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THE CHINESE DEMAND FOR IRON ORE AND ITS EFFECT ON FREIGHT RATES

By

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Acknowledgments

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Abstract

The financial crisis of 2008 had a severe effect on the shipping sector. Freight rates, especially bulk cargo freight rates, reduced in a level which made it impossible for shipowners to continue their business without losses. However, China is a big player in the bulk market and its demand for iron ore, generated by its economic growth and development may be a potential factor of future increase on the freight rates. This paper is aiming in investigating the sensitivity of freight rates in changes of demand and supply and also the effect a potential supply and demand increase would have on them.

Main research question is:

How sensitive is the iron ore drybulk shipping market, expressed in terms of freight rates, to Chinese demand for iron ore and the global supply of vessel tonnage?

In order to answer the question regarding the sensitivity on freight rates, we first look at the factors that affect them. Since the price and the demand of iron ore are variables that influence freight rates and they are also interdependent with each other we will continue our analysis by investigating each one of them separately.

The price of iron ore we believe that is highly influenced by five main factors. The total global iron ore trade, the price the spot market of iron ore is reaching daily, the negotiation power China has over foreign suppliers, the number of tonnage available on the market and finally by the quality of logistics services used in its transportation. However, we believe that the major role is played by the supply and demand equilibrium in iron ores market which can be examined by the quantities transported globally. An increase in demand should make the price of iron ore rise, if supply does not follow.

Chinese demand for iron ore, is affected by the growth in Chinese GDP and also by the price of iron ore has in the market. We assume that an increase in iron ores price would decrease demand and in the opposite an increase in the GDP of China would boost demand for iron ore. Finally the reliability of suppliers is the last variable found in our literature review which can help an increase in trade.

Finally, freight rates are the outcome of demand and supply interaction. In the demand side, we have world economy, iron ore trade, the average haul of the vessels, political stability and transportation costs. We believe that an increase in world economy, political stability and low transportation costs would boost trade and as a result decrease freight rates. The supply side is a sum of the new ships entering the market, the ones leaving the market or lost in some unpleasant situation and also the efficiency of the world fleet. An increase in vessels availability and in global tonnage is always negative regarding freight rates as it increases supply.

Our quantitative analysis starts with a correlation analysis where we witness the general relationship between our dependent and independent variables. The major outcomes show that all the variables of the price of iron ore and of the Chinese demand for iron ore are positively correlated. On the other have we can witness a lot of negative correlations regarding the determinants of freight rates. However we noticed that an increase in traded quantities is positively correlated to freight rates and also we witnessed a positive correlation between the demand of iron ore and its price, things that were not expected from our literature review.

The multiple regression method is then implemented in order to analyze the relationship between our data and our three dependent variables. Regarding the price of iron ore, we have three significant coefficients which are a -8.49 for the global iron ore trade, an 8.5 for the LPI index and finally a 0.16 regarding the spot price of iron ore. As far as Chinese demand for iron ore is concerned, great significance was shown by the Chinese GDP growth with a coefficient of 0.34, by the Australian and Brazilian exports with a coefficient of 0.33 and finally by the price of iron ore with a coefficient of 0.41. The outcome of this method regarding freight rates is a negative coefficient of -0.05 for the new buildings rate, a negative -2.14 for the scrapping rate, a positive 1.93 for the logistic price index and finally a 0.08 for the Chinese exports over GDP. All the aforementioned coefficients are highly significant.

Looking then on how the future may look, we run a partial equilibrium model (GSIM) in which we use our data regarding the iron ore trade and our global predictions of future growth in order to get an outcome for 2015. We implement three different growth scenarios (a low, a medium and a high) and we can see that a 2.5 percent increase in Chinese demand can lead to a 22.6 percent increase in iron ore trade and a 7.5 per cent increase will lead to a 22.8 per cent increase in trade.

Finally we use the outcomes of the aforementioned methods and models in order to see how much the increase in trade will affect the freight rates. However, we conclude that a 2.5, a 5 and a 7.5 per cent increase in demand would not be able to change today’s situation as the freight rates will be kept a bit higher, around 19$ per ton. As a result we can see that there are higher powers that the trade itself that are keeping the freight rates in the low. New building vessels falling daily in the market, increasing the Capesize available tonnage, better logistics services and lower scrapping rates are of great importance in the determination of today’s freight rates.

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CHAPTER 1 - Introduction

1.1 Introduction

Freight rates in dry bulk market are the result of a supply and demand interaction. Demand in dry bulk shipping it's always a derived demand resulted from the need for transportation of raw materials in great quantities. Globalization, information and technology and increased vessel size have all led to a decrease in freight rates and transportation costs. (Strandenes, 1984)

The demand of shipping activities is closely related to international seaborne trade, world economic activity and economics of commodity markets (Stopford, 2009). On the other hand, supply is a result of the number of ships available in the market, the bunker prices, the scrapping rate and the fleet productivity.

After the Second World War, development of the cities demanded large quantities of steel. As a result, a lot of efforts were done in order to discover new, bigger sources of iron ore (Earth Science Review, 1969). South America, Canada, Africa and Australia were some of the countries where great quantities of high quality of iron ore where found and the exploitation started. With the help of maritime technology and the introduction of big bulk carriers, economies of scale were achieved and iron ore trade between countries all over the world became feasible.

Chinese development witnessed over the last 30 years, has led to an increased demand for iron ore due to the strong urbanization, industrialization and modernization process observed in this area. Investment, amplified trade and demand for raw materials combined with technological innovations, increased income and changes in customer's preferences will determine future consumption and demand for iron ore and consequently steel.

Chinese growth is driven by construction and changes in infrastructure where steel is the most important material needed and demanded. Mr. Hu Chunli from the National Development and Reform Commission's Institute of Industrial Development said that "Efforts to adopt a less resource-intensive pattern of growth were unlikely to have an impact of steel consumption for at least a decade" (Reuters, 2011). He also mentioned that "Construction accounts for more than 60% of total investment and more than half of steel demand in China".

In order for China to start developing a high added value industry, it will need many years of technological innovation and research. As a result what is of great importance nowadays is the development of areas and regions (mostly in western part of China) which have not been urbanized yet. Consequently steel demand and iron ore will be driven by Chinese growth and efforts of industrialization.

Industries need iron ore for their production process. Iron ore, mixed with other minerals is used in order to produce steel which is of great use in modern life. 98% of iron ore excavated is used in steel production (Allbussiness.com, 2011). The last decade, iron ore trade and prices rose up until the year of 2008 and the financial crisis. After that the market witnessed an oversupply of steel leading in decreasing stocks of iron ore but during the first months of 2010 iron ore imports started increasing again.

The iron ore market is a highly concentrated industry where a number of 3 main companies hold more than 60% of global excavation and trade (Allbussiness.com, 2011). Despite the fact that China is one of the biggest producing countries of iron ore, the quality of its reserves are so low that extra processing is needed in order to produce high quality of steel (Lasbon et al., 1995). As a result Chinese demand for iron ore is increasing because of large quantities of iron ore that should be imported in order to supplement local production.

The financial recovery witnessed from 2008 and beyond, has been slow but demand for iron ore and steel production has started again to increase. *“As the global economy emerges from a damaging recession and shipping markets show signs of recovery, shipowners have become optimistic that the worst is over and they can start to look towards better times. But there are other voices suggesting that they could be wise to remain cautious.”* (Lloyd’s List, 2010)

Chinese development has boosted demand for steel and imports are expected to become more and more important and vital for the Chinese economy in the years to come. Local production is also expected to increase but also a sharp rise in imports is foreseen.

On the other hand, a large number of new building dry bulk vessels are expected to fall in the market in the years to come adding a lot of tonnage in supply side and causing over capacity. Scrapping rates and utilization factors on the other side are remaining low.

In this paper we would like to focus in analyzing the Chinese market of iron ore and the effect its demand has on the dry bulk market. Financial crisis witnessed in 2008 led freight rates and dry bulk market in a deep recession and it remains unknown whether people involved in shipping will witness a foreseen increase. Looking in the determinants of freight rates, iron ore price and finally demand for shipping services as well as iron ore demand we would like to analyze their interdependence and also try to take a glance in the future.

1.2 Research question

In order to focus and structure this paper the research question is the following, in line with the sketched context above:

How sensitive is the iron ore drybulk shipping market, expressed in terms of freight rates, to Chinese demand for iron ore and the global supply of vessel tonnage?

Sub questions to be answered in this paper are:

- How do we define drybulk, supply and demand?
- What is the projected demand & supply for iron ore (derived from steel)?
- What determines the price for iron ore?
- What is the effect of projected demand and supply of vessel tonnage on freight rates?

1.3 Motivation

The effect of 2008 crisis on the global economy has shifted demand and supply for products and raw materials. Demand for shipping services is a derived demand following the growth of nations. As a result freight rates are at the moments on their lowest rates witnessed in the last decade.

Dry bulk cargo has been used from the nations in production of final products. The economic slowdown and the oversupply of tonnage, has led to equilibrium in the market that is low for shipowners and the shipping industry. However, rumours of Chinese growth in demand in general and for Iron Ore particular has produced many speculations on the future of the freight rates and shipping.

After having spent two years in Chartering department of Drybulk vessels, I have a great interest in how freight rates are affected and in this case will be to supply and demand changes in the market for Iron Ore, and changes in prices. Also, we investigate where all these new economic inputs of supply and demand will lead the future equilibrium of Drybulk cargo market.

Iron ore is the main determinant of dry cargo and its demand and production affects freight rates and the main trade flows, composition and routes.

Through this thesis I would like to closer investigate this crucial subject of the global economy of today, and come to investigate what is the outcome of analysing the research problem, which would have an application in Drybulk shipping market.

1.4 Structure of the thesis

The overall area of analysis of this topic will be the interaction of demand and supply in the Chinese Iron ore market and the effect this has on freight rates.

Chapter two constitutes an extensive literature review of various components of this paper. First we will analyze the factors that determine -according to literature- the Chinese demand for steel and (as a result the derived demand) for Iron ore. Second, the review in this chapter will include the factors that determine the price of Iron Ore taking into consideration its local production (how much can the Chinese mines excavate, how quickly can this be done, what are their capabilities and restrictions in production) as well as the main producers of Iron Ore globally.

Third, we review the determinants for the freight rates of the dry bulk market according to the literature. We will investigate the main trade routes for three types of vessels (Capesize, Panamaxes and Supramaxes) for spot and time charter fixtures. Finally, we will perform an analysis on the number of vessels that are currently in the market and how their supply effects freight rates and meets demand. Factors like newbuilding vessels launching in Dry bulk market, slippage and scrapping rate will be explained as well as market structure (i.e. degree of concentration), and the potential effect of the new Ultra Large Ore Carriers ordered by Vale (2012).

In Chapter three we will present our methodology followed by our approach to finding the data and solving data issues. In order to perform an analysis which will reflect the sensitivity of the Freight Rates to changes in Chinese demand for steel, prices of iron ore, global tonnage and other factors.

In Chapter four, we will present our findings and will provide an explanation regarding the up-coming results. We will focus on the past and analyse how the freight rates reacted to changes in the aforementioned independent variables. Moreover, we will analyze the negative or positive effects they had on freight rates and how sensitive freight rates are to these changes.

Chapter five will give a look into the future. In order to find a projected equilibrium, result from demand and supply interactions, we will use the Global Simulation Model (GSIM) to produce quantitative results of the potential movement of freight rates. The GSIM Model (Francois and Hall, 2003) will be used in our research in order to infer conclusions about potential developments in balances and imbalances between Chinese demand and supply of Iron Ore. The GSIM Model, being a global partial equilibrium model, offers the advantage of a multiregional scope and offers us the opportunity to analyse growth projections.

Finally, in Chapter six we conclude, we will present our final outcomes, areas for further research and our personal points of view regarding the research findings.

CHAPTER 2 – Literature Review

2.1 Introduction

Erling Naess, the well known Norwegian ship owner once said: "God must have been a ship owner. He placed the raw materials far from where they were needed and covered two thirds of the earth with water" (Stopford, 2009). Shipping transportation offers to each nation the opportunity to obtain materials they need for the production of final goods. "There is nothing particularly new for bulk shipping. Cutting transport costs by carrying cargo in shiploads it's a strategy that has been around for millennia" (Stopford, 2009). With the use of Drybulk vessels the trade has become efficient through the years, using economies of scale in raw material transportation and obtaining law transportation costs.

According to UNCTAD and its "Review of Maritime Transport, 2010" publication, the year of 2009 left shipping industry straggling with the global recession. Freight rates had reached their lowest in a seven year period and trade shrank in numbers reaching a downturn of 4.5 per cent. The effect of the global financial crisis mostly in liner industry and in a big part of bulk shipments showed that customers had changed their behaviour, moving to a less borrowing and less consuming period, having negative results to industries all over the world. However, what was less affected was the Chinese demand for iron ore and coal, showing the huge demand of China for steel production, accompanied by huge stimulus packages which promoted trade.

