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Analysis of ship registration system and study on selection of ship registration system for China

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Analysis of ship registration system and study on selection of ship registration system for China

By

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China

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INTERNATIOANL TRANSPORT AND LOGISTICS

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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.

Tian Le

……

Supervised by

Professor Hu Meifen

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ABSTRACT

Title of research paper: **Study on China Iron Ore Shipping Market and Economic Analysis for Ship Type Selection**

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

Since 2 l century, China's steel industry has rapidly got a development. The domestic iron ore production is not optimistic as iron ore is the indispensable raw materials of steel industry. China's iron ore reserves at the top, but the quality is low, Self-sufficiency is insufficient. Therefore, it is necessary to have a choice that importing a certain amount of iron ore from the international market.

This dissertation is aimed at studying China's iron ore imports, analysis and forecast of China iron ore shipping market. It provides references for domestic iron ore import transport shipping companies to select optimal ship in order to get better benefits. Through the analysis and forecast of world iron ore shipping market and China iron ore trade market, we could get a prospect of China's iron ore shipping market, and put forward appropriate suggestions of ship type selection for China shipping company in order to get better benefits. To achieve this purpose, this dissertation will first analyze the demand and supply of China iron shipping market. Second, forecast import iron ore, freight index and iron ore ship capacity in order to get a whole trend of future iron ore shipping market. Finally, according to the present data, an economic analysis could contribute to the ship type choice of China iron ore transportation.

Key Words: China iron ore import, shipping market, demand and supply, Economic analysis

Table of Contents

DECLARATION II
ACKNOWLEDGEMENT III
ABSTRACT IV
Table of Contents V
List of Figure VIII
List of Table IX
List of Abbreviation X
1. Introduction 1
1.1 Background of the dissertation 1
1.2 Literature review 3
1.3 The framework and content of the dissertation 5
2. Analysis of demand for China's iron ore shipping market 6
2.1 The necessity of China's import iron ore 6
2.1.1 General situation of China's iron ore resources in the international environment 6
2.1.2 Demand for iron ore in China rapid growth 11
2.1.3 Low development and utilization in China 11
2.2 Analysis of China iron ore trade 12
2.2.1 Source analysis of China import iron ore in the international environment 12
2.2.2 Factors affecting the demand for iron ore shipping market 14
2.2.3 Mode analysis of China import iron ore trade 15
2.2.4 Problems of China import iron ore trade 16
2.2.5 Prospects of China import iron ore trade 17
2.3 Distribution of the port of destination in China 17
2.3.1 Current situation of ports for China import iron ore 18

2.3.2 Problems of ports for China import iron ore 20
3. Analysis of supply for China's iron ore shipping market 21
3.1 Factors affecting the supply of iron ore shipping market 21
3.1.1 Affecting factors in the international shipping market 21
3.1.2 Supply factors of China iron ore shipping market 22
3.2 Analysis of iron ore shipping capacity 23
3.2.1 Analysis of the international iron ore shipping capacity 23
3.2.2 Analysis of China iron ore shipping capacity 24
4. Forecasting of demand and supply of iron ore shipping market in China 26
4.1 Influencing factors of demand for China's imports of iron ore 26
4.1.1 China's economic development influences iron ore imports 26
4.1.2 China iron and steel industry development influences iron ore imports 28
4.1.3 Iron ore prices influences iron ore imports 29
4.1.4 Port handling ability of China's coastal influences iron ore imports 30
4.1.5 International iron ore export enterprise capacity influences iron ore imports 30
4.2 Forecasting of China iron ore import volume 31
4.3 The trend of supply for China iron ore shipping market 34
4.3.1 Trend of iron ore transportation capacity of China in the future 34
4.3.2 Trend of iron ore freight rate in the future 36
5. Development trends of iron ore shipping market and the Economic analysis for selection of ship-type 38
5.1 Trends analysis of China iron ore shipping market 38
5.1.1 Fluctuation of shipping market 38
5.1.2 Dry bulk trade pattern changes 39
5.1.3 Market main body role to focus diversification 39
5.1.4 Capitalization of international dry bulk shipping market and freight 41
5.2 Economic analysis of ship’s operation for China’s imported iron ore transportation 41

5.2.1 Determination of economy indicators for ship's operation 41
5.2.2 The Calculation of Different type of Ship Operating Economy Indicator 46
5.2.3 Analysis Results of Indicators Calculation 50
5.2.4 Sensitivity Analysis 51
6. Conclusion 53
References 54

List of Figure

Figure 1 World iron ore reserves 7
Figure 2 Distribution of the world mining of iron reserve 8
Figure 3 Quantity of mine production and reserves about main countries 9
Figure 4 Export proportions of major iron ore exporting country in 2012 13
Figure 5 Iron ore number of China's imports by country in 2011 14
Figure 6 Net growth of dry bulk capacity in the world in 2011 24
Figure 7 The iron ore import volume and GDP growth 27
Figure 9 Import volume and iron ore price 29
Figure 10 Import volume in exponential trendline 32
Figure 11 Import volume in linear trendline 33
Figure 12 Import volume in logarithmic trendline 33
Figure 13 Import volume in polynomial trendline 33
Figure 14 Import volume in power trendline 34
Figure 16 BDI from 1999 to 2013 37
Figure 17 Average freight rate of Capesize for China route by month 37

List of Table

Table 1 Iron ore reserves distribution in major provinces and regions of China..... 10

Table 2 The export volume of major iron ore exporting country 12

Table 3 Major iron ore ports in China loading and unloading quantity（million tons） 18

Table 4 GDP Database of Asia 26

Table 5 Import iron ore volume of China from 1990 to 2012. 31

Table 6 New ships number and deadweight ton from 2007-2011. 35

Table 7 Different kinds of ships' specific parameters 46

Table 8 Economic analysis of the results from Tubarao in Brazil to Beilun in China 48

Table 9 Economic analysis of the results from Dampier in Australia to Beilun in China 49

Table 10 Net present value sensitivity analysis from Tubarao to Beilun 52

Table 11 Net present value sensitivity analysis from Dampier to Beijing..... 52

List of Abbreviation

USGS	United States Geological Survey
BDI	Baltic Dry Index
SSY	Simpson Spence & Young
GDP	Gross Domestic Product
BRICs	Brazil, Russia, India, China
OECD	Organization for Economic Co-operation and Development
DWT	deadweight ton
FFA	Foreign Freight Agent
NPV	Net Present Value
OP	Oil Price
SP	Ship Price
FR	Freight Rates

1. Introduction

1.1 Background of the dissertation

The steel industry is the important basic industry of the national economy which has an important role in the production, and it is the country's economic lifeline. Since 2 l century, China's steel industry has rapidly got a development. The domestic iron ore production is not optimistic as iron ore is the indispensable raw materials of steel industry. China's iron ore reserves at the top, but the quality is low, Self-sufficiency is insufficient. Therefore, it is necessary to have a choice that importing a certain amount of iron ore from the international market as China's steel production is growing. Since 2000, China iron ore imports began to increase more than 25% of growth, and in 2008 it has reached 442 million tons, in 2012 it have gone up to 730 million tons. China 's iron ore external dependence peaked 64% in 2009, while the growth rate gradually decline these years, but still high, China is the world's biggest importer of iron ore, and has become the world's largest "magnet ". By 2012 August, iron ore external dependence is about 69.2%.

In 2011, the global iron ore output reached a record 1.92 billion tons, up 4.7%, the highest point. In 2011, the global iron ore exports for tenth consecutive years of growth, the international iron ore trade volume hit a record high, up to 11.15 tons, of which developing countries accounted for 49.5%. At present, although the global

economic recession, but still maintained a growth, and there is no negative growth, the iron ore demand is still growing.

In the promotion of China's iron ore import factors, the international iron ore price rise year after year. In addition to 2008 financial crisis leading to iron ore prices fell, the iron ore prices have been rising state, strongly promote the international shipping market rising sea freight. But in the current situation, the international iron ore supply has slightly surplus, the international iron ore prices continue to decline again. The Baltic Dry Index (BDI), reflecting the international dry bulk shipping market operation level, the highest in May 20, 2008 reached 11793 points, a record high, but in February 3, 2012 it reached the lowest point in 25 years 647. Brazil to China's iron ore rate reached USD109 / ton, but with the steel market is so low period coming, rate fell rapidly, the 2012 freight keep in twenty - thirty dollars/ton. Cape type ship time charter price has risen to a record high, COSCO regularly charter cape type ship called HUANG SHAN, the type of cargo ship (175775 ton), route for Brazil to China, the rent is USD180000 per day. However, the cape type ship, one-year rent for 11250 dollars in 2012.

In the face of this variety of world iron ore trade situation, outlook of China's iron ore prospect, shipping enterprises should how to adjust business strategy, selecting the appropriate tonnage level of the appropriate route for transportation to obtain maximum income, which all these are very worthy of attention. This dissertation is aimed at China's iron ore imports for the background, analysis and forecast of China's imports of iron ore shipping market, and forecasts future iron ore shipping market. It will provide references for domestic iron ore import transport ship companies to select optimal ship. Therefore, this study has certain theoretical significance and practical significance.

The main goal of this dissertation is to use some simple forecasting methods models and economic analysis to analyze iron ore shipping market trends and to select optimal ship type for shipping companies of China. Through the analysis and forecast of world iron ore shipping market and China iron ore trade market, we could get a prospect of China's iron ore shipping market, and put forward appropriate suggestions of ship type selection for China shipping company in order to get better benefits. To achieve this purpose, this dissertation will first analyze the demand and supply of China iron shipping market. Second, forecast import iron ore, freight index and iron ore ship capacity in order to get a whole trend of future iron ore shipping market. Finally, according to the present data, an economic analysis could contribute to the ship type choice of China iron ore transportation.

1.2 Literature review

The iron ore shipping market as an important part of international dry bulk shipping market has been concerned. Modern large-scale iron and steel enterprises pay more and more attention to the market forecast, and to adjust business strategy.

As China is a big country importing large quantity of iron ore, more and more studies of the iron ore import aspect appeared. Wen Wen, Zheng Chuanjun et al. (2006) made a regression analysis on volume and price of China's iron ore imports from the actual situation of supply and demand. WangYan (2004) wrote the Logistics in China based on the Integration of Import Iron Ore Shipping System Research, which the article refers to China's iron ore import network. From the iron and steel enterprise's point of view, the research is aimed at how to optimize the logistics integration to

reduce the cost. Zhang Dianbo, Zheng Jiang, Wan Haiming (2004) analyzed characteristics and situation of supply and demand of China's iron ore, made a prediction of China's iron ore imports, and pointed out the importance of rational utilization of domestic and foreign resources. Zhang Huili analyzed the basic factors affecting the iron ore demand in China, using the method of system dynamics model to forecast demand of iron ore in China. The study shows, iron ore demand speed, development of GDP and the national economy have a close relation. Jiang Yinglie (2005) wrote paper Research on Port Payout planning of China Import Iron Ore Shipping. This paper focuses on the analysis of present situation of China's iron Ore and steel industry and China's iron ore unloading port; it proposed iron ore unloading port layout planning in china; Cao Yu (2006) wrote the paper Research on Iron Ore Import Shipping Market and Operation of the Ship in China, which is an analysis of China's iron ore import shipping market and the port situation, and got a forecast of China's iron ore imports by BP neural network method, finally he did quantitative economic analysis of iron ore import fleet ship selection. Lin Hanxin’s paper (2000) Research on China Import Iron Ore Shipping Market at the beginning of Twenty-first Century, which used methodological and econometric methods to study the overall shipping market, analyzed ship selection method using voyage estimate rationality by comparing operating benefit calculation. An article entitled Analysis of China's Iron Ore Imports in 2010, analyzed the current situation of China's iron ore imports in 2010 from the iron ore supply and demand perspective, and made a comprehensive analysis of the import situation of 2011 and 2012.

There are some special websites for China iron ore trade market such as www.mysteel.corn, www.chinasteel.com, etc., these website devoted to open up a iron ore import column, making some comments, mostly from the point of view of the steel mill to analyze iron ore imports.

