Change and began negotiations on the Global Environmental Assessment and the United Nations Framework Convention on Climate Change. At this time, China is in the economic development stage of reform and opening up, and is wary of the political postage of carbon emission reduction. Therefore, China only formally ratified the United Nations Framework Convention on Climate Change in 1994. In 1997, when the "Kyoto Protocol" was introduced, China remained skeptical and boycotted. China ’s main views at the time included the following three points: 1) Clearly opposed to adding any new obligations to developing countries,

emphasizing the responsibility of developed countries to take the lead in reducing emissions; 2) Persisting in not committing to reducing emissions; 3) Promoting the development of the Kyoto Protocol The conclusion of national emission reduction is skeptical.

After 2000, China's position began to change, and actively participated in the clean development mechanism (CDM) negotiations. In 2002, Premier Zhu Rongji announced China's approval of the "Kyoto Protocol"; in 2009, Premier Wen Jiabao announced at the Copenhagen Climate Conference that China's 2020 unit GDP carbon dioxide emissions will be reduced by 40% -45% compared to 2005. The main reasons for this change are as follows: 1) China pays more attention to the future development prospects of the carbon emission reduction economy; 2) In the late 20th century, extreme events occurred frequently, and climate scientific research gradually recognized ecological vulnerability; 3) foreign countries against China The pressure to reduce emissions is increasing, and the domestic energy demand is soaring. There is an urgent need to develop clean energy to reduce dependence on petrochemical energy.

Since 2011, China has begun to formally deploy its own carbon emission reduction policies. In October 2011, China ’s National Development and Reform Commission issued the “Notice on Pilot Work on Carbon Emissions Trading”, which approved Beijing and other six provinces and cities to conduct carbon emissions trading pilot work in 2013-2015 The development of the market. China and many countries signed a climate change statement to promote China ’s emission reduction goals to the world: In November 2014, the “Sino-US Joint Climate Change Statement” announced that China plans to peak carbon dioxide emissions around 2030 and will strive to reach the peak as early as possible. By 2030, the proportion of non-fossil energy in primary energy consumption will increase to about 20%. After this, China has successively signed the "Joint Statement on Climate Change" with India, Pakistan, the European Union, France

and other countries. In September 2015, China once again emphasized in the "China-US First Climate Change Joint Statement" that China's carbon dioxide emissions per unit of GDP by 2030 will be 60% to 65% lower than that of 2005, and forest stocks will increase by 45 hundred million cubic meters compared to 2005. The national carbon emissions trading system is planned to be launched in 2017 and will cover key industrial industries such as steel, power, chemical, building materials, papermaking and non-ferrous metals. On December 19, 2017, China's National Development and Reform Commission announced that with the breakthrough in the power generation industry, the national carbon emissions trading system was officially launched.

China's carbon emissions situation is still very severe and urgent. On the one hand, as early as 2014, China's carbon dioxide emissions were 9.76 billion tons, accounting for 27% of global emissions, which exceeded the total emissions of the United States and the European Union (9.7 billion tons), making it the country with the largest carbon dioxide emissions in the world. China's carbon dioxide emissions are still rising slowly, while the United States and the European Union have entered a decline channel. It is expected that the gap in emissions will continue to expand in the future. China's environmental pollution is becoming more and more serious. Extreme weather and smog have seriously affected people's lives and even affected the environment of neighboring countries. On the other hand, the continuous improvement of people's living standards and the increased awareness of environmental protection have forced the country to increase the importance of environmental protection. It is expected that future environmental pollution control and carbon emission reduction will be the long-term themes.

Table 1 Carbon emission control policies in China

Country	Year	Policy
CHINA	2002	China approved the Kyoto Protocol.
	2011	The “Notice on Pilot Work on Carbon Emissions

		Trading" was issued, and Beijing, Shanghai, Tianjin, Hubei, Chongqing, Guangdong, and Shenzhen were approved to conduct carbon emissions trading pilots from 2013 to 2015.
	2017	The national carbon emission trading system was officially launched.

3.2 Carbon emission control policies in other countries

The greenhouse effect is the main environmental problem caused by carbon dioxide emissions. Because the greenhouse effect is a global problem, carbon emissions also require certain international policies and agreements in the global dimension to achieve effective control and resolution. Therefore, the policy to control carbon emissions is first established on the basis of an international collaboration.

Global carbon emission policies generally formulate various conventions or agreements through international organizations in order to urge all countries in the world to assume their respective carbon emission reduction obligations. The United Nations Framework Convention on Climate Change was adopted by the UN General Assembly in 1992 and entered into force on March 21, 1994. In 1997, the "Kyoto Protocol" was signed, making greenhouse gas emission reduction a legal obligation for developed countries, requiring developed countries to reduce their emissions by 5.2% over the five years from 2008 to 2012 on the basis of 1990. The United Nations Framework Convention on Climate Change first determined the ultimate goal of combating climate change: the concentration of atmospheric greenhouse gases should be stabilized at a level that would prevent dangerous human interference in the climate system. This level should be achieved within a time frame sufficient for the ecosystem to be sustainable. It also established the basic principles of international cooperation to combat climate change, including

the principles of "common but differentiated responsibilities", the principle of fairness, the principle of respective capabilities and the principle of sustainable development. The convention also specifies that developed countries should undertake the obligation to take the lead in reducing emissions and providing financial and technical support to developing countries. The Convention also recognizes the priority needs of developing countries to eradicate poverty and develop their economies. However, because this convention will involve the economic interests of many developed countries and the difficulty in reaching agreement on the international financial mechanism, the implementation and promotion of this convention is also difficult. For example, during the 6th Conference of the Parties to the United Nations Framework Convention on Climate Change, the United States withdrew from the "Kyoto Protocol", casting a shadow over the "Kyoto Protocol" and setting up obstacles to the international emissions reduction process. This also shows that although the United Nations and other international organizations have certain compulsions in the formulation and promulgation of these conventions and agreements, due to the controversy over their supervision and punishment mechanism, more efforts are needed to make the conventions in place.

Under the constraints of various international conventions, in order to achieve emission reduction targets, all countries have proposed their own domestic emission reduction regulations.

