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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**Freight fluctuation risk assessment and management
of container shipping companies
the application of derivatives of Shanghai shipping exchange as a
risk management example**

By

Shen Bochao

china

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

MASTER OF SCIENCE

In

INTERNATIONAL SHIPPING AND LOGISTIC

2019

Declaration

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

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

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Acknowledgement

I want to show my thanks and respect to those teachers in this program, my classmate and those who gave me help.

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Abstract

Title of Research Paper: Freight fluctuation risk assessment and management of container shipping companies

----the application of derivatives of Shanghai shipping exchange as a risk management example

Degree: MSc

Shipping industry is an industry with special risks. Shipping companies have huge risks in a series of activities from investing, building or leasing ships to operating, carrying cargo, shipping, calling ports and delivering cargo. Therefore, it is necessary for the managers of shipping companies to understand the risk level of their companies so as to formulate corresponding strategies according to the risk level and reduce the companies' risk. At present, there are few studies on risk management of container shipping companies. Based on the characteristics of container shipping companies and the principles of systematic, scientific and practicable, this paper studies the theory and methods of risk management of container shipping companies in order to provide a scientific and effective basis for risk management of container shipping companies. This paper is studied from the three stages of company's risk management process, risk identification, risk assessment and risk control. Firstly, risk identification is studied. Then, starting with the meaning of container transport enterprises and their risks, the sources of risk of container transport enterprises are studied. Then the paper identifies the internal and external risks existing in shipping enterprises. It evaluates these risks through ANP and determines the weight of each risk. For the most important risk of freight fluctuation, this paper puts forward a risk management method- using derivatives. It also studies the risk management effect of

container derivatives issued by Shanghai Shipping Exchange through a real case. Finally, some suggestions are put forward for container shipping companies and Shanghai Shipping Exchange. Some ideas for the development of container derivatives and training of professional on derivatives are raised.

Key words: Container shipping companies, Risk, Risk Assessment, Derivatives, Hedging

1. introduction

1.1 Research Background

In recent decades, shipping industry has gained unprecedented opportunities for development because of the world economy globalization and more frequent international trade. Shipping industry has already made great contributions to the fast development of the world economy and international trade, it has also become the basic industry to promote the globalization of the world economy. Besides, shipping industry is an industry with special risks. First, shipping companies need a huge amount of investment which means huge risks. Second, the service of shipping company is at sea, and it is accompanied by many accidental or unforeseeable natural disasters and accidents. Third, shipping companies are faced with a lot of risks such as internal control, operation management, information system and customer credit like other companies. Finally, shipping demand is derived from international trade which undoubtedly makes shipping service dependent and passive. The fluctuation of the world economy and the change of international trade may influence the risks of shipping company.

Shipping industry is a risk-intensive industry with many risk points and difficult monitoring. With the further globalization and specialization of the shipping industry, as well as environmental protection, labor protection and other reasons, the state and industry authorities have imposed more restrictions on the shipping industry, and various new risks have emerged and intensified. From the perspective of manifestation, risks of shipping companies can be divided into several kinds, such as operation risk, investment risk, management risk, security risk, financial risk,

personnel risk and legal risk. Therefore, it has great practical significance to study and discuss how to correctly and effectively assess and manage the risks faced by shipping companies.

1.2 Research Objectives

Although scholars have studied risk management and evaluation theory for a long time, most of the studies on risk of container shipping companies are qualitative studies on risk, few studies and demonstration are about the weight of different risk. The risk of container shipping companies is complicated, it involves many variable factors and the risk is big. This study mainly focuses on the analysis of the main factors influencing the risks of container shipping companies then seeks for an effective and simple risk assessment model. It also concentrates on how to use derivatives to manage freight rate fluctuation risk. Using effective scientific assessment method to assess container shipping companies' risks is advantageous to the companies stable operation and to adapt the complex and changeable market environment. It can help the company to eliminate or avoid the risks so that container shipping companies can avoid, transfer, reduce and utilize the potential losses at a lower cost.

2. Literature review

2.1 Theoretical basis of risk assessment and management

Willet is the first man to do scientific research on risk. He believes that risk is the objective reflection of uncertainty about unwilling occurrence. Knight(1921) proposes that only uncertainty is the real source of profit. Pfeffer(1956) points out that risk is the aggregation of dangerous situation. From the probability view, it is objective. From the uncertainty view, it is determined by belief. According to Williams(1964), risk is the change between possible losses in a given situation and a specific time. In reality, risk and uncertainty are often linked. Peter(1999) points out that risk often means loss, but it can be avoided or even eliminated. Uncertainty is just the unknown which is not necessarily lead to loss. And taking risks or taking advantage of uncertainty can increase opportunities. However, uncertainty makes people feel more uneasy than when they are faced with risks. Uncertainty is not always a bad thing, nor is it necessarily linked to risk. In fact, all systems that need both change and stability need uncertainty. Wei Fang(2008) believes the freight market needs stability to maintain people's confidence in the economy, while the freight market also needs certain fluctuation to maintain the basic vitality of market competition.

In order to control the loss caused by risk as much as possible, risk assessment and management become very important. Chang Guibin(2008) classifies the risks of shipping companies and gives four stages of the risk management process of shipping companies - risk identification, risk assessment, risk control and risk management effect evaluation. He also constructs a risk evaluation indicators system and studies the risk control problems and risk control strategies of shipping companies. Wei fang(2008) provides operators and investors a quantitative analysis of the volatility risk of dry-bulk ocean freight market by the risk assessment method of freight index rate of return. He also forms a relatively complete framework for the

assessment of the volatility risk of dry-bulk ocean freight market through their internal relations. Huang Hui(2009) divides the risk of shipping company into operation risk, market risk, cost risk and financial risk. He also gives a general method of risk management for shipping companies. Lin Zhizhong(2011) analyzes and quantifies the risks of shipping companies from the perspective of safety management. He also gave the time, scope and procedures for the implementation of risk assessment. Qian Yuan(2008) divides the possible operational risks of oil tanker shipping companies into operational management risks, economic risks, environmental risks and safety risks. Based on risk management theory and risk assessment theory, she analyzes the risk factors affecting the operation of oil tanker shipping companies, and constructs an evaluation indicators system for the operational risks of oil tanker shipping companies.

In simple words, risk assessment and management is very important to container shipping companies.

2.2 Theoretical basis of shipping derivative

There is no consensus on the definition of financial derivatives. Wei Jingao(2003) think that derivatives are bilateral contracts for exchanging cash flows and transferring risk. Wu Fan(2009) believes, at the expiration of a contract, the amount owed by the trader to the other party is determined by the price of the underlying commodity, security, or index. Some people think derivatives are financial contracts, their value depends on one or more underlying assets or indexes. The basic types of a

contract include forwards, futures, swaps and options. There are many kinds of big risks in the shipping market, freight fluctuation is faced by both suppliers and demanders. In order to avoid some risks in the shipping industry, shipping derivatives appears. It is a tool developed on the basis of financial derivatives and can manage shipping risks. It has the function of hedging and price discovery. Shipping derivatives are mainly based on three primary risks-freight price, fuel price and exchange rate. The freight derivatives are unique to shipping. Yan Haikuan(2014) gives a brief introduction of three main types of freight derivatives, FFA, FOP and BIFFEX.

Fu mingyang(2015) believes that FFA, as a kind of shipping derivative, not only has the risk of general financial derivatives, but also has the risk of base difference and speculation. Participating companies should manage FFA risks effectively and establish sound management and supervision system. Kavussanos(2004), a shipping economist, has made representative studies on FFA's practical application. His study finds that FFA has a large liquidity difference in different routes which leading to a gap in hedging efficiency in different routes. John and Jeffrey(2003) finds that almost all shipowners and charterers are concerned about the development of shipping derivatives market, especially the hedging and investment function of FFA and shipping options. Yin Ming et al.(2015) shows that the bid-ask spread of forward freight in various ship markets was positively correlated with FFA. Xu zunwu(2014) believes that the innovation and application of freight futures and other derivatives not only hedge and control risks, but also create new risks.

2.3 Theoretical basis of assessment model

As a very abstract concept, risk is hard to assess. There are several methods to assess a company's risks. First is expert interview (Delphi). First, experts are invited to determine the weight of indicators at all levels according to their experience; secondly, the standard value or standard interval of basic indicators and the direction of optimization are determined; finally, normalization and weighted accumulation are carried out to calculate the quantitative value and the most economic value of indicators at all levels. Because this method has a greater subjectivity in determining the weight, so in the specific operation, it may be difficult to agree.

Second is AHP. It divides complex problems into several ordered levels, and then compares the schemes one by one. Then, it gives quantitative numbers for the relative importance of each element in each level, constructs a judgment matrix, calculates the weight of the relative importance of each element in each level according to the judgment of certain objective reality. Finally carries out comprehensive ranking evaluation. This method combines induction and deduction into a complete logical structure, and it is a semi-quantitative method which has been widely used nowadays. However, this method only deals with a linear relationship between weights, so it is also subjective to some extent.

Third is fuzzy method. This method first uses the evaluation index system to give the factor set. Then determines the evaluation grade and its corresponding standard, gives the evaluation set. Then carries on the single factor evaluation in order to find

the exchange matrix and determines the weight distribution of the evaluation index. Finally carries on the comprehensive evaluation.

The forth is the entropy weight method. In information theory, information is a measure of the degree of order of a system, and entropy is a measure of the degree of disorder of a system. The information entropy of a target is smaller, it indicates that the variation of its index value is greater, and the information provided is greater and the weight of the target should be greater. Vice versa, the less information provided, the less weight it should have. For the initial matrix of m evaluation indexes of n schemes discussed, the judgment matrix is obviously a carrier of information, so the weight of each target can be determined by calculating entropy according to the degree of variation of each index value.

