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## Risk analysis of mega container ship

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**WORLD MARITIME UNIVERSITY**

Shanghai, China

**RISK ANALYSIS OF MEGA CONTAINER SHIP**

By

ZHU Xiaojing

**China**

A research paper submitted to the World Maritime University in partial  
Fulfillment of the requirements for the award of the degree of

**MASTER OF SCIENCE**

**(INTERNATIONAL TRANSPORTATION AND LOGISTICS)**

2007

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## **DECLARATION**

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

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

(Signature): .....

(Date): .....

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# ABSTRACT

Title of Dissertation: **Risk Analysis of Mega Container Ship**

Degree: **Master of Science in International Transportation and Logistics**

With the globalization and integration of world economy, the maritime worldwide network is formed. Mega container ship is more and more popular, because of the increasing of freight quantity, main stem transportation, and the appearance of container hub ports. And as well known, the mega ship has the advantage of scale economies, but can they successfully getting into service depend on cargo flow, shipping distance, port efficiency and constraints? And, is it the truth that using a mega container ship will bring a rich and generous benefit? And if the market is bad, how the profit change? This dissertation `s goal is to illustrate the economic risk of mega container ships.

At first, the thesis analyzes the advantage and disadvantage of mega ships. The advantages are: occupy more market quotas, reduce cost, and promote the alliance and merge of liner ship company. And the disadvantages are: limitation of berthing, limitation of routing, and the risk of investment.

Then, two factors that affect the mega ship `s profit-making ability are listed, and the general views of them were given. The risk analyses were followed. From the analyses, we can get an answer about questions above.

**KEYWORDS:** mega ships, risk analysis, oil price, load rate

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## **LIST OF ABBREVIATIONS**

CFS	Container Freight Station
DA	Depth measured in After-perpendicular
DF	Depth measured in Fore-perpendicular
OPEC	Organization of the Petroleum Exporting Countries
R	Rate
TSA	Transportation Security Administration
UK	United Kingdom
USA	United States



# 1. Introduction

## 1.1 Background

With the globalization and integration of world economy, the maritime worldwide network is formed. From the time when container ships born, the container ship can be dividing as six eras (SHI Jun-fang 2004): in era 1. Container ship can carry 70-1000 TEU; in era 2, the capability increased to 180—2000 TEU, and the speed of ships is 26-27kn; in era 3, the speed of ships sharply decreased to 2-22kn, and the weave of shipman is about 40 people. But, because of the bigger ship size and the improved transport efficiency, the stowage capability rise to about 3000 TEU. The characteristics of ships in the era are high efficiency, and saving energy sources; in era 4, the container ship size implements enlargement. The sail speed was increased and the carry capacity was mounted up which is 4,400 TEU. Ships in this era was called “Panamax container ship”. With using high strengthen steal, the weight of container ship is reduced 25%. The high efficiency diesel engine development reduced the fuel bill greatly, and as a result of the ship`s automatic enhancement reduced the crew population, the container efficiency further enhanced; in era 5, the commissary is German Shipyard constructs first 5 APLC-10 type ships. This kind of ship can load 4800TEU, and the inverse proportion of captain and beam is 7-8. This causes the ships` restoring force increased.

Hereafter, the container ships are in era 6. In 1996, another kind of ship was completed. The most capacity is 8000TEU. This trend persists to today, and the max capacity now is far over 10,000 TEU. Ships in this area were called Mega Ship. Because of the increasing of freight quantity, main stem transportation, and the appearance of container hub ports, mega container ship is more and more popular. We can see the trend in Table 1.1.

The world famous international containership transportation market essayist -- Professor Steve Matthew pointed that, the export quantity of container cargo rose

quickly in Asia in 2006, especially in China. In every trade line around the world, the freight quantity grew day by day in a long period about six months. Almost container liner ship companies allege that their export container liner ships are all fully loaded. With such huge demand of transportation, nearly all carriers want to use large-size or even mega container ship to run their business.

With world trade expands and cargo traffic grows, the development stride of containership size being large are great, especially after 1990. The largest ship in the world is 4,400 TEU in 1991, 6,000 TEU in 1996, and 7,500 TEU in 2003. The 8,000 TEU ship of OOCL currently rewrites the record, and the ship is the largest ship among existing ships used. Moreover, mega ship of 9,000+ TEU will be brought into Asia-Europe and Transpacific services soon in the near future, and mega ship of 12,500+ TEU is also expected to deliver in five to ten years (Frankel, 2002). Today, we can see that the rise trend is from strength to strength. For example, sources from the communication departments of Fujian Province say that after an all-round test, the P&O Nedlloyd Shackleton, which belongs to P&O Nedlloyd Container Line Limited, was formally put into operation along the China-Europe shipping-line lately. With a length of 300 meters, a width of 42.8 meters and a draft of 14 meters the Shackleton is one of the largest containerships of the world. Departed from Shanghai, it will anchor at Xiamen, Fujian Province and Singapore, and then call at key ports in Europe. The largest container ship size is over 12,000 TEU up to now.

Table 1.1 capacity structures of container ships from 2004.01 to 2007.01				
Ship Type / Year	2004.01	2005.01	2006.01	2007.01
999-	554	596	630	693
1000-1999	1293	1355	1394	1513
2000-2999	1253	1356	1439	1602
3000-3999	950	971	990	1054
4000-4999	1046	1246	1323	1514
5000-5999	720	985	1077	1157
6000-6999	517	559	589	701
7000-7999	198	251	288	296
8000+	16	231	350	855
Total Freight Capacity	6529	7550	8080	9385
Total Freight Capacity of Mega Ship	2017	2304	2304	3009
Proportion of Mega Ship	22.2%	26.7%	28.5%	32.1%

*Source: Drewry Shipping Consultants 2003*

## **1.2 purpose of this study**

Nowadays, 90% of freightage is by ship in ocean. The container ship transportation occupies a big inverse proportion in the shipping market. And, from that time, the inverse proportion increases day by day. As the carrier of container ship transport, the container ship developed quickly in 50 years in many aspects, for example, in ship size, in shipbuilding technology and so on. The mainstream in these developments is ship size. Nearly all containership producers in the world have the strong wish to build the bigger size container ship than others do. The near five years and the near future will be the newness period of mega container ships. It will be the focus of world shipping market, whether in the aspect about ship designing and shipbuilding or in the aspect about booking and ship operation.