The EU has always maintained a positive attitude towards reducing global carbon emissions. In the "Kyoto Protocol", from 2008 to 2012, the average annual emissions of six types of greenhouse gases such as carbon dioxide from the European Union were 8% lower than the emissions from 1990. In order to help EU member states to achieve this goal together, the EU has developed an emissions trading system, which was put into trial operation in early 2005 and officially started operation in early 2008. The European Carbon Emissions Trading

System (EU-ETS) is the world's largest carbon emissions trading market, and it has made tremendous contributions to the global reduction of carbon emissions through the mandatory regulation of carbon emissions by companies. On May 17, 2011, the UK became the first country in the world to make a legally binding commitment to post-2020 carbon reduction targets. British Energy Secretary Huon announced the fourth "carbon budget" in the UK, planning to reduce greenhouse gas emissions to half of 1990 levels from 2023 to 2027, reducing the total to 1.95 billion tons, and reducing emissions by 60% by 2030. Reduce emissions by 80% by 2050. France launched the "National Plan for Controlling the Greenhouse Effect" on January 19, 2000. The EU also levies taxes on carbon emissions, but currently there is no uniform carbon tax, and only some member states such as Finland, Sweden, Denmark, the United Kingdom, Spain, Poland, and the Netherlands have already imposed fossil fuel consumption based on their carbon emissions (or carbon content) To levy a tax with the nature of carbon tax, the taxation of motor vehicles should also consider carbon emission factors. However, the carbon emission reduction policy of carbon tax collection, especially when expanding the scope to the aviation and nautical industries, has caused great controversy.

In contrast, the United States has a relatively negative attitude towards carbon reduction. In March 2001, the US government refused to sign the "Kyoto Protocol", and on February 14, 2002, it issued its own replacement plan. The core of the plan is that the United States will reduce greenhouse gas intensity by 18% in the next 10 years, that is, to reduce 183 t per million US dollars of GDP in 2002 to 151 t in 2012, and provide $ 4.6 billion in clean energy for the next 5 years. Tax incentives are used for renewable energy, hydrogen energy, fuel cell vehicles, combined heat and power systems (CHP), and carbon absorption by land. It can be seen from this that the United States has a strong economic appeal for carbon reduction. The reason may be that the United States itself is rich in energy resources, and economic

development also needs to be based on high energy consumption. If carbon emission reduction is promoted quickly, it may damage the economic interests of the United States.

Table 2 Carbon emission control policies in other countries

Country	Year	Policy
UN	1992	United Nations Framework Convention on Climate Change was adopted at the UN General Assembly.
	1997	Kyoto Protocol was signed to make greenhouse gas reduction a legal obligation for developed countries.
EU	2005	EU-ETS began trial operation.
		Some EU member states, such as Finland, Sweden, Denmark, the United Kingdom, Spain, Poland, and the Netherlands taxed on carbon emissions.
UK	2011	British Energy Secretary Huon announced the Fourth Carbon Budget in the UK.
FRANCE	2000	National Plan for Controlling the Greenhouse Effect was launched.
US	2002	After refusing to sign the Kyoto Protocol, the US issued its own alternative plan.

3.3 Current status of shipping carbon emission control policies

The shipping industry is a high energy consumption and high emission industry. The total amount of fossil energy consumed each year is huge, and the total amount of carbon dioxide emitted is also large. Statistics show that about 30% of the global

nitrogen oxide gas emissions come from the shipping industry, and 3% of the global carbon dioxide emissions also come from the shipping industry. The situation of carbon dioxide emission reduction is urgent. The International Maritime Organization (IMO) and various countries have introduced various emission reduction measures to reduce the carbon emissions of the shipping industry.

The International Maritime Organization (IMO), in the amendment to the MARPOL Annex V1 Regulation on Energy Efficiency of Ships, determined that the ship energy efficiency design index will take effect on January 1, 2013, while allowing the contracting authority of the Contracting State The agency grants a grace period of no more than 4 years to the new ship EEDI. EEDI is an indicator to measure the CO_2 effectiveness of new ships. The principle of the new ship's energy efficiency design index is to indicate the energy efficiency of the ship based on the ratio of CO_2 emissions and freight capacity; that is, according to the propulsion power and related auxiliary power consumed by the ship at a certain speed when the ship is designed to carry a maximum load Calculated CO_2 emissions from fuel oil (g CO_2 / t · nm). At the same time, through statistical analysis of existing ships of various types and different tonnages, an emission baseline is established, and the energy efficiency of the new shipbuilding is controlled in the basis of the baseline. According to the Energy Efficiency Design Index (EEDI) launched by the International Maritime Organization (IMO), the carbon efficiency of ships built between 2015 and 2019 must be increased by 10%, and the carbon efficiency of ships built between 2020 and 2024 must be increased by 20%. The carbon efficiency of ships must be increased by 30%, and the regulations apply to all ships with a gross tonnage of over 400, effective from January 1, 2013. EEDI puts forward higher requirements on ship design, production technology, supporting equipment, and application of new energy technologies. Once IMO enforces EEDI, ship design, construction and supporting units must improve ship types that do not

meet the requirements before they can enter the international market. The role of EEDI is to hope to reduce emissions technically from the source of emissions. This is the performance of IMO's determination to reduce carbon emissions from the shipping industry.

After the introduction of the aviation carbon tax, the European Union introduced a large international carbon tax, the maritime carbon tax, but the maritime carbon tax was opposed by all parties as soon as it was proposed. In February 2012, the European Union had just promised to "conditionally suspend" the aviation carbon tax regulations, and the European Commission proposed to increase the "nautical carbon tax" in June 2012 to formulate a carbon emissions tax for the global aviation and maritime transport industry. Levied price list. For the purpose of this initiative, the European Commission and the shipping industry have their own opinions. The European Commission said that the levy of marine carbon tax can eliminate ships and even shipping companies that do not meet carbon emission standards from the market; however, experts in the shipping industry believe that the EU hopes to promote its own energy-saving emission reduction technology through such actions. This is an opportunity for European economic recovery. Because it wants to meet the EU standards, currently only the EU technology is purchased. The levy of the nautical carbon tax is only an excuse for the EU to increase the source of tax revenue.

The European Union Emissions Trading System (EU ETS), established in 2005 by the European Union, is by far the world ’s largest emissions trading system and the only inter-country, multi-sector mandatory emission reduction trading system. During the construction of the carbon trading market, high-quality greenhouse gas emission data is the basis of carbon trading. Therefore, it is necessary to strictly control the quality of carbon emission related data and information to ensure that the greenhouse gas emission data generated within the enterprise is accurately accounted for and reported, and can be used by the government, enterprises, the

international community, and the public. On June 28, 2013, the European Union proposed a draft law to monitor, report, and verify greenhouse gas emissions from maritime transportation (MRV, Measurement, Reporting and Verification). On May 19, 2015, the European Commission 's Regulation on Monitoring, Reporting, and Verification of Shipping Greenhouse Gas Emissions (MRV Regulation) was officially published in the EU Official Gazette in June 2013. This signifies that the regulation has completed all legislative procedures and has officially become EU law. The regulations came into effect on July 1, 2015, and the first monitoring cycle began on January 1, 2018. The EU MRV regulations cover carbon dioxide emissions from the burning of all fuels on board, excluding other greenhouse gases; coverage covers all ships of 5000 gross tonnage and above that enter and exit the EU, sail between EU member states, and dock at EU ports, without distinction Flag and shipowner. However, there are also views that the implementation of the EU MRV regulations and subsequent market measures will have a significant impact on shipping economic costs, international trade and the vitality of the international shipping market.