In the academic research abroad, Japan, the United States, Poland and other countries begin to study the theory and method of technical and economical evaluation of ship from the 1950s, they combined with analysis of ship technology, operational, economic, and gradually formed a new science. From November 1969 to March 1970, an American scholar John L.Everett completed the research on best structure of the system for carrying large bulk cargo transport fleet in the future ten years later. A.N.Perakis and W.M.Bremer from the United States University of Michigan designed a optimization aided scheduling system using 0-1 integer programming on a computer, according to the source distribution to work out schemes of feasibility, and then find out the optimum ship type in scheme selection of projects.

In addition, in terms of the iron ore transportation market data, mainly have CLARKSON, SSY and DREARY these three research institutions. The publication of the every month specially comment the international iron ore transportation market, detailed analysis of latest iron ore import and export situation of the importer and exporter in every shipping route, published the latest statistics of an iron ore trading contract details. Because China's iron ore imports takes up a large proportion in the world, so the three research institutions always reviewed China’s shipping market in a separate.

1.3 The framework and content of the dissertation

The main content of this research is the iron ore transportation problems, especially for China's iron ore transportation. Through the analysis of international and China's

iron ore transportation market, China's iron ore transportation market would be prospected and forecasted. In addition, in terms of the optimal ship type transported iron ore for ship companies have made an economic analysis for ship's operation, in order to help ship companies benefit maximization. To achieve this purpose, this dissertation will first analyze the international iron ore shipping market and China iron ore transportation market. Second, forecast import iron ore, freight index and iron ore ship capacity in order to get a trend in the future. Third, according to the analyses and prospect, economic analysis for ship's operation illustrates the ship type choice of China iron ore transportation. Finally, give the author's recommendation for China shipping company.

2. Analysis of demand for China's iron ore shipping market

2.1 The necessity of China's import iron ore

2.1.1 General situation of China's iron ore resources in the international environment

According to the statistics published by USGS in 2005, the world reserves of iron ore are 160 billion ton, the mineral base are 370 billion ton; the reserves of mining of iron (the metallic iron of iron ore) are 80 billion ton, the basic reserves are 10 billion ton.

The concentrated distributions of iron ore in the world are Ukraine, Russia, Brazil, China and Australia, the respective reserves of them are 30 billion ton, 25 billion ton, 21 billion ton, 18 billion ton, occupying 18.8%,15.6%,13.1%,13.1% and 11.3% of the world gross reserves. In addition, Kazakhstan, America, India, Venezuela and Sweden also have abundant iron ore reserves, the respective reserves are 8.3 billion ton, 6.9 billion ton, 6.6 billion ton, 4 billion ton and 3.5 billion ton, occupying 5.2%、4.3%、4.1%、2.5% and 2.2% of the world gross reserves. The detail numbers shows in Figure 1

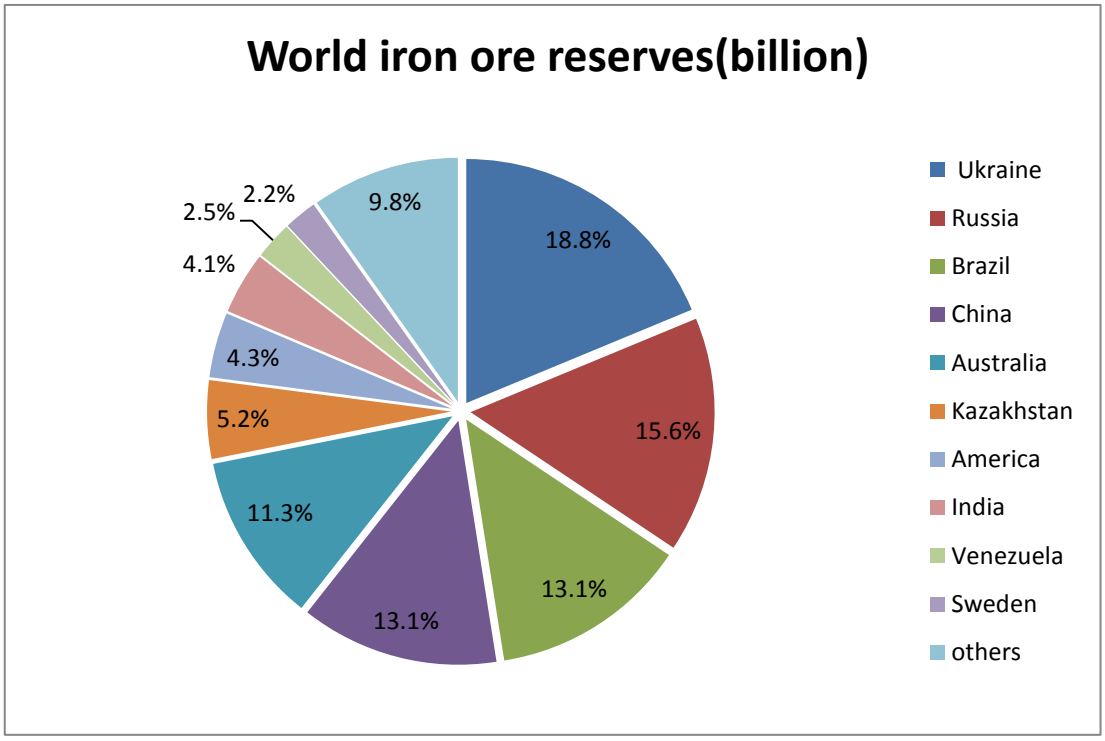

Figure 1 World iron ore reserves

Resource: USGS

The whole world iron ore resources are rich. The evaluated geological reserves are more than 800 billion ton, while identified iron ore are more than 400billion ton. According to the current degree of production, they can be supplied for 400 years.

The iron ore are mainly distributed in more than ten countries, and more than 90% of the proved reserves are distributed in ten countries and regions.

They are: the Commonwealth of the Independent States (the identified iron ore are 114 billion ton, including 80 billion ton of Russia), Brazil (68 billion ton), China (50 billion ton), Canada (36 billion ton), India (17.57 billion ton), America (17.4 billion ton)，France (7 billion ton), Sweden (3.65 billion ton). Besides, the reserves of UK, Venezuela, Chile, Liberia, and South Africa are also abundant.

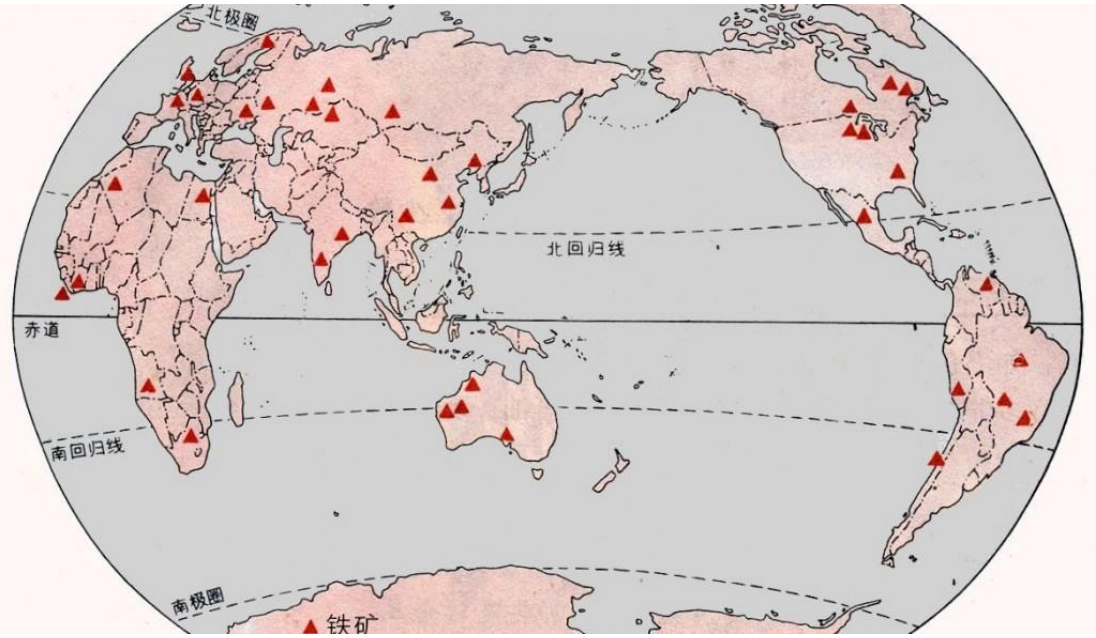

Figure 2 Distribution of the world mining of iron reserve

The world mining of iron reserves are mainly concentrated in Brazil, Russia and Australia, the respective reserves are 14 billion ton, 14 billion ton, 11 billion ton, respectively occupying 17.5%, 17.5% and 13.8% of the world gross reserves. The reserves of mining iron and mineral base are the most important elements of showing the degree of abundance of iron ore resources, thus Brazil, Russia and

Australia are the richest countries of owning mining iron in the world. (Million tons)

	Mine production		Reserves	
	2011	2012	Crude ore	Iron content
United States	55	53	6,900	2,100
Australia	488	525	35,000	17,000
Brazil	373	375	29,000	16,000
Canada	34	40	6,300	2,300
China	1,330	1,300	23,000	7,200
India	240	245	7,000	4,500
Iran	28	28	2,500	1,400
Kazakhstan	25	25	2,500	900
Mauritania	12	12	1,100	700
Mexico	15	13	700	400
Russia	100	100	25,000	14,000
South Africa	60	61	1,000	650
Sweden	25	25	3,500	2,200
Ukraine	81	81	6,500	2,300
Venezuela	17	20	4,000	2,400
Other countries	59	61	12,000	6,000
World total (rounded)	2,940	3,000	170,000	80,000

Figure 3 Quantity of mine production and reserves about main countries

Sources：USGS

According the statistics of Figure 3, China’s mining iron resources are affluent, but rich in lean ore, poor in high-grade ore, the iron content is low. China is relatively rich in mining iron resources in the world, and the statistics shows that there is more 2020 iron producing areas in the whole nation. Until the end of 2010, there are 3846 iron producing areas in China, the available reserves of identified iron ore are 72.699 billion ton. It includes mineral base 22.232 billion ton and resources 50.467 billion ton. Compared with 2009, the iron producing area increased by 209, the reserves of identified iron ore increased by 13.314 billion ton, containing mineral base increased by 0.628 billion ton and resources increased by 12.74 billion ton.

The iron ore distributes broadly in China, but relatively concentrated in Liaoning, Sichuan, Hebei, Anhui, Shandong and other 8 provinces, cities and districts. These

regions' gross identified iron ore resources are more than 1billion ton, the total available reserves are 64.992 billion ton, occupying 89.4% of the whole nation reserves.

Table 1 Iron ore reserves distribution in major provinces and regions of China

Iron ore reserves distribution in major provinces and regions of China (100 million tons)				
Region	Mineral Base	Resources	Identified available reserves	Of the country(%)
Whole nation	222.32	504.67	726.99	100
Liaoning	75.46	107.84	183.3	25.21
Sichuan	28.73	68.11	96.84	13.32
Heibei	37.49	50.12	87.61	12.05
Anhui	8.19	39.72	47.91	6.59
Shandong	10.31	36.94	47.25	6.5
Yunnan	3.82	33.5	37.32	5.13
Inner Mongolia	12.12	24.93	37.05	5.1
Shanxi	12.13	21.4	33.53	4.61
Hubei	3.73	26.26	29.99	4.13
Henan	1.65	14.7	16.35	2.25
Sinkiang	3.57	8.01	11.58	1.59
Hunan	1.63	9.67	11.3	1.55
Beijing	0.88	9	9.89	1.36
Total	199.72	450.2	649.92	89.4

Sources: t-k.com.cn

However, 97.5% of iron ore reserves of China are lean iron ore and China's average grade of iron is only 33%, below 11% of the world average grade. What's worse, the current resources are mainly distributed deep underneath the surface or sea area, which is really difficult to exploit and high cost.

2.1.2 Demand for iron ore in China rapid growth

Currently, China is one of the fastest growths of GDP in the world, since 2003, it has remained the growth over about 10%. China is at the time of fast industrialization, thus the fast developing infrastructure and the change of way of life will naturally arouse huge increase of the need of raw material.

At the background of fast development of economy, China's steel industries are growing rapidly. The production of crude steel increased from 0.128 billion ton in 2000 to 0.717 billion ton in 2012, which increased over four times during 10 years. China has entered into a speedy developing stage. During this stage, most production of crude steel comes from our country. The increase of the steel production put a motion to the needs of iron ore. At the "2012 China's iron ore conference", many specialist think that China's need is still the most crucial motivating engine of the iron ore market in the world.