With the world economic straighten up, shipping market and shipbuilding market present a flourish vision that never appeared before, especially these two markets in container ships. From its birthday, the container ship owns much attention in the shipping market because of some characteristics of it. Container ship transportation is the emblematical commissary in modern traffic transport. It has good transit economical benefit, eminent security, perfect ability of punctuality and huge incidence. And, its effect for city development is obviously. A lot of research show that, the contribute of ports container ship transport is four times than crude oil and two times than coal. So, not only ship company favor container shipping, but also lots of seaports. With the transportation model of container ship, sorts or cargo owners can divide cargos. This kind of taxonomy can save space in the ship and can hold out a more scientific manage system. According some statistic data, people can find that the Size of container ship increased 42% than before, and the trends will persist in the future. The provider of container shipping seeks "the crazy scale effect". For instance, they hope the container ship size press close to limit. And they favor fixed shipping service, and they also like a no more than 36 hours `s stay time in the ports.

A forecasting research based on real data today shows that, the trade demand capacity in container ship market between American Atlantic and European will be satisfied by use container ship with 10,000 TEU three times a week. The economic benefit and high working efficiency are obvious to all. But, is this sublime status can become true? The answer is no. There is much causation about it, and an example will be given followed. It comes to light that a container ship size claimed as 10,000 TEU usually can not carry the max amount containers, because ratify carrying capacity is on the assumption that all cargo in container is low weight goods. Actually, in real transportation process, it is not probability for a ship to carry low weight goods only. So we can know that, in actual exercise, the carrying capacity cannot reach the ideal status, which means the container shipping market needs more container ships or larger size container ships to conveyance.

The main goal of this dissertation is to illustrate the economic risk of mega container ships. To achieve this goal, the first is to realize advantage and disadvantage of mega container ship. Then, according to the risk analysis about mega container ship, we can find that whether it can keep a good status with a bad shipping market. A modeling about how oil price and cargo quantity influence the earning of mega container ship will be built and measured to show the result.

### **1.3 the research methodology**

The comprehensive view of mega container shipping market and the risk about it will be defined based on the review of literature and combined with the research on fact data. In this dissertation, the quantitative analysis and the qualitative analysis have mainly been used in the research process. And the standard analysis and the real diagnosis analysis have also been used to elicit the research result.

### **1.4 The limitations of the study**

There are some limitations about this study, because in real life many determinate complications exist. At first, the shipping market is so daedal that have good status and bad status. Nobody can forecast the market correctly. In 2005, more than half of whole shipping marketing exporters forecasted that the shipping market would drop sharply in 2006. But the truth is they were wrong. Actually, year 2006 is a bright period of time for maritime market. Secondly, oil price is precarious. As we all known, the oil price is important for a container ship `s operation, because it relates the operate cost directly. Thirdly, when the ship producers stigmata the container ship `s capacity, they usually use TEU as a unit. But in the container, light cargos are installed. It sticks out a mile that lots of cargos are weight goods. So, in real loading, a ship cannot carry so many containers as label. How heavy a real container with cargo is the difficult matter to judge. All these limitations are so idiographic that I could not define it exactly. So, in this paper, I just analyzed the risk with rough trends and some logical supposes.

## **2 Advantage and disadvantage of mega-container ship**

### **2.1 Advantage of mega ship**

The increased international trade needs more mega ships. Because, the mega ships` advantages make it has more competition ability than other scale of container ships. Those advantages are listed and discussed in the following sections.

#### **2.1.1 Occupy more market quotas**

Since the cold war had ended, the world economics have had the deep transformation, which improve the need of mega ships. On one hand, the economy had the globalization tendency, and the world wide resources started to carry on the disposition. At the same time, the enterprise's production method and the business model also had the significant change. Zero stock became the main production method, and the outsourcing tendency strengthens unceasingly. On the other hand, the process of science and technology progress, especially the advancement of electronic information technology, also causes cargo exchange in the global scope to become possible, and the marine technology progress causes this organization to become the reality.

With the demand of shipping capacity increased, mega container ships were used in international shipping. When the frequency of transportation is fixed, mega ship can carrier more containers than other scale of container ships. Because of this, shipping companies choose mega ships to help them occupy more market quotas.

#### **2.1.2 Reduce cost**

As we all know, the mega ship has the good scale economic performance in operation. The scale that mentioned in the word “scale economic” means the batch quantity of

production, and it has two kinds of circumstances concretely. The first kind is, with the constant equipments condition, in other words, in the condition that production ability is fixed, the change of batch quantity. The second kind is, the batch quantity change under the changed batch quantity. And the “scale” in the scale economic conception means the last one. And the economic means thrift.

Generally speaking, the economies of scale are taking certain economical scale as a foundation. The economies of scale basic meaning refers in the technical level invariable situation, as M times of investment produced has been bigger than M times of output. In the specific limit, along with the increase that delivers, the unit product cost can reduce gradually. This kind of production cost increases the phenomenon along with the volume of output, which reduces, is the economies of scale, or calls the increasing the scale benefit. But the mega ship has the latent scale efficiency. The shipping ton is bigger, the unit ships construction cost is lower, and the unit transportation cost is also lower. So, the ships transport business cost cannot increase along with the ships scale becomes the proportion enlargement, therefore the unit transport business cost quite usual is advantageous to the big ships. We can see from the Table 2.1 that, if the organization of high-quality goods source is well, and a certain carries box rate can be achieved, the saved cost for 6,000 TEU container ships is 20% compared with 4,000 TEU container ships. Like this not difficult to see, present exceeding over 10,000 TEU container ships can save more cost, and the scale benefit of it does not allow belittling.