Table 3 Carbon emission control policies in shipping industry

Organization	Year	Policy
IMO	2013	In the amendments to the MARPOL Annex V1 Regulations on Ship Energy Efficiency, the Ship Energy Efficiency Design Index (EEDI) took effect.
EU	2015	The Monitoring, Reporting, and Verification Regulations for Shipping Greenhouse Gas Emissions (MRV Regulations for short) completed all legislative procedures and formally became EU law.

4 Advantages and disadvantages of carbon trade system and carbon offset

4.1 Status of carbon trade system

The concept of carbon emissions trading originated from the concept of "emission trading" first proposed by American economist Dales in 1968, that is, to establish the right to discharge pollutants legally, and to express it through the form of emission permits, so that the environment Resources can be bought and sold like commodities. At the time, Dales gave a plan for the application of water pollution control. Subsequently, in solving the problem of reducing emissions of sulfur dioxide and nitrogen dioxide, emission rights trading methods were also applied. The "Kyoto Protocol" under the "United Nations Framework Convention on Climate Change" regards the market mechanism as a new way to solve the greenhouse gas emission reduction problem represented by carbon dioxide, clearly defining the greenhouse gas emission rights, making it a scarce resource and an asset Because of its commodity value and the possibility of trading, it has spawned a carbon emission trading market represented by greenhouse gas emission rights.

Although carbon emissions trading was born out of the United States' governance of sulfur dioxide, the United States has not yet established a national carbon trading market. The EU is the first to introduce a mandatory carbon emissions trading mechanism in the world. The Global Carbon Market Progress 2019 released by the International Carbon Action Partnership (ICAP) in March 2019 shows that since the launch of the EU carbon market in 2005, new systems have been established. Today, 27 different jurisdictions (including 1 supranational institution, 4 countries, 15 provinces and states, and 7 cities) from local to national levels

operate 20 carbon markets of different sizes. These jurisdictions with carbon trading markets cover 37% of global GDP, but only 8% of global carbon emissions. This is because many high-carbon emission industries have not yet been included in the trading scope of the carbon emission trading market, such as the shipping industry.

The European Union's Greenhouse Gas Emissions Trading Mechanism (EU-ETS) was officially launched in 2005. It is the world's first and largest transnational carbon dioxide trading project, covering EU member states and Norway, Iceland and Liechtenstein, covering nearly half of the region's greenhouse gas emissions , Set an emission cap for more than 11,000 high-energy-consuming enterprises and aviation operators. The operation of the EU carbon market from its establishment to 2020 can be divided into three phases: the first phase is a trial operation from 2005 to 2007, and the second and third phases are 2008-2012 and 2013-2020, respectively. From 2013 to 2020, the upper limit of emissions will be reduced by a linear coefficient of 1.74% every year on the basis of the average annual allocation of the total allowances from 2008 to 2012. Thanks to the declining emission ceiling, the total amount of emission allowances available for fixed facilities in the EU in 2020 will be 21% lower than in 2005. In early 2018, the European Parliament passed a law to accelerate the reduction of the total amount of emission allowances issued by the EU carbon market, stipulating that the ceiling for carbon allowances will be increased from 1.74% to 2.2% annually from 2021, and this indicator will be increased again in 2024. This will reduce the emissions of EU fixed facilities in 2030 by about 43% from 2005 levels. At different stages, the EU uses different operating methods: In the first and second stages, the EU member states formulate a national allocation plan (NAP) and report it to the European Commission for review, which includes a list of target companies covered by the country and their national emission reduction targets. Then the European Union Carbon Quota (EUA) will be allocated to various departments

and companies; and in the third stage, the NAP will be cancelled, and the EU-wide uniform emission limit will be implemented, under which the emission quota will be based on the principle of full coordination Allocated to member countries. In the first and second phases, the EUA is mainly based on free distribution, supplemented by paid distribution; in the third phase, emission companies need to obtain the EUA through open auctions. The EU implements decentralized trading, and EUA can be traded on multiple platforms (such as the European Climate Exchange in London, the European Energy Exchange in Leipzig, Germany, and the Nordic Power Exchange in Norway, etc.). In addition, the EU carbon market was developed in the context of a highly developed financial market. At the beginning of its operation in 2005, the EUA and other emission reduction credits (such as CER and ERU), Forward, options, swaps and other transactions. From the perspective of the carbon emission market price, since 2011, the EUA price has remained in the single digits, and prices have been sluggish for a long time. Through a series of reforms, the EU carbon market finally broke through the multi-year low carbon price hovering in single digits in 2018, and broke through 25 euros /ton in the third quarter. The EU carbon market has served the purpose of promoting energy saving and emission reduction in Europe, and the EU's carbon emissions have been decreasing year by year as the carbon market advances. But again, due to the continuous reduction of the EUA's free quota, it will be necessary to obtain all auctions from 2020. It is difficult for member countries with relatively backward grid construction or a single energy structure and less developed economy to continue.

The US Regional Greenhouse Gas Emissions Reduction Initiative (RGGI) was officially launched in 2009. It is the first market-based greenhouse gas emissions trading system in the United States based on mandatory regional total control and trading. It is composed of 10 states in the northeastern United States and the central Atlantic (Connecticut, Delaware, Maine, Maryland, Massachusetts, New

Hampshire, New Jersey, New York, Rhode Island, and Vermont) jointly signed the establishment and joint operation to limit and reduce carbon dioxide in the power sector Emissions, and only covers the power industry. Each performance period of RGGI is 3 years. In the first two performance periods, the total quota of each member state remains unchanged. Starting from 2015, the total carbon quota decreased by 2.5% annually, and cumulatively decreased by 10% in 2018. In the specific operation, each state first obtains the corresponding quota based on its own emission reduction share in the RGGI project, and then sells almost all the quota to the state's emission reduction enterprises in the form of an auction. RGGI believes that auctions can ensure that all entities obtain quotas in a uniform manner. At the same time, auctions rather than free allocation of quotas can realize the reinvestment of quota values in energy projects, thereby benefiting consumers and benefiting the development of clean energy. The results of RGGI's emission reduction have a certain effect in terms of results: from 2009 to 2016, the emissions covered by RGGI fell by 35%. The reason for the significant reduction in emissions is on the one hand due to factors outside the RGGI system, such as the reduction in natural gas prices has stimulated manufacturers' fuel conversion behavior, on the other hand, the total emission limit of RGGI also encourages companies to improve energy efficiency to a certain extent And increase the proportion of non-fossil fuel use to achieve emission reduction targets. In addition, reinvestment of RGGI auction proceeds further promoted emission reduction, and energy efficiency improvement projects and clean and renewable energy projects played an important role in reducing emissions.