2.1.3 Low development and utilization in China

China's massive producing iron ore starts at 1950s, in the past half century, especially after the reform and open up, the exploitation of iron ore resources

developed at fast pace. With the improvement of iron ore production, the problem that recoverable resources are not enough revealed. The using extent of China's identified resources is not high enough, there are still half of the resources not being exploited and used. Now in the identified iron producing area which is more than 2020, there are still half of the identified resource reserves not being exploited and used.

However, many key and local main mine's delineation resources are declining, which enters into the producing medium and long term. The planning reserve resources lack attractiveness. Some plans of mine cannot be put into capital construction, or large mine exploit at low degree, which causes the waste of resources to a certain extent.

2.2 Analysis of China iron ore trade

2.2.1 Source analysis of China import iron ore in the international environment

From the above analysis can see, the world iron ore resources are mainly concentrated in Australia, Brazil, Russia, Ukraine, Kazakhstan, India, the United States of America, Canada, South Africa and other countries and regions. The main export countries and regions are Brazil, Australia, India, Canada, South Africa etc. The table 2 is about the export volume of major iron ore exporting country.

Table 2 The export volume of major iron ore exporting country

Country	2008	2009	2010	2011	2012
Australia	309.5	362.4	401.9	437.8	486.2

India	101.1	116.2	103.1	78.5	38.1
Peru	6.9	6.4	8.2	9.6	9.9
Brazil	277.4	264.3	306.5	326.3	322.4
Canada	22.4	27.2	27.9	30.1	31.0
Sweden	13.8	13.4	16.9	17.6	18.8
South Africa	31.6	44.6	48.0	53.3	54.2
Mauritania	10.7	10.3	10.1	10.7	11.2
TOTAL	843	899	992	1,053	1,115
% change	8%	7%	10%	6%	6%

Source：Clarkson

The Figure 4 shows that export proportion of major iron ore exporting countries in 2012. And Figure 5 shows the iron ore number of China's imports by country in 2011.

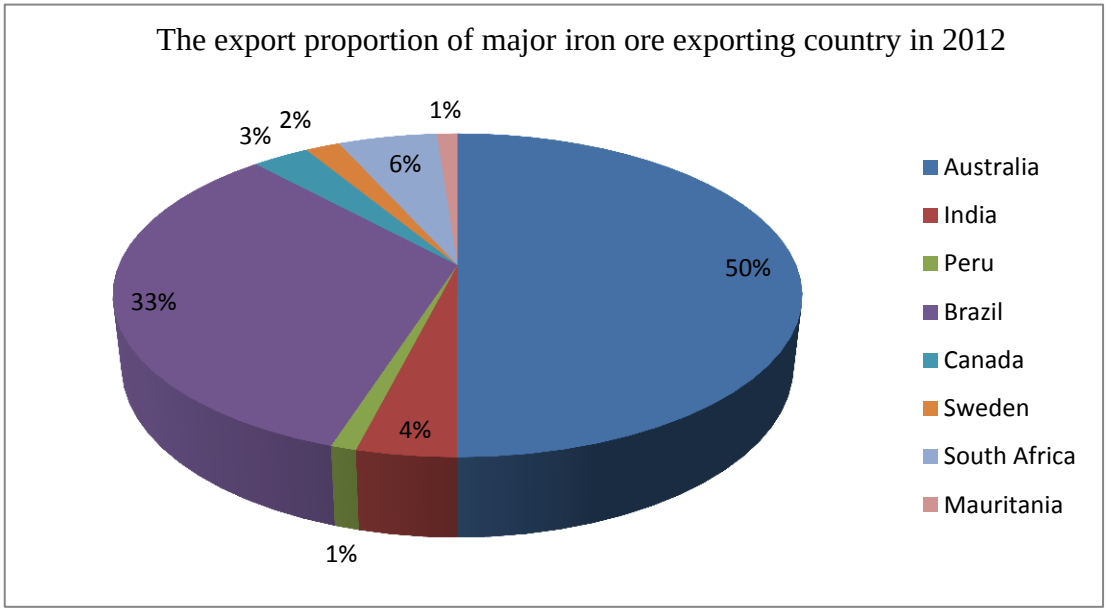

Figure 4 Export proportions of major iron ore exporting country in 2012

Source: Clarkson

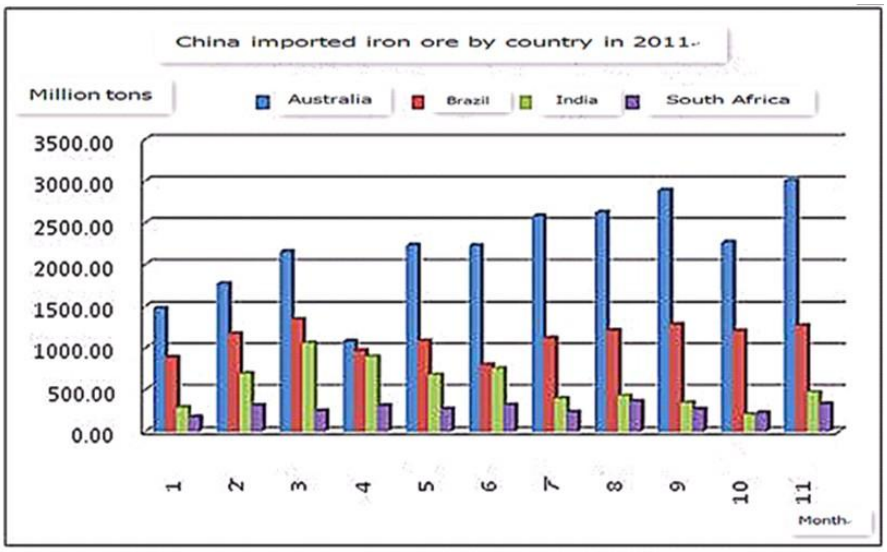

Figure 5 Iron ore number of China's imports by country in 2011

Through the above analysis and Figure 4 and Figure 5, we can see that the main source of China imports iron ore is Australia, Brazil, India, and South Africa. According to some relevant data, in 2012, China becomes more dependent on Australia and Brazil for importing iron ore; however, the import volume from India has a large decline.

2.2.2 Factors affecting the demand for iron ore shipping market

The demand for international shipping originated in international trade cargo shipping’s needs, and the development of international trade depends on the development of the world economy. While the world economy and international trades are influenced by social, economic, political, scientific and technological, as well as natural factors. These complex factors often affect the international shipping market in the same role, including iron ore transport market.

(1) Economic factors

If the world economy is strong, with the blooming demand of the world market, the international trade is bound to increase, thus leading to the expansion of the scale of iron ore trade; otherwise, if the world economy is weak, the international trade decreases and the volumes of iron ore trade declines.

(2) Political and legal factors

The transport market of iron ore is always affected and restricted by the policies and laws of the trade-related countries. The trade may go smoothly due to the political needs and may also be constrained by political reasons. When the political relationship between the two nations is advancing towards friendship, the trade volume, generally speaking, would increase and then motivates the raises of international demands of steel, which is the potential drive to the augments of iron ore. When its internal situation is comparatively stable and peaceful in political and administrative aspects, one country is able to focus on economic developments, thus contributing to the improvements of iron ore trade.

(3) Natural Environmental Factors

The natural environment refers to the nature location、distribution of resources, coastal zone and its resources development and utilization, as well as weather and other environmental conditions of country or region. As the above analysis, the iron ore resource is the embodiment of natural environmental factors.

2.2.3 Mode analysis of China import iron ore trade

Before 90 of the 20th century, China's imported iron ore trade had been monopolized

by Sinosteel Group, after 90 s, with the development of the national reform, China's imported iron ore trade way has changed, basically has the following kinds:

A. Steel factory direct purchase

B. Through intermediate traders

C. The processing trade

2.2.4 Problems of China import iron ore trade

(1) The violent fluctuation of iron ore price in the international market increases the trade hazard.

As China replaced Japan to be the maximum iron ore importer, the increased demand from China make the violent fluctuation of iron ore price in the international market. A decrease in the price of iron ore has been seen since the Chinese government proclaimed its macroeconomic control policies, which lead the situation that no one want to buy iron ore from India even the price had fell by half. Lots of merchants purchased a large quantity of iron ore because of the high price. However no manufacturer decided to accept that price to augment cost. As a result a widely deficit and debt appeared in some merchants, in addition numbers of minor steel enterprises closed down at the same time. To sum up, the fluctuation of price is a double-edged sword, which can damage all three sides of business, suppliers, merchants and steel enterprises.

(2)The change of iron ore grade damage final user’s profit

Production in iron ore mine usually is relatively inflexible. Under the influence of productive power and limited resources, most of iron ore mine cannot manufacture extra iron ore to raise availability at short notice. To catch up with the increase of Chinese market for iron ore, some merchants replace superior quality products with

shoddy products to expand export and get a better profit. A large proportion of iron ore imported from India do not come up to the standard contract. Objectively, a part of Chinese steel enterprises' benefit has been damaged by such conduct.

(3)Transport bottleneck restricts the further development of iron ore market

The year 2007 saw some severe loading port stagnations in most of world iron ore port. Because of the centralized arrival of too many ore ships, the overstock also appeared in some Chinese sea port. As a result, the traffic expense per ton of ore has almost doubled at that time. Current, Chinese railroad carries along the line ability is already saturated, which is not able to fulfill the requirements of steel enterprises, aggravating the overstock problem.

2.2.5 Prospects of China import iron ore trade

Since the second half of 2003, the development of China's economy has been further speeded up. After a long period of rapid growth from 2001 to 2007, China's steel production increase had changed to a normal speed since 2008. Today China's economy has got into the mid-term stage of the industrialization as accelerated development of heavy industry. On the other hand, economic globalization and new international division cause some significant manufactures (automobile, realty industry, equipment industry, etc.) have a swift growth. The two above factors make the whole society of China will retain a higher level demand of products by iron and steel in a considerably long future. China's steel industry still has a superior development space; therefore, the iron ore trade will keep developing for a period.

2.3 Distribution of the port of destination in China

2.3.1 Current situation of ports for China import iron ore

(1) Current situation of infrastructure

In 2009, four new 100000 dwt of iron ore terminal berths were set up, two in Lianyungang and two in Taicang. The Sijiao harbour district of Ningbo-zhoushan port has adopted completion acceptance by Ministry of Transport in 2011, which has put into operation in 2008 with a 300000 tons terminal berth. In the end of 2011, Bayuquan,Yingkou port completed 300000 dwt class iron ore terminal connecting with the original 200000 dwt class terminal. In 2012, Baoman harbour district in Zhanjiang port has finished a 300000 dwt class bulk cargo terminal. At present, in 2012 Nanjiang terminal in Tianjin port is constructing the 300000 dwt (also accept 400000 dwt) class terminal berth specialized for iron ore.

(2) Current situation of lay out

In 2011 China's main sea ports had handling 618 million tons of iron ore, thereunto, and 418 million happened in the north of China that took 64.4%, sea ports in Yangtze River Delta took 23.9% and the south of China seaports account for 9.9%. Since 2010, with the rapid development of port market reform as well as the port industry, ports of different regions continue to accelerate the pace of resource integration in order to further improve the major iron ore ports loading and unloading quantity. The Table 3 shows that major iron ore ports in China loading and unloading quantity in recent years.