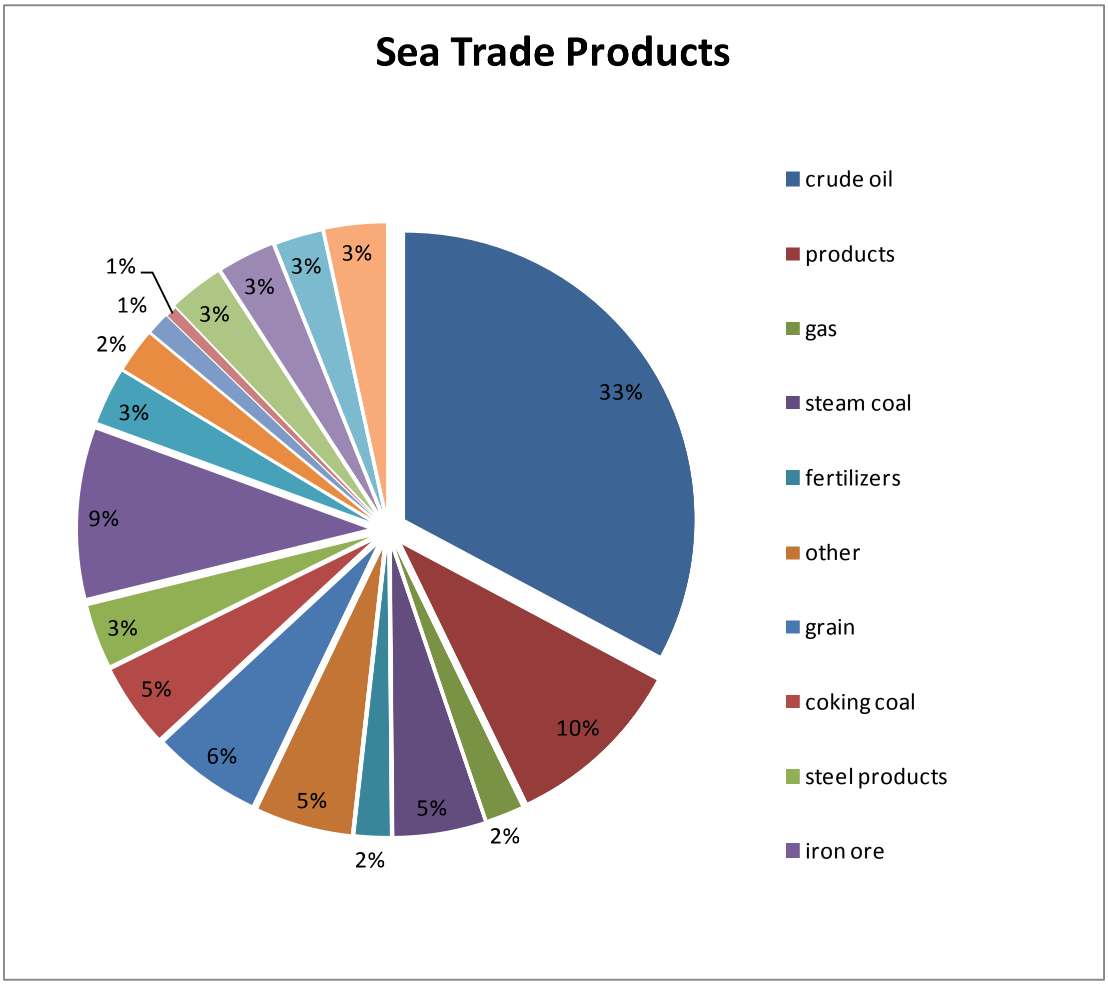
The year of 2010 was characterized by an effort of bigger financial systems to control the crisis and stabilize economy. However, until nowadays the fear of a "premature winding up of the stimulus packages" still remains alive. (UNCTAD, 2010) "The shipping sector may not be out of the woods yet. All shipping investments are highly dependent on future growth in Far East emerging economies- particularly China – to bring rates to better levels for acceptable investment returns." (Majarian, 2011). Demand and supply equilibrium in shipping industry are far from being met in those years characterized by an unstable environment. Demand remains strong but the supply of tonnage will keep increasing in the years to come due to the huge number of vessels ordered in the years before the financial crisis (UNCTAD, 2010). Moreover, environment and safety have also become a huge issue, affecting sea born trade. Regulations introduced every year, put constraints and promote sustainably as well as an effective supply chain management.

2.2 Commodities transported by sea

Commodities transported by sea can range in shape, size, value and quantity. "The shipping industry transports everything from a 4 million barrel parcel of oil to a cardboard box of Christmas gifts" (Clarksons Research Studies, 2004). In the figure below we can see the commodities traded globally categorized in 6 main groups:

1. **Energy:** commodities used in production of energy, like coal, crude oil, gas and oil products are a huge part of dry bulk trade, as they account for almost 50 per cent of bulk shipping sector.
2. **Agriculture:** products used or produced by the agricultural sector (cereals, food oil, fertilizers, etc.) compose an almost 15 per cent of shipping trade.
3. **Metal:** minerals used in the production of steel and in metal sector. It is one of the biggest categories of dry bulk trade and it compounds an almost 25 per cent of sea born trade.
4. **Forest materials:** products of wood that are used in construction process or creation of paper or various wood commodities.
5. **Materials used in industry:** for example gypsum, chemicals, salt, cement, etc. They are used in different sectors and they cover almost 9 per cent of total sea born trade.
6. **Materials used in manufacturing progress or final products:** Liner industry most of the times is trading the products of this category (machinery, cars, consumer goods, etc.). They may account for the 3 per cent of total sea born trade but their value is much higher and as a result they are of great importance.

Figure 1: Sea Traded Products



Source: Clarksons Research Studies, 2004

2.2.1 Bulk Cargo

When we use the term of bulk cargo we refer to commodities (liquid or bulk) that are shipped in huge quantities (10 to 450,000 tonnes) without the use of any packaging material (Clarksons Research Studies, 2004). Most of the times those homogenous products are thrown, poured of piped into the holds of bulk carrier vessels (with the help of cranes) or into the tanks of tanker vessels using pipelines. However, there are also few cases where the bulk cargo is in small quantities and can be standardized by the use of pallets or boxes.

Bulk cargo is any cargo transported in large quantities in order to take advantage of the economies of scale. Both tramp and liner shipping are used in order to transport bulk cargo. However, most of the times tramp shipping is preferred because the huge quantities of one product can fill the whole vessel and also the big holds of the bulk vessels can be used in order to separate different cargoes (Caribbean maritime institute, 1999).

The most common dry bulk commodities are:

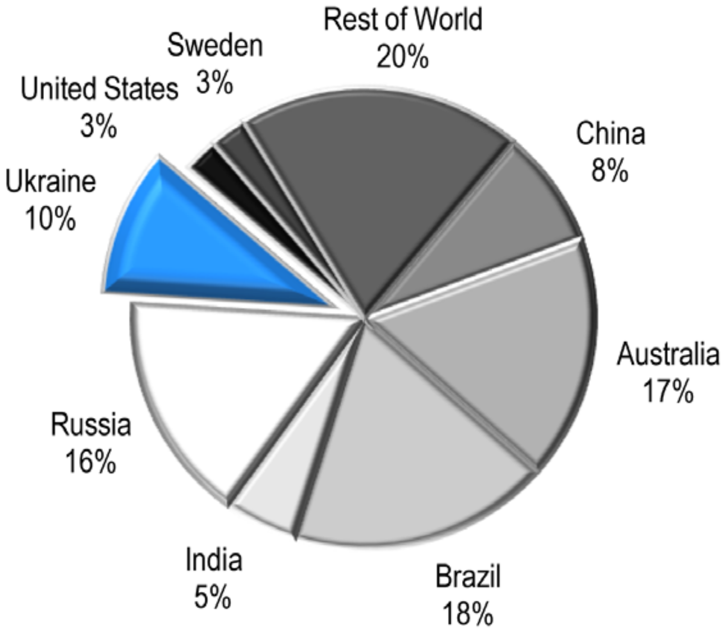
Coal, grains (for example wheat, maize, oats, soybeans and other agricultural products acquired from mills, refineries or even farmers), iron (ferrous & non-ferrous ores, pig iron, scrap metal), bauxite wood chips, cement chemicals (fertilizer, plastic granules & pellets, resin powder, synthetic fiber, etc.), dry edibles (for consumption of animals or humans: alfalfa pellets, citrus pellets, livestock feed, flour, peanuts, raw or refined sugar, seeds, starches, etc.) and final bulk minerals (sand & gravel, copper, limestone, salt, etc.)

2.2.2 Iron Ore

“Iron is ranked the fourth most abundant element in the Earth’s crust, behind, oxygen, silica and aluminum. However, it rarely occurs as the native metal.” (GSA, 2009) According to scientists the inside of earths’ outer layer has even more content of iron deposits and has been combined with nickel in order to produce the strong surface of earth’s core. Pure metallic iron is silver white, very ductile and strongly magnetic. (GSA, 2009)

“Because of the great number of iron sources witnessed around the world, its price remains comparatively low. As a result in order for a deposit to be worth in recovering, it should contain a big percentage of iron (over 25 per cent). However, a lower rate can also be used if the quantity of the source is very big and the excavation and transportation have a low cost. (Weiss, 1985) The mines used in the excavation process are most of the times open-air and the iron ore produced is then transferred to dedicated ports and with the use of bulk carriers is shipped around the world. (Yellishetty et al., 2010)

Figure 2: Iron ore reserves



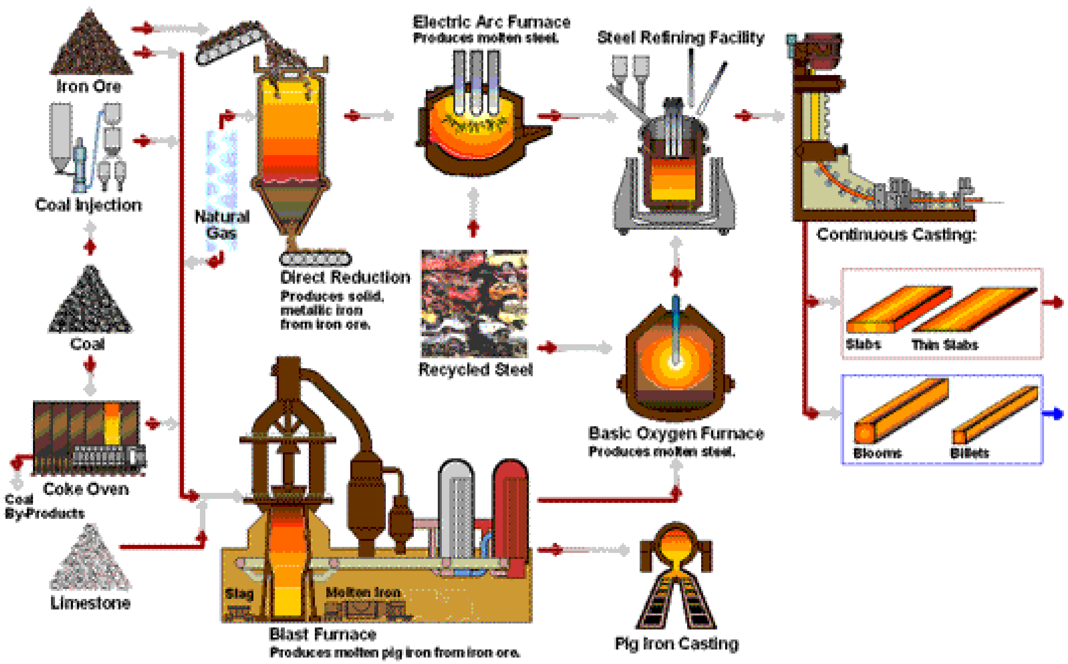
Source: Black Iron

The raw materials from which metallic iron can be economically produced are called "iron ores" (GSA, 2009). According to the Mineral Information Institute "the principal ore minerals of iron are hematite (Fe2O3), magnetite (Fe3O4), siderite (FeCO3) and goethite (FeO(OH))," and 98 per cent of the iron ore found on earth's crust, is used in the production of iron and steel. The other 2 per cent is used by human in the production of a wide variety of materials. "Powdered iron: used in metallurgy products, magnets, high-frequency cores, auto parts, catalyst. Radioactive iron (iron 59): in medicine, tracer element in biochemical and metallurgical research. Iron blue: in paints, printing inks, plastics, cosmetics (eye shadow), artist colours, laundry blue, paper dyeing, fertilizer ingredient, baked enamel finishes for autos and appliances, industrial finishes. Black iron oxide: as pigment, in polishing compounds, metallurgy, medicine, magnetic inks, in ferrites for electronics industry." (Mineral Information Institute, 2010)

As a result, we can see how vital the iron ore is in the manufacturing and production industry, since it can be used as a raw material in production of steel and other sub-products which are vital in today's way of living. The demand for iron ore is strongly correlated to the demand of steel and iron in manufacturing industry.