As a major carbon dioxide emitter in the world, China is still a developing country, but China's carbon emission reduction pressure is also increasing with the development of urbanization and industrialization. In order to achieve the goal of "CO_2 emissions per unit of GDP by 2020 will be 40 to 45% lower than in 2005", the Chinese government established pilot carbon emissions trading in 7 provinces

and cities including Beijing and Shanghai in 2011. In December in 2007, the construction of the national carbon emission trading market was launched. Since 2013, China's carbon trading market has been very active, and the spot trading volume and turnover of carbon allowances have shown an upward trend, and the growth rate is obvious. In 2017, the growth rate has slowed down. The spot transaction quota for the whole year was close to 67.4 million tons, an increase of approximately 5.31% from the total transaction volume in 2016; the transaction volume was approximately 1.181 billion yuan, an increase of approximately 13.01% from the previous year. However, due to differences in the scale of quotas, market access threshold transaction prices, etc. in each pilot region, carbon emissions trading in some pilot regions is relatively active, and some regions are almost stagnant. This is also a sign that China's carbon trading market is not mature enough.

As an important part of the response of countries around the world to climate change policies, the carbon market is constantly emerging and developing. In order to align the goals of the carbon market with the climate goals of the entire economy, several major global carbon markets are currently implementing ambitious aggregate control actions for 2030. In addition, the next-generation carbon market in Mexico and other countries is also under active construction. The further development of the carbon market will inevitably have an important impact on all industries, and promote the development of all industries in a cleaner, more efficient and lower-carbon direction.

4.2 Effects and limitations of carbon trade system

4.2.1 Research Methods

The carbon emissions trading policies of the EU and China will be analyzed separately. Take the implementation of the carbon emissions trading policy as a kind of

"quasi-natural experiment". Although it is impossible to control all irrelevant variables that may affect the experiment and has lower rigor, it reduces the level of control and at the same time enhances its practicality and wide application.

When analyzing the effectiveness of China's carbon emissions trading policies, six pilot provinces and cities in Beijing, Shanghai, Tianjin, Chongqing, Guangdong, and Hubei were selected as the policy impact treatment group, and the other provinces as the control group. China has implemented a carbon emissions trading policy since 2011, so it selected 2011 as the cut-off point for policy implementation for analysis. Through regression of the carbon emissions of the treatment group and the control group around 2011, it is analyzed whether China's carbon emissions trading policies have a curbing effect on China's carbon emissions growth.

Analyze the effectiveness of the EU's carbon emissions trading, that is, compare the return trend of carbon emissions before and after the implementation of the EU carbon emissions policy. The EU began implementing the carbon emissions trading system in 2005, using 2005 as the demarcation point for policy implementation, comparing the carbon emission trends from 1993 to 2005 and the carbon emission trends from 2005 to 2016, and analyzing the carbon emissions trading Whether the policy has a curbing effect on EU carbon emissions.

4.2.2 Explanation of data

This article selects carbon dioxide emissions as the form of carbon dioxide emissions.

China's carbon emission sample data comes from the China Carbon Emissions Database CEADs from 2004 to 2017; EU carbon emission sample data comes from the CAIT Climate Data Explorer from 1990 to 2016.

China’s carbon emission trading data from 2014 to 2017 comes from Shanghai Environment and Energy Exchange.

4.2.3 Results and analysis

Table 4 Carbon emission in China from 2004 to 2017 (thousand tons)

Total Final Consumption								
	SHANGHAI	GUANGDONG	BEIJING	TIANJIN	HUBEI	CHONGQING	ZHEJIANG	JIANGXI
2004	9538.4	12464.9	13632.7	12079.6	11574.2	3559.7	22950.2	3503.1
2005	10535.6	14678.8	14766.9	13089.6	11898.3	4565.4	30842.5	4249.6
2006	11293.2	15862.6	15248.5	14029.6	15853.1	4723.7	36920.8	4791.8
2007	12221.4	18048.1	16655.3	14759.8	17276.6	5364.6	42700.8	5589.2
2008	12582.8	18017.7	17899.6	15663.8	18334.4	6879.2	45769.3	5928.5
2009	12426.3	20099.5	18816.3	17406.9	18305.1	7183.7	46926.6	6649.9
2010	13552.5	27671.3	20145.7	20055.3	20332.6	8177.4	47242.8	6111.6
2011	13965	28998.6	20998.5	21527.6	23341.9	8946.9	51293.6	5655.1
2012	13905.3	30940.2	19535.1	23977	23768.7	11749.3	52841.3	6313.7
2013	17740.8	32048.4	17806.2	24048.5	20135.6	8209.1	48125.8	9031
2014	16632.9	32919.3	19059.5	24504.9	20370.6	9716.6	49040.8	9281.5
2015	16836.6	32017	19613.2	24936.1	20701.6	10385.2	54066.7	8085.7
2016	16674.52	38902.18	19263.77	24753.92	20317.67	10063.55	57566.7	8550.75
2017	16270.35	37599.56	19828.5	25142.54	22560.99	9098.5	61245.88	8809.93