The last one is ANP. ANP is developed on the basis of AHP. It is the same as the research objective of the AHP. Compared with AHP, ANP more scientific and theoretical. ANP considers about the inter-group and inter-influence relationship of each index. At the same time, ANP divides the target and each index into three structures according to the degree of inclusion and control. Are target hierarchy, criterion hierarchy and element network hierarchy respectively. The control hierarchy represents the purpose and objectives of the research evaluated by ANP and the criteria that affect the decision-making or the degree of goal realization; The element network hierarchy is based on the target and the basic index elements under the corresponding criteria. These elements are the most basic factors that affect the target or decision.

Though some of these methods are complicated, there are also problems with them. To make the assessment more correct, scholars usually combine these methods. In this paper, ANP is used as the assessing model.

3 Risk Assessment

3.1 Risk identification theory

Company has a wide range of risks, they almost exist in every step of company's daily production and operation, container shipping companies have no exception. Besides, container shipping companies have their own unique risks because of several reasons. There are three main reasons. The first is that container shipping companies are highly capital-intensive industries which require huge money. So they have the characteristics of high investment, long cycle and low return. Secondly, shipping market is not only affected by the world economy and international trade but also affected by political and natural factors. Third is the derivation of shipping demand, it leads to passivity and dependence of shipping service. In simple words, the risk of container shipping companies mainly refers to the loss which caused by the uncertainty of the internal and external environment of the container shipping companies.

To avoid the risk accident which may not happen, the companies need to analyse the risks. The whole process of risk analysis of container shipping companies can be divided into three stages. The first stage is the risk identification in which companies

find risks in the actual business activities according to various economic, political phenomena and market conditions. The second stage is the risk assessment in which companies use various methods to determine the probability of the risk accident and the possible loss caused by the risk in a certain period of time. The third stage is the risk control in which companies take various measures to avoid risks and reduce or make up the losses caused by risks. According to the three stages, we can design a method of risk analysis for container shipping companies.

The purpose of risk identification and analysis is to identify and classify the risks which may affect container shipping companies. On this basis, the incentives of each risk factor, the interaction and influence between different risks and their impacts on container transport enterprises are analyzed and studied. This will make risk assessment and risk control more reasonable. According to the basic principles of risk assessment, the risk identification stage requires a comprehensive analysis of the company. The company's business activities, asset allocation and staff composition, the risks existing in human financial, material and business activities, and the possibility of risks need to be analyzed. Besides it is also necessary to analyze the possible losses and forms of risks faced by companies which include casualties, property damage, business interruption, civil liability, devaluation of financial assets and so on. Risk identification is a continuous and systematic work. It must be institutionalized and programmed to ensure that all major activities of the organization and their risks are included and effectively classified.

Before the occurrence of risk accidents, risk management decision makers need to use various methods to systematically and uninterruptedly identify the various risks of container shipping companies. The work of risk identification is to identify the

risks faced by container transport enterprises and their sources through investigation and classify them so that the causes, conditions and forms of risks can be understood. For risk management decision makers, common risks can be identified by their experience and general knowledge. However, for new and potential risks, it is difficult to identify and analyze them in a certain way, external forces shall be used to identify them when necessary. The main methods for risk identification include scenario analysis, historical accident analysis, process analysis, risk questionnaire and financial statements.

Scenario analysis method uses brainstorming meetings to discover a series of major risks related to economy, policy, technology, culture and other factors affecting container shipping companies. It can also identify the future development trend of shipping industry. Once a certain trend is identified, it is necessary to analyze the impact on container shipping companies and then find out a series of existing or potential risks. From a strategic perspective, scenario analysis is particularly effective in identifying risks caused by the emergence of new technologies, the structure and dynamics of fleets and changes in economic conditions. It can also be used at the strategy level to identify some existing risks and their impacts.

The historical accident analysis method summarizes risks by analyzing historical risk accidents and then identifies potential risks that may occur in the future. Generally speaking, some cases of historical accidents with bad consequences are collected first, then the risk factors leading to these accidents are analyzed and summarized. Moreover, this analysis process also includes the analysis of those accidents that did not lead to losses in practice but indicated potential crisis. The disadvantage of historical accident analysis method is that major risks accidents rarely occur, so there

are few risk cases for analysis in this company. Under such circumstances, the collection of historical risk cases should be extended to other container shipping companies with same businesses and structures. Another problem is that it can only identify the risks of accidents that have happened and some important new risks are ignored especially those related with technology updating, industry practice and industry dynamics.

Third is process analysis method. The risks of container shipping companies can also be identified by analyzing the business processes of container shipping companies. This method first draws business flow charts of container shipping companies which show different business functions. This flow chart must be sufficiently detailed to include the entire analyzable business processes of container shipping companies from the beginning to the end. Each step in the flowchart represents an independent business process. It is necessary to find out the details about the process, including its purpose, how to do it, who will do it and the mistakes it may cause. When the business flow chart is completed, it can be used to analyze and find control defects, potential failure links and other weak links. Special attention shall be paid to the potential risks that may arise at the junctions of different departments. This analysis identifies the missing control procedures that are not shown in the existing process. It can also identify the misplaced tasks and responsibilities that may lead to process mistake or out of control. Process analysis is particularly effective in identifying risks associated with poor practices. Different from the historical accident analysis method, the process analysis method can identify the potential risks before the actual loss occurs. It can also help to understand the impact of these potential risks on the operation of the container shipping company.

Risk questionnaire is also called Risk Factors Analysis Questionnaire. The risk questionnaire is made from the views and methods of system theory, then send it to all employees to give out the risks and risk factors faced by their units. Generally speaking, the grass-roots employees participate in the operation of the container shipping companies themselves. They are familiar with the details of the operation of the business and know the factors and weaknesses of the container shipping companies. They can provide valuable and detailed information for risk managers and help risk managers to systematically identify and accurately analyze all kinds of risks.

The financial statement method identifies and analyses the risks that an company may encounter in every property and business activity according to the financial data. It is the most common and effective method for risk identification and analysis, because the various businesses and operation of companies are extremely reflected in the capital flow. The loss of risks and the various costs of risk management will be shown as negative results in financial statements. Therefore, the balance sheet, profit and loss statement, financial statement and various detailed appendices can be used as tools to identify and analyze risks. Therefore, financial statements can be used to identify and analyze the risks in companies and summarize the overall risks of container shipping companies.

Different risk identification methods are suitable for identifying a different kinds of risks. Both process analysis and historical accident analysis can be used to identify operational risks and potential risks associated with the integration of container shipping companies. Market risk is almost identified by historical accident analysis. In addition, although historical accident analysis may be difficult to identify

intangible risks such as credit risk, it can estimate the frequency and measure of risk accidents. Finally, scenario analysis can be used flexibly to identify major risks at the strategic level. Due to the limitations of the above five risk identification methods and the complexity of the container shipping companies, the risk identification and assessment is a process of comprehensive use of various methods. This paper mainly uses the four methods to identify risks.

3.2 Risk identification and classification

No matter in theory or in practice, any factors related to container shipping companies may affect the operation of the companies, then lead to a risk accident. However, not all factors will have a significant impact on the companies, so the key is to identify and classify those risks that have a significant impact on the sustainable and stable operation of the companies. These risks may lead to the failure to achieve the goals and even cause losses to the companies. In order to identify and classify the risks of container shipping companies better, it is necessary to analyze the characteristics and sources of risks of the companies. First of all, we need to understand the characteristics of container shipping companies so that we can analyze the sources of risks better. The main characteristics of shipping are as follows.

First is that the shipping products is unable to store. The displacement of the cargo is the production. It is producing and consuming at the same time and it can not be stored. If the capacity cannot be fully loaded, the remaining space will be lost. On contrary, the capacity will exceed and it is not able to pre-stored.

Second is the increasing competition. Since 2008, the international shipping industry has been affected by the international economy. The increase of fleet capacity greatly exceeds the growth of trade volume, which leads to the severe situation of oversupply. The price competition has become increasingly fierce, and the shipping industry shows a large downward trend.

Third is monopoly. Monopoly in economics refers to the exclusion of all competition in a certain field and own the biggest bargaining power. The container shipping industry often results in monopoly because of the competition. Nowadays, there are three huge alliances in the shipping industry, which fully shows that the container shipping industry has a monopolistic situation.

Forth is high risk. In addition to the risks of ship operation and management, international policies, economy, strikes and other incidents will have impact on container shipping companies. For example, the strikes caused by the labor disputes among the workers in the west coast of the United States in 2002. This strike caused nearly US\$100 million in losses to COSCO shipping in few days. Besides, financial crisis in Southeast Asia has affected China's exports to these countries. This reduces the revenue of container shipping companies in these routes during the crisis.

Fifth is capital-intensive. The investment of container shipping companies is undoubtedly a really huge amount for general companies. The cost of a 10,000 TEU ship is enough to match the fixed assets of a medium-sized company. With the development trend of large-shape, high-speed and modernization of ships, the

investment is also increasing, and shipping industry is becoming a highly capital-intensive industry. This not only increases the difficulty of raising funds for companies and increases the burden of repaying loans and interest, but also brings high risks by huge investment. It also requires managers to put emphasis on the operation and management of companies.

The last is that the fixed cost is huge. Once a container ship sails, whether full or not, it has to pay huge fixed and variable costs which can not be reduced by the reduction of passengers and cargo. Even if the ship is empty and there is no freight revenue, the entire costs will also exist.

Then the sources of risk associated with these characteristics can be divided into the following five categories.

First is the gap between supply and demand. At present, the shipping market is mainly composed of shippers, traders, producers and financial companies. Besides, more and more cargo owners and financial institutions join the shipping financial derivatives market and gradually become the main force of dry bulk FFA transactions. The increasing number of traders makes the liquidity of FFA increase gradually which attracts more traders to participate in it. However, many companies do not regard shipping financial derivatives as a hedging tool, but as a speculative tool. This has led to many container shipping companies with weak operational capacity and insufficient risk awareness to make misjudgments, and then bear huge risks or even fail in the operation of FFA. Through low-level warehousing to promote, boost the market and short-selling arbitrage mode to manipulate the market and make profits.