From 1950s until today the methods used in production of steel have been changing, depending on environmental, political and technological factors. During 50s and 60s demand for steel production was very high, encouraging producers to create big quantities. "Integrated steel plants produce steel by refining iron ore in several steps and produce very high quality steel with well controlled chemical compositions to meet all product quality requirements." (ISTC, 2010)

Figure 3: Steel production process



Source: www.steel.org

During 70s there was the crisis in energy which required efficient steel factories and improvements in the production procedures. "The large integrated plants of the 1950s and 1960s tended to produce steel in batches where iron ore was taken from start to finish. This causes some equipment to be idle while other equipment was in use." (ISTC, 2010) As a result, new methods of production had to be invented in order for the production to be more economically efficient.

Through the years, environment and sustainability became more and more important in production procedures and during 80s and 90s new, more strict regulations were introduced and brought another change in the industry. The markets also started to become more competitive as a larger number of players were entering the scene. Efficiency, low costs and higher quality were essential in order for a steel mill to survive and compete in the new market situation.

With the rise of the new millennium steel production factories had to be integrated again and production process changed in order to face the global economical, political and technological changes. Just-in-time methods were introduced and smaller steel miles were starting to operate, using steel scrap in order to re-produce steel. However, the smaller mills played a smaller part in the steel industry as they produced a much smaller quantity than the integrated factories.

2.3 Tramp Market

Commercial shipping is divided in two main sectors; liner shipping and tramp shipping. Both sectors are used in order to promote and facilitate trade. However, there are great differences in the way they operate although they both charge a "price" for the services they provide.

Tramp shipping in the sea trade is characterized by high competition. In economic terms it could be a great example of a perfect competition market where the products traded have the same characteristics; players can enter and leave the market very easily; the number of companies/ ships trading is very large; the market is very clear and transparent and information is easily and sometimes freely accessed. “Dry bulk shipping is vital as 285 million deadweight tons are transported through dry bulk ships every year” (www.dry.gr)

In a report produced by Clarksons research studies in 2004 regarding the “economic description” of the tramp shipping market, 10 main characteristics are given in this sector. Tramp shipping market is described as a worldwide market where competition is witnessed in all its operations. As a result it can be closely characterized as a “perfect competition” market model where there is a huge response on the needs of every customer - shipper. All the sub-market divisions are competing for cargo where the demand can range in every time period and cannot be easily predicted. Finally, the entrance and the exit in this market is very simple as there is a big number of small companies existing in this sector, each of them trying to control their costs in a smart way in order to be more and more effective. (Clarksons, 2004)

In bulk shipping four different ways of shipping contracts are used in order for the transportation to be carried out. The variety of shipping contracts offers bigger elasticity to charterers in order for them to meet their special transporting conditions.

The form of services provided by each type of chartering contract includes a range of differences. In the “Maritime Economics” book of Martin Stopford there is a division of 5 different types of contracts. The voyage charter (VC), the consecutive voyage charters or contract of affreightnment (CoA), the time charter or period charter (PC), the trip charter (TC) and finally the bareboat charter (BC).

The differences on these 5 different methods of chartering are mainly focused in the duration of the contract (this can range from a small number of days to a big number of years), in the process in which the freight rate is calculated and finally in the allocation of costs and responsibilities.

In dry bulk shipping the freight rates achieved each day are extremely unpredictable and they are a result of several market factors. “Typically bulk shipping freight rates are twice as volatile as the US S&P 500 stock index.” (Clarksons, 2004)

2.4 Chinese history and economic development

China has been in the last decades an extraordinaire example of economic development. Its industry has been transformed from a public owned one to a private owned and the GDP growth witnessed has an average of 8 per cent (Prasad, 2004, page 1). In the Occasional paper No. 232 published by the International Monetary Fund in 2004 it is mentioned that Chinese trade has played a massive worldwide role by experiencing a yearly increase from 1 per cent in 1979 to 6 per cent in 2003 (Prasad, 2004, page 1). However, it has to be estimated if the macroeconomic factors needed will be there to support this growth. Chinese exports and imports, with a reference to the aforementioned paper have increased in an average of 15 per cent since 1979 while the global trade has only experienced a 9 per cent growth.

Taking a glance into the history of China, we can see that before the Chinese Communist Party took over, organization of Chinese economy was based in poor technology, communication and transportation (Qian and Xu, 1993, page 21).

Industries where isolated and remote from one another and as a result development was hard to achieve.

In 1949 People's Republic was founded, Mao took over and introduced the first five year plan (1953-57). China started using the model of “administrative decentralization” in order to achieve a better structure in its economy. During this period, two main parts of decentralization occurred. The first one was in 1958 called “The Great Leap Forward” and the second one in 1970 called “The Cultural Revolution” (Qian and Xu, 1993, page 22).

However, China yet remained a closed economy with no interaction regarding information and technology with the rest of the world. Exports and imports were determined by the government and each five year plan, which also forbidden to companies that were not owned by the state to communicate with foreign investors (Park, 1993 –moneywatch.com). As a result, local government didn’t have the required funds in order to promote and support development and China remained in a situation where progress was very hard to achieve.

In the year of 1979, Chinese economy gained its liberalization to the outside world and reorganizational policies were introduced in order to promote decentralization (Qian and Xu, 1993, page 23). Mr. Deng Xiaoping the person behind the policy towards the openness of Chinese economy, required from Mr. Rong Yiren to create a company which would handle all the external financing of capital ventures. The Chinese International Trust and Investment Corporation (CITIC) was then founded and was used in issuing of bonds and provide to Chinese economy a window to the world. The following years, foreign industries were able to establish their businesses in China and Chinese people’s behavior towards consuming and borrowing started to change.

Over the years the mentality of the Chinese people changed gradually and became from “a nation of no domestic and external debt”, to a nation facing in 2005 an outstanding balance of government bonds of 2.7 trillion Yuan and with financial assets almost 2 times its’ GDP. (Xiaoling, 2006, page 1)

The reliability of Chinese growth in the trade with countries around the world, made the impact of the financial crisis strong, mostly in its exports. However, as Mr. Jiang Zhenghua, Vice Chairman of the Standing Committee of the National People's Congress, proposed in his opening address at the 15th Annual Meeting of the Chinese Association of Productivity Science on November 19, 2009, that “China should turn the current challenge into opportunity through (1) increasing domestic consumption, (2) lowering carbon emissions, (3) promoting a green economy, (4) supporting the “Go Out” Policy, and (5) improving China’s financial system” (Tang, 2009, page 2).

Taking into account the present situation, China has based its development in three main approaches. First China will focus on increasing net exports. Chinese products are at the moment what the crisis demands. Law priced. As a result after the financial crisis, China came out as e winner regarding exports, as it surpassed Germany and now leads the race of the worlds’ top exporter.

The second approach will focus on domestic investment. A stimulus package is introduced to Chinese economy in order to support domestic investment. In 2009 Chinese GDP growth reached 9.6 per cent (Tang, 2009, page 3). However, the non-government investment only increased by a 2 per cent since during 2009 and that showed that Chinese economy should find a way to increase private investment in order to maintain growth.

Finally the third approach will be on the subject of domestic consumption. It is in the Chinese mentality not to spend a lot of money and to always keep savings for education, housing or retirement. As a result, China may be the largest car market and the second in the world for high priced goods but that is not an indication for high consumption rates. “China has had high savings rates estimated to be between 30 to 40 per cent 30 to 40 per cent for the last 30 years “(Tang, 2009, page 3). However, policies are introduced in order to create a “spending/ consuming” mentality to people of China.

Chinese demand for steel has become a big factor in affecting global demand for iron ore. Pig iron is the intermediate product between iron ore and steel. As a result it is a very good indicator of iron ore’s demand and China in 1992 became the primary production country of pig iron, taking the lead from Japan. “In 2003, China produced more than 200 million tons of pig iron, almost 2½ times the production of the second leading producer, Japan, at 82 million tons. China’s pig iron production grew at an average rate of more than 9% per year from 1992 through 2003.” (USGS, 2004)

Through the years there has been a big number of Chinese cities which have access to iron ore deposits. The quantity found in the whole country reaches 472.000 million tones but only 24.600 million tones are worth mining (Zhen, 1990). In most cases the grade of iron ore found in Chinese territory is not high enough to be economic valuable to be excavated and used. “Lean ore with an average iron content of 32.1 per cent makes up 97.8 per cent of the total deposits” (Zhen, 1990). As a result shortages of iron ore is a phenomenon viewed very often in Chinese iron and steel manufactory.

The 71 per cent of the Chinese iron ore deposits are met in the north-east, north and south-west of the territory, while the 20 per cent can be located east and mid-south. The biggest mines, which consist the 65 per cent of Chinese mines, are located in Anshan, Bengxi, east of Hebei and Miyun, in Panzhihua, Xichang, in Ningwu and Lohe, east and west of Hubei, in Baotou, Beiyunobo and Hanxing (Zhen, 1990).

In the period between 1950 and 1985 a total of USD 3.2 billion where invested in building iron ore mines. “By the end of 1985 it had built up a total annual mining capacity of 158.6 million tones and an annual mineral concentration capacity of 135.3 million tones” (Zhen, 1990). In 1985 the Chinese production of iron ore reached 131.44 million tones and during the sixth five year plan the enlargement of iron ore production was following a rate of 4.1 per cent annually.

At the beginning of the 20th century, China followed a huge economic expansion consuming huge quantities of iron ore. In 2006 it consumed about 40 per cent of world production, surpassing Japan (Singh and Hoyt, 2007). In 2007 China became the most important player in steel industry and the percentage of consumption of global iron ore kept increasing.

Chinese demand for iron ore is a result of its steel industry which is the pillar industry of national economy (Xia Li, 2006). As a result the price of iron ore adds a lot to a healthy development in the Chinese economy and also to other related industries. In order to follow the price of iron ore an extensive analysis of the present market is needed also the investigation of the forces between supply and demand.

Since the creation of the mining industry in China and until 1984 the price of domestic iron ore was very law and didn’t leave any profit to the companies. As a result the Chinese State Price Bureau together with the Metallurgical Industry Department increased the iron ore price in an average of 15 to 20 per cent in order to boost production.

However, during the 80s, the government of China saw the importance of iron ore in economic development and decided to start importing the quantities missing. New policies were introduced that recognized that each country has a comparative advantage in the production of specific products. As a result it would be more efficient for China to start importing better quality of iron ore, since the local mines produce mostly lean ore and the transportation procedures added extra costs. In order for China to be able to compete with the importing iron ore price and quality, new factories needed to be built, using new technologies and resulting in more efficient production (Zhen, 1990). However, factories need time to be constructed and time was not there. Moreover, they were situations where there was more profitable for the Chinese industries to import crude steel and transform it only in the last stage of construction.

2.5 Determinants of Chinese demand for iron ore imports

Since the Second World War the production of steel started increasing tremendously as a result of the urbanisation and industrial development. Countries that were using local production started searching for new sources in order to keep up with the increased demand. Canada, South America, Africa, Far East countries and Australia were exploited in order to start exporting iron ore found in their territories. Freight rates and costs, globalization and economies of scale helped the demand of the developing countries to be covered by the exploration of pure iron ore deposits in several places around the world.

Chinese development has led to an increase in demand for bulk cargo which can be used in production of steel. “It is a note worthy that China is a physically and highly diverse economy and it produces many primary products. Imports reflect the difference between demand and domestic supply. There has been an extraordinary growth in imports of inputs into China’s steel industry, whose output is now the largest in the world and continues to grow rapidly” (Eichengreen B., Pak Y., Park Y., Wyplosz C., 2008).

Iron ore is a key raw material and despite the fact that China is a large producer, the quality demanded cannot be derived from local production “Although China has a large volume of iron ore deposits the grade of iron ore is very low. This has led to unfavorable conditions for developing China’s iron and steel industry.” (Resources Policy, Volume 16, Issue 2, June 1990, Pages 95-130)

The main factors affecting the demand of China for iron ore imports are the following:

1. <u>The structure of the domestic - Chinese Iron Ore Market</u>

Steel is what a developing economic needs in order to support all its growth and construction expansion. GDP per capita is a great indicator of development and economic growth. Taking into consideration a study which took place in 2007 by the European Parliament's Committee on the Environment, Public Health and Food Safety:

“The Gross Domestic Product is the market value of all final goods and services produced within a geographical entity within a given period of time. It is "Gross" because the depreciation of the value of capital used in the production of goods and services has not been deducted from the total value of GDP; "Domestic" because it relates only to activities within a domestic economy regardless of ownership (alternatively: "national" if based on nationality); "Product" refers to what is being produced, i.e. the goods and services, otherwise known as the output of the economy. This product/output is the end result of the economic activities within an economy. The GDP is the value of this output."

From the above analysis we can see that an increased GDP per capita indicates higher growth rates and in our literature we found that "there is a strong correlation between GDP per capita and steel consumption in China" (Tcha and Wright, 1999). As a result increased demand for steel leads to an increase in iron ore demand. Taking into account the unsatisfactory domestic production, that leads to a boost in iron ore imports.