Source: China Carbon Emissions Database CEADs from 2004 to 2017

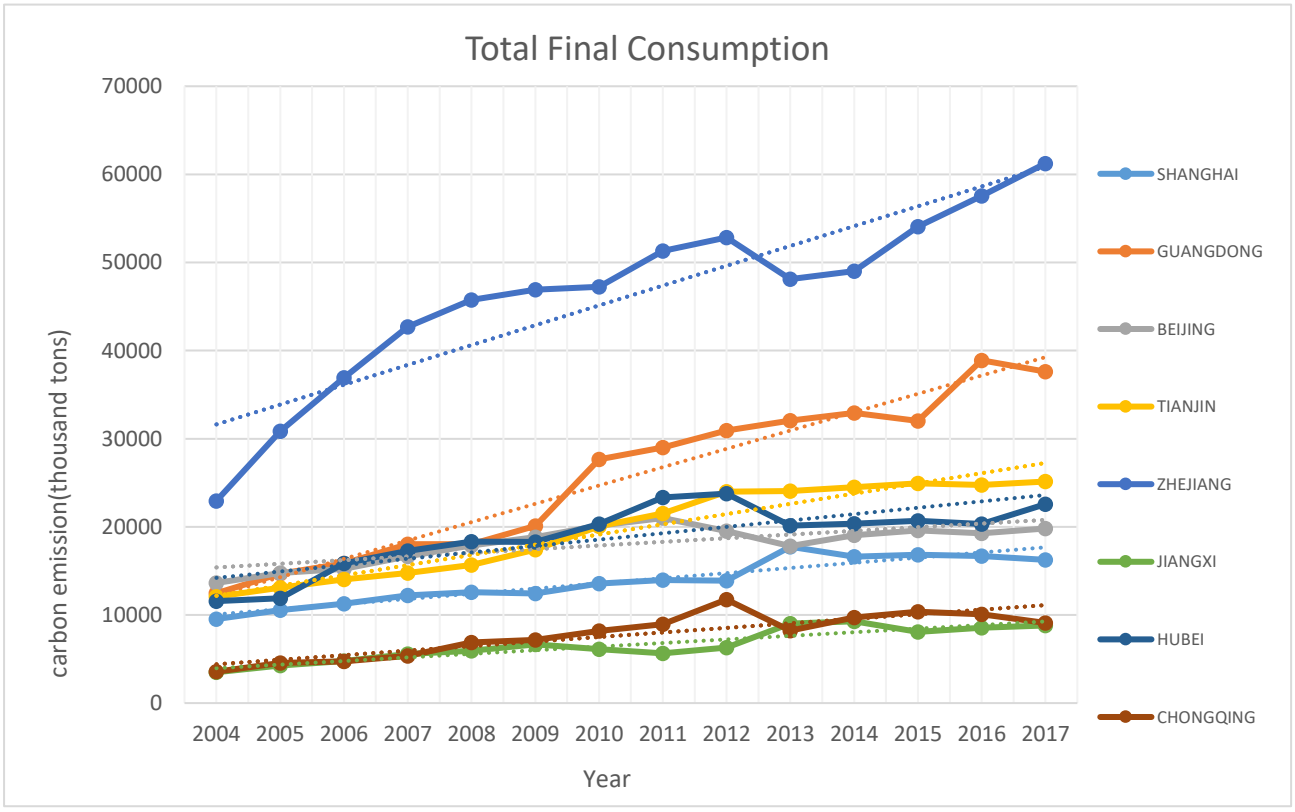

Figure 2 Carbon emission in China from 2004 to 2017 (thousand tons)

China's carbon emissions have been growing rapidly since 2000, and in 2013 it began to trend toward a steady and slow decline. For carbon trading policy pilot areas, Beijing 's carbon emissions have shown a downward trend after 2011, but have shown a gradual upward trend since 2014; Shanghai reached the highest value of carbon emissions two years after the carbon trading policy pilot began, 2013 It began to decline slowly after the year; Tianjin 's carbon emissions have basically been on the rise, but the rate of growth began in 2012 to be slower than before; the growth trend of Guangdong's carbon emissions has not changed significantly before and after the implementation of the carbon emissions trading policy, and even showed a substantial increase in 2015-2016. For non-pilot control group regions, Zhejiang 's carbon emission trend has been increasing, and there was a significant decline in 2013 (probably due to the impact of the private lending crisis in the region), and the growth rate after 2013 has not occurred significantly change; the growth trend of carbon emissions in Jiangxi is similar to the growth trend of Beijing, and the overall growth is relatively stable, generally fluctuating with the overall impact of economic development.

A linear regression analysis was conducted using the carbon emissions trading volume of each pilot region of carbon emissions trading from 2014 to 2017 and the carbon emissions of the region.

Let parameter X be the annual carbon trading volume (tons) of the pilot area, and parameter Y be the annual carbon emissions (tons) of the pilot area.

Table 5 China's carbon emission trading data

(tons)	SHANGHAI		BEIJING		GUANGDONG		CHONGQING		TIANJIN		HUBEI	
	Trading VOL	Carbon emission	Trading VOL	Carbon emission	Trading VOL	Carbon emission	Trading VOL	Carbon emission	Trading VOL	Carbon emission	Trading VOL	Carbon emission
2014	1,973,714	16,632,900	1,071,505	19,059,500	1,270,289	32,919,300	4,457,500	9,716,600	1,011,340	24,504,900	7,001,171	20,370,600
2015	2,940,496	16,836,600	1,254,586	19,613,200	6,956,520	32,017,000	2,335,128	10,385,200	975,713	24,936,100	13,904,100	20,701,600
2016	7,226,032	16,674,520	6,536,556	19,263,769	22,340,520	38,902,180	684,483	10,063,549	367,936	24,753,920	10,305,490	20,317,669

2017	7,016,571	16,270,350	7,515,621	19,828,500	17,559,746	37,599,560	7,436,603	9,098,500	1,162,370	25,142,540	12,728,844	22,560,990

Source: Shanghai Environment and Energy Exchange

Take the regression analysis results of Shanghai as an example. The regression results are as follows:

$$Y = 16836699.7 - 0.0486735X$$

t Stat = -0.94295717

R Square = 0.30775924

It can be drawn from the result that the coefficient of parameter X is -0.0486735, indicating that parameter Y decreases with the increase of parameter X. However, the t Stat of parameter X is -0.942957, which means that parameter X is not significant, and the contribution value to the model is not large, and it is not an irremovable parameter. Therefore, the correlation between the reduction of parameter Y and parameter X is not high, and the growth of Shanghai carbon trading volume is not enough to explain the reduction of Shanghai carbon emissions.

In summary, China's carbon emissions trading policy can play a role in suppressing excessive growth in China's carbon emissions, but due to the large differences in the economic development levels of various regions in China, the carbon emissions trading mechanism's effect on carbon emissions suppression is not significant And, because China is a developing country and its economy is huge, it is difficult for carbon emissions trading policies to meet China ’s development speed and reality, and it is difficult to achieve China ’s carbon emission control goals.

The carbon emissions of the European Union have been slowly decreasing since 1993. After the implementation of the carbon emissions trading policy in 2005, the downward trend in carbon emissions was more pronounced than before, but after that, the downward trend was significantly weakened. Due to the impact of the global financial crisis in 2008-2009, the EU's carbon emissions have dropped

significantly, and they have risen in 2010 and 2015. It can be concluded that carbon emissions trading has played a role in controlling carbon emissions, but with the passage of time, carbon emissions rights resources are becoming scarcer, and carbon trading as a means of controlling carbon emissions has lacked expectations Effectiveness and sustainability.

4.2.4 Limitation of carbon trade system

The development of the carbon trading system has gradually revealed some limitations. The key obstacles of the carbon emission trading system are: lack of liquidity between various trading markets, which is not conducive to supervision and management; there is unfairness between developed and developing countries; carbon emission rights quotas are becoming scarce; legal regulations are not sound enough, affecting the effectiveness of carbon reduction.

First of all, there is still no unified carbon emissions trading market in the world. The carbon rights trading market has poor liquidity and imperfect development. It has been divided into multiple closed markets by various types of transactions, and there is a lack of liquidity among the markets. For example, the Clean Development Mechanism (CDM) is a compliance mechanism adopted by Annex I Parties to implement part of their emission reduction commitments abroad by the COP3 (Kyoto Conference) of the Third Conference of the Parties to the United Nations Framework Convention on Climate Change. Its purpose is to assist Parties not listed in Annex I to achieve the ultimate goal of sustainable development and beneficial to the Convention, and to assist Parties included in Annex I to achieve their quantified limit and emission reduction commitments under Article 3. . However, in fact, as a carbon emission reduction project implemented by developing countries and developed countries, CDM can only sell emission reduction credits to developed countries ’intermediaries, but cannot sell them to the international market. An obvious buyer's market. On the contrary, international

buyers can sell the emission reduction credits purchased in developing countries to the international market and obtain huge economic benefits. The interests of developing countries in emissions reduction transactions have been seriously damaged.