Besides, there are still many other financial institutions use financial leverage to make profits. Therefore, the fluctuation of shipping market is not only affected by basic supply and demand, but also by anticipation, speculation and other financial factors.

Second is complicated influence factors. They can be divided into three parts. First, the climate, wind and wave conditions in different seasons have great influence on shipping. Therefore, it is important to pay attention to the influence of season and weather conditions on shipping, such weather risk premium should be accounted for in shipping business. From the demand side, a large number of existing research have found that most of the, maritime container trade data including the total import and export volume. This show certain seasonal characteristics which leads to the seasonal demand for shipping. From the supply side, bad weather will cause ships to stop and wait for berthing, reduce the supply, these will result in a decline in short-term capacity. Secondly, the economic development of the trade area and the level of trade are the basis of the shipping industry. The level of economic development in the areas related to routes determines the level of trade. The level of economic development of traders determines the supply and demand of products for containers. The change of supply and demand of products will affect the supply and demand of shipping industry, and then affect shipping prices. Third is political events, especially emergencies, they have the most direct impact on shipping demand and freight rates. For example, plague, epidemic diseases, terrorist attacks, local wars, trade wars, economic and financial crises, changes in international relations, exchange rate all have impacts on shipping. The closure of the Suez Canal, the Iranian Revolution, Somali pirates and the anti-dumping investigations of the United States all had a great impact on shipping in the relevant routes.

According to the sources of risks, the risks of container shipping companies are divided into five parts.

3.2.1 Initial capital risk

The first category is initial capital risk. Ship purchasing risk is a major risk faced by container shipping companies. If the purchasing decision maker of buying and building ships can not judge the trend of the shipping market correctly, a vessel may be operated at a low freight route with high-cost purchasing. The companies will face tremendous cost pressure and risk. Since the price of container ships is higher than that of dry bulk ships, the risk of purchasing in container shipping is higher. The main sources of ship purchasing risk can be explained from the following three aspects. First is the uncertainty of the purchasing environment of international shipping ships, both internal and external environment of ship purchasing may change. After the change of environmental, investors need to adjust the ship purchasing to adapt to the change of environment, thus forming the uncertainty of ship purchasing. This uncertainty is the most direct reason of ship purchasing risk. Second is the limitation of international shipping investors' ability to understand the purchasing environment. To understand and grasp the purchasing environment of ships, investors must first grasp the purchasing environment which are reflected by various data and information. The investor's ability to understand the ship purchasing environment has limitations both in depth and in breadth. The limitation of the investor's ability to obtain the data and information of the ship purchasing environment and the Infinite possible change of the ship purchasing environment

really exist. It is difficult for the investor to obtain the complete information of the ship purchasing environment and to accurately predict its future trend and change. As a result, the risk of ship purchasing is formed. Thirdly is the delay of purchasing environment information. Although the ship purchasing environment can be reflected by data and information, these data and information need to be updated, and the update is always completed lately after the environment changed. It leads to the undoubtedly delay of information for the investors' purchasing decision-making. In other words, when making decision, the actual data and information about ship purchasing have not yet collected. The data and information used in decision-making are only the description of the decision-making environment at that time and the some predictions of the future environment, which leads to the incompleteness of information and the risk of ship purchasing. The delay of information is undoubtedly an important reason for the purchasing risk of container shipping companies.

Next is the leasing risk. Container shipping companies are capital-intensive companies which need a lot of capital to build or buy ships, while ship leasing can solve the problem of ship financing. But there are great risks in the process of leasing. Container shipping companies first face market risks. Shipping market is affected by various factors such as world economy, international trade, capacity supply, emergencies and so on. It shows a strong volatility, the law is not easy to grasp and the trend is very difficult to predict. Container shipping industry, as an industry to transport semi-finished products, is easily influenced by international politics. For example, the recent Sino-US Trade War had a great impact on Sino-US container shipping. At the same time, there is also a problem of misjudgment in leasing. If high-priced leasing or chartered ships are put on low-income routes, they will reduce profits or even make losses.

3.2.2 Political risk

The second category is political risk. First is shipping policy risk. The shipping policy is the specific policy adopted by the government for the domestic shipping industry and there are some international conventions raised by IMO. It is the attitude, policy and measures of a government or organization to treat the fleet for the purpose of developing maritime trade and shipping, improving the balance of international payments. Container shipping companies have global routes which connect almost everywhere on the earth. If they cannot grasp the changes in laws and regulations of the countries and ports they will reach, they may suffer various risks such as detention, huge fees, and arrest of ship.

Then the social instability risk. Ships reach to areas with unstable factors in some social environments. These unstable factors, such as strikes and riots, may cause social chaos. They will adversely affect the operation of container shipping companies. This may cause loss to container shipping companies.

3.3.3 Shipping market risk

The third category is shipping market risk. First is freight rate fluctuation risk. The freight rate is the monetary performance of the necessary labor required to complete the unit shipping production, or the monetary performance of the unit shipping

service value. The freight rate is affected by many factors, these factors are constantly changing, and the changes are extremely irregular. These will lead to fluctuations in freight rates in the shipping market. These changes make the shipping companies face a freight crisis and cannot obtain stable income. The risk of freight rate changes is one of the most influential risks to container shipping companies. As the “barometer” of the shipping market, the shipping freight index reflects the changing trend of the shipping market freight rate, which reveals the supply and demand situation of the entire shipping market and related markets further. At present, there are many kinds of freight index published in the world. The most influential freight index is the British Baltic Dry Freight Index, Clarks Dry Bulk and Tanker Freight Index, World Tanker Freight Index, Germany Bremen Shipping Index, China Export Container Index, Shanghai Export Container Index, etc.

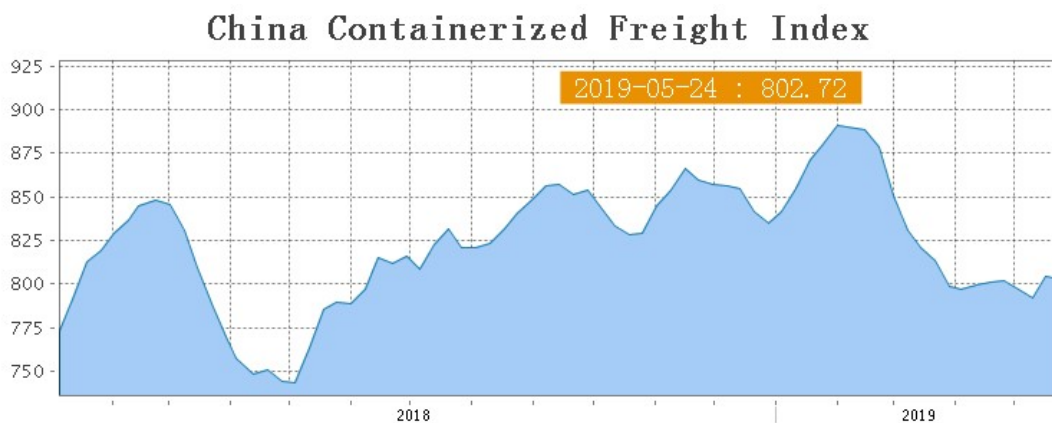


Figure 1: China Containerized Freight Index

Next is shipping demand and supply risk. The market demand in international shipping is essentially the demand derived from the natural demand of international trade, so the changes in the quantity, value and commodity structure of international

trade will affected shipping demand. For companies engaged in international shipping, the cargoes are foreign trade cargoes. Since this cross-international trade volume is affected by policies, economics, diplomacy, regional situations, cultural differences, etc. among countries, so the market demand affected by many complicate and changing factors has great risks. Then the supply risk, the change cycle of the international container fleet seems to be lagging behind the changes in the world maritime volume by 3-5 years. The number of ships ordered by container shipping companies often exceeds the changes in the world maritime volume, resulting in excess capacity. According to Clarkson's statistics and forecasts, the growth rate of supply and demand in 2018 is also greater than the increase in trade volume, and the decline in freight rates will happen with no doubt. How to maintain the stability and even rise of freight rates in this situation has become a difficult problem of container shipping companies.

There is also fuel price fluctuation risk in this category. Fuel cost is one of the most important operating costs of container shipping companies. Due to strong demand and geopolitical factors, international oil prices have fluctuated in recent years. Taking the emergency fuel surcharge imposed by the 2018 major liner companies as an example. Fuel prices rose more than expected in 2018, reaching \$440/ton in Europe, the highest price since 2014. Compared with the beginning of 2018, the price increase has exceeded 20%. When facing unforeseen incidents, it is impossible for liner companies to recover fuel costs through reducing the routine. In general, the EBS increase standard will change with the fuel price. For example, if the fuel price rises to US\$530/ton, the fee will rise to US\$120/TEU. If the fuel price returns to US\$370/ton, cancel the collection of EBS. Some container shipping companies' fuel

cost is more than 30% of the total cost. If fuel prices continue to rise, it will have an obvious impact on the operation and profitability of container shipping companies.



Figure 2: Brent crude oil price

The last risk in this category is competition risk. Although the container market is a monopoly market, the world economy is weak, the situation of ship tonnage oversupply has existed for a long time, and the competition among major liner alliances is difficult to change. The freight forwarder and NVOCC are full of competition due to the low entry barriers. In order to develop in the competition, some container shipping companies have to purchase new ships to open up new routes and increase the distance. It is very uncertain whether they can achieve the desired purpose. On the other hand, container shipping companies must also seek the cargo, and sign contract with large customers, big cargo owners as much as possible.

Their hunger and desire to maintain the market share increase competition in the shipping market undoubtedly. Moreover, the adjustment of industrial structure brought by knowledge economy makes the proportion of intangible commodity trade in international trade, especially trade in services, and the elasticity of international shipping demand appears a downward trend. This will certainly lead to further intensification of competition among container transport enterprises.