Table 3 Major iron ore ports in China loading and unloading quantity（million tons）

Region	Port	2007	2008	Increase	2009	Increase

				Rate(%)		Rate(%)2
North Ports	Qingdao	6089.7	7590.6	24.6	8513	12.15
	Rizhao	5831.2	6740.7	15.6	9204	36.54
	Tianjin	4663.1	5768.3	23.7	8383	45.33
	Tangshan	3515.7	4730.3	34.5	8395	77.47
	Yingkou	1182	1373	16.2	2299	67.44
	Yantai	970.4	1361.9	40.3	1851	35.91
	Dalian	1053.6	1143.2	8.5	2086	82.47
	Qinghuangdao	729	708.6	-2.8	1041	46.91
	Jinzhou	75.1	——	——	61	——
North Port Total		27625	34146.9	23.6	41833	22.51
Yangtze River Delta Port	Ningbo.Zhoushan	6169.8	7225.7	17.1	7574	4.82
	Shanghai	2904.6	2851	-1.8	2809	-1.47
	Lianyungang	1073.7	1462.2	36.2	2850	94.89
	Nantong	897.2	1031.36	12.9	1116	10.13
	Zhenjiang	296	298	0.68	549	84.2
	Zhangjiagang	223.4	150	-32.86	222	47.7
Yangtze River Delta Port Total		11564.7	12552.46	8.5	15120	20.45
South Ports Total	Zhanjiang	1587.3	2005.5	26.3	2595	29.39
	Fangcheng	929.9	1395.7	50.1	1906	36.56
	Shenzhen	595.4	777.7	30.6	929	19.45
	Guangzhou	181.5	161.3	-11.1	262	62.43
	Xiamen	398.63	436.9	9.6	554	26.8
South Ports Total		3692.73	4777.1	29.4	6246	30.75

According to the Table 3, Bohai area has been formed mainly six ports inculding dalian, Tianjin, Yingkou, Tangshan, Qingdao and Rizhao with Qinhuangdao, Yantai, Jinzhou port as the supplement of iron ore terminals. Yangtze River delta formed port layout of imports of iron ore transportation system composed of the coast of Ningbo, Zhoushan and the Yangtze River mouth in Shanghai, Nanjing, Zhenjiang, Nantong, Zhangjiagang and other ports. Southern China coastal formed effective supplement iron ore port layout mainly in Zhanjiang, Fangcheng Port specialized in handling iron ore, and Shenzhen, Shanghai, Guangzhou which are general bulk cargo berths.

2.3.2 Problems of ports for China import iron ore

(1) China's iron ore terminal loading and unloading capacity is insufficient

So far, only the Dongjiakou Qingdao port has built 400000 dwt of iron ore specialized berths, Dalian Port has 300000 dwt of iron ore specialized berths, docked 400000 dwt after the upgrade. Tianjin Port 400000 dwt of bulk cargo terminal is under construction. Other ports only have terminals under 300000 dwt. Ningbo - Zhoushan port in 2009 were handling iron ore more than million tons, but still cannot meet the iron ore import growth rate which led to the port of iron ore yard full, imports of iron ore transport ship only waiting for discharging at harbor. This not only plagued the shipping company, but also causes economic losses to the steel mill.

(2) China's large iron ore terminals are insufficient

In addition to Qingdao, Tangshan, Rizhao, Dalian, Ningbo- Zhoushan has a large-scale specialized terminal and water conditions are good, the other terminals mostly are not good enough, small berth tonnage, poor channel conditions, and low level of specialization.

(3) Port transportation ability still need to improve

In order to ensure the terminal on the normal production, good transportation is very essential. The collecting and distributing system of current import iron ore port mainly contains the water to water and water to the railway transportation, the road is obviously insufficient. The railway transport capacity is obviously insufficient, which also caused imports of iron ore in China's large backlog of terminal.

3. Analysis of supply for China's iron ore shipping market

3.1 Factors affecting the supply of iron ore shipping market

3.1.1 Affecting factors in the international shipping market

Factors that affect the supply of iron ore transport market are perplexing. It ranges from the market fluctuation caused by other cargoes in a small region to the overall world economic environment. The following analysis will dig into the factors affecting the supply in iron ore transport market from three perspectives.

(1) Effects of Iron Ore Shipping Demand

Shipping supply, aimed to meet the demand for shipping services, changes with the demand. Accordingly, factors influencing the shipping demand for iron ore will surely

change the shipping supply of iron ore. The elements include the international economic and trade development, laws and regulations of the country, variation of natural environment, advancement of science and technology etc.

(2) Effects of Iron Ore Freight Rate

Freight rate goes down in a depressed market and if the freight revenue fails to meet the running cost, the ship owner will unavoidably suffers loss. When the deficit outnumbers the suspending storage cost of the ship, the ship will be suspended to avoid further losses. As a result, the number of ships declines. On the contrary, more ships will be demanded and more suspended ships will be put into use again if the prevailing freight rate is positive.

(3)Effects of Related Markets

Relevant markets such as the markets of vessel manufacturing, vessel transaction and demolition as well as the seafarer employment market also contribute to the ability of shipping supply. Change of shipbuilding market determines the input of new fleets into the market while that of vessel transaction reflects the quantity of laid-up tonnage in the market. The impact of recycling market and crew market is also of great importance.

3.1.2 Supply factors of China iron ore shipping market

At present, the world is slowing down its pace in industrial development including the BRICs and the OECD. Global steel production suffers the maximum year-on-year decline since the middle of year 2009. As the growth rate of investment goes down, the steel industry is eliminating backward capacity and strictly controlling the input of production capacity. It is estimated that growth rate of iron ore import will decrease

sharply, compared to that in the Eleventh Five Year Plan. Fortunately, as the nation will expand its scale in large infrastructure construction during the period of the Twelfth Five-Year Plan, iron ore import is still expected to rise, which will affect the iron ore transport market in China. The capacity of iron ore transport in China will adjust itself to volume of iron ore import.

Since the beginning of 2012, the recovery of world economy turns to be feeble. Shipping demand in the doldrums, freight rate going down and fuel charges increasing; the business environment for ship owners is deteriorating. The situation even turns worse as vessels ordered before the global economic crises are put into the market. In contrast, the vessel demolition booms when more and more vessels are laid-off. In China, ship recycling volume climbs up slightly by 8% to the loading capacity of 7.028 million ton. In ship market downturn, a number of domestic shipping companies get a foot in ship demolition to diversify their range of business. The iron ore transport market is adjusting its pace to the changing global market.

3.2 Analysis of iron ore shipping capacity

3.2.1 Analysis of the international iron ore shipping capacity

The size of international transport fleet engaged in iron ore is very large. Based on the ship type, the mainstream ship of iron ore are very large bulk carriers, Capesize and Panamax vessels. In some regional routes there is also part of handysize or even smaller boats in the transport of iron ore.

There has been recycling of older vessels and new vessels putting into the market

each year. The entire international bulk cargo transportation fleet is always in constant change. Under the impact of changes in international bulk cargo transportation market cycles, the total tonnage of the ship also will change. Until 2011, the world's dry bulk fleet has 8890 vessels, 611.1 million dwt, among which there are 2463 Handysize, 126.2 million dwt; 3049 Handymax, 84.4 million dwt; Panamax 2026, 154.7 million dwt; Capesize 1352, 245.8 million dwt.

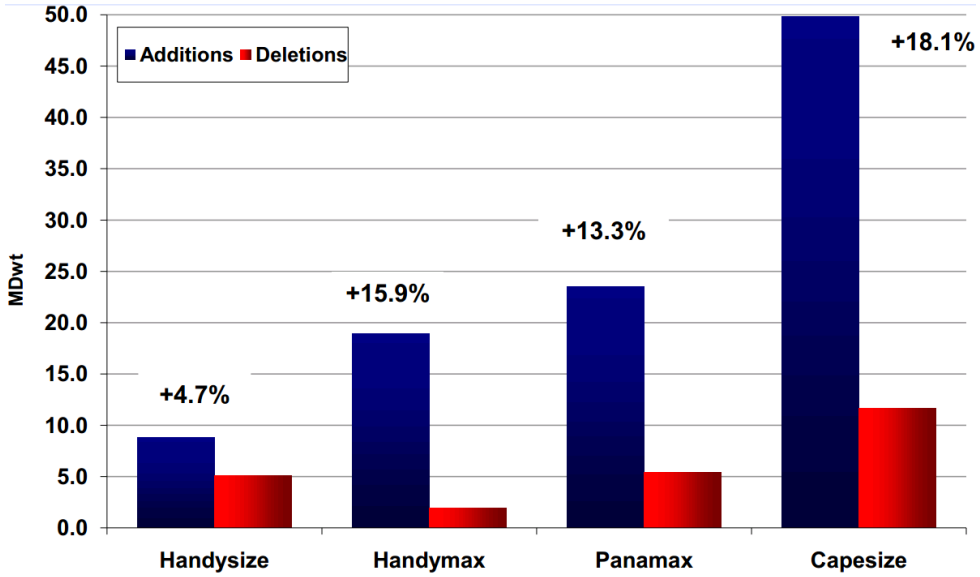

Figure 6 Net growth of dry bulk capacity in the world in 2011

Source: SSY

Figure 6 shows the net growth of dry bulk capacity in the world in 2011. Until 2011, the world's dry bulk fleet has 8890 vessels, 611.1 million dwt, among which there are 2463 Handysize, 126.2 million dwt; 3049 Handymax, 84.4 million dwt; Panamax 2026, 154.7 million dwt; Capesize 1352, 245.8 million dwt.

3.2.2 Analysis of China iron ore shipping capacity

The main iron ore in China comes from Australia, Brazil, India, and South Africa etc. According to the conditions of shipment in foreign port harbor and the composition and development trend of the ore carrier, China's iron ore reasonable ship types are: the routes of South America, South Africa are mainly more than 200 thousand tons bulk carriers; The routes of Australia is mainly using the Cape of Good Hope vessel that between 150 thousand and 160 thousand tons; India routes to 4-6 million tons Panamax and Handymax vessels.

(1)The northern region

Iron Ore transportation mode of the northern region: Capesize ship are more than 150 thousand tons calling at Qingdao Port, a portion of the volume transported by rail, road to the hinterland of the steel mills, as well as part of the traffic is subject to two-way transport to the north or other port of the Yangtze River Delta region, and then transported by rail, road to the steel mills: in addition to part of the traffic through the 10 tons ship or a small part of the ship load shedding, loss of load transported to the northern ports.

(2) Yangtze River Delta and regions along the Yangtze River

The Iron ore transportation mode of Yangtze River Delta and regions along Yangtze River: influenced by the limit of channel depth of the Yangtze River estuary, ore transport ship to Ningbo, Zhoushan two-way transshipment into the river or Ningbo, Zhoushan, Shanghai shedding directly into the main river, the middle and upper reaches of the Yangtze River required for iron and steel enterprises iron ore delivered to the plant Yangtze River barge transfer.

(3)The southern region

Southern region iron ore transportation mode: iron ore shipped to the Zhanjiang Port

or Guangzhou port by Panama ship, Fangcheng port and so on. Now Capesize iron ore boats can directly unloading at the port of Zhanjiang or load shedding, losses are transported to Guangzhou, and Fangcheng.

4. Forecasting of demand and supply of iron ore shipping market in China

4.1 Influencing factors of demand for China's imports of iron ore

4.1.1 China's economic development influences iron ore imports

One country’s economic development can advanced strongly the expanse of steel industry. In China, if the economics keeps growing up, more infrastructures will be constructed anyway, which lead to the activating consumer market with an increasing demand for iron ore that China has to import, and vice-versa.