Second, the level of development among countries is very uneven, and the carbon trading system is unfair. If the carbon emission right is regarded as a resource, it will generate a certain degree of resource predation. Developed countries can easily purchase carbon emission credits from developing countries, which will limit the development of some factories in developing countries, because their emissions will be squeezed out accordingly. And to a certain extent, it will promote CO_2 emissions in developed countries, so that they will take lightly on how to reduce CO_2 emissions. Quotas for carbon emission rights are also becoming scarcer. In the future, it may appear that quotas can no longer meet the needs of development. Not only can they not reduce emissions, but they may also cause new international problems.

In addition, the legal requirements of many developing countries' carbon trading systems are still not sound enough. Due to the lack of legal support, there is a certain degree of blindness in the practice of carbon emissions trading, which makes carbon emissions trading unreasonable. For example, China is relatively backward in measuring and measuring the greenhouse gas emissions of enterprises, and its supervision capacity is seriously insufficient. The lack of testing equipment and conditions makes many places and industries lack the basic conditions for establishing carbon emissions trading. When the emission behavior is not regulated, companies may have the urge to over-emission and lose their enthusiasm for carbon purchases, resulting in a decline in carbon demand in the trading market, which directly affects the effective establishment of the carbon trading market.

This shows that in addition to establishing a carbon trading system, we also need to

develop other carbon emission reduction measures to make carbon emission reduction work more sustainable.

4.3 The rise and prospects of carbon offset

4.3.1 Status of carbon offset

Carbon offset refers to companies, groups or individuals measuring their total carbon emissions within a certain period of time, by purchasing equal amounts of carbon emission reduction indicators and canceling them (that is, carbon emission reduction indicators are no longer transferred), thus offsetting their own carbon emissions Total emissions. To give an example in real life, we are constantly producing greenhouse gases (such as car exhaust or even eating meat from livestock) every day. These greenhouse gases will damage our environment. In order to offset the negative impact of our own actions on the environment, we can take compensation methods, such as planting trees. Through planting trees or other acts of absorbing carbon dioxide, we offset or compensate the carbon footprint we have produced to a certain extent. As the global consensus on green and sustainable development gradually condenses, more and more consumers and people begin to pay attention to the transformation of personal consumption and life behavior, actively participate in energy saving and emission reduction actions, and realize the growing demand for carbon offsets for personal consumption activities. Promote the development of green and low-carbon production and green and low-carbon lifestyles.

The current carbon offset mechanisms are all voluntary carbon offsets. Voluntary offsetting refers to the act of groups or individuals buying carbon offset units for carbon offsets without their own external pressure and out of their own will. The voluntary offset model is more suitable for personal daily life and project activities. The form of voluntary offset is generally through the launch of projects and

activities. The amount of single offset is relatively small, and there is a good public participation. For example, the Ali Forest project launched by China Alipay. Ant Forest is a charity action designed by Alipay client for the first phase of "carbon account": users' behaviors such as walking, subway travel, online payment of utility bills, online payment of traffic tickets, online registration, online ticket purchase, etc. will reduce the corresponding The carbon emissions can be used to raise a virtual tree in Alipay. After this tree grows up, non-profit organizations, environmental protection companies, and other ant ecological partners can "buy away" the virtual "tree" planted by the user in the ant forest, and plant a physical tree in a certain area in reality. In addition, various carbon offset projects have been launched around the world: You Control Climate Change in the European Union, One-Tonne Challenge in Canada, Eco-Family in Japan, etc. These activities are all designed with diversified activities, and have received enthusiastic participation from all levels of government agencies, corporate bodies, and non-governmental organizations, attracting people to take small actions from their own lives, and thereby driving changes in social patterns. As a new form of environmental protection, carbon offset has become a carbon emission reduction practice adopted by international conferences, such as the 2010 United Nations Climate Change Tianjin Conference, the 2014 APEC Beijing Conference, the 2016 G20 Hangzhou Summit, and the 2017 BRICS Leaders 'Xiamen Meeting Such large conferences have achieved carbon neutrality.

In addition to voluntary carbon offsets, compulsory carbon offsets are also very suitable for applying to companies' carbon emission reduction. Turning voluntary behavior into compulsory behavior can require companies to compulsorily offset a certain amount of carbon emissions, either by purchasing offsets outside the company or by deducting the offsets generated by the company itself. For enterprises, the implementation of carbon offsets not only reflects the company's awareness of environmental responsibility, establishes a good brand image and enhances the

brand value of the company, but also conforms to the era and market development trends of green consumption, green procurement, and green investment, which is conducive to effective response Green trade barriers and enhance market competitiveness. In addition, it is also possible to form an industry that “produces” carbon offset credits—accumulating carbon offset credits through environmental protection activities can also be traded as a resource.

4.3.2 Advantages of carbon offset

Carbon offsets and ETS have certain advantages in certain aspects: First, carbon offsets have less impact on the development of economies. Take enterprises as an example. If carbon trading is used to reduce emissions, companies need to consider the limited carbon emission quota, which often imposes restrictions on the development of enterprises. However, if the company uses carbon offsets, the carbon offsets can be created externally or by the company itself, which is less restrictive and reduces the pressure for companies to reduce emissions. Second, the carbon offset mechanism is more flexible. The so-called "All roads lead to Rome", the carbon offset mechanism to achieve emission reduction goals is more flexible and diversified. Enterprises can achieve carbon offsets by using low-carbon resources, updating technologies, or afforestation. Enterprises can not only digest internally, but also pay by paying external companies. Third, carbon offsetting is more proactive and sustainable than carbon trading. Compared with passively accepting the limits of carbon emission limits, carbon offset through energy saving and environmental protection measures is more proactive. Environmental protection activities can often not only serve as temporary carbon offsets, but can also continuously improve the environment, such as planting trees.

4.3.3 Barriers to advancing carbon offsets

The implementation of emerging carbon offsets in various countries has not been smooth.

First, the carbon offset's looser requirements for carbon emissions can easily lead to objections. There is a view that priority should be given to reducing carbon emissions, followed by ways to offset those excess carbon emissions. The carbon offset mechanism is easy to cause the result of the inversion, so that companies have no worries about emissions.

Second, the diversity of carbon offset activities can also easily cause pitfalls. Various types of carbon offsetting activities have sprung up, but many have problems. How to distinguish whether a carbon offset project is good or bad. Against the background that carbon offset specifications are still imperfect, it is easy to step into the trap of carbon offset projects.

Third, there is no guarantee how long a carbon offset project can last. For example, to protect forests from deforestation, the benefits from carbon offsets must be greater than the normally lucrative industries that cause deforestation. Driven by different interests, the land under sustainable management this year may be completely changed by new political will next year.