3.2.4 Freight transportation risk

The next category is freight transportation risk. First is the ship safety risks. When talking about freight transportation risk, both ship and cargo shall be considered. Container shipping companies are facing risks in ship management, such as accidents of collision, grounding and pollution which may occur in the course of navigation and docking. The aging of fleet structure also brings some difficulties to the ships safety of container shipping companies. First, the old ships have poor cargo worthiness, weak market competitiveness. They are difficult to pick up cargo and even harm the ships themselves. Second, it increases the work and investment of ship maintenance which brings great pressure to company cost. Thirdly, old ships have increased the pressure of safety management. Since the PSC is becoming more and more strict, the requirements for ship safety are becoming higher and higher which brings more difficulties to the safety management of the company.

Next is cargo safety risk. Cargo safety is a comprehensive concept which mainly reflects whether the loading and unloading of goods are accurate or not, and whether

it can meet the special requirements of the shipper for the transportation of goods, the loss of goods in transit, the difference of goods, the degree of general average, and whether the goods are delivered to the enterprise on time, etc. Cargo safety is one of the main aspects reflecting the operation situation of container shipping companies. It is closely related to the interests of companies as well as the credibility and competitiveness of companies. Therefore, such risks are one of the risks that container shipping companies must pay attention to.

The last is natural risk. The environment is complex at high sea. When a vessel is operation, it faces with many uncertainties and high risks. Ocean vessels often sail on high sea that is far away from the coast for a long time. They have to go through different geographical regions and different climatic zones, the marine environment is complex and the weather is changeable. It is possible to encounter high winds, heavy rain, snow and also attacked by natural disasters such as thunder and lightning, tsunami, and ice floes, especially when passing through some of the world's famous storm areas. It can be attacked by these natural disasters all the time. This natural risk has a great impact on the safety and quality of shipping as well as the speed of shipping.

3.2.5 Settlement risk

One is credit risk. Container shipping company is a special kind of service company. The main factors that cause its credit risk are as follows. First, under the

circumstances of rapid changes in the current market, the service cycle is longer because of the limitation of its means of transport. This is one of the main reasons that cause credit risk. Second, a considerable number of customers of container shipping companies are trading companies. Because the trade volume of trading companies is always very large, they are forced to engage in transactions that do not conform to their own volume. At the same time, trade companies are also greatly affected by market changes. Therefore, in credit management, it is generally considered that professional trade companies are a great credit risk factor. Thirdly, container shipping companies have to deal with many foreign companies. Because of the geographical and information transmission, most container shipping companies can not have a better understanding of the credit status of foreign companies, which is also a major cause of credit risk. Therefore, the credit risk of container shipping companies can be considered from two aspects.

This risk can also be divided into two parts. One is employee credit risk. In container shipping companies, most of the salesmen only pay attention to the quantity of cargoes, they do not realize that a transaction can not recover freight on time is not a good transaction. From some aspects, it shall be counted as the loss of the companies. At present, there is a misunderstanding that many salespeople think that credit managers and accountants hinder their business development. There are even some individual salesmen lying to the credit management department about the operation status of customers and concealing the bad records of customers in order to complete the task of collecting cargoes. This makes the work of the credit management department of container shipping companies very difficult. Some business managers think that the profit on the books is the actual profit and they are unwilling to abandon some big customers with bad credit, which is also a major difficulty in the

credit management of container shipping companies. Therefore, the first thing that the credit management department of container shipping companies shall do is to improve the credit awareness of the staffs inside the companies and change the understanding of the staff on sales, so that the credit management of container shipping companies can be carried out in an right way.

Another credit risk is customer credit risk. At present, most container shipping companies use a non-credit sales mode which give their general customers B/L after payment to avoid the occurrence of credit risk. But for some long-term customers who have huge amount of cargo, they adopt the credit sales mode of agreement payment. The main reasons are as follows. Firstly, these cargo owners are the main source of profits of container shipping companies. In order to maintain long-term cooperation with them, they must give these customers certain credit preferential conditions. Secondly, the large volume of shipping of these customers leads to a limitation of liquidity. Besides, the customers can not pay the freight in a very short time. This kind of customer is the most important customers so container shipping companies are unwilling to abandon them. Therefore, such a large customer can adopt the credit sales method of agreement payment. But on the other hand, most of the overdue accounts of container shipping companies are also caused by such customers. So the risk managers of container shipping companies must consider the credit risk of these customers.

The second part in settlement risk is exchange rate risk. At present, more countries have realized the free exchange of foreign exchange under operating projects and adopt a managed floating exchange rate mechanism. In the business of container shipping companies, income is mainly in US dollars, and a considerable part of

operating expenses is in US dollars. The imbalance in foreign exchange receipts and payments and the depreciation of the US dollar will affect the exchange losses of container shipping companies. Therefore, exchange rate fluctuations are an important type of risk that container shipping companies should pay attention to.

3.3 Risk assessment for container shipping companies

Analytic Network Process (ANP) was first proposed by Professor T. L. Saaty in 1996. It is a new decision-making method developed by Analytic Hierarchy Process (AHP). It is suitable for non-independent hierarchical decision-making. It mainly studies the problem of dependence and feedback decision-making. Using the network analytic hierarchy process, we can simplify the point processing, and simplify the problem of the structure is not obvious. In the hierarchical structure, it includes not only the hierarchical level, but also the internal circulation level. The interaction and feedback of some elements in many decision-making problems are dependent. If ANP is used to calculate, the relationship between elements in the system is similar to that of grid structure, which can be solved simply and effectively.

Typical ANP system elements mainly include two parts: the first part is the control hierarchy, and the second part is the network hierarchy. The control hierarchy is the highest level hierarchy system, which mainly includes goals and decision criteria. The decision criteria for control factors must be independent of each other, and control the target elements. If there are no guidelines, have at least one goal. There are two types of control standards: one is the connection standard, which can be

directly connected to the structural system in the hierarchical target structure. The other is the induction policy, which is not connected to the structure but can be used in the network to compare the induction of the network. The network hierarchy consists of elements controlled by the control hierarchy, which contains many elements that do not belong to each other and are not independent of each other. Because of the basic characteristics of an element, the presence of interacting elements may affect another element. The interaction of the elements, even to a set of elements, ultimately results in the interaction of the network structure.

Scale	Meaning
1	The former is as important as the later
3	The former is a little more important than the later
5	The former is obviously more important than the later
7	The former is mightily more important than the later
9	The former is extremely more important than the later
2, 4, 6, 8	The intermediate value of an adjacent element
Reciprocal Value	The latter is a scale of importance over the former

Figure 3: The value and specific meaning of dominance degree

In the application of ANP, constructing ANP supermatrix is a key step. Suppose there are criterion elements $B_1, B_2, B_3, \dots, B_n$, which are relative to the target in the

control hierarchy of an ANP. There are elements $C_1, C_2, C_3, \dots, C_i$ in the network hierarchy and $c_1, c_2, c_3, \dots, c_i$ ($i = 1, 2, \dots, n$) in C_i . The importance of the network hierarchy is determined according to the previous judgment method. According to the above method, the first step is using B_s as the control hierarchy element and it is defined as the standard. c_{j1} , which is the element in C_j , is set as the second criterion. After that, the dominance of the elements, $(W_{i1}^{(j1)}, W_{i2}^{(j1)}, \dots, W_{in}^{(j1)})^T$, is compared to get the judgment matrix, and the sorting vector is obtained according to the eigenroot method. Similarly, C_i can obtain the corresponding ordering matrix. All elements in the group of elements are subcriteria to get the sorting vector by matrix W_{ij} . Take the column K of the matrix as an example, B_s is the control hierarchy, and the element C_{jk} is a sorting vector. B_s is the control hierarchy, The ordering vector matrix of all its groups of elements constitutes the supermatrix, $W = (W_{ij})$. It is as follow:

$$W = W_{ij} = \begin{bmatrix} W_{i1}^{(j1)} & W_{i1}^{(j2)} & \dots & W_{i1}^{(jn_1)} \\ \vdots & \ddots & & \vdots \\ W_{in}^{(j1)} & W_{in}^{(j2)} & \dots & W_{in}^{(jn_1)} \end{bmatrix}$$

By comparing the importance of two elements, a set of judgment matrix can be obtained. Since the supermatrix is all non-negative matrix, the maximum eigenvalue λ_{max} and the W eigenvector of each matrix need to be calculated by the formula $AW = \lambda_{max}$. The entire matrix is not uniform and standardized, and the consistency test of C.R. should be carried out to ensure a reasonable conclusion. The first step is

consistency index test, $C.I. = (\lambda_{\max} - n) / (n - 1)$. λ_{\max} is the maximum value of characteristic root of pare comparison matrix, and n is the power of judgment matrix. The second step is consistency ratio test, $C.R. = C.I. / R.I.$. When $C.R. < 0.1$, the judgment matrix is consistent. Otherwise, relevant judgment matrix needs to be adjusted until it passes the consistency test.

Then, the weighted supermatrix of ANP needs to be constructed. The criterion B_j is the control hierarchy, the sub-criterion is any element group, $C_j (j = 1, 2, \dots, n)$. The judgment matrix A is the comparison of the importance of each element group, $a_{1j}, a_{2j}, \dots, a_{nj}$ is the normalized eigenvector. Using the weighted matrix A to carry on the weight of the supermatrix W's element. It obtains $W_{ij} = a_{ij} W_j (i = 1, 2, \dots, n; j = 1, 2, \dots, n)$. The weighted supermatrix is W, and the sum of each column is 1. This is called the random matrix. For the sake of simple statement, the following supermatrices are weighted supermatrices, but the symbol is still expressed by W.