<b>Table 2.1 Operation cost contrast of different container ships</b>			
<b>Tons</b>	<b>TEU</b>	<b>Operation Cost per Day (\$)</b>	<b>Operation Cost per Container (\$)</b>
12,000	1,000	3,250	3.25
35,000	2,900	4,400	1.52
48,000	4,500	5,100	1.13
65,000	6,000	5,500	0.92

*Source: World Shipping, 2001*



### **2.1.3 Promote the alliance and merger of liner ship company**

In order to realize the economic scale, the mega ships need the high “suitable cargo scale”. As we all know, the operation cost and building cost of mega ships are bigger than other scale ships. Without the enough cargo capacity, mega ships will lose the benefit in the business. When the cargo is less than anticipation capacity, the carriers will reduce the shipping frequency. This action will cause the customer's disaffection.

How to find the balance point between shipping frequency and cargo capacity? For the small market share liner ship companies, cannot provide achieves “the suitable cargo scale”. For this kind of companies, there are two ways to solve the problem. The first one is to purchase other liner ship companies to enhance the market share in this route. The second way is to enhance the cooperation with other scheduled ship companies, and share the transport capacity.

The typical example is the great alliance and the new world alliance leagued “the super alliance”. At present, these two alliances already reached the route collaboration agreement. In some kind of significance, the liner ship company's cooperation is equal to merge the market share, thus can provide more sufficient ship capacity. This causes both to be possible to guarantee the liner shipping frequency, and may realize the steamship scale economies fully. In fact, along with ships large-scale advancement, even if the high share liner ship companies cannot provide the suitable cargo scale easily. Therefore, they also favor in adopt the alliance to solve this problem, as well as the merger way. For any liner ship company, the way to solve this question is based on these two ways` synthesis.

## **2.2 Disadvantage of mega ship**

As we have discussed in the precious section 2.1 that mega ships bring considerable profit to carriers, shipping companies, or ship owners. But, every coin has two sides. Mega ships also have some disadvantage compared with other scale container ships. In this section, those disadvantages will be searched in details.

### **2.2.1 Limitation of berthing**

At the present time, a lot of ports in the world have no ability to service container ship in new generation. The water depth of berth is the biggest limitation. The operation cost of mega ships is about 25,000 dollars every day, and the freight income amounts to USD 150,000 per day (Zheng Lou-xian, Lin Xiao-dong, 2005). If the mega ships can only berthing at the flood period into the ports, the shipping company will suffer great damage in economy. The channel and berth depth in international hub ports over the world were designed with a standard about 15 meters (Zheng Lou-xian, Lin Xiao-dong, 2005). A forecast given by ship building expert said that, the sea gauge of Malaccamax ship<sup>[1]</sup> would achieve 21 meters. With the current ship building craftwork and advanced design level, the sea gauge of Malaccamax ship can be reduced to 18 meters. It is obvious that in order to service the mega ships, hub ports over the world should design channel and berth depth as at least 18 meters. This kind of design will cost a huge number of money to construct suitable channel and berth. And it will also take a long time to complete the project.

In order to acclimatize it to mega ships, the hub ports which service for loading and unloading of mega container ships should provide corresponding equipments and suitable channels. With the increscent container ship quantity, the development of ports certainly will be influenced. For example, the width of ship with 9,000 TEU is

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<sup>[1]</sup> Malaccamax ship :one kind of mega ships with 18,000 TEU, and it takes the max bound for ships can pass through the Malacca strait as a standard. Source: Containerization, 2003

45.6 meters and the width can provide 18 lines for containers to lie on board. This scale needs ports to invest at longer and wider crane to match it. Davis, the senior engineer of international port of container in Virginia in USA, has the same view. He said that, mega container ship needs a deeper port channel and a larger berth. It also asked a wider water area for ships and super cranes. These changes mean an essential revolution about basic construction in ports should be done to match ports and mega container ships.

In order to reduce operate cost and abbreviate time on ports, shipping companies need ports with high loading and unloading efficiency. But a majority of ports cannot satisfy their requests. As loading and unloading frequency depends on manipulation efficiency in Cargo Freight Station, and the efficiency of cranes. As a result, ports are asked to improve the efficiency and use new equipment to service the mega container ships. With scientific transport layout in port and high productivity crane, the port service accepts mega container ship consummate.

As a result of the scale economies, the mega ship's single container cost is possibly low, but such container ship have the negative influence to transports service. Because, from the first container was unloaded from the mega ship to the last container was loaded from the port, it usually three or four days to complete the process. These three or four days account for a big proportion in the whole journey. If the days can be saved, a big cost of mega ship will be saved. Therefore, in the choice process of harbor, loading and unloading time also must be attached importance to. As the delay of mega ships in port, the port where have cargos more concentrative would be the better one.

As a result, these ports should invest much money on reconstruct equipments and enlarge their confine. The amount is so huge, for example, a suitable berth for mega container ship needs more than 300 million dollars. And, it is not so easy to take a short time to accomplish the reconstruction and enlargement. It is a vast project that

needs planning and fabrication in a long period better.