In 1995, Ladson et al. made a research regarding the domestic price of iron ore compared to the imported one. Due to the fact that the quality of iron ore found in Chinese reserves is low and new processing is needed in order to produce iron and steel with sufficient quality, an extra cost is added in the production process. Taking also into consideration the taxes imposed in production process the price of domestic iron ore ends up to be higher than the price of the imported one.

The "Five Year Plans" enacted by the government in order to set the goals of Chinese economy for the years to come are also providing a policy regarding increasing the domestic steel production. In the Five Year Plan number eight and nine China had set its goals in order to expand sectors that need steel and as a result increase steel demand (Sugimoto, 1993).

Additionally with all the increase in steel production, iron ore is not the only ingredient needed. In order to meet the higher demand, iron products will also be required and requested from foreigner suppliers. In that way an increase in imports will also be noted regarding not only basic raw iron ore but also iron intermediate products like DRI, high quality pellets, and lumps. We can see that value added products will also be of great importance and need.

2. Price of iron ore

Iron ore market and demand can be characterized as an inelastic one regarding iron ores' price. Iron ore has the main characteristics of an inelastic product. One reason is that the percentage cost of iron ore in the manufacturing of steel is estimated to be only around 5 percent (Chang and Sheales, 1993). As a result an increase in its price will not change dramatically the demand for iron ore production.

Another characteristic of iron ore that is that we cannot find other raw materials that can replace it in the production of iron and steel. As a result its demand remains inelastic to price changes.

Finally, steel miles are factories that have needed a lot of capital and time in order to be constructed. As a result the best and more economical outcome comes by the use of economies of scale and steadiness in the production process. If we reduce the percentage in which the capital is utilized because of an increase in iron ore price, then the production process will lose its cost-effectiveness.

3. Reliability of the foreign suppliers

Labour disputes occurring in the countries of origin of the imported iron ore, most of the times cause delays and extra costs. Iron ore flows are limited and restricted (Tcha and Wright, 1999). China is in a position to examine importing countries and to check what kind of delays and collusions are occurring and in what frequency. If the added costs are great then China can change the country of import and turn to a different supplier.

Table 1: 2010 Iron Ore production

Country	Iron Ore 2010 Production (millions of tonnes)
China	900
Australia	420
Brazil	370
India	260
Russia	100
Ukraine	72
South Africa	55
United States	49
Canada	35
Sweden	25

Source: US Geological Survey

2.6 Determinants of the price of iron ore

1. Supply and demand

Since the excavation of iron ore and its use in steel production, there is less iron ore reserves discovered yearly. Since 1949 there have been 59.3 billion tons of iron ore in Chinese territory and 48.59 billion tons have been retained. However, the consumption rate of iron ore increases every year and it doesn't match the increase of the reserves (Xia, 2006).

China holds the first place in iron ore production globally with the sum of 273 million tons which is the 26.83 per cent of world output. United States, Japan and Russia follow the race (Xia, 2006). This fact reveals that China has a huge need for iron ore, imported and domestic, in order to keep its growth and development. As a result, the huge need for iron ore changes the equilibrium in the international iron ore market and leads continually in an increased price

2. The negotiation power China has over the foreign suppliers.

Taking into consideration the theory of Michael E. Porter regarding competition we can clearly see that the power a customer or a supplier has over a product influences the price negotiations. This power comes and is affected by "industrial concentration".

"Industrial concentration refers to a structural characteristic of the business sector. It is the degree to which production in an industry—or in the economy as a whole—is dominated by a few large firms. Once assumed to be a symptom of "market failure," concentration is, for the most part, seen nowadays as an indicator of superior economic performance." (Shughart II, 2008) As a result when a small number of companies/suppliers have the biggest percentage of market share, their negotiation power is bigger than the power customers have.

Figure 4: Michael E. Porter “Competition”

Source: Wikipedia

From 1981 as we already mentioned, Chinese government opened the borders in foreign iron ore suppliers as a result of the increased need for iron and steel. Rio Tinto was one of the first bigger dominant companies of iron ore market that entered the sector in 1972 (Singh and Hoyt, 2007). Having not predicted the size of Chinese growth, it gave the opportunity to other companies like Australia’s BHP and Brazil’s CVRD to become huge players.

Through the years following the liberation of imports, demand was in a crazy race surpassing supply. As a result suppliers took over control in price setting, visualizing a lot of profits. During the period between 2003 and 2006 the price of iron ore had almost doubled (Singh and Hoyt, 2007).

Long term contracts were made between the customers and one of the three suppliers. In that way price of iron ore was settled and the other suppliers and customers just followed the discussed price. Since 2003 Chinese customers were clearly inactive in price setting ore negation. However, in 2004 China became a member of International Iron and Steel Institute and its negotiation power started to increase. “In December of 2006, China became the first negotiator to conclude the negotiation with CVRD, BHP and Rio Tinto, the price rise for the fiscal year 2007 is 9.5%.” (Xia, 2006)

Today, the iron ore market is conquered by the three above mentioned companies (BHP, RTIO and Companhia Vale do Rio Doce) which they control 57 percent of the total sector. The share of the biggest 5 companies in iron ore market reaches 75 per cent of the global production and they constitute an oligopoly. Companhia Vale do Rio Doce has a 26 percent, Rio Tinto Iron Ore a 25 percent and finally BHP has a 16 percent. This unification witnessed in that market is really unique and cannot be seen frequently in other products (Singh and Hoyt, 2007).

Table 2: Top iron ore companies 2009

RANK	Company name	Country	Production MT
1	Vale	Brazil	255
2	Rio Tinto	Australia	172
3	BHP Billiton	Australia	137
4	SAIL/ NMDC	India	55
5	Anglo American	South Africa, Brazil	43.8
6	ArcelorMittal	Global	37.7
7	Metalloinvest	Russia	35.5
8	Fortescue Metal Group	Australia	34.9
9	System Capital Management	Ukraine	27
10	Cliffs Natural Resources	USA	24.9

Source: Raw Materials Group, Stockholm 2011

<u>Rio Tinto Group and Rio Tinto Iron Ore</u>

Rio Tinto Group is a result of the merging of two main companies, the Rio Tinto Company which was located in England and was established in 1873 in order to excavate copper in the homonymous region on Spain. The second firm was Consolidated Zinc Corporation, based in Australia and founded in 1905. Its role was "to treat zinc-bearing mine waste in New South Wales, Australia" (Singh and Hoyt, 2007). Merging of the two companies took place in 1995 and since then the Rio Tinto Iron Ore has also been established, operating in north-west Australia in an area called l Pilbara.

The iron ore part of Rio Tinto is a result of the merging of two other companies operating in the Australian region. The first one was Hamersley Iron and the second one was Robe River and they were at first operated under a common sign of "Pilbara Iron". When the merging occurred Pilbara Iron provided Rio Tinto with all the required knowledge and technology in order to proceed with the iron ore mining. In order for the iron ore to be transported into the Australian ports, the company owned and operated the biggest private rail network globally.

<u>BHP Billiton</u>

This big player is a result of a merging between two smaller companies BHP and Billiton. Billiton was established around 1860 in an Indonesian island with the same name. "Billiton became a global leader in the metals and mining sector and a major producer of aluminum and alumina, chrome and manganese ores and alloys, steaming coal, nickel and titanium minerals. Billiton also developed a substantial and growing copper portfolio" (BHP Billiton, 2011)

On the other hand, BHP starts as a corporation in 1885 in Broken Hill, Australia. It was dealing with a number of different minerals like iron ore, silver, zinc, copper and other natural resources. Its scope was the innovation, improvement, expansion, manufacturing and promoting these products. Moreover it was adding value in steel commodities offering a diversifying number of services.

In 2001 the merging of the two companies took place and the newly formed company became one of the largest in trading different kinds of natural resources. As people from BHP declare "We now have significant positions in major commodity businesses including aluminum, energy coal and metallurgical coal, copper, manganese, iron ore, uranium, nickel, silver and titanium minerals, and substantial interests in oil, gas, liquefied natural gas and diamonds" (BHP Billiton, 2010).

BHP being a large company active in different metallurgical sectors had also a comparative advantage due to the fact that it is also the second bigger energy coal supplier globally. Customers who trade iron ore most of the time demand also large quantities of coal in order to produce steel. As a result BHP can combine and accomplish both requests. In 2007 its market capital has almost reached USD 120 billion (Singh and Hoyt, 2007).

Both the previous mentioned companies have their base in Australia and have a big number of similarities on their structure, operation and geographical factors. As a result the competition between them is very big and as we already mentioned the difference on the percentage market share it's close to 1 percent.

Companhia Vale do Rio Doce

In 1942 the Brazilian Federal Government established the CVRD public company in order to be in charge for Brazil's iron ore excavations. The following years Vale started gaining the place of the largest exported of iron ore in Brazil. In 1949 Vale was already controlling 80 per cent of iron ore exportation.

In 1966 the port of Tubarao was established and played a very important role in the development of the company. In 1974 the company became the first iron ore exporter worldwide and still keeps that title.

After 1982 Vale started to provide a bigger variety of services in its customers through more consolidate logistic services and also started producing aluminum and in 1985 they also started to export from Carajas Mine in Para (Vale, 2011).

With its operation Vale was each year creating 15 percent of the Brazilian GDP. The quality of the iron ore exported was of excellent quality and with a very high grade of iron. As a result Vale remained the premier exported of iron ore globally and in the last years has aggressively tried to take a big share in Chinese market.

The last years an innovation came from the side of Vale through the ordering of new mega-ships vessels for their exclusive use and transportation in order to be able to provide better door to door services and also have a control on freight rates and prices. Following the road of independency, Vale will be able to possibly increase its share in the iron ore exportation industry following the increased Chinese demand (Reuters, 2010)

3. Logistics Factor: Bottlenecks

In order for iron ore to be imported, sea and land transportation have to be combined in order to produce an economic efficient result. Because of the low price of iron ore, the transportation cost is a big part on the final cost of the commodity.

However, the Chinese logistic system lacks of efficiency. “The current logistics system in China is not well functioned. The logistics expenditure is a considerable part of the purchasing cost of importing iron ore. The handling capacity of China’s sea ports, such as Beilun, Qingdao, Rizhao, Tianjin and Dalian is expanding, but the railway transport is becoming a bottleneck and cannot meet with the increasing demands. According to the statistics released by China Customs in 2004, the specialized ore handling capacity of China’s coastal ports could only satisfy 50% of the demand. The total imported iron ore is about 2 million tons in 2004. The iron ore stocks up in the sea ports because of the limited land transportation capacity, so the steel manufacturers cannot obtain the iron ore timely. As a result, it helps to break the balance of demand and supply and put China into the disadvantageous position in price negotiation with overseas iron ore suppliers.” (Xia, 2006)

A wide number of internet articles are provided, talking about the delays and congestions witnessed in ports globally, effecting the smooth logistics operation. “The combined congestion of the dry bulk fleet at Australian, Brazilian, Indian and Chinese ports has risen during the last three weeks to exceed 57Mdwt. This is the highest level we have seen since January and is equivalent to over 10.50% of the entire dry bulk fleet, marginally greater than the year-to-date average of 10.25%” (Bernard, 2011)

Being able to provide 3PL logistic services in an efficient manner, having the correct knowledge, enough cargo space, good information systems, market recognition regarding the provided services and economic stability is what influences the quality of the logistic services provided (Bing and Ying, 2008).The companies established in China providing logistics services are all very new and have to face a lot of daily operational problems, with transportation infrastructure and bottlenecks in order to overcome them and be effective.

Legal systems effective in China are also not very familiar with all those trade changes taking place the preceding years. Legislation, policies and the existing set of laws are not perfectly fitting the logistic problems arising daily. As a result, problems in the normal operation are not very easy to overcome, causing delays and increasing costs.

4. Indian Factor

There are two main types of contracts regarding iron ore imports. Long term contracts which most of the time are fixed with Australian and Brazilian companies and contracts based on spot prices which are fixed with companies based in India.

Spot prices are most of the time higher than the price of a long term contract, resulting in a higher yearly average iron ore price. This higher price helps the 3 main companies also to raise the price of their commodity following the trend. (Xia, 2006)

The smaller Chinese iron ore importers are focusing more in Indian exporters and as a result they receive the higher prices. Their inability to sign long term contracts and their need for smaller quantities leads them in accepting higher prices of spot market. In the same study made by the School of Economics and Trade, Henan University of Technology that "China imported 22.53 million tons of iron ore from India in 2002, 68.55 million tons in 2005, an growth of 204 percent in 3 years. About 25 percent of iron ore import is from India. The median price of Indian import ranges around US$80/t in 2004, reaching the climax. In 2005, it fell a little over US$50/t. China is a passive receiver of the climbing price because the demand elasticity coefficient is fairly low and the consumption of iron ore is absolutely large. It is reported that the Indian government began to levy duty upon iron ore export. So the export prices of Indian iron ore rise by 10-15 percent accompanying the implementation of this temporary policy" (Xia, 2006)

5. <u>Vessels tonnage availability</u>

The number of vessels entering the market each year is increasing tremendously. As a result, the availability of tonnage makes trade easier and transportation costs tend to decrease boosting trade between countries. Shipping cycles are a result of the lag time between the time a ship is ordered and the time they fall in the market (Stopford, 2007) resulting in a change in the price of transported commodities and in our case iron ores price is always influenced by the availability of global tonnage.