Another important step is to construct the limit weighted supermatrix of ANP. W_{ij}^0 is defined as the element of the supermatrix W. It reflects the primary importance of i to element j. The second importance of I to element j can be obtained by calculation, $\sum_{k=1}^n W_{ik} W_{kj}^0$, which is W2. And it is still column normalization. When $W^\infty = \lim_{t \rightarrow \infty} W^t$ exists, the W^∞ of column J Is the limit relative ordering vector of each element in the network hierarchy to element j under PS.

To make this part simple, some complex descriptions are ignored. Generally speaking, the process of applying ANP has four steps. The first step is to study the problem. Analyze the need to solve this problem, based on the literature research and experience, through expert interviews, questionnaire survey, field investigation, standard reference method, determine the influencing factors, and based on the relationship between the element hierarchy analysis of the independent, and discuss its dependence and feedback, the final set of factors. The second step is to establish the basic structure of ANP. Through problem analysis, determine decision criteria, control level Settings, set substructures, ANP goals and decision criteria. If the number of criteria is more than two, they target at the higher level and realize the structure of the control network at the lower level, determine the control hierarchy, can build a hierarchical network structure, classify each factor, form a subset, and analyze its internal influence. Third, the supermatrix model of ANP is established to calculate the corresponding weights. After determining the basic structure of ANP and considering the obtained Numbers, the final index results are obtained by comparing the judgment matrix and calculating the supermatrix, weighted matrix and limit weighted supermatrix of ANP, so as to calculate a certain degree or the recombination of standard bodies of elements according to the actual requirements. This paper uses Super Decisions to help with calculations, improving accuracy and reducing complex calculations. Fourth, analyze the results. Through ANP, the standardized weights of various factors and the construction of the whole structure are obtained. Each element is analyzed and evaluated, then the weight is calculated by means of comprehensive evaluation method through the relationship between elements. At the same time the relationship is compared among all levels to determine the required score value to a certain extent.

In the specific calculation process, solving the supermatrix is a very complicated calculation process with a large amount of calculation. In this paper, Super Decisions, which can solve the network analytic hierarchy process, is selected for auxiliary calculation. SD software is made by an American company, Expert Choice. ANP can be fully realized by this software. It can establish a decision model that reflects both dependence and feedback. Using SD software to solve the supermatrix calculation can greatly shorten the operation time, simplify the difficulty of operation, and improve the accuracy of operation. Finally, the operation results obtained can provide necessary data support for subsequent analysis. In this paper, SD is used to simplify the calculation. The complete process will be shown in the appendix. Only the result is shown in this part.

												final	
A: initial investment risk	Ship investment risk	a1	0.12897	0.123439	0.0458	0.04958	0.0591	0.1049	0.0441	0.0725	0.001	0.057499	0.068699
	ship leasing risk	a2	0.08388	0.07645	0.0162	0.03406	0.022	0.0638	0.0134	0.0725	0.0032	0.022708	0.040823
B: social risk	Shipping policy risk	b1	0.09624	0.029423	0.1237	0.15284	0.1166	0.0281	0.0398	0.065	0.0805	0.180219	0.091231
	social stability	b2	0.09073	0.118232	0.0899	0.15226	0.0699	0.1422	0.0559	0.0984	0.219	0.130624	0.116728
C: shipping market risk	Freight rate fluctuation risk	c1	0.11603	0.075299	0.1397	0.04976	0.2254	0.0987	0.1697	0.161	0.0024	0.118159	0.115616
	shipping demand and supply risk	c2	0.05484	0.071216	0.1398	0.05738	0.1421	0.0313	0.0743	0.0544	0.0097	0.057516	0.069254
	Fuel price fluctuation risk	c3	0.00687	0.003077	0.0124	0.00676	0.0218	0.009	0.0262	0.0275	0.0002	0.007706	0.01215
	competition risk	c4	0.10149	0.072894	0.1366	0.07495	0.0867	0.0384	0.129	0.0978	0.0109	0.011029	0.075974
D: Freight transportation safety risk	ship safety risk	d1	0.05379	0.057203	0.0551	0.07999	0.0565	0.0379	0.0804	0.0453	0.0808	0.105628	0.065265
	cargo safety risk	d2	0.02499	0.033689	0.0257	0.03754	0.0295	0.0312	0.0464	0.0377	0.1075	0.066688	0.044091
	natural risk	d3	0.16288	0.152434	0.1377	0.23875	0.1001	0.2436	0.2169	0.1455	0.3692	0.189202	0.195631
E: settlement risk	exchange rate risk	e1	0.03056	0.088793	0.0304	0.01121	0.0161	0.0914	0.029	0.0432	0.0283	0.006224	0.037521
	credit risk	e2	0.04873	0.097852	0.0469	0.05493	0.0542	0.0794	0.075	0.0792	0.0872	0.046797	0.067017

Figure 4: the result of the risk assessment

It is obviously that the freight rate fluctuation risk is one of the most important risks to the container shipping companies. So the companies need to put emphasis on it.

4 Freight volatility risk management

4.1 Definition and management of freight volatility risk

Shipping market is a place full of risks. The structure of shipping market, market transparency, market intervention and competition will have a profound impact on freight rates. The freight rate is directly related to the profit and competitiveness of container shipping companies. The fluctuation of freight rate in shipping market has a profound impact on container shipping companies. Therefore, freight risk is one of the most important risk faced by container shipping companies, and the fluctuation of freight rate has a tremendous impact on container shipping companies. Over the past decade, shipping industry participants have experienced an shipping peak once in a blue moon, and freight rates have increased by nearly 300% from 2003 to 2008. However, with the impact of the financial crisis, shipping market prices have fallen by nearly 95% since September 2008. Freight fluctuations in the shipping market are so intense that shipping participants are often at a loss in the complex and volatile shipping markets, which makes it difficult for them to make decisions. On the other hand, the intense fluctuation of freight rates also makes it possible for the shipping industry participants to make huge profits. Therefore, many shipping participants have changed their operating methods and paid more attention to the risk management of container shipping companies. In recent years, the freight derivatives market has gradually grown. Shipping participants can manage risks and hedge freight through forward freight agreements. Nowadays, freight can be made a deal like commodities.

In the shipping market which full of competition and risk, container shipping companies must establish effective risk management mechanism if they want to realize capital operation worldwide. Only in this way can they survive and maintain

sustainable development in the competitive shipping market. In simple words, the risk management can be roughly divided into four steps. Firstly, it defines the risk and what is the most influential risk to the company. For container shipping companies, freight risk is an important risk they face. Secondly, it evaluates the risk that may cause loss to the company. Third, using effective tools for risk management. For container shipping companies, the risk can be avoided by marine insurance and hedging through shipping derivatives such as forward freight agreement. The use of shipping derivatives can manage the risk of freight fluctuation well. Freight derivatives for dry bulk cargo, although also a new thing, there is a more mature system. But for containers, freight derivatives don't have a complete system. At present, some container shipping companies manage the risk of container freight fluctuation through the derivatives of container freight index issued by Shanghai Shipping Exchange. Such derivatives are similar to forward freight agreements in dry bulk freight derivatives. Besides, companies also need to monitor and control the risk of risk aversion.

4.2 History of shipping derivative and SSE's container derivative

In May 1985, the Baltic Shipping Exchange issued maritime futures. Its purpose is to provide traders with a tool for hedging and avoiding risks in the downturn of the shipping market. This is the first real futures trading of non-tangible commodity ships or cargoes. In addition, the price discovery function of maritime futures can help shipping industry participants predict future spot market of freight rates. The BIFFEX was first traded on the London Mercantile Exchange (later traded inn the London International Financial Futures Exchange). After the issue of BIFFEX, its trading volume began to rise, but due to the lack of liquidity and poor hedging effect of the contract. Its trading volume soon declined continuously and stopped trading in April 2002.

BIFFEX trading volume continued to decline year by year, and eventually stopped trading. On the one hand, because of its poor hedging effect, even after the Baltic Shipping Exchange improves the freight index, the hedging rate of the futures is still very low. On the other hand, the more flexible and efficient forward contract - Forward Freight Agreement (FFA) is emerging. Forward freight agreement is a contract signed by both sides of the trade, which settles freight or chartering on a certain date in the future for a particular cargo or ship type, aiming at the main routes of dry bulk market or tanker market or container market. The underlying assets of forward freight agreements may be any route that constitutes a freight index provided by the Baltic Shipping Exchange or other institutions, such as (SSE). Forward freight agreements are settled in cash by the difference between the contract price and the applicable settlement price. For single-voyage vessels with the Baltic Capesize Index (BCI) or the Baltic Panamax Index (BPI), average rates for the last seven trading days of the settlement month are adopted. For future charters of BCI, BPI, BHMI and BSI, the average rent of settlement month is adopted . Due to the great volatility of the international shipping market, the forward freight agreement market has been greatly developed, and shipping industry participants can hedge the risks by trading forward freight agreement.

Forward freight agreement has a good hedging effect, but in the case of good market, its disadvantage is also obvious. When the market is good, shipping option is used. The advantage of shipping option is that it gives the option holder the right to buy or sell a specific subject at a predetermined price at a certain time in the future. Although the current trading volume is a little bit small, its high hedging value and potential high speculative earnings are favored by shipping operators. Compared

with forward freight agreements, shipping option have better flexibility. When the development trend of the spot market is against their will, option holders can opt out of the transaction, and when the market is good, they can enter the market. Call option holders have the right, not the obligation, to finalize the future contract of carriage at a certain freight rate. If the price rises at the settlement day, the call option holder will practice the option to finalize the contract of carriage at the agreed price. If the freight rate falls, he will not practice the option, but will finalize the contract of carriage at spot freight rate. Therefore, call option holders have the same upward trend as forward freight agreements, but they do not have downward trend of forward freight agreements. It should be noted that the option holder needs to pay premium to obtain the option. Therefore, if the freight price rises above the sum of premium and strike price, the option holder will be profitable. Similarly, the holders of put options are similar. Only when the freight price falls below the strike price plus premium can they make a profit.