4.4 Prospects of carbon trading and carbon offset in the shipping industry

At present, no matter whether it is carbon emissions trading or carbon offset, the shipping industry has not yet been integrated into any system. However, the carbon emission reduction of the shipping industry needs to be resolved as soon as possible. Carbon trading and carbon offsetting are both promising carbon emission reduction solutions.

The shipping industry can try to join the carbon trading system as soon as possible.

Because the carbon trading system has a longer development time and a more mature mechanism. If the shipping industry wants to use carbon trading to reduce emissions, it has more experience to learn from. In June 2013, the EU formulated the shipping industry emission policy, and announced that the shipping industry emission reduction policy will take three steps: (1) Establish a shipping "monitoring, reporting, verification (MRV, Measurement, Reporting and Verification)" mechanism Shipping GHG emission reduction provides the necessary data foundation; (2) Set GHG emission reduction targets for shipping industry; (3) Implement market-based mechanism emission reduction measures (MBMs) in the medium and long term The MRV mechanism came into effect on July 1, 2015. The design and construction of the maritime greenhouse gas MRV system helps more accurately grasp the industry's greenhouse gas emissions and emission reduction potential, and is also a prerequisite for using market means to reduce emissions. Judging from the current construction work of the EU and IMO in the maritime greenhouse gas MRV system, both parties have expressed their willingness to cooperate in order to achieve the goal that the maritime MRV system can be adapted to the EU ETS and can be applied globally. In the construction of the maritime market mechanism, it is also possible to eliminate as early as possible disputes arising from the carbon emission calculation method in aviation carbon trading. MBMs mainly encourage shipowners to adopt energy-saving and emission-reducing measures by increasing ship operating costs. Some countries have proposed the establishment of a greenhouse gas fund to achieve energy conservation and emission reduction through economic means. Despite the rich experience in using market instruments to reduce emissions, such as the European Union, MBMs still have a lot of controversies that have not been implemented uniformly. The focus of debate in MBMs is whether the mechanism hinders the development of developing countries and reduces the competitiveness of developing countries. Developing countries such as China, India, Brazil and

South Africa pointed out that they should abide by the principle of "common but differentiated responsibilities", that is, developed countries should be responsible for their historical emissions and the current status of high per capita emissions. Developed countries should take the lead in reducing emissions and give development China provides financial and technical support; developing countries, with the technical and financial support of developed countries, take measures to mitigate or adapt to climate change. The issue of MBMs is very controversial, so the IMO Environmental Council suspended the discussion of market mechanism issues.

Combined with the limitations of the carbon trading market mentioned above, poor liquidity, unfair issues, and inadequate supporting legal systems, these issues cannot be avoided if the shipping industry is to be included in the carbon trading system. Shipping is often cross-regional and cross-country, and there are many international laws and regulations involved. The industry is also very sensitive to international trade. Therefore, the existing problems in the carbon trading market will only be amplified and become more serious when it comes to the shipping industry more complicated. Therefore, the prospect of carbon trading in the shipping industry is still not clear.

Carbon offset, as a new way to reduce emissions, is now being used as a flexible mechanism. Due to the great potential of carbon offset emission reduction efficiency and environmental effects, it is also considered as a carbon emission reduction scheme that may be applied to the shipping industry. Carbon offsets are a type of carbon credit, and carbon credits include quota credits and compensation credits. The former is a quota obtained by an emission reduction entity under a mandatory emission reduction mechanism and can be traded in the market; the latter is based on the project ’s carbon credit. The emission reductions achieved by the emission reduction entity through investment in emission reduction projects can only be obtained after being certified by a qualified institution. For quota

credits, you must first obtain carbon credits, and then reduce emissions; for compensation credits, emission reduction projects can achieve emission reductions, and emission reduction entities can obtain carbon credits. "produce".

From the perspective of the main body of emission reduction, first of all, once the shipping industry is required to force emission reduction, the pressure to reduce emissions is very large, and the cost of emission reduction is very high. For shipping companies, reducing emissions may directly reduce competitiveness and affect the market share of the company, and even affect the survival of the company. At this time, shipping companies can use carbon compensation to transfer the emission reduction actions to another enterprise or industry with lower emission reduction costs. Shipping companies purchase carbon credits by paying (transferring technology and funds) Offset your own emission reduction targets that cannot be achieved through internal emission reduction measures such as reducing energy consumption or using renewable energy. Second, the shipping industry ’s emission reduction plan covers a large area and involves many departments (usually not just ships). If the intensity of emission reduction is greater, the better the effect, the cost of the shipping industry ’s emission reduction mechanism will increase. Due to the huge number of emission sources for shipping, the total emissions are not small. Although they cannot be included in the mandatory emission reduction mechanism, there is still a need to reduce emissions, and these parts can be involved in the emission reduction process through carbon compensation. And some environmental projects, if managed by market means, will not happen without carbon offset transactions, such as carbon capture and storage projects.

From an international perspective, in the international emission reduction plan under the Kyoto Protocol, due to various reasons, the developing countries did not participate in the mandatory emission reduction, which will bring Carbon Leakage that the developed countries will transfer substantial carbon emissions Developing

countries, thereby destroying the emission reduction effect of the emission reduction mechanism. But climate change is a global problem. If developing countries cannot participate in emission reduction, the emission reduction effect of developed countries will be offset by emissions from developing countries. If companies in developed countries are allowed to use compensation credits from developing countries to reduce emission reduction costs, they can better maintain the operation of the emission reduction mechanism and avoid carbon leakage.

In addition to solving some of the existing carbon emission reduction problems, carbon offset also has some potential benefits. First, carbon compensation projects can produce benefits that are not directly related to climate change. For example, those projects that promote soil carbon sequestration (such as cultivated land protection) will improve soil structure and prevent soil erosion. If forestation can improve air quality, conservation of water sources, etc. makes the one-time emission reduction project have the effect of continuous improvement of the environment. Second, due to the mandatory emission reductions in developed countries, it is difficult for some carbon offset projects to obtain qualified certifications in developed countries, and due to less regulation in developing countries, these projects will become qualified carbon offset projects. The implementation of these projects will promote the transformation of the energy structure of developing countries, which is conducive to sustainable development and improves local air quality. Third, if a country ’s emission reduction mechanism allows the use of compensation to fulfill its emission reduction obligations, domestic non-emission reduction enterprises can obtain a certain amount of economic benefits by developing compensation projects to obtain emission reductions, and if a country ’s emission reduction plan If international compensation credits are allowed, then certain domestic sectors may benefit from international trade in emission reduction technologies and services. In addition, various types of intermediaries in compensation transactions have also gained certain benefits. Fourth, because the price of carbon credits puts

pressure on emission reduction entities to actually reduce emissions, the compensation project market will encourage all parties to develop emission reduction technologies and discover new emission reduction methods outside the regulated sector.