Table 4 GDP Database of Asia

Asia…	% Year-On-Year							
	2005	2006	2007	2008	2009	2010	2011*	2012"
Japan	1.3%	1.7%	2.2%	-1.0%	-5.5%	4.5%	-0.8%	2.2%
P.R.China	11.3%	12.7%	14.2%	9.6%	9.2%	10.4%	9.2%	7.8%
R.o.Korea	4.0%	5.2%	5.1%	2.3%	0.3%	6.3%	3.6%	2.7%
India	9.0%	9.5%	10.0%	6.9%	5.9%	10.1%	6.8%	4.9%
Pakistan	9.0%	5.8%	6.8%	3.7%	1.7%	3.1%	3.0%	3.7%
Malaysia	5.0%	5.6%	6.3%	4.8%	-1.5%	7.2%	5.1%	4.4%
Indonesia	5.7%	5.5%	6.3%	6.0%	4.6%	6.2%	6.5%	6.0%
Philippines	4.8%	5.2%	6.6%	4.2%	1.1%	7.6%	3.9%	4.8%
Singapore	7.4%	8.8%	8.9%	1.7%	-1.0%	14.8%	4.9%	2.1%
Thailand	4.6%	5.1%	5.1%	2.6%	-2.3%	7.8%	0.1%	5.6%
Hong Kong	7.1%	7.0%	6.4%	2.3%	-2.6%	7.1%	5.0%	1.8%
Vietnam	8.4%	8.2%	8.5%	6.3%	5.3%	6.8%	5.9%	5.1%
Taiwan	4.7%	5.4%	6.0%	0.7%	-1.8%	10.7%	4.0%	1.3%
TOTAL Developing Asia	**9.5%**	**10.3%**	**11.4%**	**7.9%**	**7.0%**	**9.5%**	**7.8%**	**6.7%**

Source: Clarkson

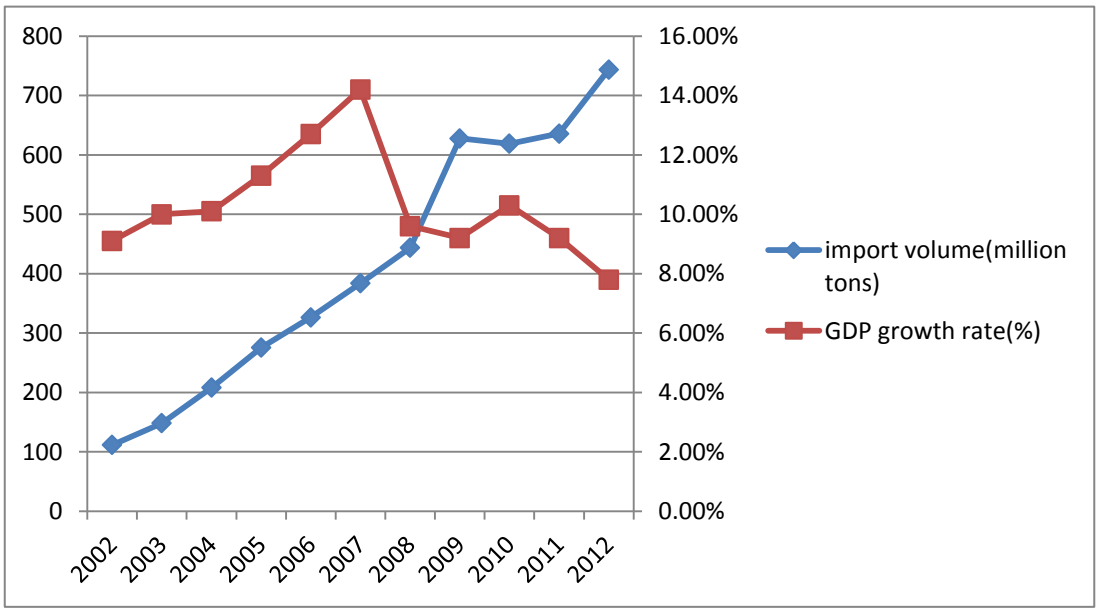

Figure 7 The iron ore import volume and GDP growth

According to Table 4 and the iron ore import volume and GDP growth in Figure 7, they are obviously seen China's GDP keeps the high speed comparing with other counties. Altough a slight drop appeared in 2008, high rate of growth did not have

changed. Therefore, iron ore import volume increase year by year.

4.1.2 China iron and steel industry development influences iron ore imports

Iron ore is the initial raw material in the production of steel, steel production directly lead to the increase or decrease of iron ore consumption, which naturally affects the volume of imported iron ore. With the increase China's steel production, iron ore demand will increase. China's domestic mining capacity is insufficient to meet the increased demand for iron ore. In order to ensure the normal production, the only way is imported iron ore. At present, China's iron ore external dependence is as high as more than 60% and this situation is difficult to change in the short term.

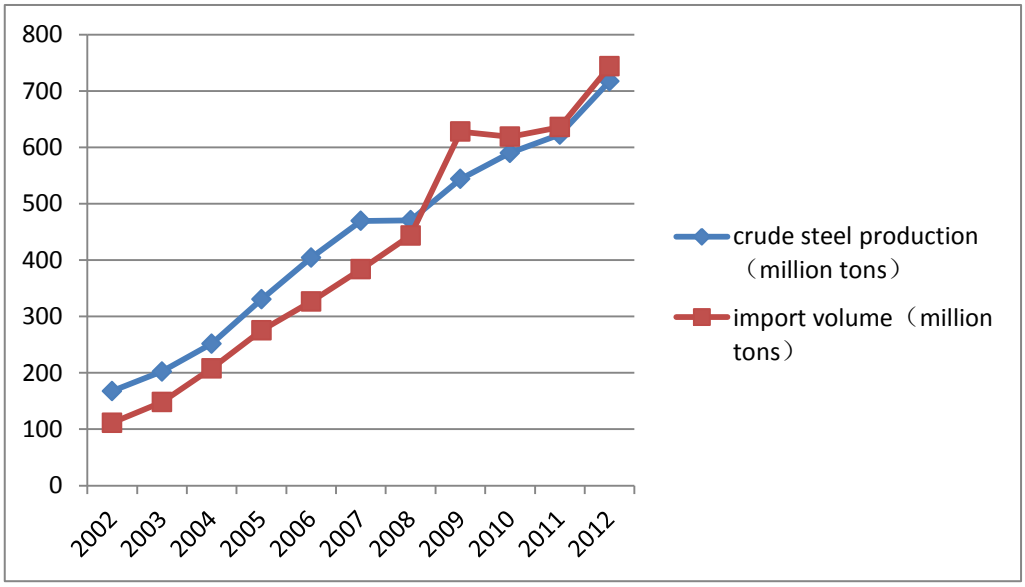

Figure 8 Import volume and crude steel production

From the Figure 8 import volume and crude steel production in China, we can see the trend of import volume and crude steel production is almost proportional, which the relationship between them is apparently close.

4.1.3 Iron ore prices influences iron ore imports

Considering the increase of China's steel demand, every year can see a raise about the iron ore import. However, during 2002 to 2012, the price of iron ore has increased by 110 dollars per ton from 30 dollars per ton, and in some time of that, a culmination, 180 dollars per ton, had been found.

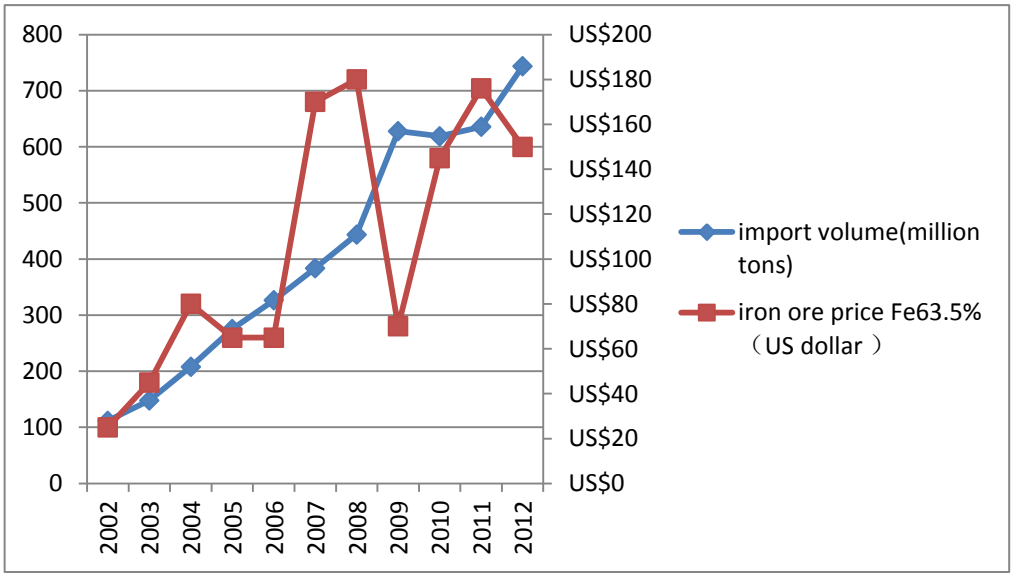

Figure 9 Import volume and iron ore price

Figure 9 shows the comparison of iron ore price and the import volume, we can find how iron ore price influences on import volume: the price of iron ore is inversely proportional to the import volume. As a result, if the price grow to the level that steel enterprises are unable to accept, the market will calm down with less trades, even there is still a huge demand in the market.

4.1.4 Port handling ability of China's coastal influences iron ore imports

At present, only in Qingdao, Rizhao, Tangshan, Dalian, Ningbo-Zhoushan are built as the large specialized terminals with enough depth of water. Other ports used to unload iron ore usually are with lower berth tonnage, the channel conditions are undesirable. In addition, most of these ports are general berth, with low-level specialization. And some main ports, except Dalian port, have the same two situations that there is not enough space to store iron ore, and the problem of overstock is serious. The two factors above have great influence on the port's operational efficiency and the iron ore quantity of China import.

4.1.5 International iron ore export enterprise capacity influences iron ore imports

International iron ore export enterprises are the main supplier about the countries who have a large quantity iron ore importation. Their capacities affect the volume of iron ore trading. China has the biggest iron ore importation quantity around the world. If the supplies of iron ore reduced, it will appear short supply situation which could lead to driving up the price of iron ore, thus parts of small and medium-sized steel enterprises may decrease import volume. Actually, in 2013, four mining enterprises increase new capacity about 50 million tons in total, in which VALE unchanged than before, Rio Tinto increased by 15 million tons, BHP Billiton increased by 10 million tons and 25 million tons are increased by FMG. To some extent this situation influence changes of China's imports volume, and is also likely to lead to oversupply situation.

4.2 Forecasting of China iron ore import volume

In terms of forecasting the volume of imported iron ore, there are many methods. From the complex to simple forecasting method, which are too numerous to enumerate. Undeniably, many factors affect the imports of iron ore, but through the above analysis we can see that the past iron ore imports mostly keep a rising trend. According to the international environment and China's policy, it will not appear sudden change for China’s iron ore imports trend. Accordingly here we use a simple trend line to forecast by excel. Conditions is ruled out a lot of uncertain factors, in an ideal state, roughly predict the trend of China's iron ore imports.

In the Excel chart, the trend line is a visual forecast analysis tool, we can easily obtain data directly from the known information. The main types of the trend line method are linear, logarithmic, polynomial, exponential and power trend line, etc. Choosing the right trend line type is the key to improve the fitting degree, improve the accuracy of forecasting analysis. In the process of Excel computing will generate the trend line formula. In the formula, the number of R^2 equals to or close to 1, the trend line is most reliable. Specific methods are as follows:

Table 5 Import iron ore volume of China from 1990 to 2012.

year	1990	1991	1992	1993	1994	1995
import volume（million tons)	1.4	1.9	2.5	3.1	3.7	4.1
year	1996	1997	1998	1999	2000	2001

import volume （million tons)	4.4	5.5	5.1	5.5	7	9.2
year	2002	2003	2004	2005	2006	2007
import volume （million tons)	11.4	14.8	20.8	27.5	32.6	38.3
year	2008	2009	2010	2012		
import volume （million tons)	44.4	62.8	64.9	74.3		

Type China import volume from 1990 to 2012 in the Excel, and forecast them in order to get 5 figures as followed:

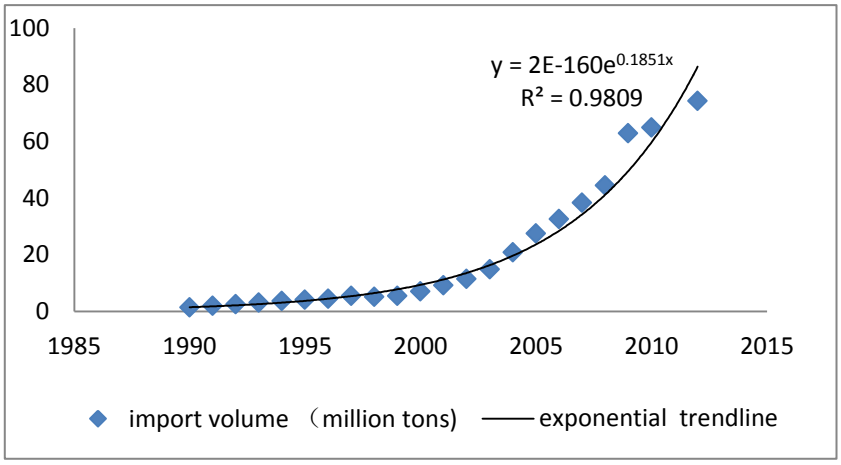

Figure 10 Import volume in exponential trendline

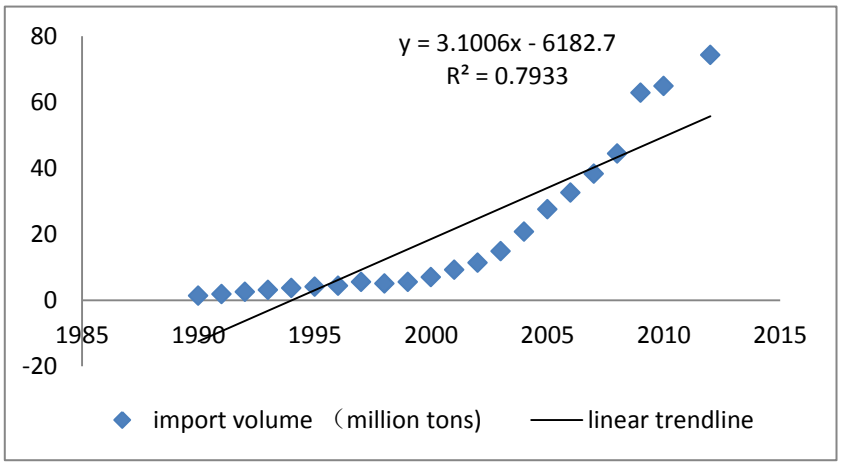

Figure 11 Import volume in linear trendline

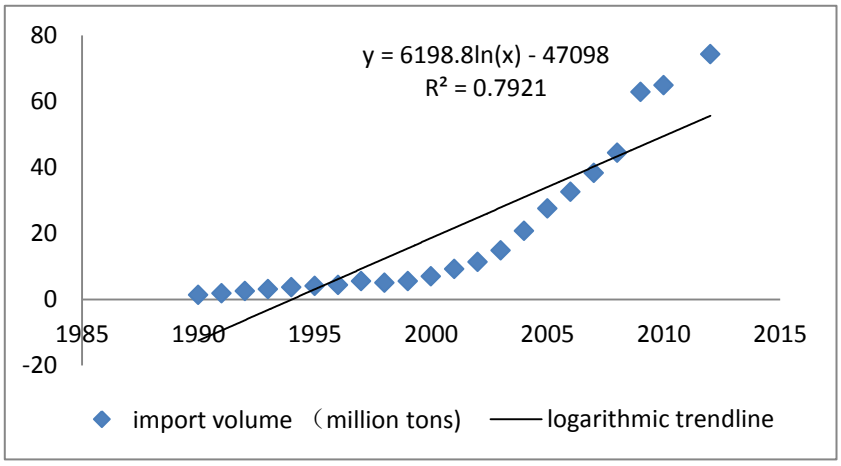

Figure 12 Import volume in logarithmic trendline

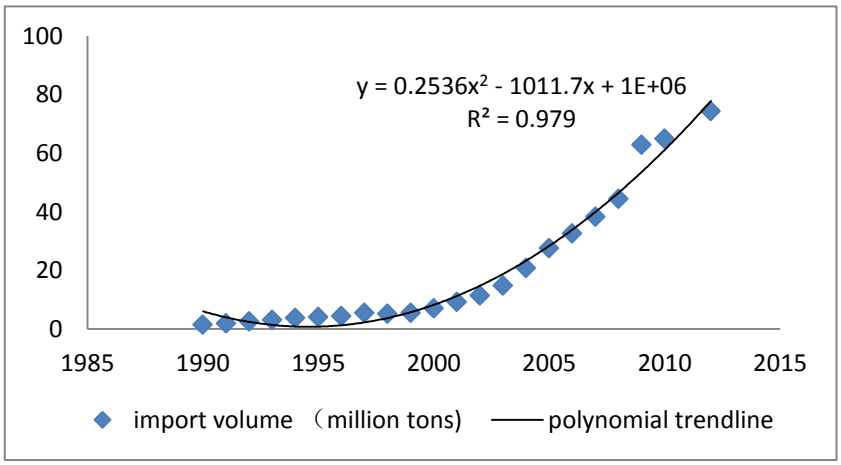

Figure 13 Import volume in polynomial trendline

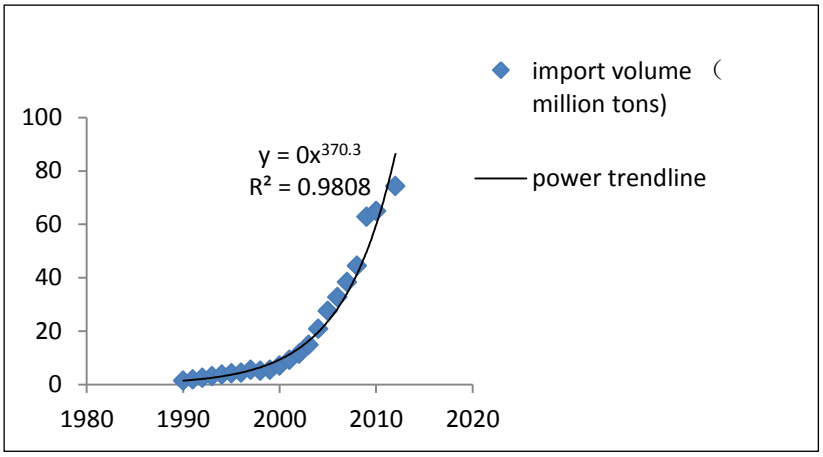

Figure 14 Import volume in power trendline

Through the calculation of Excel, it can be seen form Figure 10 to Figure 14 that each trend line is on the rise. In terms of the data, the R ² of exponential trend line is most close to 1, so it should be taken as the forecasting trend.

To sum up, simple forecasting demonstrated China's iron ore import volume will rise over the next few years.

4.3 The trend of supply for China iron ore shipping market

4.3.1 Trend of iron ore transportation capacity of China in the future

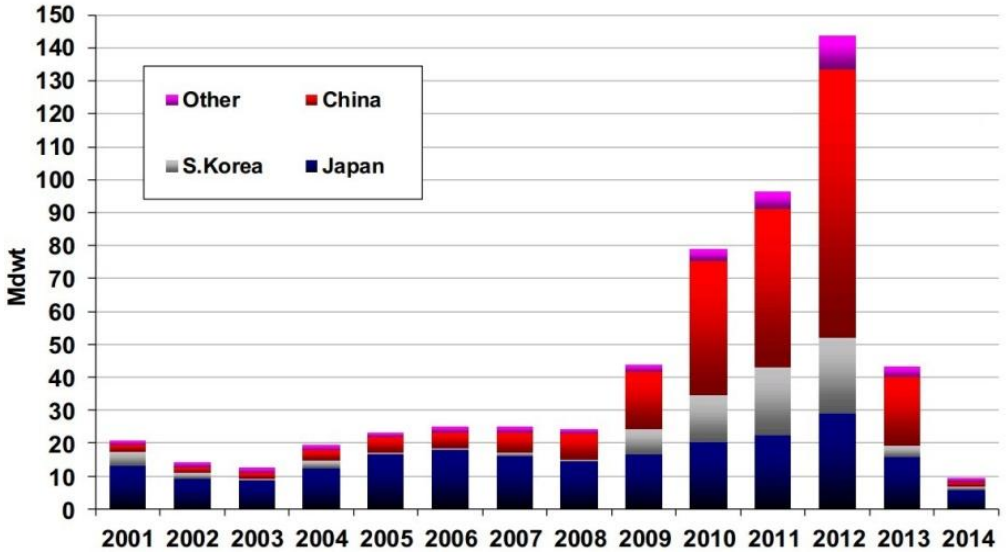

Figure 15 Shipbuilding quantities of dry bulk ships by country

Source: SSY

Figure 15 implied China shipbuilding quantities take up a large proportion. As the transportation volume of domestic coastal provinces continued to show rapid growth momentum. By the end of 2011, the domestic coastal dry bulk ships(more than 10000 dwt) total 1500 ships /42870000 dwt, a net increase of 229 ships /8340000 dwt and a net increase 24.2% of transportation capacity than 2010. The newly built vessels since 2011 put into operation totaled 7480000 dwt, accounting for 89.7% of the same period total capacity increment. The graph below shows the shipbuilding quantity of dry bulk ships by country.

The domestic coastal dry bulk capacity shows the following trends:

1. The number of new ships continues to run high, average tonnage increased year by year. The new ship has become the main factors of dry bulk capacity growth. The table 6 shows that the new ships number and deadweight ton from 2007-2011.

Table 6 New ships number and deadweight ton from 2007-2011.

	2007	2008	2009	2010	2011
New ships number	57	152	336	223	183
DWT	1000000	2680000	6590000	6570000	6730000

2. Ship age younger trend of dry bulk cargo ship (above 10000 tons) is very obvious. Due to the large number of new ship operation, average ship age of dry bulk cargo ship decreases year by year.

3. The transportation capacity of small and medium-sized private shipping enterprises continues to increase; however, the transportation capacity share of three big state-owned enterprises (Cosco, China shipping, sinotrans changhang) will decline rapidly.

4.3.2 Trend of iron ore freight rate in the future

Affected by slowdown of economy, the global commodity demand has reduced, as well as the whole shipping industry overcapacity phenomenon is serious, Baltic Dry Index, regarded as the global economic leading indicators, continue to decline in global commodity markets.

Figure 16 BDI from 1999 to 2013

According to ship type, three main ship freight index showed a larger decline, the decline range is as follows: the average price index of Panama ship is 1749 points, fell by 44% in the year; the average price index of super Handymax is 1377 points, down 36% from last year; the average freight rate index of Capesize is 2237 points, compared with last year down 36%.

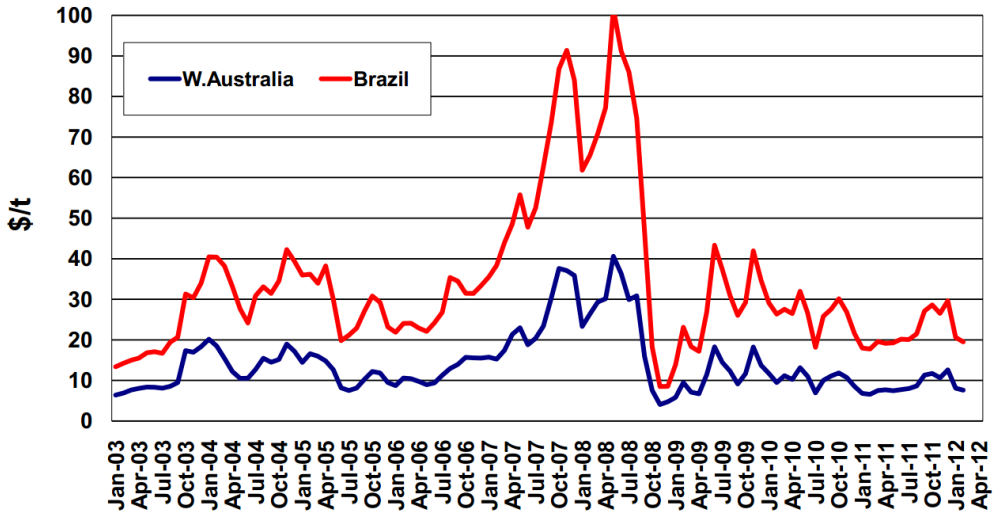

Figure 17 Average freight rate of Capesize for China route by month

Source: SSY

According to Figure 17 the average freight rate of Capesize for China route by month, we can conclude that although the freight rate appeared slight fluctuation during the period, lower freight rate trend is obviously to be seen. Therefore, the freight rate may continue go down with some slight fluctuation in the future.

5. Development trends of iron ore shipping market and the Economic analysis for selection of ship-type

5.1 Trends analysis of China iron ore shipping market

5.1.1 Fluctuation of shipping market

Since 2003, the development of international dry bulk market have increased for over 5 years, however, a 2-year rapid decrease appeared after that for two years. During the time that the market increasing, fluctuate of shipping market has totally broken the intrinsic shipping circle, which has some features, long wave trough, short wave crest, changing with seasons. It had new features, rapid and strong rate. Another factor was that iron ore and coal replaced grain to become the main dry bulk goods. Because of the intrinsic shipping circle disappeared gradually, a new wave moved from crest to trough in a very short time. To compare with the old circle, the new circle changed more violent.