### **2.2.2 Limitation of routing**

Firstly, mega ships will be restricted when they get across the Panama Canal and the Suez Canal. At present, the width and length of brake room in Panama Canal is 33.5 meters and 305 meters. The max size of ships can across the Panama Canal is Panamax ships. This size of ships can carry 4,000 TEU only. But 27% of all ships in the world are ships with 8,000 TEU, and all these ships cannot sail through the Panama Canal. And the inverse proportion will increase to 37% in 2011. The president of COSCO, Wei Jia-fu, complained about the limitation in his presentation at Panama Congress. He said, there were nearly 100 ships waiting to pass the Panama Canal every day. This number exceeds the normal capacity of the Panama Canal far away. <sup>[2]</sup>

Ships can pass the Suez Canal must accord with the data below: (1) there is no limitation of length, but the width should less than 74.67 meters. And ships wider than 64 meters only can pass the Suez Canal when the crosswind speed less than 10 KN. (2) there is a sea gauge limitation for a full loaded ship with width less than 74.67 meters. The DF<sup>[3]</sup> of this ship is less than or equal to 9.75 meters, and the DA<sup>[4]</sup> is less than or equal to 10.97 meters. (3) the max headroom height of ship should not more than 68 meters. Because of these limitations, mega ships cannot pass these two canals and they have to choose other sea route loathly.

Secondly, the mega ship's superiority consists in the high transportation capacity, the high average frequency, and the low average oil consumption of marine transportation. So, the mega ship is more suitable for the long route transportation. Now, the ships

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<sup>[2]</sup> Source: [www.news.cn](http://www.news.cn)

<sup>[3]</sup> DF: the sea gauge depth measured in fore-perpendicular

<sup>[4]</sup> DA: the sea gauge depth measured in after-perpendicular

surpass 8000TEU mostly put in the Asian - Europe and the Asian - North America in Pacific Ocean's route.

### 2.2.3 risk of investment

In the international shipping market, the ship transport business total cost holds the quite great proportion in the capital cost, and the financing market change also has the pivotal influence function to the international shipping investment. The financing risk in international shipping investment mainly comes from some aspects, like the fund supplies, the bank loan policy, the interest rate and the exchange rate.

It is well known that the container shipping industry is a high investment profession, particular in the container ship construction. Massive funds are needed to makes a mega ship, but these funds usually come from financing. And a phenomenon was discovered from some reports, that is, the international shipping investment fund supply is not invariable. The interest rate undulation brings the international shipping ships invest interest rate risk. Regarding by the high debt proportion financing international shipping investment, the debt financing interest cost is a very important fixed cost in the ships transport business cost. In addition, the different interest rate level also can affect the investor to the international shipping ships investment opportunity choice. The building cost of different scale container ships is showing in the table 2.2.

Ship type	4,000 TEU	6,000 TEU	8,000 TEU	10,000 TEU	18,000 TEU
Building cost of ships (ten thousand USD)	4,500	6,350	8,100	9,600	12,120

*Source: Drewry Shipping Consultants 2003*

Suppose the change range of exchange rate is 5%<sup>[5]</sup>. The changed building cost of ships is:  $C_1=C_0*(1+R)$  and the result is showing in Table 2.3.

Ship type	4,000 TEU	6,000 TEU	8,000 TEU	10,000 TEU	18,000 TEU
Original Building cost of ships (ten thousand USD)	4,500	6,350	8,100	9,600	12,120
Changed Building cost of ships (ten thousand USD)	4,725	6,668	8,505	10,080	12,726

The original margin of ships with 6,000 TEU and 18,000 TEU is 57.7 million dollars. And with the exchange rate alteration, the margin of ships with 6,000 TEU and 18,000 TEU is 60.58 million dollars. From the quantitative analysis, it is clear that investment risk of mega ships is larger than that in other scale container ships. When the exchange rate floats as 5%, the more 2.88 million dollars should be paid. The sensitivity is:  $S=2.88/57.7=5\%$

Therefore, in summary, looking from the financing aspect, we can know that the mega ship investment has more risk than other scale of ships. Forecast the correct judgment to the international shipping fund supplies and the bank loan policy change is extremely not easy. So, the investor needs to synthesize various aspects of the situation to consider whether invests or not.

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<sup>[5]</sup> 5%: it means the exchange rate ascended and descended are 2.5% respectively

## **2.3 Conclusion**

There is no doubt that the mega ship has some disadvantages, like influence of ports, limitation of line, investment risk, which are mentioned in 2.2. But, the advantages are more important than these disadvantages. Because, the economies scale of mega ships can bring huge benefits to shipping companies, ship owners and carriers. As we all known, with the development of world trade, the capacity of cargos that needed to transport from one country to another will increase rapidly in a short period. In this situation, the mega ships can carry more containers than other type of ships in the same voyage. Comparing with the increased operation cost, the return of mega ships is more considerable. So, the carriers, and the shipping companies would like to choose mega ships to transport more cargo than before. And the ship investors are also like to invest in mega ships considering with the need of shipping market. Getting more profits is the main aim of businessman.

### **3 Risk analysis of mega container ships**

After having a general understanding of economies scale, it is clear that getting more profit needs some preconditions. These preconditions are oscillatory, so, there exist risk in mega ship`s operation.

#### **3.1 general view of risk**

About the risk, domestic and foreign still has not given an authority definition until now. Usually, people regard risk as possibility or the opportunity to suffer danger and lost; either people regard risk as some kind of motion possibly to occur the possibility which all or good or bad results and each result appear. These two kinds are popular at present, and they are also the widespread used view to under the risk institute definition. In view of the itemized appraisal, “the risk” is refers to the result, which is made by disadvantageous complications.

The international shipping ships investment risk refers to a process that the international shipping investment maybe changed after the investment. And it has the distinct characteristics, which mainly displays in 6 aspects as follow:

##### **1. Objectivity**

The international shipping investment risk will not shift with the hope of investors, because the risk existence is decided by many kinds of objective existence environmental factor.

The risk factors in the international shipping ships investment process are so many and so varied. They come from the shipping market, the international shipping community policy, and also some coming from capital market and so on. These risk factors objective existences in international shipping ships investment each aspect.



## 2. Paroxysm

The risk's exhibition is a warp between the real return and the anticipated income. And the risk will not take investor's will as the shift excuse. The actual risk caused by risk factor is gusty for the investors, especially the sudden income change caused by some paroxysmal international events.