Hedging the risk of shipping price fluctuation through shipping derivatives is gradually becoming the way for shipping industry to seek stable development. Shanghai Shipping Exchange is committed to build a multi-level shipping derivatives platform, provide diversified shipping derivatives services. and SSE also actively build shipping spot forward trading and OTC shipping price index derivatives platform services. To achieve the goal, Shanghai Shipping Exchange established a freight risk management platform, Shanghai Shipping Freight Exchange Co., Ltd. (SSEFC). SSEFC issued Shanghai Export Container Freight Transaction Contract for trade in June 2011 on the basis of Shanghai Export Container Freight Index (SCFI) contract. The contract assets are Shanghai Export to Europe Route (Rotterdam and

Hamburg) and Shanghai Export to West America Route (Los Angeles and Long Beach).

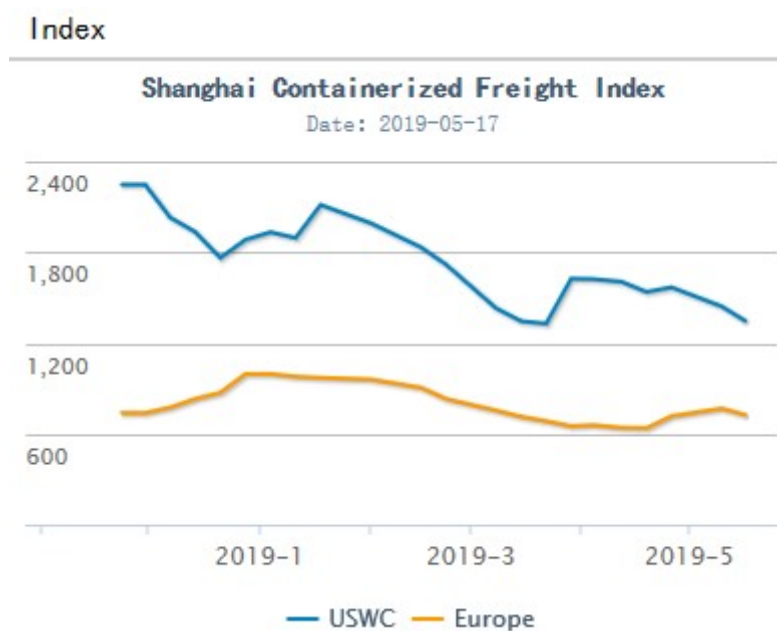


Figure 5: shanghai containerized freight index

Taking EU as an example, on March 6, 2018, Shanghai Export Container (Europe) Freight Derivative which is issued by Shanghai Shipping Freight Exchange Co., Ltd. is first traded under the mixed delivery mode. This delivery mode meets the needs of China's foreign trade logistics companies according to the characteristics of the market. At present, container shipping participants have gradually participated in the transaction. They quote the anticipated freight price to the trading platform, lock the freight revenue ahead of time and also hedge the risk of freight fluctuation.

Contract Information						
Contract	Listing Date	Last Trading Day	Delivery Deadlines	Benchmark Price	Exchange Rate	Current Percentage of Deposit
UW1911	2019-05-27	2019-11-15	2019-12-01	1650.00	6.8993	0%
UW1910	2019-04-22	2019-10-25	2019-11-10	1730.00	6.8993	0%
UW1909	2019-03-18	2019-09-20	2019-10-06	1750.00	6.8993	0%
UW1908	2019-02-25	2019-08-16	2019-09-01	1830.00	6.8993	0%
UW1907	2019-01-21	2019-07-19	2019-08-04	1800.00	6.8993	0%
UW1906	2018-12-24	2019-06-21	2019-07-07	1729.00	6.8993	0%
EU1911	2019-05-27	2019-11-15	2019-12-01	815.00	6.8993	0%
EU1910	2019-04-22	2019-10-25	2019-11-10	820.00	6.8993	0%

Figure 6: contract information of container derivatives

EU is China's largest trading partner. In recent years, it has gradually recovered from the debt crisis in Europe. The warming of bilateral economy between China and Europe has led to the recovery of China-EU shipping market. Every day, a large number of containers are shipped from Chinese ports to Europe ports. In 2017, the volume of containers on the Far East-Europe routes reached 22.9 million TEU, and the weekly capacity reached 400,000 TEU. These support FE-EU becoming one of the three largest liner routes in the world. However, the shipping market objectively has the characteristics of high risk, high frequency and unpredictability of freight fluctuation. From 2015 to 2017, the average index of China-EU routes was 872.8 USD/TEU, 694.8 USD/TEU and 620.3 USD/TEU with an obvious decrease. It is difficult for Chinese foreign trade exporters to cope with the risk of large fluctuations in freight rates through traditional trade ways. Therefore, Shanghai export container (Europe) freight derivatives with the function of hedging and price discovery are issued which are mainly based on the demand of spot companies. They hit the pain points of the industry and take an important step in expanding China-EU trade and economic business.

In order to serve the shipping companies better, Shanghai export container (Europe) freight derivatives have five characteristics. First, it shall adopt the electronic trading mode, break the information barrier, embody the quotation information of all parties in the electronic platform, and give full play to the characteristics of open and transparent electronic trading. Traders can understand the price trend changes according to the changes of the price quotation on time, and play games according to their own views to make decision and then form a balanced price. The price will also play a guiding role in the future business plan of the companies and price discovery of freight derivatives.

Quotes Information							
Contract	Last	Chg	Prev. Settle	Bid	Ask	Volume	Open Interest
EU1908	775	-2	777	0	0	2	0
EU1909	795	-5	800	0	0	1	6
EU1910	815	-5	820	0	0	1	0
UW1906	1470	-7	1477	0	0	1	1
UW1907	1571.5	-11.5	1583	0	1662	39	5
UW1908	1610	-10	1620	0	0	2	0
UW1909	1630	-10	1640	0	0	1	3
UW1910	1650	-20	1670	0	0	1	1
UW1909	1630	-0.61	1640	0	0	1	3
UW1910	1650	-1.20	1670	0	0	1	1

Figure 7:quotes information of container derivatives

Secondly, adopting the mixed delivery model and taking the third index releasing date of the expiration month of the contract as the final trading day. After expiration, on the basis of preferential use of index cash delivery, actual capacity delivery is provided to customers with actual shipping demand. Index cash delivery takes Shanghai Export Container Freight Index as the basis for settlement of delivery and strike price, so as to realize the convergence of derivatives prices to the spot at

expiration. For those companies that make spot delivery, they can also make declarations through spot delivery, find suitable shipping dates or boxes in the derivatives market, and make actual capacity delivery on the premise of consensus.

Thirdly, payment and settlement prices are based on the calculated average prices of the European Route Freight Index corresponding to the first three Shanghai Export Container Freight Index in the month when the contract expires. This mechanism uses a credible third-party price index as the basis of settlement, effectively avoiding the price deviation caused by the transaction price as the strike price. Three-week arithmetic averaging also avoids transaction risk caused by excessive volatility of the day-of-delivery index in single index settlement.

Fourthly, increasing the margin ratio monthly according to the expiration date of the contract. The margin ratio is 25% in the initial stage of the contract signing, 30% in the month before delivery, and 40% in the month before delivery. This not only takes into account the activity of the transaction, but also ensures that the transaction risk can be effectively controlled.

Fifthly, adopting the price limit system. In general, 5% is used as the limitation of price limit on trading day. When the market continues to rise and fall unilaterally, the limitation gradually enlarges to 7% and 9%. Through a deeper quotation range, a reasonable price can be found and give full play to the function of price discovery. UW freight derivatives are also the same.

4.3 Application of SSE's container shipping derivative

Since SSEFC issued and traded the contract of Shanghai export container freight based on Shanghai Export Container Freight Index (SCFI) in June 2011, the

container freight derivatives market has gradually begun to develop. After 2018, in order to better meet the characteristics of the shipping market, the mixed delivery model was introduced. Mixed settlement mode refers to that cash settlement based on index can also be settled through the transfer of actual capacity, but this mode of settlement does not affect the effect of hedging. Next, a case will be used to analyze and calculate the effect of container freight derivatives intuitively.

This is a real case. In order to avoid unnecessary trouble, company A and company B represent both sides of the transaction here. Company A is a one-stop international logistics service platform, which provides comprehensive international logistics services including freight forwarder, booking, trailer, customs declaration, warehouse loading and insurance agent. Company B was established in 1994. It is a first-class freight forwarding company approved by the Ministry of Commerce of China and also a registered NVOCC by the Ministry of Transportation. After more than 20 years developing, Company B has become a fairly large-scale freight forwarder, ranking among the top 50 logistics companies and freight forwarder in China. In this case, Company A acts as freight forwarder, the shipper, and Company B acts as NVOCC, the carrier. This case occurred in 2018, during the Sino-US trade war. As a common knowledge, shipping is a derivative demand, trade and shipping complement each other. The Sino-US trade war directly affects the import and export volume of cargoes between this two countries, and then changes the customer demand of liner companies. These eventually leads to freight fluctuations. With the escalation of Sino-US trade war, its negative effects have also affected shipping. Since 0:00 on July 6, the United States has imposed tariffs on \$34 billion of Chinese commodities. Company B feared that trade protectionism would affect the freight rates on Sino-US routes, they then decided to short one hand of UW 1807 contract at \$1450/FEU to lock in July freight revenue. Subsequently, the trade war between China and the United States tended to escalate, President Trump clamored that the target of tariff would increase to \$500 billion commodities. Many light industry exporters in China, such as clothing and furniture, are afraid of being returned by American buyers because of the imposition of tariffs in the future, so they request for early delivery. The orders received by Company A in July did not decrease but increased, and then longed one hand of UW 1807 contract at the price of \$1394/FEU to lock in the cost of shipment.