5.1.2 Dry bulk trade pattern changes

International dry bulk trade demand is derived from the international dry bulk trade, so that the change of dry bulk trade pattern will have a great influence on demand, especially the two main goods, iron ore and coal. At the present stage, the international trade of these two goods will become more complex depending on the change of world economic situation and the adjustments of policy in different countries. Currently, China's and India's fast economic development provide the motive power for international dry bulk trade demand. The development of China's economics has a great demand for iron ore, coal and provisions. This great demand has promoted the international dry bulk trade for several years and this trend will continue.

Originally, China had trade with the three biggest mines by the pattern that sign long-term price contract, and this pattern was adopted by almost all the ore sales industry in the world. However, this long-term marketing pattern meets seriously challenged today, the rate of sales in spot-market has a quickly increase year by year, which becomes a tendency. Furthermore, the annual pricing mechanism of iron ore had been broken up completely last year, and the quarterly pricing mechanism is widely adopted, which will further increase the fluctuation of iron ore shipping market. India's economic development leads a more demand of iron ore; as a result, India decreases the quantity of iron ore export, and seems to increase the import of high grade iron ore. So India will become a new power to underpin the international dry bulk trade.

5.1.3 Market main body role to focus diversification

In latest ten years, depending on the world economic situation's dramatic change, the two subjects of dry bulk trade, demand side (shipper) and supply side (ship-owner), tends to be centralized, thus the large enterprise become larger, and the small ones are unable to survival. At the same time, more players participate in the international dry bulk trade market, instead of the previous simple business just trading by ships and goods.

(1) Demand side–shipper. The past few years have seen an aggravated monopolization appeared in the iron ore and provisions trade, especially iron ore trade which takes the biggest rate of international dry bulk shipping trade. The worldwide mining for iron ore has almost completely been monopolised by Vale, Rio tinto and BHP billiton, the three biggest ore miners. They use some business strategies that add the quantity of supply and speculation in FFA, by which they can almost control rhythm of shipping market transformation, the Vale even, built a very large ore carrier to monopolize iron ore exported from Brazil.

(2) Supply side-ship-owner. After the global financial crisis in 2008, the international dry bulk trades have suffered huge loss, which caused the shuffling of the market. As a result, those huge size shipping enterprises show its advantage of operating; in the other hand many small enterprises must face the worse situation with less living space.

(3) According to the roles who join in the market, there is a great development of the market mode about chartering pattern; the shipping market subject become more complex; ship-owner and shipper exchange their character sometimes. Investment companies and banks also participate in the market through the way ship sale,

financing or providing security. In particular, some investment bank whose purpose is for profit has become a new force in shipping market in recent years, have a great influence on the changes of the market.

5.1.4 Capitalization of international dry bulk shipping market and freight

The so-called international dry bulk shipping market capitalization refers to in recent years the ship, freight index and ship orders are regarded as commodity, such as FFA. These paper goods trade appeared in spot trading around the spot shipping market, both interact with each other, making the international dry bulk shipping market volatility, as well as increased the shipping market risk. At this stage of the international dry bulk shipping market volatility, is not restricted by the relationship of supply and demand, freight has been capitalized, subjected to change of the FFA market, time charter rents and the market game mentality factors, thus control the spot, forward freight rates and dry bulk ship rent levels, making change of pace of international dry bulk shipping market faster and bigger.

5.2 Economic analysis of ship's operation for China's imported iron ore transportation

5.2.1 Determination of economy indicators for ship's operation

There are a lot of economic indicators to measure the quality of different type, different indexes can reflect the investment efficiency and ship type from different sides. This paper will be divided into operating indicators, economic and financial indicators, and investment efficiency indicators. Ship's economy will be investigated

from these three aspects respectively and finally advantages and disadvantages of ship's economy will be taken investment effect index as a best measure.

A. Operating Indicators

Operating indicators is to estimate the transport capacity of different ship types when put into operation, including speed, fuel consumption and annual freight turnover and so on.

B. Economic and Financial Indicators

Economic and financial indicators include shipping cost estimate, income, expenses, profit.

C. Investment Efficiency Indicators

Investment efficiency indicators according to whether to consider the time value of money is divided into static evaluation and dynamic evaluation index, in which the static evaluation index is the investment profit margin, payback period, the investment profit tax rate, dynamic evaluation index is net present value, net present value rate, net annual value, required freight rate . This paper focuses on the required freight rate, net present value, payback period of the three indicators.

Here are a few indicators calculation method to introduce in detail:

A. Operating Indicators

1. Operating Time Statistics

According to the experience, operating rate is selected around 90%, operating time is selected 340 days, including the sailing time, berthing time etc.

(1)Sailing Time-$\mathrm{T_{SR}}$

$$\mathrm{T_{SR}} = \mathrm{L_S}/24\mathrm{V_S}\ （\mathrm{day}）$$

In the formula：$\mathrm{L_S}$ is sail distance，$\mathrm{V_S}$ is sail speed

(2)Berthing Time-$\mathrm{T_{PR}}$

$$T_{PR} = T_{ZX} + T_{DB} = \frac{Q}{M_1} + \frac{Q}{M_2} + T_{DB}$$

Q- Single Trip Freight Quantity (tons)

M_1、M_2- Overall efficiency of loading and unloading of cargo (tons/day). T_{ZX} is the productive berthing time.

M_1, M_2 are considered to handling efficiency of unproductive berthing and auxiliary operation, select Q=O．95DW; T_{DB} is turn time of two ports, select average T_{DB}=4 days.

(3) Time of Round Trip-T_{SPR}

$$T_{SPR} = T_{SR} + T_{PR}$$

2. Annual Freight Traffic-ATC

$$ATC = CW * N_{BTR} * 10^{-4}(\text{ten thousand tons})$$

$$CW = 0.95DW$$

3. Annual Oil Consumption

Main engine oil consumption per voyage day-OCM

OCM= main engine power * main engine fuel consumption rate*24*10^{-6}(t/d)

Auxiliary engine oil consumption per voyage day is 10% of the main engine, that is：

OCG=0.1*OCM

Berthing fuel consumption per day of auxiliary engine and boiler= 0.8*OCG

Heavy oil is used by Main engine with 70% of the time, light oil with 30% of the time. Auxiliary engine and boilers all use light oil.

Oil Consumption Yearly:

Heavy Oil：$W_{HOY} = 0.7 * T_{SR} * N_{BTR} * OCM$

Light Oil ： $W_{LOY} = (0.3 * T_{SR} * N_{BTR} * OCM + 0.1 * T_{SR} * N_{BTR} * OCM + 0.8 * T_{PR} * N_{BTR} * OCG)$

B. Economic and Financial Indicators

1. Ship Price-P

Ship price is the payment of shipping company to buy a ship.

2. The Cost of Yearly Operation-YC

(1) Capital Costs and Depreciation- S_1

It is used by straight-line depreciation method. The lifetime of bulk carriers is set to 20 years; Residual value is 5% of the original value.

Depreciation Cost

$$S_1 = \frac{P - RL}{N} = P(1 - 5\%)/N$$

In the formula：

S_1- Depreciation Cost

P- Ship Price

RL-Residual Value

N- Number of Years of Depreciation

(2) Crew Expense and Additional Expense-S_2

Crew Expense is the cost of the Crew working on the ship that Crew expense including basic salary, all kinds of subsidies and allowances, and training, welfare funds, and other miscellaneous fees. "According to salary and welfare standard of large bulk shipping enterprises, a set of crew staff wages and surcharge is $230000.

(3) Yearly Repair Costs -S_3

Yearly Repair Costs is the cost of the regular maintenance and the regular Repair. Repair costs refer to the extraction percentage of ship price; here take 1.5% of yearly repair costs.

$$S_3 = P * 1.5\%$$

(4) Yearly Insurance Expense-S_4

Insurance Expense is the necessary cost of the owner for shipping insurance, such as ship, freight, crew insurance, etc. According to the insurance company's current situation, yearly insurance expense is set to 0.7% of the shipping cost.

$$S_4 = P * 0.7\%$$

(5) Yearly Cost of Fuels-S_5

$$S_5 = 360 * W_{HOY} + 650 * W_{LOY}$$

Heavy oil is set to $360 / ton; light oil is set to $650/ton.

(6)Cost of Lubricating oil-S_6

Lubricating oil is usually 7%-10% of the costs of fuels, here select 8% of it.

$$S_6 = \text{Cost of Fuels} * 8\%$$

(7) Material Expense-S_7

It is usually 10% of the cost of fuels.

$$S_7 = \text{Cost of Fuels} * 10\%$$

(8) Yearly port charges-S_8

Yearly port charges include harbor dues, cargo agent charge and tuggage etc. Different port charging items and standards are not identical and often change.

$$S_8 = \text{average port charge per voyage} * \text{number of voyages in one year}$$

(9) Management Cost and other Expenses-S_9

According to experience, this cost is set to 18% of the total operating fixed cost.

$$S_9 = (S_2 + S_3 + S_4 + S_6 + S_7) * 18\%$$

(10) Yearly Total Operating Cost-YC

$$YC = S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7 + S_8 + S_9$$

C. Investment efficiency indicators

1．The Required Freight Rate-RFR

Required freight rate is small, gain more in the same market, the better the economy of ship.

$$RFR = [Y_C - S_2 + P \times (A/P, i, N) - RL \times (A/F, i, N]/Q$$

In the formula：Y_C is the Yearly Total Operating Cost,

$$Y_C = S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7 + S_8 + S_9$$

2．Net Present Value-NPV

$$NPV = (F - Y_C + S_2) \cdot (P/A, i, n) + RL(P/F, i, n) - P$$

The net present value is positive, says the scheme is feasible, the greater the net

present value project, the better; Net present value is zero, to achieve the desired investment benchmark yield; If the net present value is negative, that plan is not workable.

3. Pay Back Period-PBP

Pay back Period refers to the project's net income counter in a total investment (including fixed assets and working capital) the time, it takes year usually as unit. The shorter the pay back period of investment, investment risk is smaller.

$$PBP = -\frac{\lg\left(1 - i \cdot \frac{P}{F - Y_C + S_2}\right)}{\lg(1+i)}$$

5.2.2 The Calculation of Different type of Ship Operating Economy Indicator

This paper selected main ship types transported China's imported iron ore in Clarkson Shipping Intelligence database which is 10 thousand to 25thousand ton ships as the analysis objects, in which per 10 thousand ton as a set to take economic analysis on fixed routes. Ships' specific parameters are shown in table 7.

Table 7 Different kinds of ships' specific parameters

Name	Deadweight ton (DWT)	Length (m)	Breadth (m)	Draught (m)	Oil consumption (ton/day)	Speed (km)
Brilliant	105496	250.00	39.01	15.57	40.0	14.7
Ijmuiden Maru	111695	260.50	43.90	13.80	39.0	13.5
Gina Iuliano	122829	265.57	40.42	14.50	47.0	15.7
Hebei Dove	135160	249.10	45.00	16.83	52.0	14.0

Great Moon	145968	273.00	43.04	17.54	45.7	13.8
Docecape	152308	277.00	43.50	17.61	43.0	13.0
Kirmar	164218	288.00	44.0	17.60	53.0	14.0
Aduclking	175075	283.00	44.90	18.63	51.0	14.0
Pacific Triangle	184744	299.75	50.00	17.02	64.5	14.5
Hebei Star	194941	300.00	50.00	18.26	60.5	14.1
Kerkis	208953	315.00	50.05	18.33	48.1	12.6
BaoFu	215159	297.00	50.00	19.84	48.5	13.5
Constance N	224666	315.05	50.04	19.80	49.4	12.7
Rhine Ore	233016	315.00	54.06	18.32	58.4	14.0
OceanUniverse	245609	326.00	53.00	19.20	55.6	14.15
Waterman N	259586	328.56	54.00	19.72	44.2	12.0

China imports iron ore mainly from Brazil, Australia and India. In this paper ship route is set to Brazil to Beilun and Australia to Beilun, China. Since India and China belong to one area, so it doesn't calculate separately.