## 3. Levity

The international shipping investment income receives the influence of multitudinous environmental factors. And any environmental factor's change can bring discrepancy between the real return and the anticipated income.

## 4. Diversification

The international shipping investment risk's character and the influence it brings present a dynamic tendency. For example, the international shipping market, which bring the enormous influence to investment incomes, always change ceaselessly, because of international trade volume, shipping cost, ships supplies, ships efficiency changes. This change brings the dynamic risk for the international shipping investment incomes.

## 5. Relativity

The international shipping ships investment risk is different when regarding the different investor. In other words, the investor has the different bearing capacity on the international shipping investment risk. This kind of bearing capacity is usually affected by financial strength, risk manner, the investment cost, and so on.

## 6. Immateriality

The international shipping investment risk does not look like the concrete object to be weighed or describe easily. But it needs to use the special concept and the method, like system theory, probability, elasticity, fuzzy and so on to weigh.

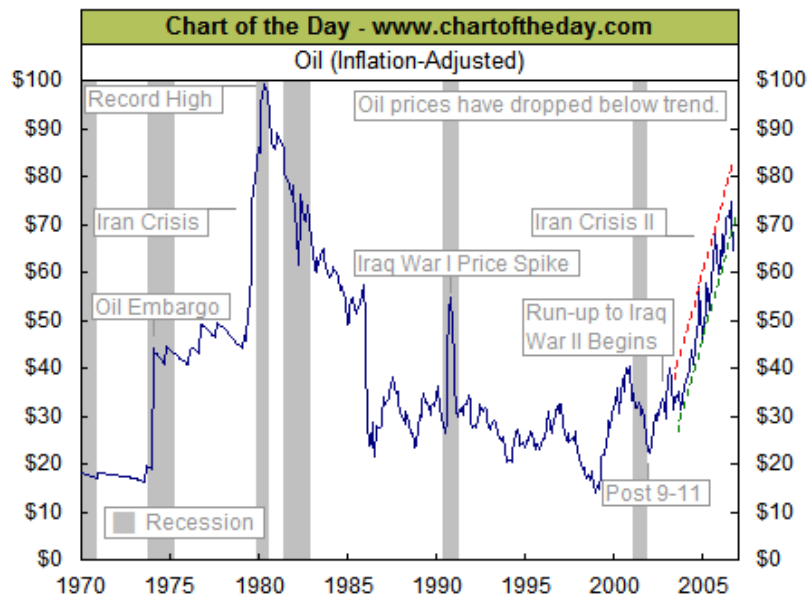
## **3.2 Oil price factor**

The rise fuel oil price has already influenced the present traffic market advancement obviously. The carriers who under the high oil price pressure have to put a part of oil price to customers or strengthen the dominant status in the fuel oil market. The using of large quantity of mega ships in the next several years will trigger the fuel oil rise in price in the quite great degree. Under this atmosphere, the open sea carriers who make order to the mega ships on a large scale will faces the enormous fuel oil cost pressure.

### **3.2.1 Trend of oil price**

The petroleum is one kind of important energy and the important industrial raw material. It is the important strategic resource that relates the national economy and the people's livelihood. And the oil industry is an important foundation industry for a country. We can see from table 3.1 that, since 2002 after the Iraqi war, the oil price continuously rising, and have an obvious rising channel. In this chart, red broken line expression rise up channel, green dashed line expression rise down channel. Recently, the petroleum price fell to 64 US dollars per barrel. This price has already broken the green dashed. The viewpoint according to the technical analysis is that, the petroleum price will rise possibly. If this rise channel maintains invariable, then in 2007 year's end or at the beginning of 2008, the petroleum price will approach 100 US dollars as one barrel.

Table 3.1 oil price trends from 1970 to 2007



Source: [www.chartoftheday.com](http://www.chartoftheday.com)

The reason that started the picture from 1970 in this chart was US dollar started to fluctuate freely at that time. Then, in 1973, the first petroleum crisis appeared very quickly, and we know that, before 1973, the oil is so cheap that people today cannot imagine. Moreover, we also may see from the chart that, the petroleum historical maximum price appeared in 1980. At that time, the oil price was equal 100 US dollars per barrel. Iran revolutionized at that time erupts, and the second petroleum crisis appeared. The oil price shake intensifies, overall price level rise with a large extent. The oil price in the whole year mounted up to 1.2 times as quondam price.

Looking from the trend, it is clear that the international market oil price rises at first and then fall down. Since the beginning of this year, the international market oil price continues to shake largely, because the global oil supply and demand was unbalance, and the policy situation is queasy. After that, because of the alleviation of policy situation and the rich oil stockpile in USA, the international market oil price appears recedes largely.

View from all aspects, the demand and supply relationship will keep a flimsy balance.

The policy of OPEC<sup>[6]</sup>, the weather over the world, the different area's politics and the trend of financing will dominate the oil price trend in a short period. With the rise of dubious factors, the reasons for oil price increase or decrease will all exist at the same time. Because, firstly, the increase of oil demand in the world becomes laggardly; secondly, the oil supplied without OPEC will go up in a large extent, this event will benefit the demand and supply relationship around the world; thirdly, the large stockpile make countries have advantage at restrain the oil price; fourthly, the lessened output of OPEC is the main complication for high oil price. So, the generalized analysis shows us, if there have no big unexpected events occur, the oil price in the international market will shake at the high price, but the overall price level will possibly be depressed. Experts estimate that, the crude oil price in 2007 can be slightly lower than it in 2006.

### **3.2.2 Risk analysis about oil price**

In the international shipping market, carriers under the pressure that the fuel oil market price rises suddenly and repeatedly. The factitious carrier could not keep equanimity as before, and they feel worry by all appearances. The price given by global sea carrier group now changes every day, for example, they find multifarious methods to put increased part of oil price to their customers. For example, many marine transport companies enhance the fuel oil extra charge in the original increase foundation. Obviously, the reason is that the price of oil that used in ships keeps increase all the time.