On July 16 and 17, Company A and Company B submitted the UW 1807 Application Form to SSEFC on time. After the SSEFC verified and matched, the UW 1807 Shipping Capacity Delivery Matching List was sent to both sides after closing at 15:00 on July 17. After consultation between the two sides, the booking contract was signed on July 18 in the conference room of the 32nd floor of Shanghai International Shipping Service Center. The contract stipulates that forward freight shall be determined in the form of exponential linkage, the forward freight will be UW 1807 strike price plus premium or discount. They will use the space of Hyundai Merchandise Maritime in late July and the discount is - 75 USD/FEU, the loading port is Shanghai and the unloading port is Los Angeles. July 20 is the last expiration day. After closing at 15:00 on that day, SSEFC announced the UW 1807 strike price of USD 1618.7/FEU (the arithmetic average index of Shanghai Export Container Price Index Shanghai-US-West Route Index in the first three weeks of July), and then frozen USD 161.87 as the margin for capacity delivery. On July 19, Company A sent the booking note to Company B and copied to SSEFC, which included cargo information and operation items such as scheduled voyage, box type and volume. On July 23, Company B responded to Company A with a copy of the manifest, including the name of the ship, voyage and sailing date. Affected by Typhoon No. 10 in 2018, the Yangshan Terminal was closed for one day which delayed the arrival of ships. On July 28, at 12:30, the vessel with cargo left the berth and sailed successfully (the hedging effect is shown in the table below).

Table 1:hedging effect of UW1807

Hedging effect			
item		A company(buyer)	B company(seller)
Spot	Freight settlement	1618.7-75=1543.7\$/FEU	
Freight derivatives	UW1807 Open price	1394\$/FEU Buy open position	1450\$/FEU Sell open position
	Exit price(UW1807 Settlement Price)	(1555+1685+1616)/3=1618.7\$/FEU	

	Quotation profit&loss	$1618.7-1394=224.7\$/FEU$	$1450-1618.7=-168.7\$/FEU$
	Transaction fee	$1618.7*0.05\%=0.697\$/FEU$	$1450*0.05\%=0.725\$/FEU$
	Capacity delivery fee(exemption)	$1618.7*5\%=80.94\$/FUE$	
	Actual payment	$1543.7-224.7+0.697=$ $1319.697\$/FEU$	$1543.7-168.7-0.725=$ $1374.275\$/FEU$

Therefore, participating in the hedging of shipping derivatives can effectively hedge the huge financial risks and operational pressures brought to container shipping by the large fluctuations of shipping prices. In this case, Company A succeeded in reducing the shipping cost for the company in this transaction by using derivatives to lock the freight rate in a lower position, and its prediction of the freight rate was quite successful. However, because of the wrong judgment of freight rate, Company B locked the freight rate in a disadvantageous position, which led to the decrease of shipping revenue. It can be seen that the judgment of freight trend plays an important role in the transaction of freight derivatives. Just as Company A predicts the trend of freight rate accurately, UW 1807 has achieved the effect of hedging, but hedging also needs to be cautious. First, hedging itself requires capital. In the course of the price decline of selling hedge, occupancy of margin will decrease continuously, and the float revenue will expand. So the equity will increase gradually in this market, and vice versa. Buying hedging is the opposite of selling. Therefore, in addition to the necessary margin, companies need to retain additional funds to cope with the risk of insufficient margin caused by overdraft of freight derivatives. Secondly, there may be speculative trading risks in the operation process. If the short is made into long, the opening of a position into a closed position or the number of varieties and months does not match the plan, and the financial and policy makers do not find and correct it in time, the hedging effect will be reduced or even fail. Therefore, when hedging, companies should separate trading, monitoring and decision-making and they need to establish necessary responsibility system, process management system, transaction approval system and risk monitoring system.

4.4 The advice for container shipping companies and Shanghai Shipping Exchange

First, shipping companies should strictly follow the concept of hedging and control speculative risk. Financial derivatives speculation is an important reason for the failure of the operation of financial derivatives in shipping companies and brings huge risks to the companies. Shipping companies should determine the object of hedging is the products they really need, and the scale and time span of companies hedging should match the spot demand of companies. Only by defining their own demand and direction of hedging and strengthening the control of their own direction of hedging, can shipping companies effectively prevent speculation, prevent derivatives gambling and reduce the risk of shipping financial derivatives. Secondly, shipping companies should strengthen the risk assessment of shipping financial derivatives. Because of the complexity and high volatility of shipping financial derivatives, shipping companies should not only reasonably predict freight trends and identify risks, but also choose appropriate methods to strengthen the effective prediction and risk identification of fuel and exchange rate trends, and adopt special treatment mechanism for high-risk business. Risk assessment of derivative transactions includes the process of discovering risk, estimating its importance and evaluating the possibility of risk occurrence, which requires a sound risk assessment system and model to confirm the degree of risk associated with the use of derivatives and the possible consequences. Finally, shipping companies should improve the internal control structure of derivatives and effectively prevent risks. The internal control mechanism of financial derivatives of shipping companies should establish risk management mechanism combined with the actual situation and characteristics of companies, and improve the internal risk prevention system of shipping companies derivatives. Shipping companies must pay close attention to the shipping

market and related spot prices, adopt a reasonable method to observe the risk status of freight derivatives in real time, and implement comprehensive, continuous control in advance, in and after the transaction. In addition, shipping companies should strengthen the role of internal audit in derivatives risk control, and focus on training specialized internal auditors with relevant shipping financial knowledge and knowledge of shipping companies' market risks.

At present, the number of types of shipping financial derivatives in China is insufficient and the homogeneity is high. Shanghai shipping exchange should strive to provide more choices for investors and moderately increase the types of shipping financial derivatives. Shanghai Shipping Exchange should try hard to provide investors with more choices of derivatives and increase the types of shipping derivatives. The Shanghai shipping exchange should accelerate the development of the shipping price index derivative business, and catch the chance to transform the trade mode and upgrade the shipping service level with the help of Shanghai free trade area. On the basis of SCFI and CBFI, Shanghai Shipping Exchange can establish more kinds of shipping derivatives, then try to attract more foreign traders and increase control over pricing power of shipping financial derivatives, and actively accelerate the healthy development of China's shipping derivatives. As the derivatives market of dry bulk shipping has been formed, it is difficult for SSE to gain a voice in this market, so SSE should concentrate on the development of container derivatives. At the same time, because China itself is the place where many containers are shipped, SSE has unique advantages. With policy support and government support, it can get first-hand container information, which is very suitable for the development of container derivatives. As long as properly developed, SSE can become the founder of container derivatives market order and dominate

most of the container derivatives trading in the market. In addition, SSE should cooperate with various universities which are specialized in finance and shipping even some scientific research institutions to set up research groups to carry out multi-directional, deep-seated and meticulous research on the purpose and content of shipping finance derivatives for a long time, so as to provide a solid theoretical basis for the shipping finance session and enable the shipping financial market to develop healthily along an efficient way. In addition, comprehensive shipping professionals are also crucial to the development of shipping financial markets, and the education of Chinese universities in this aspect is weak. Therefore, SSE should cooperate with universities to set up courses on shipping financial derivatives in schools and integrate the contents of shipping and finance and other related disciplines. At the same time, students in this direction should participate in the daily work of SSE or enter relevant companies for practices, these experiences can make students more professional in shipping financial derivatives. In addition, training should also be carried out for the society, so that investors can improve their understanding, application and management ability of shipping derivatives. SSE shall play a leading role in enabling investors to master knowledge of shipping, finance, derivatives, risk control and other aspects through various means (such as regular business training and risk education) as well as improving their operational ability and risk control ability. SSE need to guide investors to make rational investment. Finally, SSE can introduce a group of professionals who are familiar with the mechanism of the international derivative market, have rich practical experiences and solid theoretical foundations so that they can be leaders to drive the development of China's shipping financial derivatives continuously.

5.Conclusion

The integration of global economy provides container shipping companies with unprecedented development opportunities and puts them at high risk at the same time. Scientific and effective risk management is the guarantee for companies to reduce losses and achieve predetermined goals and interests. There are external risks and internal risks in shipping companies. External risks include natural risks, political risks, shipping market risks and financial risks. Internal risks include ship investment and lease risk, operation and management risk, human resource risk and credit risk. Among these risks, the most important is the market risk, especially the risk of freight fluctuation. Although the container derivatives market is still not mature, container shipping companies can carry out risk management through SSE's container derivatives. Container companies need to keep in mind that the most fundamental role of derivatives is hedging, not speculation.

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Appendix I- The risk assessment questionnaire

Since this paper aims at manage the risk of the container shipping companies in a practical way, employees who work in the container related companies may know better about the real situation of the companies. So this questionnaire is sent to ten employee in container related companies, such as liner company, freight forwarder and international trading companies. The list of the respondents is shown as the following table.

Table 1: List of respondents

NAME	TELEPHONE
Med Qu	0086 2123018100-3090
Gakki Lyu	0086 2123018082
Qian Mengjiao	0086 13817651266
Hu Yanwen	0086 18321005729
Yuan Junjie	0086 18221325165
Tang Jiayan	0086 13917106602
May Feng	0086 2123018036
Pan Qinyi	0086 13621627340
Gong Yanfei	0086 13816563718
Fan Rong	0086 2165950038

Because of the complexity of this questionnaire, it is difficult to show it in table. So it is shown by picture.