Through calculation as above formulas, the 16 typical ships could get calculation results of economic indicators between Tubarao Brazil to Beilun China and Dampier Australia to Beilun China. As shown in table 8

Table 8 Economic analysis of the results from Tubarao in Brazil to Beilun in China

Ship type	105496	111695	122829	135160	145968	152308	164218	175075	184744	194941	208953	215159	224666	233016	245609	259586
Operating indicators																
Oil Consumption(ton/day)	40	39	47	52	45.7	43	53	51	64.5	60.5	48.1	48.5	49.4	58.4	55.6	44.2
Speed (kn)	14.7	13.5	15.7	14	13.8	13	14	14	14.5	14.1	12.6	13.5	12.7	14	14.5	12
Annual round trips	4.57	4.19	4.57	4.16	4.1	3.9	4.12	4.11	4.21	4.11	3.75	3.95	3.75	4.04	4.06	3.56
Annual freight volume of single ship	580228	614322.5	675559.5	743380	802824	837694	903199	9629136	1016092	1072176	1149242	1183375	1235663	1281588	1350850	1427723
Economic and financial indicators																
Ship Price-P	4000	4200	4700	5000	5300	5500	5750	6000	6300	6500	6700	6900	7100	7300	7500	7700
Crew Expense and Additional Expense-S_2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Depreciation cost-S_1	190	199.5	223.25	237.5	251.75	261.25	273.13	285	199.25	308.75	318.25	327.75	337.25	346.75	356.25	365.75
Yearly repair costs -S_3	60	63	70.05	75	79.5	82.5	86.25	90	94.5	97.5	100。5	103.5	106.5	109.5	112.5	115.5
Yearly insurance expense-S_4	28	29.4	32.9	35	37.1	38.5	40.25	42	44.1	45.5	46.9	48.3	49.7	51.1	52.5	53.9
Yearly cost of fuels-S_5	291.27	302.07	314.623	303.39	314.32	319.62	327.51	345.98	417.9	391.98	311.64	314.23	320.06	378.37	360.23	286.37
Cost of lubricating oil-S_6	23.3	24.17	25.17	24.27	25.15	25.57	26.2	27.68	33.43	31.36	24.93	25.14	25.61	30.27	28.82	22.91
Material expense-S_7	31.46	32.62	33.98	32.77	33.95	34.52	35.37	37.37	45.13	42.33	33.36	33.94	34.57	40.86	38.91	30.93
Yearly port charges-S_8	31.85	33.1	36.08	34.94	36.49	37.08	39.17	39.87	40.84	41.08	41.22	43.43	45.06	48.47	48.69	49.81
Management cost and other expenses-S_9	113.23	114.55	132.31	133.07	138.16	137.05	154.3	154.77	177.2	174.26	160.03	163.42	167.57	182.9	181.76	169.06
Yearly total operating cost-YC	792.11	821.41	891.363	898.94	939.42	959.09	1005.18	1045.67	1175.35	1155.76	1069.83	1082.71	1109.32	1211.22	1202.66	1117.23
Yearly total income	1438.7	1534.2	1609.4	1715.8	1771.2	1860.65	1914.1	1900.9	1918.8	2144.4	2249	2346.8	2249.7	2468.7	2579.5	2663.1
Investment efficiency indicators																
Required Freight Rate-RFR	23.8	23.97	22.86	23.36	22.94	23.26	22.43	21.45	22.09	21.42	20.92	19.75	20.42	19.57	18.58	19.32
Net Present Value-NPV	410.64	360.91	894.46	689.21	919.25	772.58	1299.89	1908.15	1691.64	2137.96	2384.95	3329.52	2883.4	3818.62	4778.51	33918.94
Pay Back Period-PBP	14.97	15.6	12.45	13.82	12.86	13.75	11.69	10.13	10.9	9.97	9.61	8.23	9.01	7.88	7.03	8

Table 9 Economic analysis of the results from Dampier in Australia to Beilun in China

Ship type	105496	111695	122829	135160	145968	152308	164218	175075	184744	194941	208953	215159	224666	233016	245609	259586
Operating indicators																
Oil Consumption(ton/day)	40	39	47	52	45.7	43	53	51	64.5	60.5	48.1	48.5	49.4	58.4	55.6	44.2
Speed (kn)	14.7	13.5	15.7	14	13.8	13	14	14	14.5	14.1	12.6	13.5	12.7	14	14.15	12
Annual round trips	12.23	11.42	12.23	11.19	10.98	10.48	10.92	10.82	10.98	10.7	9.82	10.23	9.76	10.33	10.3	9.17
Annual freight volume of single ship	738472	781865	859803	946120	1021776	1066156	1149526	12255264	1293208	1364587	1462671	1506113	1572662	1631112	1719263	1817102
Economic and financial indicators																
Ship Price-P	4000	4200	4700	5000	5300	5500	5750	6000	6300	6500	6700	6900	7100	7300	7500	7700
Crew Expense and Additional Expense-S_2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Depreciation cost-S_1	190	199.5	223.25	237.5	251.75	261.25	273.13	285	299.25	308.75	318.25	327.75	337.25	346.75	356.25	365.75
Yearly repair costs -S_3	60	63	70.05	75	79.5	82.5	86.25	90	94.5	97.5	100.5	103.5	106.5	109.5	112.5	115.5
Yearly insurance expense-S_4	28	29.4	32.9	35	37.1	38.5	40.25	42	44.1	45.5	46.9	48.3	49.7	51.1	52.5	53.9
Yearly cost of fuels-S_5	291.27	302.07	314.623	303.39	314.32	319.62	327.51	345.98	417.9	391.98	311.64	314.23	320.06	378.37	360.23	286.37
Cost of lubricating oil-S_6	23.3	25.17	25.17	24.27	25.15	25.27	26.2	27.68	33.43	31.36	24.93	25.14	25.61	30.27	28.82	22.91
Material expense-S_7	31.46	32.62	33.98	32.77	33.95	34.52	35.37	37.37	45.13	42.33	33.36	33.94	34.57	40.86	38.91	30.93
Yearly port charges-S_8	86.7	90.18	96.59	93.97	97.7	99.56	103.72	104.95	106.55	106.96	108.02	112.54	117.09	123.93	123.54	128.32
Management cost and other expenses-S_9	122.94	124.66	143.02	143.52	149	148.11	165.72	166.29	188.83	185.92	171.85	175.65	180.32	196.26	195.01	182.96
Yearly total operating cost-YC	856.67	888.6	962.583	968.42	1011.47	1032.63	1081.15	1122.27	1252.69	1233.3	1138.45	1164.05	1194.1	1300.04	1290.76	1209.64
Yearly total income	1598.7	1634.2	1689.4	1775.8	1871.2	1960.65	1914.1	1930.9	1978.8	2244.4	2149	2246.8	2389.7	2568.7	2679.5	2863.1
Investment efficiency indicators																
Required Freight Rate-RFR	9.26	9.32	9.01	9.14	9.02	9.12	8.89	8.55	8.85	8.6	8.37	7.99	8.25	8.02	7.67	7.89
Net Present Value-NPV	691.36	453	880.87	739.21	935.25	806.43	1211.45	1765.74	1442.67	1866.97	2195.38	2270.75	2544.48	3194.53	4021.96	3399.86
Pay Back Period-PBP	12.87	14.78	12.52	13.54	12.78	13.57	12	10.48	11.63	10.6	9.99	8.74	9.58	8.67	7.77	8.63

5.2.3 Analysis Results of Indicators Calculation

By the economic measure results, we can see that either Tubarao Brazil-Beilun China or Dampier Australia-Beilun China routes, the bigger tonnage of ship, the better economic benefit. This is because the large bulk carriers - on the speed difference is not obvious, the costs of crew and associated fee are also different inconspicuously. And the differences between the port charges and cost of shipping have disappeared slowly as the ship's tonnage enlarged gradually.

In terms of specific ship type, the priority of ship type economy on the two routes can be described as followed: (interval 110-120 means the ship tonnage from 110 thousand to 120 thousand tons, and the rest can be done in the same manner)

Tubarao Brazil-Beilun China：

(110-120)<(100-110)<(130-140)<(150-160)<(120-130)<(140-150)<(160-170)<(180-190)<(170-180)<(190-200)<(200-210)<(220-230)<(210-220)<(230-240)<(250-260)<(240-250)

Dampier Australia-Beilun China：

(110-120)<(130-140)<(100-110)<(150-160)<(120-130)<(140-150)<(160-170)<(180-190)<(170-180)<(190-200)<(200-210)<(220-230)<(210-220)<(230-240)<(250-260)<(240-250)

From the calculation results, it is clear that ship in (240-250) interval has the best economy.

In addition, from the CAPE fleet composition structure, with 200000 tons of the ship as a watershed, the two routes, optimal CAPE ship below 200000 tons is a ship on the interval (170-180), above 200000 tons optimal CAPE ship is a ship on the interval

(240-250). Above 200000 tons the sub-optimal CAPE ship is in two intervals (230-240) and (250-260). Therefore, consider setting up the CAPE fleet, 240000 -250000 tons class should be considered as the main form, supplemented by ship 170000 -180000 tons class, 230000-240000 tons class and 250000-260000 tons, and taking into account other tons class ships.

5.2.4 Sensitivity Analysis

The conclusion is a static analysis in the current situation of unchanged oil prices, ship price and freight rates. In a perfect market mechanism of international shipping market, any one factor fluctuation will have an impact on economic performance of the ship, which influence of oil prices, ship price and freight rates 3 factors is the most obvious. From the composition of annual operating costs for ship can be seen in fuel costs accounted for about 1 / 3 of the proportion in the ship cost, so the changes of the future price of fuel cost will greatly influence the cost of ship operation; Freight is the important source of revenue for of ship management, the international market price fluctuations directly affect the ship company profit and loss; ship price is a one-time maximum input of shipping company, so appropriate cost timing will affect the ship economy in the shipbuilding market. In this paper, take oil prices, ship price and freight rates as three variable factors, and take 5% and 10% respectively as the change rate, to calculate the net present value of the selected type of ship in different level.

Table 10 Net present value sensitivity analysis from Tubarao to Beilun

	170-180 (thousand ton)			230-240			240-250			250-260		
rate of change /value	**OP**	**SP**	**FR**	**OP**	**SP**	**FR**	**OP**	**SP**	**FR**	**OP**	**SP**	**FR**
10%	1661	1213	1565	3536	2972	2061	4509	3909	2918	3705	3602	2195
5%	1785	1560	1236	3677	3396	2940	4644	4344	3848	3812	3812	3057
0	1908	1908	1908	3819	3819	3819	4779	4779	4779	3919	3919	3919
-5%	2032	2256	2580	3960	4242	4697	4913	5213	5709	4026	4365	4781
-10%	2155	2604	3252	4101	4665	5576	5048	5648	6639	4133	4811	5643

Table 11 Net present value sensitivity analysis from Dampier to Beijing

	170-180 (thousand ton)			230-240			240-250			250-260		
rate of change /value	**OP**	**SP**	**FR**	**OP**	**SP**	**FR**	**OP**	**SP**	**FR**	**OP**	**SP**	**FR**
10%	1519	1070	1379	2912	2348	1433	3753	3153	2171	3180	2507	1658
5%	1642	1418	1073	3053	2771	2314	3887	3587	3097	3293	2954	2529
0	1776	1776	1776	3195	3195	3195	4022	4022	4022	3400	3400	3400
-5%	1889	2113	2459	3336	3618	4075	4156	4457	4947	3507	3864	4271
-10%	2013	2461	3152	3477	4041	4956	4291	4891	5873	3614	4292	5141

From the Table 10 and Table 11 we can see clearly, the changes of 3 factors influenced different ship's NPV, in which fluctuation of freight rates is stronger than the ship price fluctuations, ship price fluctuations is stronger than oil prices. Therefore, pay close attention to market supply situation, accurately judge the future market price movements, can improve the economic benefits for shipping company.

6. Conclusion

The paper concentrates on analysis of imported iron ore transportation of China. Through the analysis of international and China's iron ore transportation market, China's iron ore transportation market would be prospected and forecasted. From the data and situation of recent years and the international and China’s environment, China’s iron ore imports volume will increase in the few years later. As the number of new-build ships going up, the transportation capacity will grow up as well and accordingly the freight rate would decrease in the future. In terms of shipping company, the most significant theme is how to maximize the benefit, thereby, economic analysis for ship’s operation help them choose the optimal ship type. In general, the larger tonnage, the more benefits for shipping company. At the same time, the shipping companies should depends on their own situation to make the perfect choice to make benefit maximization

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