At present, the open sea carrier suffers strikes not only the increased oil price, but also the oil extra charge comes from multi-model transport carriers, like railway carrier and highway carrier. Therefore, the TSA<sup>[7]</sup> ocean carrier members are considering how to regulate evaluation of extra oil charge, and change the frequency to once a

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<sup>[6]</sup> OPEC: Organization of the Petroleum Exporting Countries

<sup>[7]</sup> TSA: Transportation Security Administration

month at least. This evaluation is programmed in order to reduce the ocean carriers' extra cost. The executive officer in TSA, Albert A. Pierce, said that nowadays the reiterative rising of fuel price has already substituted the port jam, and becomes the first factor to block, affect even destroy the development of international shipping industry. Before several years, global ocean carriers, or container liner ship companies, and carriers of the railroad and the road always thought the insufficient transportation infrastructure and the frequent jam betide in ports is the bottleneck of international containerized traffic survival. But now, jam goes far away. Even in the Los Angeles at west coast in USA, the jam has been straightened up in near several months. But, the price of ships' fuel has increased to a situation which never appearance before, and the carrier cannot accept the bill of fuel.

Now, the problem is, compared with other industry, how the marine carriers face to the force of fuel? This answer is extremely obvious that the ship used the fuel oil price and the fuel oil extra charge of multi-model transportation already works on development of present containerized traffic. Although ocean carriers put the rise part of ship used fuel into oil extra charge, in order to obtain certain compensation. Maersk Sea Land Shipping Company has not got all compensation from oil extra charge project. In recent years, the Maersk Sea Land mergers some fuel oil company, and this action enable it to obtain the enhancement in the fuel oil market holding status. But many people suspect that, the ocean carrier's merger and acquisition activity, especially merge the energy production enterprise's strategy will further intensify the increase of oil price. But, some experts have different view that as a top carrier, there is no reason for it not to merge more companies widely to consolidate its status. And there is a leading card in air transport. The Southwest Airlines is through the several petroleum companies' merger and acquisition, grasps the unceasingly rises in price directly. Thus, it enhances its aviation market competitive power, and finally defeats its competitors.

In recently several years and the next several years, many mega ships' operation will

consume more and more fuel. It is hard for carrier to control fuel supply chain by trade agreement. And the fuel oil extra charge meets inevitably rises again, as soon as the day when the price drop down is hopeless. However, why can the fuel oil rise in price have the so tremendous influence to the shipping companies? The quantitative analysis from view of mega ship's operation marginal cost will be given below.

The container ships transport operation cost mainly includes: the personnel wages, the insurance, the ships management fee, the harbor fee, the lubricating oil storage, the fuel cost and so on. In the total cost, the harbor fee and the fuel occupy approximately 70%. And the fuel cost even holds a greater proportion, is approximately 50%. Therefore, it can be seen that, the fuel cost is the most primary factor, which restricts the mega ship's operation cost.

We can see from chart 3.2.1 that, in year 2000, the oil price is 20 USD per barrel, but now, the price climbed to 70 USD per barrel. The markup of oil price is 350%. As the 50% of total cost, the oil price rise up to this degree will affect the international transportation so much is not strange and no wonder. But, when the oil price rise in a large extent continual, which type of container ship will be affected most? The single container's material build parts and operation cost are showed in table 3.2 below.

Ship type factor	4,000 TEU		6,000 TEU		10,000 TEU		18,000 TEU	
	Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
Personnel factor	233	10.13%	133	6.82%	83	5.79%	83	5.87%
Insurance	200	8.69%	167	8.56%	183	12.77%	167	11.82%
Ship management	34	1.47%	33	1.67%	33	2.3%	17	1.2%
Ports cost	500	21.73%	450	23.08%	300	20.94%	283	20%
M&R	217	9.43%	167	8.56%	100	6.98%	133	9.41%
Preserve and Lubricant	50	2.17%	50	2.56%	17	1.19%	13	2.12%
Fuel	1067	46.37%	950	48.72%	717	50%	700	49.54%
Total	2301	100%	1950	100%	1400	100%	1413	100%

Source: Chinese shipping industry development and investment opportunity analysis report in 2006

It is clearly that, the operation cost will decrease when the size of container ship comes from 4000 TEU to 10000 TEU. As a mega ship with 10000TEU, the single container `s operation cost reach the minimum number which is 1400 USD. With the increase of mega ship size, the operation cost climbs to 1413, and the increase trend will continued. So, considering from the single container `s marginal operation cost, the mega ship with 10000 TEU has the predominance about operation cost. Then, a quantitative analysis was given below to research on the single container operation cost when the oil price increases only.

As we all known, the capacity of consumed fuel is fixed. Then, we only need to calculate the infection, which the changed oil price brought to the mega ships. An account about the infection was given below.

First of all, I suppose the other cost keep fixedness, and then the change can be accounted as flowing:

The changed price of fuel is:  $P_1 = P_0 * (1 + R^{[8]})$

The changed total cost is:  $T_1 = T_0 + P_0 * R$

The percentage is:  $S_1 = P_1 / T_1$

The results are listed in Table 3.3, Table 3.4, and Table 3.5. From the data in these three tables, it is clear that the percentage of fuel fee in the total cost increased from ships with 4,000 TEU to ships with 10,000 TEU. Then the trend decreased from ships with 10,000 TEU to ships with 18,000 TEU. A result can be seen from the three tables that, when the other cost keeps fixedness, the fuel price infection of mega ships with 18,000 TEU is the minimum one, especially at the period when the markup is huge.

But, the discrepant building cost of mega ships with 18,000 TEU and 10,000 TEU is as huge as 2.52 billion USD in Table 3.6. Comparing with the price difference of mega ships with 10,000 TEU and 18,000 TEU in building cost and cost saving with

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<sup>[8]</sup> R: the fluctuant range



the increased fuel fee, it is obvious that the mega ship with 10.000 TEU is the most economical, rational and advisable investment.