2.7 Determinants of the freight rates

Shipping market is a continuous trade between supply and demand mechanisms trying to meet somewhere in the middle. However each change in their equilibrium brings new chances or new risks to the people involved. A ship manager may witness the value of each fleet to boom or to decrease in a very short period of time. Market circles may come and go and predicting the moves of the market is not always easy. The best investors in the industry are the ones "who can judge when the other players in the market are wrong" (Stopford, 2007)

Freight rates in dry bulk market undergo a lot of changes in the short run period (Kavoussanos, 1996) and this is why different policies and scenarios are followed by ship owners and charterers in every different period.

The environment of the shipping industry is highly broad and diversified. As a result there is a big range of aspects influencing supply and demand by continuously affecting and driving shipping cycles.

In the Table below, we can find the 10 main variables influencing supply and demand.

Table 3: Determinants of demand and supply

Demand	Supply
1. The world economy	1. World fleet
2. Sea born commodity trades	2. Fleet productivity
3. Average haul	3. Shipbuilding production
4. Political events	4. Scrapping and losses
5. Transport costs	5. Freight rates

Source: Stopford, 2007, page 115

2.7.1 Demand side

Demand of transport services is calculated in ton miles of cargo and is a result of uneven distribution of natural resources and differences in production and consumption globally. Those differentiations generate trade between countries. (Lun et. al., 2010)

1. The world economy

During the history of human kind we can see how political events, wars, unexpected fluctuations in commodity prices have affected global output and trade, resulting in decreasing commerce. The period before the financial crisis we were observing a growth in world output which also had boosted trade and sea transportation. However, the 2008 financial crisis was followed as we already discussed by a crisis in international trade and commerce.

Changes in global production follow a cyclical trend which most of the times is hard to be predicted. An indicator of business cycles is the elasticity of the world economy which is “the percentage of sea trade divided by the percentage growth of industrial production” (Stopford, 2007, page 121). Reasons that change the elasticity of trade through the years are mainly the changes that occur in global resources of raw materials, industrial and technological developments and also changes in the need of countries that start to develop or development reduction to others.

2. Sea born commodity trade

Short term fluctuations on the products traded globally generally occur due to seasonality in trade. From an analysis regarding the seasonality of dry bulk industry we saw that “regular seasonal patterns in dry bulk freight rate are attributed to the nature and pattern of trade in commodities transported by these ships, while the differences emanate from the factors that sub-divide the dry bulk sector and commodities such as ship size, flexibility, route and commodity parcel size.” (Kavussanos and Alizadeth, 2000) In general, the analysis showed that different kinds of vessels (size, type, etc.) are showing different seasonality, revealing another way in order for ship management companies to reduce risks through holding a variety of vessels.

On the other hand long term changes in commodities traded by sea have to do with transformations in the each production sector. Peoples tastes, priorities and needs change through time. Accordingly technology moves faster, innovations are a part of our daily life and sources are disappearing or found changing the trade in which commodities or raw materials were demanded and supplied.

3. Average Haul

The distance in which commodities have to be travelled also has an effect on demand for shipping services. Average haul measures “the sea transport demand in terms of ‘ton miles’, which can be defined as the tonnage of cargo shipped multiplied by the average distance over which it is transported” (Stopford, 2007, page 125).

Taking into advantage the economies of scales provided by the bigger vessels the average distance of the voyages executed started to increase. As a result demand for shipping services started to increase and new countries – suppliers came into the market ready to offer their services.

In the case of iron ore China has the opportunity to increase the range of its suppliers by trading with South America and Brazil. After the liberation of imports China started trading with Australia and India regarding iron ore. However, there was a steady increase with trade with Brazil, increasing the haul of the voyage and exploiting economies of scale.

4. Political events

When we use the term of political events in shipping we refer to “such occurrences as localized war, a revolution, the political nationalization of foreign assets or even strikes” (Stopford, 2007, page 126). Demand of shipping services can indirectly change dramatically when a political event as those discussed above take place.

We can even today witness the result of the aggressions in Middle-East and the negative effect they have in the shipping industry as well as the indirect increased added cost in the transportation. Going back through time we have several other examples of political situations affecting demand for goods. In 50s there was a crisis in the Suez Canal which led all the ships passing from there to extend their voyage and to travel round the Cape of Good Hope leading to a sudden increase in demand. Later on during 1973 the oil asset that were owned by Libya were nationalized and as a result demand in tanker industry increased because the average distance on the haul was increased. However, the same year the Yom Kippur War led to a reduction of production from the Organization of Arab Petroleum Exporting Countries which almost cost the wipe out of the tanker market. Finally the Gulf War in 90s also raised the demand of oil transportation. (Stopford, 2007)

5. Transport costs

Over the years technological changes, maturity of transportation methods, increasing in the size of vessels and efficient organization of logistical methods have all helped decreasing of transportation costs. Economies of scale have been essential in the increase of demand and “reduced transport costs stimulate more demand for sea transport, with an impact on consumers’ purchasing decisions, locations of markets, sourcing, and pricing decisions (Coyle *et al.,* 2000).

Transportation costs influence decisions regarding the location of resources, raw materials even commodities. “Although transport costs may not appear to be such a dramatic influence upon sea born trade as the world economy, their long term effect on trade development should not be underrated” (Stopford, 2007).

2.7.2 Supply side

Tonnage capacity available in the market is measured by the free space offered in ships, able and ready to transport raw materials and products. “Active shipping supply” refers to ships that do business in the shipping market. “Available shipping supply” refers to the ships that do not trade. Finally all the tonnage that has the ability to trade and the “available shipping supply” compose the “shipping supply” (Lun et. al., 2010).

In order to calculate the supply of shipping industry not only the number of tonnage available has to be estimated but also the distance of the trip should be included. Moreover, when we discuss about the supply of tonnage available, we should take into account the time difference between the order and delivery of the vessels as well as their life expectancy which reaches 15-30 years.

Owners play a huge role as the people who take the most important decisions in the shipping sector. They order the newbuilding ships; they negotiate in the market older ones; they even decide about scrapping rates. Charterers from the other hand have also a great influence on the shipowners and on the freight rates achieved each day. Bankers and financial institutes are controlling loans, interest rates and investment in general. Finally, regulations globally affect the ships built and scrapped. As we can see those five groups of people have a great influence in the supply of global tonnage and they are in charge for a wide range if decisions (Stopford, 2007).

1. <u>The world fleet</u>

Going back on time, we can see that in the beginning of 60s the fleet of tanker vessels was growing driven by the huge demand for oil. Despite the fact that shipyards were growing in order to facilitate more ships, the demand was hard to be covered. The result of the huge demand for tankers was the over-supply of the market taking place in the mid 70s and the fall of the freight rates. In order for the market to re-reach equilibrium, a 14 year circle was needed.

Dry bulk carriers were started trading during late 50s. Their size became bigger and bigger over the years in order for economies of scale to be exploited. From 60s till the financial crisis of 2008 their tonnage was progressively increased because if the big range of products that were able to be transported and the increase need of raw materials and grains in developing countries. However, in 2008 freight rates dropped dramatically because demand of shipping decreased. On the other hand the dry bulk fleet continued to grow following the mismatch of order and delivery of shipbuilding industry.

World fleet is changing over the years with bigger and more efficient vessels entering the market. Specialized ships have also made their appearance taking their part in the development of global fleet and reflecting how complex it is for today’s ship-owner in deciding what to follow and which market to choose. (Stopford, 2007)

2. <u>Fleet productivity</u>

The size of a ship cannot be the single characteristic of determining the size of global supply. The tonnage may be there, however, it is possible that it is not used strictly in the transportation procedure. In Maritime Economics book (Stopford, 2007) we find an example regarding the average VLCC vessel trading. The example shows that she spent 137 days transporting a shipment, 111 days “ballast” and 40 days on "cargo handling". As a result, productivity of the vessel is a very important factor when we refer to the supply part of the equation.

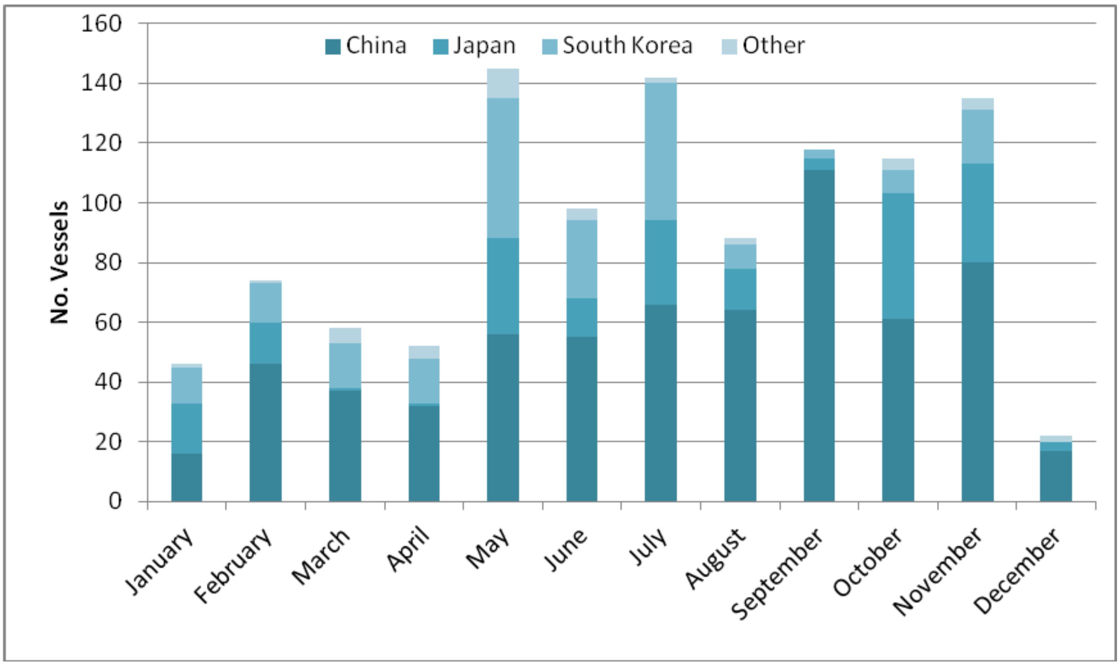
Productivity is determined by 4 factors. The speed by which the vessel moves which provides an indication for the total time the ship will spend in the sea. The time the vessel spends in the port which is a factor determined also by the port effective operations and logistical organization. The "deadweight utilization" which determines how much space of the vessel is covered by bunkers, stores etc. Finally, the days by which the vessel is loaded in the sea also determine the number of productive days. If for example time spent in the port is minimized then the productivity of the vessel increases.

3. Shipbuilding production & Scrapping/ losses

Building of new vessels is a result of the need for more tonnage witnessed in shipping sector. However, the period in which a vessel is ordered until the time of delivery, lasts on average 4 years. That gives us an idea about the way ship-owners have to act and predict future demand sometimes with success or some other times causing overcapacity in the market.