Risk assessment of container shipping company

introduction

When you answer this questionnaire, please compare the both index in each question. If you think the left one is more important then you just fill in the proper degree. The same to the right.

index	degree		importance degree										degree		index					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
food																				cloth

This means the cloth is extremely more important than food

1. assessment of the first class risk

1-1. Compare with each other, which first class risk in the following is more important to container shipping company?

risk	degree		importance degree										degree		risk					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
A:initial investment risk																				B:political risk
A:initial investment risk																				C:shipping market risk
A:initial investment risk																				D:Freight transportation safety risk
A:initial investment risk																				E:settlement risk
B:political risk																				C:shipping market risk
B:political risk																				D:Freight transportation safety risk
B:political risk																				E:settlement risk
C:shipping market risk																				D:Freight transportation safety risk
C:shipping market risk																				E:settlement risk
D:Freight transportation safety risk																				E:settlement risk

2 assessment of the second class risk

2-1. Compare with each other, which second class risk in initial investment risk is more important to container shipping company?

risk	degree		importance degree										degree		risk					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
a1: ship purchasing risk																				a2: ship leasing risk

2-2. Compare with each other, which second class risk in initial political risk is more important to container shipping company?

risk	degree		importance degree										degree		risk					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
b1: shipping policy risk																				b2: social stability

2-3. Compare with each other, which second class risk in shipping market risk is more important to container shipping company?

risk	degree		importance degree										degree		risk					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
c1: Freight rate fluctuation risk																				c2: shipping demand and supply risk
c2: Freight rate fluctuation risk																				c3: Fuel price fluctuation risk
c3: Freight rate fluctuation risk																				c4: competition risk
c2: shipping demand and supply risk																				c3: Fuel price fluctuation risk
c3: shipping demand and supply risk																				c4: competition risk
c4: competition risk																				c4: competition risk

2-4. Compared them, which second class risk in Freight transportation safety risk is more important to container shipping company?

risk	degree		importance degree										degree		risk					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
d1: ship safety risk																				d2: cargo safety risk
d2: ship safety risk																				d3: natural risk
d2: cargo safety risk																				d4: natural risk

2-5. Compare with each other, which second class risk in settlement risk is more important to container shipping company?

risk	degree		importance degree										degree		risk					
	extremel y imprtant		9	8	7	6	5	4	3	2	1	2	3	4		5	6	7	8	9
e1: exchange rate risk																				e2: credit

This questionnaire is used for academic papers. You need to fill in your name and telephone number. There may be some professors may ask you later. I apologize for disturbing you. Thanks alot for taking time out of your busy schedule to fill out this questionnaire.

Name:

Telephone:

Figure 1: the questionnaire

Appendix II- The process and result of ANP assessment in Super Decision

In this paper, SD is used to simplify the calculation. First, some clusters are set and some descriptions are made.

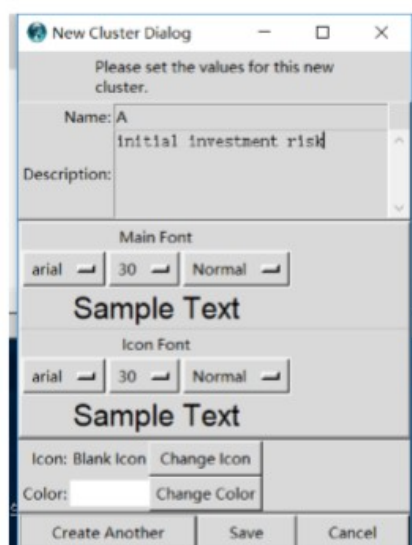
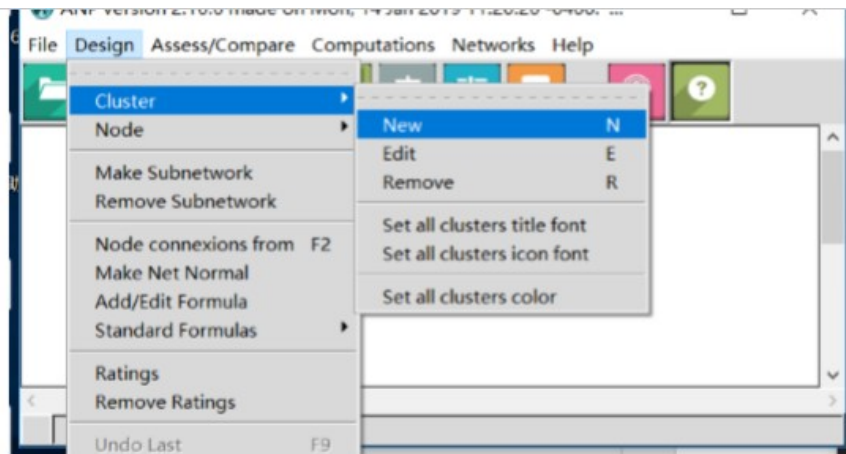


Figure 1: the way to set the clusters

Second, some nodes which belong to the clusters are set and descriptions are made.

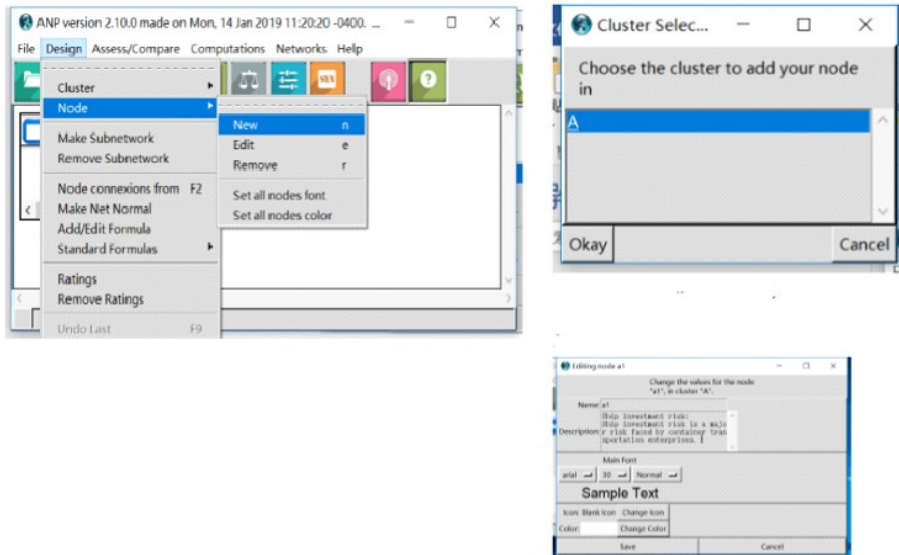


Figure 2: the way to set the nodes

Finally, network is set between these element.

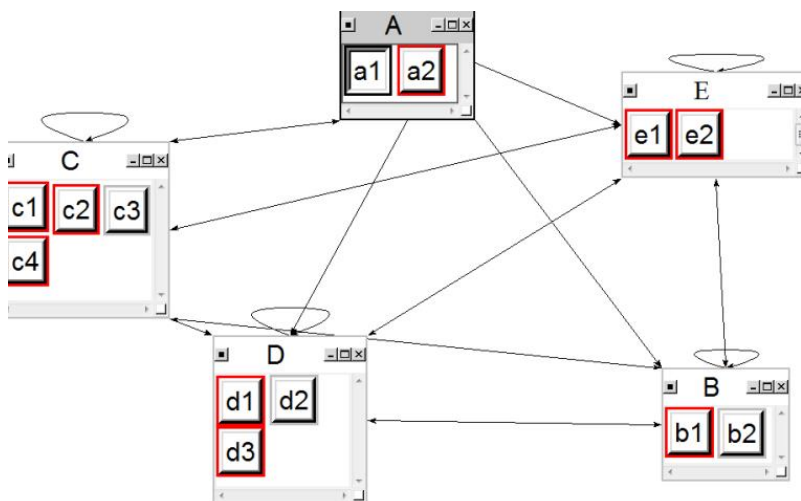


Figure 3: network in SD

Then the results of ten questionnaires of the risk assessment are entered into this software by hand and ten priorities are get.



Figure 4: questionnaire in SD

They are put into the excel and the arithmetic average of the ten priorities is regarded as the final result.

													final
A:initial investment risk	Ship investment risk	a1	0.12897	0.123439	0.0458	0.04958	0.0591	0.1049	0.0441	0.0725	0.001	0.057499	0.068699
	ship leasing risk	a2	0.08388	0.07645	0.0162	0.03406	0.022	0.0638	0.0134	0.0725	0.0032	0.022708	0.040823
B:social risk	Shipping policy risk	b1	0.09624	0.029423	0.1237	0.15284	0.1166	0.0281	0.0398	0.065	0.0805	0.180219	0.091231
	social stability	b2	0.09073	0.118232	0.0899	0.15226	0.0699	0.1422	0.0559	0.0984	0.219	0.130624	0.116728
C:shipping marketrisk	Freight rate fluctuation risk	c1	0.11603	0.075299	0.1397	0.04976	0.2254	0.0987	0.1697	0.161	0.0024	0.118159	0.115616
	shipping demand and supply risk	c2	0.05484	0.071216	0.1398	0.05738	0.1421	0.0313	0.0743	0.0544	0.0097	0.057516	0.069254
	Fuel price fluctuation risk	c3	0.00687	0.003077	0.0124	0.00676	0.0218	0.009	0.0262	0.0275	0.0002	0.007706	0.01215
	competition risk	c4	0.10149	0.072894	0.1366	0.07495	0.0867	0.0384	0.129	0.0978	0.0109	0.011029	0.075974
D : Freight transportation safety risk	ship safety risk	d1	0.05379	0.057203	0.0551	0.07999	0.0565	0.0379	0.0804	0.0453	0.0808	0.105628	0.065265
	cargo safety risk	d2	0.02499	0.033689	0.0257	0.03754	0.0295	0.0312	0.0464	0.0377	0.1075	0.066688	0.044091
	natural risk	d3	0.16288	0.152434	0.1377	0.23875	0.1001	0.2436	0.2169	0.1455	0.3692	0.189202	0.195631
E:settlement risk	exchange rate risk	e1	0.03056	0.088793	0.0304	0.01121	0.0161	0.0914	0.029	0.0432	0.0283	0.006224	0.037521
	credit risk	e2	0.04873	0.097852	0.0469	0.05493	0.0542	0.0794	0.075	0.0792	0.0872	0.046797	0.067017

Figure 5: result of the assessment