After the risk analysis about fuel price factor, the analysis about loading rate was given. In this analysis, a result can be found, which is if the international trade will shrink in the few years' future, the mega ship with 10,000TEU is the best ship scale to invest in.

Table 3.3 the markup of oil price is 100%

Ship type	4, 000 TEU		6, 000 TEU		10, 000 TEU		18, 000 TEU	
Fuel	Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
	2134	63.36%	1900	65.51%	1434	67.74%	1400	66.26%
Total	3368	100%	2900	100%	2117	100%	2113	100%

Table 3.4 the markup of oil price is 200%

Table 3.4 the markup of oil price is 200%								
Ship type	4, 000 TEU		6, 000 TEU		10, 000 TEU		18, 000 TEU	
	Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
Fuel	3201	72.38%	2850	74.03%	2151	75.9%	2100	74.65%
	4435	100%	3850	100%	2834	100%	2813	100%
Total	4435	100%	3850	100%	2834	100%	2813	100%

Table 3.5 the markup of oil price is 500%

Table 3.5 the markup of oil price is 500%								
Ship type	4, 000 TEU		6, 000 TEU		10, 000 TEU		18, 000 TEU	
Fuel	Cost	Percentage	Cost	Percentage	Cost	Percentage	Cost	Percentage
		6420	84. 08%	5700	85. 07%	4302	86. 3%	4200
Total	7636	100%	6700	100%	4985	100%	4913	100%

Table 3.6 Average cost of container and The building cost of container ships					
Ship type	4,000 TEU	6,000 TEU	8,000 TEU	10,000 TEU	18,000 TEU
Marginal cost of one container (USD)	9980	9250	8750	7500	12600
Average cost of one container (USD)	11250	10583	10125	9600	10100
Building cost of ships (ten thousand USD)	4500	6350	8100	9600	12120

*Source: Drewry Shipping Consultants 2003*

### **3.3 Precarious marketing factor**

The international shipping market is seasonal, and it always in a cycle that begin from resuscitation to climax, then to atrophy, and then it touch the lowest situation, and finally to resuscitation again. In the market, there is a period with huge benefit, and also have the winter, in which many international shipping companies or some ship owners become impoverished. The change of international shipping market in this century shows us the characteristic adequately. In order to holds the risk in international shipping market, the analysis about supply and demand relationship is the most important key. And the supply and demand relationship is affected by two factors. They are the capacity of international shipping and the distance of the transportation.

Actually, the capacity of international shipping is influenced by the capacity of international trade, other kinds of transport way, the transport cost and the policy events. The transport distance is influenced by ecumenical distance and policy events. We can get a conclusion from the description that the supply and demand relationship is so complicated to forecast. In this precarious marketing, the loading rate is the most important aspect for carriers or the investor in the international shipping market.

#### **3.3.1 general view of world trade**

The need of mega ships in international shipping market presents a bullish trend. Because of the captivating low cost and efficiently the expectation of the benefit, the ordered mega ships to build never interrupted, and the shipbuilding scale continuously promotes. Speaking from the theories, the supreme benefit is that the mega ship with more than 8000 TEU can gather the max number of containers at one sequence of voyages. And because the decreased number of ports for mega ship to berth, the economic benefit for mega ship operator will increase. Compared with ships with 5,000-6,000 TEU, the average expense of mega ships is lower about 10% to 12% than

it. However, this premise is these mega ships have to carry the full container in a maximum capacity. Otherwise, the advantage will disappear.

According to the Statistic given by the world container ship transportation center, the carrying capacity in Japanese south trade line increased to 3,090,000 TEU in 2004, and the increased range attained 17.3%. In 2005, the markup was between 10.4% and 10.9%. Then in 2006 the markup was 9.7%. The transport capacity from Southeast Asia to Northeast Asia increased to 3,700,000 in 2004, and the actual rise was 6.2%. According to the report given by the international containerization in UK, the container ships` carrying capacity growth a rate for 4.6% between Southeast Asia to Northeast Asia trade routing. The container ships` carrying capacity between Oceania and Europe also has a big change, especially in 2004. In this year, the capacity of container ships up to 318,000 TEU. The rise increased as 8.5% in 2004, and in 2005 for 8.5% and 3.8% in 2006. Trade capacities in other areas in the world were also increased with different degrees.<sup>[9]</sup>

But, from the beginning of 2006, the total capacity of ocean carriers over the world was withttled. And in the end of 2006, there were some liner shipping companies claimed that they reduced their capacity of liner shipping. And some of them reined up the speed of container ships without more ado. There is expert point out, the speed of container ships` used in Asia and North Europe trade line put slowly two knots can not only reduce the ships` consume amount of oil, but also can accepts one more container ship in this line. This action can help liner-shipping companies to solve the problem about superfluous capacity.

With the worsen situation, ocean carriers had to arrange a part of mega ships with scale more than 8000 TEU to be employed. For example, some members in the New World Alliance Organization, like APL, Hyundai Korea, and Mitsui O.S.K. Lines Ltd, withdraw some mega ships from their trade line in Asia to Europe and Pacific Ocean

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<sup>[9]</sup> Source: [www.cangchu.com.cn](http://www.cangchu.com.cn)

in November 2006. From that time on, the cabin reduction program in liner shipping was started formally. According to the latest data, the ocean carriers in new world alliance organize considered that, the competition ability in Pacific Ocean line is more powerful than Asia/Europe line obviously. So, it needs special protection.

The Containerization feels worry about the foreground of international shipping market. It said that, the supply and demand relationship in main shipping market over the world will show a worsen circumstance from the second half of 2007 to the whole year in 2008.

### **3.3.2 Risk analysis of precarious marketing**

In the international shipping market, all the benefit came from the freight. The capacity of cargos, which need to be transported, affected the profits of shipping companies, carriers and ship owners directly. As we all know, there is no mega ship would reach the full loading situation. Then, the problem came. In which point of loading rate, the shipping companies can keep the balance between incomes and payout?