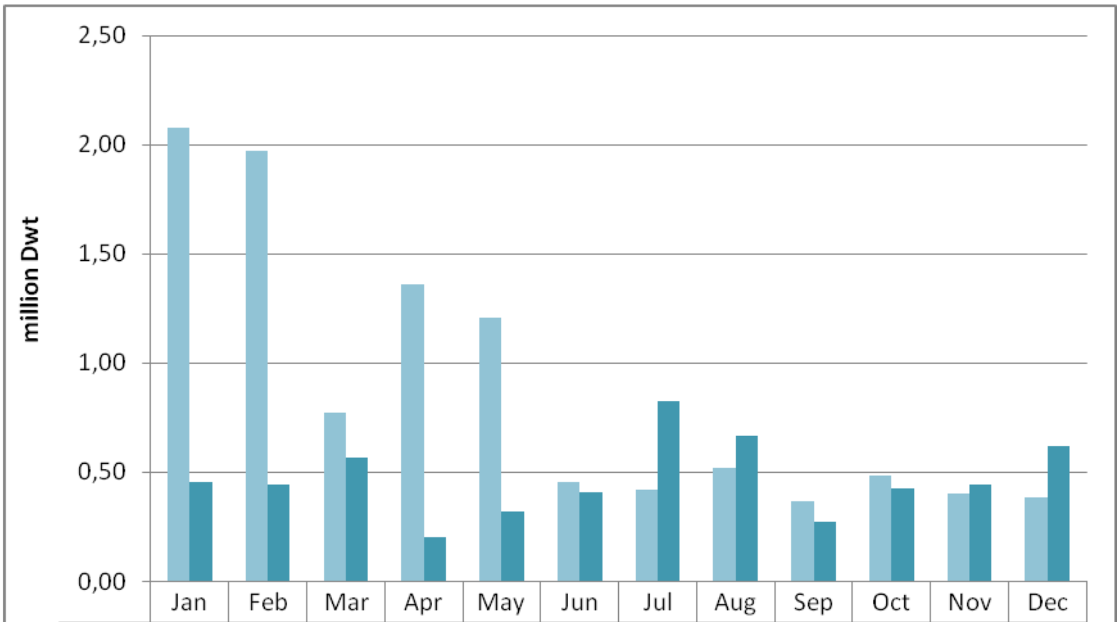
There is a balance between the new ships falling into the market and older ships being scrapped or lost in ship accidents. Scrapping became of more and more importance during 80s because of the large number of vessels that had reached their expected life and also resulting from changes in regulations globally. Another factor that plays a great role is the money achieved in scrapping market. When prices are high then more and more ship-owners tend to demolish their vessels. (Stopford, 2007)

Figure 5: Newbuilding 2010



Source: Intermodal

Figure 6: Demolition 2010



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	2,08	1,97	0,77	1,36	1,21	0,46	0,42	0,52	0,37	0,48	0,40	0,39
2010	0,46	0,44	0,57	0,20	0,32	0,41	0,83	0,67	0,27	0,42	0,45	0,62

Source: Intermodal

There is a balance between the new ships falling into the market and older ships being scrapped or lost in ship accidents. Scrapping became of more and more importance during 80s because of the large number of vessels that had reached their expected life and also resulting from changes in regulations globally. Another factor that plays a great role is the money achieved in scrapping market. When prices are high then more and more ship-owners tend to demolish their vessels. (Stopford, 2007)

4. Freight rates

The price paid in the market for the transportation services, is always of a great influence regarding decisions of ship-buying or building. Motivation is given to owners through the market in order to increase their profits in short term and reduce their costs in long term (Stopford, 2007).

2.7.3 The freight rate determination mechanism

Demand and supply are connected in a way which gives as a result the freight rates of the shipping market. "Shipowners and shippers negotiate to establish a freight rate which reflects the balance of ships and cargoes available in the market. If there are too many ships the freight rate is low while if there are too few ships it will be high. Once this freight rate is established, shippers and shipowners adjust to it and eventually this brings supply and demand into balance." (Stopford, 2007)

The interaction of both demand and supply drive freight rates high or low depending on the situation occurring in the market. "The supply and demand curves intersect at the equilibrium price in the shipping market, which determines the freight rate at which the quantity demanded by shippers for shipping services is equal to the quantity supplied by carriers. At this point, both shippers and carriers reach a mutually acceptable freight rate level.” (Lun et. al., 2010)

CHAPTER 3 – Methodology and Data

3.1 Introduction

In our thesis we want to examine the relationship between the variables affecting the Chinese demand for iron ore, the price of iron ore and finally the freight rates. In order to analyze how the independent variables affect the dependent variables we will use the tool of the multiple regressions which enables us to connect our independent variables by putting one residual of the previews equation into the next equation.

The multiple regression method with the use of linking residuals is used when we have a number of equations with endogenous regressors. "This method is asymptotically efficient" (Heij, 2004). In order to use this method of analysis we have to establish a multiple regression model that explains the relationship between "the variables to be forecasted, which are called the dependent variables and variables that the statistics practitioner believes are related to the dependent variables. The dependent variables are denoted Y, whereas the related variables are called independent variables and are denoted X1, X2, X3, …., XK (where k is the number of independent variables)." (Keller, 2009, page 616)

However, we will start our analyses by examining if there is a high or low correlation between our independent variables and analyze the possible existence of heteroscedasticity. Secondly, we will move in performing the multiple regressions with the help of Eviews Statistic program and try to interpret the coefficients of each of our regressions.

3.2 The methodological approach

3.2.1 Correlation analysis

The correlation analysis is a statistical tool which defines a relationship between two variables – sets of data. The coefficient of correlation is the covariance divided by the standard deviation of the variables:

Sample coefficient of correlation: $r = \frac{s_{xy}}{s_x s_y}$

The coefficient of correlation is a number between -1 and 1:

$$-1 \leq r \leq 1$$

As a result, when the coefficient of correlation equals -1 we know that there is a negative linear relationship between the two variables. On the other hand, when the coefficient of correlation equals +1 then we have a perfect positive relationship and in both cases the scatter diagram is a straight line. Finally when the coefficient of correlation equals 0, there is no linear relationship. (Keller, 2009, page 126)

We can see that by interpreting the coefficient of correlation we can examine the degree of linear relationship that exists between the variables. However, when the coefficient of correlation is another number different than -1,0,1, we can only interpret the relationship by telling in what degree the two variables are related and nothing more.

Another limitation of the correlation analysis is that it does not give us an idea about the causation in the relationship. When we find a correlation between two variables that does not mean that they have or that they don't have a cause-effect relationship. The only way to be sure and to find out whether the correlation also means causation is the experimental method.

3.2.2 The multiple regressions method with linking residuals

Multiple regression method is asymptotically more useful than the separate estimation of each equation. When we want to perform a quantitative analysis on dependent variables that have an endogenous relationship multiple regression method with the use of linking residuals provides estimation of variables, taking also into account the covariances across equation turbulences.

In the multiple regressions method we have a number of equations in which the independent variables affect the dependent ones and also a relationship between the dependent variables itself is observed. As a result we will construct a model which will have the following equation:

$$Y = a_o + a_1x_1 + a_2x_2 + \ldots + a_kx_k + \varepsilon$$

Where:

- is the dependent variable
- x_1, x_2,…, x_k are the independent variables
- β_o, β_1, …, β_k are the coefficients
- ε is the error variable

In order to perform the regressions we will follow some main steps. First of all we will generate the coefficients and the various statistics used to analyze the model. Secondly, we will try to find if there are any violations to the conditions required in order for the model to be valid. Thirdly, we will use Durbin Watson and the F-test in order to see if the model fits the data and finally, if the model is correctly specified then we use the coefficients and we try to predict a value for the dependent variable.

3.3 Correlation and multiple regression method specifications

3.3.1 Correlation analysis specifications

In order to examine the relationship between the determinants of the Chinese demand for iron ore, of the price of iron ore and finally of the freight rates we will perform several correlation analysis between the main variables.

Regarding the price of iron ore, we will try and see how the independent variables analyzed in Chapter 2 are correlated to each other. As a result we will perform a correlation analysis between global iron ore trade, bottlenecks on the traded ports, iron ores spot prices and finally the yearly rate of new building vessels entering the market.

From the demand side of view, we will perform a correlation between the Chinese GDP per capita growth, the price of iron ore and the Australia's and Brazil's iron ore exports to see if the correlation between them is in levels that do not cause any problems to our analysis. Moreover we will also analyze the correlation of the demand of iron ore as a dependent variable with the independent.

Finally we will use the data that we have gathered regarding the freight rates of Capesize vessels trading iron ore with a Chinese port on their destination, in order to see how those freight rates are correlated to their variables. We will also perform a correlation between the independent variables were we will examine whether we have a strong relationship between them and also whether this relationship is a positive or negative one.

3.3.2 Multiple regression method specifications

As we mentioned above, the correlation analysis may be a well known statistical method, however it has some disadvantages that do not let as view the full picture between the relationship of independent variables and also between the dependent and independent ones. As a result in order to produce more specific quantitative results we will use the multiple regression method as described above customized in order to fit our case.

In order to analyze the freight rates of Chinese iron ore trade, we will first have to look on the demand side and try to analyze the independent variables affecting the Chinese demand for iron ore imports. However, since a main determinant of the demand for iron ore imports is the price of iron ore, we will try to also model the determinants of iron ore's price as a second step to our analysis. Finally, we will take a look on freight rate as a dependent variable and use the multiple regressions with interacting residuals in order to see the magnitude between all three equations and the determinants of freight rates and how the this mechanism is coming into action concluding in equilibrium each chronic period.

We will use a model constituting by three single equations:

1. Price of iron ore (Y_1)
2. Chinese demand for iron ore imports (Y_2)
3. Freight rates (Y_3)

Based on the literature description of Chapter 2 we will list the explanatory variables that we have selected as potential determinants of the Chinese demand for iron ore, of the price of iron ore and finally of the freight rates:

ChGDP: The Chinese GDP purchasing power parity per capita;

$X_{io}^{Aus,Br}$: The Australian and Brazilian iron ore exports;

GT_{io}: The global iron ore trade;

SP_{io}: The spot prices of iron ore;

LPI: The logistics performance index;

ChX_{GDP}: The Chinese exports as a percentage to the GDP;

Cape: The total Capesize world fleet;

NBR: The newbuilding deliveries rate;

LSR: The losses and scrapping rate;

Consequently the three regression equations will look as follows:

Equation 1

$(Y_1) = \alpha_0 + \alpha_1 GTio + \alpha_2 LPI + \alpha_3 SPio + \alpha_4 NBR + \varepsilon$

Equation 2

$(Y_2) = \beta_0 + \beta_1 CHGDP + \beta_2 X_{io}^{Aus,Br} + \beta_3 Y_1 + \beta_4 ResidY_1 + \varepsilon$

Equation 3

$(Y_3) = \gamma_0 + \gamma_1 Y_1 + \gamma_2 NBR + \gamma_3 Y_2 + \gamma_4 LSR + \gamma_5 LPI + \gamma_6 Cape + \gamma_7 ChX_{GDP} + \gamma_8 ResidY_1 + \gamma_9 ResidY_2 + \varepsilon$

In our literature review in Chapter 2 we can find various other variables that can be characterized as control variables and are not mentioned in the above equations. We tried to find a way to quantify the theory established regarding our dependent variables and their factors of influence. As a result we collected data indicating each determinant and we will now use the three-stage least squares method in order to analyze their interdependency

We will first start by running a regression in Equation 1, regarding the price of iron ore. We will analyze its independent variables, find their coefficients and interpret the relationship they have with the price of iron ore. We will look at their p-value to see how significant the relationships are and finally we will run a Durbin-Watson test to check for autocorrelation between the residuals.

P - values indicating a significance at less than 1 per cent level will be characterized as highly significant and will be noted with three stars (***). Less significant p-values between 1 to 5 per cent level will be noted with two stars (**) and even lower significance between 5 to 10 per cent level will be noted by a single star (*). Finally when the level of significance is over 10 percent level, the coefficients will be characterized as insignificant.

The outcome of the residuals of equation 1 will be then used in the regression of equation 2 in order to link these two equations and also to include both the direct and the indirect effect price of iron ore has in the Chinese demand for iron ore. We will run the second regression and we will also perform the same analysis and tests as in the first equation.

In the equation of freight rates, we can see that both the price of iron ore and the Chinese demand for iron ore are in addition endogenous and exogenous variables. As a result in order to perform a regression on freight rates we will also use the residuals of Y1 and the residuals of Y2 which were an outcome of the previous regressions. In that way we will cover both the direct and the indirect effect they have on freight rates.

Finally, after the last regression is performed we will also analyze its coefficients and perform a Durbin-Watson test also to check for autocorrelation. We will then have our freight rates equations which can also be used later on in cooperation with the GSIM model in order to give us a future prediction.

3.4 Data and data issues

The price of iron ore (Y_1) was found in the website of indexmundi.com where the values of different commodities are listed in time series tables. Those prices are referring to 67.55 per cent iron ore content commodity and they are prices Free on Board in Ponta de Madeira port. They are measured as US cents per dry metric ton.

In order to collect data regarding the independent variable of the global trade of iron (GT_{io}) ore we used the SIN network of Clarksons where we found data regarding the yearly trade of iron ore globally from 2000 until 2011. However, in our model we use monthly data. As a result we divided the yearly output of trade into twelve months and we came up with an equal monthly proportion of iron trade for each year.