5 Future carbon emission control measures in shipping industry

5.1 Technical measures

Regarding alternative emission reduction measures, currently the technology is relatively mature, and the technologies that have been applied to different degrees at home and abroad mainly include the use of LNG and other clean energy sources, the installation of exhaust gas after-treatment, and the use of shore power. Relative to the complexity of using high-voltage shore power for ships calling at ports, inland navigation is more convenient for the use of shore power and LNG. Of course, whether it is liquefied natural gas or shore power, the policy support and incentive guidance behind shipping emissions reductions are essential. If you want to apply new energy technologies on a large scale to promote shipping carbon emissions reduction, you need to have more supporting facilities as support.

5.2 Policy measures

In addition to using carbon trading and carbon offset mechanisms to reduce emissions, it is also possible to formulate more coercive and stricter regulatory policies. For example, the International Maritime Organization has issued a “sulfur restriction order” in order to vigorously promote the prevention and control of ship air pollution. Carbon emission reduction can also issue some “carbon limit orders” to restrict the use of high-carbon emissions ship fuel and ship navigation areas. China's "Ship Air Pollutant Emission Control Zone Implementation Plan" has

achieved significant sulfur reduction effects since its implementation. Compared with 2015, in 2019 ships will reduce emissions of sulfur dioxide by about 600,000 tons and particulate matter by about 78,000 tons.

Lowering the speed is also a feasible method of reducing emissions. Over the past 10 years, practice has proved that decelerating navigation is very effective in reducing the energy consumption of ships. After reducing the speed, the same voyage will take longer and require more ships to complete the original transportation workload, but even considering these factors, the energy consumption savings from decelerating navigation is still very considerable. The formulation of laws and regulations for decelerating navigation can be carried out simultaneously at the global and regional levels.

There are also measures that can provide low-carbon technical support at the regional level. For example, create incentive frameworks that promote the use of renewable fuels on short-haul routes. In order to develop low-carbon shipping, the industry often conducts ship fuel tests, such as battery-powered, hydrogen-powered, and methanol-powered ship projects. These types of tests require dedicated infrastructure and ships, so they are suitable for ships that often travel to and from specific ports or areas.

6 Conclusions and extensions

6.1 Main conclusions

As the most important way of cargo transportation, sea transportation has achieved 90% of the world's cargo transportation. With the development of economic globalization and international trade, the carbon emissions generated by the shipping industry have exploded. In order to solve the problem of global shipping

carbon emissions, international organizations and various countries and regions have made corresponding measures and efforts. Therefore, according to the carbon trading and carbon offset policies and implementation status, we analyze the applicability of shipping carbon emission reduction.

This paper uses a combination of qualitative analysis and quantitative analysis to study the current status and development direction of carbon trading and carbon offset. From the perspective of qualitative analysis, it is a difficult task to analyze the characteristics of long shipping cycle, large transportation volume, low cost and mobility, and want to effectively achieve carbon emission reduction. The carbon trading system has been developing in various countries for a long period of time, and it is relatively complete in terms of regulations and supervision. However, there are also obstacles such as the lack of liquidity in the market, unfairness between countries and the increasingly scarce quotas. In contrast, carbon offsets are more flexible and more sustainable, and there are also problems in that it is difficult to distinguish the merits of the project and the effect of reducing emissions cannot be guaranteed. But both have the value of trying to reduce shipping emissions.

From the perspective of quantitative analysis, select the carbon trading volume in the pilot area of China's carbon trading and the current year's carbon emissions in the region, and get back the correlation between the impact of carbon trading volume on carbon emissions. From the results, it can be seen that carbon trading has not caused a significant impact on the reduction of carbon emissions, and the effectiveness of carbon trading in reducing emissions in China is still worthy of further observation.

6.2 Possible research orientations

Although this article studies the current status and development prospects of carbon trading and carbon emissions from two perspectives: qualitative analysis and

quantitative analysis, there are still the following deficiencies: First, the research sample is limited, and China ’s carbon trading development time is short, only 4 years The data in the pilot areas cannot determine the long-term impact of carbon trading; second, there are many factors that affect carbon emissions, and the separate role of carbon trading cannot be stripped; third, carbon offsets are also in the initial stage, and potential problems may not yet appear. . In the future, we can conduct in-depth research on the above issues.

References

Lei Fang. (2015). Research on Ship’s Carbon Footprint Based on Theory of Life Cycle. Doctoral dissertation, Ningbo University, Ningbo.

Jie Chen. (2017). The Influencing Factors of Carbon Emissions from International Logistics Industry—Based on the Empirical Study on Energy Consumption of COSCO Group. Doctoral dissertation, Southeast University, Nanjing.

Hongxin Yin. (2015). Research on the Impact of Large Ships on the Carbon Emissions of the Shipping Industry. Doctoral dissertation, Dalian Maritime University, Dalian.

Zhenyang Zhou. (2015). Research on monitoring methods and limitation methods of ship carbon emissions. Doctoral dissertation, Dalian Maritime University, Dalian.

Yue Zhao. (2015). Research on the Impact of EU Maritime Carbon Tax on China's Liner Industry. Doctoral dissertation, Dalian Maritime University, Dalian.

Mellin, A. , & Rydhed, H. . (2011). Swedish ports’ attitudes towards regulations of the shipping sector's emissions of co2. Maritime Policy & Management, 38(4), 437-450.

Chang Liu. (2016) . Carbon reduction measures and actions for ships in the international shipping industry. Energy Conservation & Enviromental Protection in Transportation ,(3), 33-37.

Giziakis, C. , & Christodoulou, A. . (2012). Environmental awareness and practice

concerning maritime air emissions: the case of the greek shipping industry. Maritime Policy & Management, 39(3), 353-368.

Weiwei Shi. (2018) . China's shipping industry carbon emission reduction actions. China Ship Survey, No.218(7), 55-58.

Dales, J. H. (1968). Pollution, property & prices /. , 14(2), 306.

Yaxue Yan, Xiaoling Zhang, Jihong Zhang, Kai Li.(2020). Emissions trading system (ETS) implementation and its collaborative governance effects on air pollution: The China story.Energy Policy,Volume 138,111282

Hermeling, C., Klement, J., Koesler, S., Koehler, J., & Klement, D. (2014). Sailing into a Dilemma - An Economic and Legal Analysis of an EU Trading Scheme for Maritime Emissions. SSRN Electronic Journal. doi: 10.2139/ssrn.2416750

Aiping Gan, Kezhen Chen. (2013). Market prospects and countermeasures of shipping carbon trading in China. China Ports ,(6), 47-49.

Yadav Sapkota, John R. White.(2020). Carbon offset market methodologies applicable for coastal wetland restoration and conservation in the United States: A review.Science of The Total Environment, Volume 701,134497

Yanzhao Gong, Zongjie Wu. (2012). On carbon compensation in greenhouse gas emission reduction. Journal of Shandong University of Technology： Social Science Edition (1), 5-10.

Mengmeng Liu. (2015). Research on International Aviation Global Carbon Emissions Offset Mechanism. Doctoral dissertation, Civil Aviation University of China, Tianjin.