At first, I define the building cost as B, the full loading rate as R, operation cost as O, the freight is F, the ship scale is X TEU.

The total operation cost is:  $O_1=O_0*X$

The income is:  $I=X*R*F$

According to the <opinions about discard the over age ships coercive > in China, the ships over 35 years old should be discarded. So, in this analysis, the limitation of mega ships` using time is 35 years.

The total payout in one year is:  $P= O_1+B/35= O_0*X+ B/35$



The total income in one year is:  $I=X*R*F$

In order not to lose money in business, carriers should insure the  $P=I$  at least. In another word, they should operate their mega ships in this status:

$$O_0*X+ B/35= X*R*F$$

The loading rate is:  $R=(O_0*X+ B/35)/(X*F)$

Take the mega ships with 10,000 TEU and 18,000 TEU shipping between Qingdao in China to Santiago in Chile as examples. The freight for one TEU in this voyage is 2,750 dollars.<sup>[10]</sup> And the mega ship `s building cost and the operation cost are showing in Table 3.7.

Table 3.7 Building cost and operation cost in one year		
Ship type	10,000 TEU	18,000 TEU
Building cost (\$)	2742857	3462857
Operate cost per container (\$)	1400	1413

Source: Drewry Shipping Consultants 2003

For mega ship with 10,000 TEU:

The balance loading rate is:  $R=(O_0*X+ B/35)/(X*F)=60\%$

For mega ship with 18,000 TEU:

The balance loading rate is:  $R=(O_0*X+ B/35)/(X*F)=64\%$

The result is that, when the loading rate is over 60.1%, the mega ship with 10,000 TEU can pay off, but the mega ship with 18,000 TEU needs a 64% loading rate to keep the finance balance. It means, with 6,000 full containers, the mega ship with 10,000 TEU will win benefit. But the mega ship with 18,000 TEU needs 11,520 full

<sup>[10]</sup> Source: <http://www.shippingchina.com/>

containers under the same circumstance. Seeing from this aspect, when the international trade capacity cannot satisfy the need of the mega ship with 18,000 TEU, the mega ship with 10,000 TEU have more predominance than it.

### **3.4 conclusions**

In this chapter, risk analysis about fuel price factor and precarious marketing factor were discussed amply. The first risk analysis gave a conclusion that, with the huge increase range of fuel price, the total operation cost variety of mega ships with 18,000 TEU is the least one. But considered with the building cost of different types of ship, the mega ship with 10,000 TEU is the best choice to invest. The second risk analysis showed that, when the loading rate decreased, the mega ships with 10,000 have more competition than mega ships with 18,000 TEU.

## **4 CONCLUSION AND RECOMMENDATIONS**

With the steady development of international economy and international trade, containerized transport will increase by a large margin in the future. The market demand of containerized transport is increasing constantly. And the trend of using mega ships to transport cargos is obvious. Mega ship has brought enormous influence on the liner shipping company and ports. Facing the fierce competitive market, the shipping company increased the scale of container ship with the hope of getting the maximization scale effect of shipping and occupying the advantage position in the market competition. With the mega ships, the competition of the world container pivot harbor is weak. On one hand, mega ships can only berth those ports, which condition of depth of water, efficiency of loading and unloading, and management level is qualified. On the other hand, for pursuing scale economic benefits, the liner shipping company choose fewer ports to berth, in order to saving the whole time of sail. Pearson (1998) draws the conclusion, "no matter what ship type it is, with the increasing of the scale of ship, the shipping cost of every load ton or every case is reduced ". Jansen and Shearson (1987) point out, adopt mega ships mean "large-scale production of shipping take at sea, and its scale uneconomically receives in the harbor."

This text begins to analyze the current situation of containerized transport market, the developing history of container ship and current situations and trends of container ship maximization in detail. Thinking about with the fast development of container transports and more and more fierce competition of international containerized transport, every large container liner carrier in the world under the enormous competition pressure, accelerate the process and promotion of international containerized transport.

This text continues to demonstrate the motive force of ship maximization of containerized transport - -Scale effect. Using mega ships has become one inevitable

tendency, but as a result of many factor limits, this tendency should be the step-by-step and moderate. The main aim of mega ship transportation is that, the liner ship companies hoped the mega ship can be able to reduce the single container transportation cost, thus they can occupy the dominant position in the intense market competition. There are more and more mega ships are used in international trade line, but it will be limited because of the original ports distributed in every corner in the world. The port limitation expressed in loading and unloading ability, infrastructure, trade routing and so on. And, it is not so easy to reach the perfect scale effect. The mega ships have many factor restrictions. Research on the restrictions, the analysis is advantageous in taking the correlation measure of large economy scale about mega ships.

Have analyzed and researched several limiting factors which influenced the effect of scale effect of ship maximization, the text think of the mega ship is restricted by two main factors. They are oil price factor and loading rate factor. Two kind of risk analysis were given to compare the different scale container ship in these two aspects. From the risk analysis of oil price factor in chapter 3, a result can get facilely. It is that, without considering other operation cost, 18,000 TEU is the most economical scale of mega ships. But some other factors should not be ignored in the real application. For example, the building cost of mega ships with 18,000 TEU is more expensive than mega ships with 10,000 TEU.

Therefore, considering the two conclusions together, the mega ships with 10,000 TEU will soon spread over the international shipping market. And, if the capacity of international trade can increase as the last several years, the mega ships with 1200 TEU or 13,000 TEU can be popularize. But, the scale of mega ships cannot too near or over 18,000 TEU. Mega ships in this scale will surmount the extreme limit of development. Once this situation happens, the risk of mega ships will become too high to be accepted. Meanwhile, the income will also descend. For carriers, shipping companies and ship owners, they will get more kicks than halfpence.

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