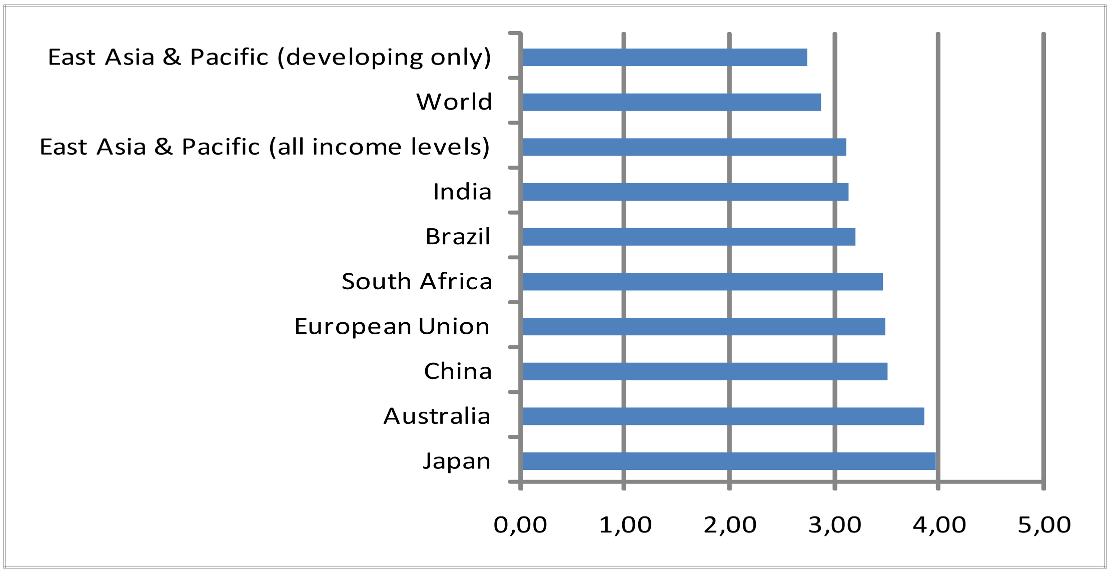
As we discussed in Chapter 2 of our thesis, there is also a spot market regarding iron ore. Another country that exports smaller quantities of iron ore to China is India. As a result the prices of the spot market have also a deterministic effect on iron ore's price. The spot markets prices (SPio) were gathered from the Metal Bulletin but unfortunately the data started to be recorded from 2005 and beyond. Consequently we are faced with a restriction regarding spot prices available for the years before 2005.

The data regarding the supply of new building tonnage in iron ore market (NBR) were also collected by Clarksons SIN website, where we were provided by the number of new building vessels tonnage entering the market yearly. In order to get the yearly rate needed in our equation, we divided each year's newbuilding tonnage to the total tonnage of the global Capesize fleet.

The last determinant of iron ore price is the bottlenecks (LPI) that sometimes occur in the logistic process of transportation. The worse the problems faced in the logistic procedure, the higher the price of iron ore. Delays and collusions are some of the indicators of bottlenecks and in order to find data representing this malfunctions, we used an indicator provided by the World Bank named the Logistic Performance Index.

The Logistic Performance Index "reflects perceptions of a country's logistics based on efficiency of customs clearance process, quality of trade- and transport-related infrastructure, ease of arranging competitively priced shipments, quality of logistics services, ability to track and trace consignments, and frequency with which shipments reach the consignee within the scheduled time." (World Bank, 2011) The range of the index starts from 1 until 5 and the higher the score the better the performance.

Figure 7: Logistics performance index



Source: World Bank

However, in China's case we only have an indicator for 2 years. In 2006 it was 3.2 and in 2009 it was 3.54. In order to have enough data for our regressions, we assumed a 0.1 yearly increase in the Logistic Performance Index and this is because every year China is trying to improve its logistic performance in the port and also in the land transportation.

The data regarding the Chinese imports of iron ore (Y_2) were collected by Clarkson's Research Services Ltd website, Shipping Intelligence Network (SIN) and they are in million tons starting from January 1996 till March 2011. With the use of weekly publications (regarding iron ore trade found in SIN), we created a time series model which contains the monthly imports of iron ore from the Chinese market.

Regarding the dependent variable of the iron ore's price (Y_1), we use the exact same data used in the Equation 1.

In the data of the World Bank, we can find annual GDP prices for all the countries globally. China until 2010 used to publish its data in a yearly basis. However, the China's National Bureau of Statistics (NBS) announced that since April 2011 they will start publishing data in a quarter-on-quarter basis in order to "better reflect economic changes" (Yang, 2011). This statistical reform has started in 2009 and since then China is trying to provide more public analytical information for its economic development. However, regarding the annual Chinese GDP purchasing power parity per capita (ChGDP) we will use the annual GDP purchasing power parity per capita in a US currency found in World Bank's data, equally divided to twelve in order to find the monthly price of the Chinese GDP output.

The last determinant of the Chinese demand for iron ore is the reliability of foreign suppliers ($Xio^{Aus,Br}$). We generally know that iron ore market is high concentrated and that Companhia Vale do Rio Doce has a 26 per cent share of the industry, Rio Tinto Group a 25 per cent and finally BHP Billiton a 16 per cent. As a result we can see that three companies handle almost 67 per cent of the total market.

In order to examine their reliability, we gathered information about the quantities Australia and Brazil are exporting monthly ($Xio^{Aus,Br}$). Through the Shipping Intelligence

Network of Clarksons website we can see that as the exports increase, this means that the exporters are becoming more productive and more efficient. This increase also shows that the exporters increase their share in the Chinese iron ore market and China relies more and more on them through the years.

The data we have on Australian iron ore exports are in million tons while the Brazilian ones are in thousand tons. Transformation of the Brazilian ones in million tons will help with the regressions analysis and in the explanation of the results.

The data regarding the freight rates (Y_3) were collected from the Clarkson's Research Services Ltd website, Shipping Intelligence Network (SIN). As we already discussed there are different kinds of charter parties and in our case we can distinguish two main freight rates categories: the time-charter market rates and the trip or voyage-charter rates. In our analysis we will focus on the second one, analyzing the freight rates of the iron ore spot market with a destination to Chinese ports.

Regarding the size of the vessel, we know that the bigger party of the iron ore transportation is executed by Capesize vessels (over 100,000 dwt) and a small minority by Panamaxes (around 60-99,000 dwt). However, Panamaxes are mostly used in the trade between India and China and the amount of iron ore transferred is less in quantity. As a result, our analysis will take into account freight rates of Capesize vessels and the data that we collected start at January 2006 until March 2011.

The Chinese iron ore demand (Y_2), the price of the iron ore (Y_1), the new building rate (NBR) and the logistics factor (LPI) are four main dependent variables affecting the freight rates. As a result, we will use the same data acquired and used in the previous single equations.

Political events are situations like the financial crisis which occurred in 2008 and had a dramatic external effect on freight rates. Another example is warlike situations that could affect the economy or the exports or imports of a country. Through our research we tried to find an indicator showing the effect of different events in Chinese economy. However, we thought that those events would change imports and exports of the economy and as a result we found data from the World Bank showing the percentage of Chinese exports (ChX_{GDP}) over the GPD.

From the supply side of the shipping industry, we mainly focus on the tonnage entering or leaving the shipping sector yearly. Through the SIN website we acquired information about the total size of Capesize vessels operating yearly in the market (Cape) in million dwt. We also looked at yearly losses (Loss), acquiring data of the yearly number of dwt of vessels lost in the sea as well as data regarding yearly scrapped (SR) dwt.

However, we believe that using a rate of losses and scrapping is more useful than using actual numbers. This is why we divided the total yearly numbers to the total number of the world fleet.

Finally, in order for the outcomes of the three-stage least square method to be more accurate and in terms of simplicity, we will turn our data into logarithms leaving unchanged only the rates, the indexes and the growths. In that way our coefficients will not be huge numbers and it will be easily to handle all these huge information of data.

CHAPTER 4 – Correlation and multiple regressions results

4.1 Introduction

We now turn to the results of correlation and multiple regressions analysis. Through that we will examine the relationship of each dependent variable with the independent ones. We will investigate if their correlation is strong and to what extend a change in those determinants would affect the outcomes.

4.2 Results of correlation analysis

4.2.2 Correlation on the variables of iron ore's price

In the table below we can find the correlations between the independent variables which constitute the equation of the price of iron ore.

Table 4: Correlation between the determinants of the price of iron ore

	Y1	GTio	LPI	SPio	NBR
Y1	1				
GTio	0.96	1			
LPI	0.96	0.99	1		
SPio	0.55	0.52	0.51	1	
NBR	0.61	0.53	0.56	0.21	1

Source: Outcome of correlation analysis

We can see in table 4 that most of our variables are not highly correlated. All of the variables have a positive relationship among them but they don't show a high level of correlation. However, the only problem can be witnessed between Logistics Performance index and the global iron ore trade which are showing a multicollinearity of 0.99.This can be caused by the fact that a better logistic performance is most of the times followed and accompanied by an increase in trade. As a result we can see that while global trade of iron ore is increasing continuously, ports become more and more efficient.

4.2.2 Correlation on the Chinese demand of iron ore imports

From the Table below we can view the correlations among the Chinese demand for iron ore and four different variables

Table 5: Correlation between the determinants of the Chinese iron ore imports

	Y2	ChGDP	$Xio^{AUSBRAZ}$	Y1
Y2	1			

ChGDP	0.89	1		
$Xio^{AUSBRAZ}$	0.75	0.76	1	
Y1	0.86	0.95	0.77	1

Source: Outcome of correlation analysis

All the values achieved are not high enough in order to state a problem. However, what is of great importance is the correlation of iron ores price with the Chinese GPD ppp which shows a very strong correlation between the two variables.

4.2.3 Correlation on freight rates

In the examination of the freight rates as we already discussed in the data part of our thesis, we chose to use data referring to Capesize vessels carrying iron ore to China. The years we have available are from 1996 till 2011.

Table 6: Correlation between the determinants of the freight rates

	Y3	Y1	NBR	Y2	LSR	LPI	Cape	ChXGDP
Y3	1							
Y1	-0.19	1						
NBR	-0.23	0.61	1					
Y2	-0.04	0.86	0.57	1				
LSR	-0.63	0.24	0.13	0.09	1			
LPI	-0.13	0.96	0.56	0.91	0.23	1		
Cape	-0.02	-0.13	-0.13	-0.19	-0.14	-0.10	1	
ChXGDP	0.31	-0.84	-0.53	-0.85	-0.20	-0.86	0.06	1

Source: Outcome of correlation analysis

We can see from the table above that the only case of multicolinearity is witnessed between the price of iron ore and the logistics performance index and also between demand for iron ore and LPI. Heteroscedasticity may be witnessed between those pairs of variables and we can also observe that the same relationship was also viewed in tables 4 and 5 where Y1 and Y2 were the dependent variables. In that case the variations in the price of iron ore and its demand were highly explained by the variation in LPI.

4.3 Results of multiple regressions method

We then continue to run the multiple regressions for the all the Equations mentioned above in the way that was described in chapter 3 of our analysis.

In table 7 below all the coefficients are presented with their p-values underneath in parenthesis. As we already mentioned the stars next to the coefficients categorize their level of significance.

Table 7: Results of regression analysis

	Chinese demand for iron ore	**Price of iron ore**	**Freight Rates**
α_0	128.340*** (0.000)		
α_1	-8.488*** (0.000)		
α_2	8.503*** (0.000)		
α_3	0.159*** (0.000)		
α_4	0.007 (0.300)		
β_0		9.915*** (0.001)	
β_1		0.345** (0.023)	
β_2		0.329** (0.031)	
β_3		0.411*** (0.004)	
γ_0			-15.239*** (0.007)
γ_1			-0.312 (0.393)
γ_2			-0.050** (0.048)
γ_3			0.730** (0.048)
γ_4			-2.137*** (0.000)
γ_5			1.927* (0.094)
γ_6			-0.0003* (0.286)
γ_7			0.082*** (0.000)
Durbin Watson	1	1.3	1.6
R^2	0.97	0.95	0.74

Source: Outcome of regression analysis

Taking into consideration table 7 we can take a look into the relationship of the variables affecting the price of iron ore (Y_1). We can see that the global trade of iron ore (GTio) has a negative coefficient (α_1) which indicates that a possible increase in quantity traded globally, would reduce iron ore's price. Through the supply and demand mechanism we know that when supply increases and demand stays the same, then the price decreases in order for the equilibrium to remain. We can also see also that its p-value is almost zero which makes it highly significant.

On the other hand, the logistics price index coefficient (α_2) and the spot price of iron (α_3) ore are moving in the same direction with freight rates. Better logistics services and transportation quality raise the price of the product transported. All the developments taking place in today's ports have a huge cost but they also provide great benefits in logistics process. However, these costs are also included in the price of the products traded. As we analyzed in chapter two of our thesis, transportation costs and bottlenecks are two main determinants of the iron ore's price.

We also mentioned in our literature review that the way the spot market of iron ore is moving through the years, has a great influence in the price of iron ore traded in normal market. The positive coefficient (α_3) of 0.16 and it's highly significance, with a p-value of zero, reveals the aforementioned.

Finally, we can see that the coefficient of the new building ships (α_4) entering the market yearly is not significant.

Regarding the Chinese demand for iron ore (Y_2), as we could already suspect, there is a positive relationship, highly significant, between demand and Chinese GDP. When Chinese GDP increases, then this is an indicator of economic development and results in higher level of construction and urban expansion. Steel demand leads to iron ore demand and as a result we have an increase represented by a coefficient (β_1) of 0.345. Moreover, the reliability of foreign suppliers, represented by their exports is also statistically highly significant and positive suggesting that the consistency in the trade of iron ore can lead to greater quantities.

What was a bit unexpected was the direct effect of iron ore's price (Y_1) in its demand (Y_2). We can see that the coefficient is positive and highly significant, which indicates that an increase in the price of iron ore would lead to bigger quantities traded. However, with the use of the three-stage least square method we also included in the equation the indirect effect of the price of iron ore (Resid Y_1), which may not be statistically significant but it demonstrates a negative relationship between the demand of iron ore and its price.

Finally, we will look in the equation of freight rates (Y_3). We can see that the price of iron ore has both a direct (γ_1) and an indirect (Resid Y_1) negative effect on freight rates which however are both insignificant and this is why they are not going to be used in the regression equation. The same negative insignificant relationship is observed between freight rates and the Global Capesize fleet (Cape). This implies that there is a negative relationship between the number of vessels on the market and a forthcoming increase in global tonnage would lead to lower freight rates. However, this relationship has a high p-value of 0.286.

On the other hand, the new building rate (NBR) has a negative but significant effect on freight rates. We can see that an increase in the number of vessels entering the market each year would lead to bigger tonnage availability and as discussed in chapter 2 this would lead to lower freight rates. The opposite is noticed regarding losses and scrapping rate (LSR). We may witness a negative sign in its coefficient (γ_4) but in our data we used the 1-LSR in order to get a better outcome. That equation implies that when losses and scrapping rate go up then 1-LSR becomes smaller and freight rates increase. A decrease in global tonnage would give competition in the hands of shipowners and would increase freights.

Chinese demand for iron ore (Y_2) has also one direct positive and significant effect on freight rates and one indirect which is not significant. We can see that when the demand for iron ore increases that leads to higher freights demanded for its transportation. When the demand is increasing keeping the supply the same, the price (in our case freight rates) also increase in order to find equilibrium.

Finally, the logistics performance index (LPI) and the percentage of the Chinese exports over GDP (ChXGDP), are the two variables in our equation that are keeping positive coefficients (γ_5 and γ_7) and are also highly significant. Both of them will be used in our freight rate equation, indicating an increase on freight rates with their boost. Better logistic services as we already said, tend to increase the freight rates paid for the transportation procedure.

Looking at the Durbin-Watson test performed in all of our equations, we can see that all three regressions have a $1<d<2$. As a result those numbers are high enough do not to indicate the existence of autocorrelation though the first regression may be seen as a borderline case.

Chapter 5 – Looking forward: a partial equilibrium analysis

5.1 Introduction

In our analysis until now we have seen the effect that price and demand for iron ore has on freight rates and generally what variables are the most significant in freight rates equation. However, if we want to provide a more in-depth analysis we need a forward looking model that includes the interaction between supply and demand including also the various market actors.

Most of research departments use models and inputs like GDP growth, freight rates, ton miles, scrapping rates, etc in order to produce worthy outputs. As a result, these models surpass the limitations of simple statistical methods and provide the researchers and their customers with a bigger range of information. Their value is very high and their application can range from sector to sector depending on the required outputs.

In our case, we would like to examine the results that an increase in freight rates would have on Chinese trade, the economy and welfare. Consequently, we will use the Global Simulation Model (GSIM) to add a quantitative analysis to our research (Francois and Hall, 2003). The GSIM model it is used in this research to show how the imports and export flows of iron ore traded between China and the rest of the world will be change through the use of 3 possible scenarios of demand changes.

5.2 Methodology of the GSIM model

The Global Simulation Model was created on 2003 from Francois and Hall and it is a partial equilibrium model in which we can keep unchanged all the other variables except from prices in a specific sector. As a result in that model we can study a change (for example in tariffs) without taking into account other changes in the equilibrium.

When we use a partial equilibrium model, we have the ability to look into the future in a very rapid way, without having to collect a big range of data. On the other hand a general equilibrium model is far more demanding and more difficult to produce accurate results.

In our case we will try to model Chinese iron ore imports from 5 different regions:

1. Australia
2. Brazil
3. India
4. Africa
5. Rest of the world

We would like to see the relationship of those countries with China as Chinese iron ore imports are the interest of our research

With this model we have the ability to estimate the changes between two different moments in time. In order to model the changes in the trade between those countries we will follow the iron ore trade and also the price of iron ore in 2010 and then we will move to 2020 in order to examine all the changes occurred.

With the use of the GSIM model we know that there is no linkage between different sectors of the economy. We look only to the sector that it is of our interest using data of trade flows, initial and final tariffs and finally demand and supply shocks. The outcome of this model is the future development of the trade flows (Francois and Hall, 2003).

From an explanatory report made by Francois and Hall in 2003, we came to a close contact with the equations behind the model. All the equations used in this model concern export and import demand.

Equation (5.1) shows the assumption that the demand of imports for each country for each single product depends on the price the product has on the industry and the total spending on that specific industry.

$$\theta_{(i,v),r} = M_{(i,v),r} T_{(i,v),r} / \sum_{s} M_{(i,v),s} T_{(i,v),s} \tag{5.1}$$

Were **r** and **s** are the exporting regions while **v** and **w** the importing ones. With letter **i** we represent each sector-industry.

The demand of the share each country has on exports is result of the quantity imported and the tariffs applied in each product-area.

$$\phi_{(i,v),r} = M_{(i,v),r} / \sum_{w} M_{(i,w),r} \tag{5.2}$$

Where **M** is the imports and we can see that:

$$M_{(i,v),r} = f\left(P_{(i,v),r}, P_{(i,v),sr}, y_{(i,v)}\right) \tag{5.3}$$

We can see from above equations that demand for imported quantity is a function of the price the product has between the trade of two countries, the price the product has between the trade from different sources and finally of the total expenditure on imports of the specific product within the country.

The cross-price demand elasticity and own price demand elasticity are derived from equations (5.4) and (5.5) below.

$$N_{(i,v),(r,s)} = \theta_{(i,v),s}\left(E_m + E_s\right) \tag{5.4}$$

$$N_{(i,v),(r,r)} = \theta_{(i,v),r} E_m - \sum_{s r} \theta_{(i,v),s} E_s = \theta_{(i,v),r} E_m - \left(1 - \theta_{(i,v),r}\right) E_s \tag{5.5}$$

Further down we have the equation (5.6) representing the demand for national product varieties and equation (5.7) which is the total export quantity to the world market.

$$P_{(i,v),r} = (1+t_{(i,v),r})P_{i,r}* = T_{(i,v),r}P_{i,r}* \quad (5.6)$$

$$X_{i,r} = f(P_{i,r}*) \quad (5.7)$$

We now take the difference of equations (5.3), (5.6) and (5.7) and we have the following results:

$$\hat{P}_{(i,v),r} = \hat{P}_{i,r}* + \hat{T}_{(i,v),r} \quad (5.8)$$

$$\hat{X}_{i,r} = E_{x(i,r)}\hat{P}_{i,r}* \quad (5.9)$$

$$\hat{M}_{(i,v),r} = N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_{s\neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s} \quad (5.10)$$

The next step to our analysis is to substitute equations (5.4), (5.5) and (5.8) to equation (5.10) and then add it to the import markets.

$$\hat{M}_{i,r} = \sum_v \hat{M}_{(i,v),r} = \sum_v N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_v \sum_{sr} N_{(i,v),(r,s)}\hat{P}_{(i,v),s}$$
$$= \sum_v N_{(i,v),(r,r)}\left[P_r* + \hat{T}_{(i,v),r}\right] + \sum_v \sum_{sr} N_{(i,v),(r,s)}\left[\hat{P}_s* + \hat{T}_{(i,v),s}\right] \quad (5.11)$$

In order to reach the global market condition we will place equation (5.11) equivalent to equation (5.9):

$$\hat{M}_{i,r} = \hat{X}_{i,r} \Rightarrow \quad E_{X(i,r)}\hat{P}_{i,r} = \sum_v N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_v \sum_{s\neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s}$$
$$= \sum_v N_{(i,v),(r,r)}[P_r* + \hat{T}_{(i,v),r}] + \sum_v \sum_{s\neq r} N_{(i,v),(r,s)}[\hat{P}_s* + \hat{T}_{(i,v),s}] \quad (5.12)$$

5.3 Assumptions and limitations

The first assumption made by the GSIM model is that each product traded from a different region doesn't have a perfect substitute. As a result all the products traded are differentiated and do not go into substitution. This assumption was made by Paul Armington on 1969 and it is broadly used to a variety of models. International trade leads to product differentiation because of the tariffs or different transportation fees imposed to products. However, as we already mentioned in our case, iron ore is a product that cannot be easily substituted and this is why its demand is rather inelastic.

We should not forget in our analysis that this model is a partial equilibrium model and as a result all other variables – factors remain unchanged. As a result, changes to other sectors and effects from income or government policies or sector interaction will not occur neither are explained. However, we will combine the results of the multiple regression method in order to be able to have a more holistic approach.

Finally, this model presumes that people consuming the traded products are all reacting in the same way and have the same response in changes. Differences in culture, income, age, sex do not count in our analysis and do not influence the results of the model.

On the other hand, we find that GSIM model is a powerful tool that can offer us great help in looking into the future. Combined with supply predictions and the regression results, it will give us a concrete outcome regarding the future demand of iron ore and its effect on freight rates.

5.4 Data

According to Francois and Hall (2003), various variables are demanded as "inputs" in order to get a valuable result. In our case we are going to analyze trade of iron ore with a focus on the major exporters.

First of all iron ore trade flows between China and the exporting countries are needed in order to have a clear view of the current situation. As we have already discussed, we will use data from exporting countries (Australia, Brazil, India, South Africa and Rest of the world) to China. From our literature review we know that Australia holds a 41 per cent of the total trade, Brazil 26 per cent, India almost 10 per cent, South Africa 2 per cent and finally the Rest of the world holds the rest 21 per cent of the imports.

From Shipping Intelligence Network we analyzed the iron ore trade globally in 2010. We found the quantities traded between its country and we are using them as inputs in our model. Countries trading iron ore except from the ones mentioned above, will be included in the Rest Of the World column.

In order to find the elasticities of demand and substitution we used the values that Prof. Francois had suggested to previous studies. Regarding the elasticity of supply, we found a literature (Kang et al., 1988; Vinod, 1994; Edgerton, 2009; Martin, 1993) which gives different values of elasticities starting from 2 to 8 in most of the cases. We will use the middle price of 5 to our model.

Finally we are going to use projections for the future, generated by UNCTAD organization, Clarksons' Intelligence Network and World Bank. We will look on the expected Chinese demand growth generated by credible organizations. The same method will be used on the supply side in order to see how demand and supply will interact in the future. We will then create 3 scenarios depending on those projections (a low, a medium and a high demand scenario) and we will focus on how the iron ore trade is suppose to move in changes of demand.

The supply and demand growth used to the other aforementioned countries and also to the Rest of the World is also a projected growth from UNCTAD and World Bank but it will remain the same in all of the three scenarios.

5.5 Scenarios

In order for the model to be implemented and to look into the future by investigating whether the demand of iron ore will overcome the predicted tonnage supply availability, we will perform three different scenarios for the demand and the supply side. Regarding the demand side we will use the GSIM model and on the subject of the supply side we will use the projections of Clarksons Inc about future Capesize fleet development.

5.5.1 Scenarios of demand

Each scenario will look at a different percentage change of global demand and supply growth in a period of 5 years. Before concluding in the numbers that we used to our scenarios, we made an extensive research with valuable data providers in order to be able to come up with some rational numbers of demand and supply growth. From UNCTAD and Clarksons data base we used their predictions of Chinese development. They predict a Chinese yearly demand growth of 5 per cent and a yearly supply growth of 5 per cent.

For the other countries and for the rest of the world their total demand and supply growth are influenced by each country's growth expectations found in the World Bank and IMF website, taking into consideration estimation about demand and supply growth. Their predictions are shown in the Table 8 below and will be used by the GSIM model.

Table 8: Demand and Supply predictions

	China	Australia	Brazil	India	Africa	ROW
Yearly demand increase	5%	2%	4%	3%	2%	2%
Yearly supply increase	5%	2%	2.5%	6%	6%	3.5%

Source: Predictions from UNCTAD, Clarksons and World Bank

<u>Scenario 1 – Low demand increase</u>

In the table below we can see in the demand section a Chinese demand increase but not as big as the one projected by the UNCTAD. On the first row we have the yearly percentage increase of demand for the 5 years period and underneath the yearly increase of supply.

Table 9: Low demand increase

	China	Australia	Brazil	India	Africa	ROW
Yearly demand increase	2.5%	2%	4%	3%	2%	2%
Yearly supply increase	5%	2%	2.5%	6%	6%	3.5%

Source: Projections of GSIM model

In the first scenario we will simulate a Chinese growth of demand equal to 2.5 per cent yearly. In that scenario Chinese demand for iron ore imports, increases but not as drastically as supply does. We can see that the increase is 2.5 per cent yearly less than the prediction of UNCTAD. On the other hand for the supply, we keep the prediction provided by Clarksons with a yearly increase of 5 per cent.

This scenario could be true if the global financial crisis occurred in 2008 follows a domino effect to the growth of countries globally. Moreover, as we also know, inflation is also increasing in Chinese economy and that could lead to a lower demand growth in the years to come and in a decrease in the development pace.

Scenario 2 – Medium demand increase

In the table below we can view a stable Chinese demand and supply increase of 5 per cent. On the first row we can see the demand growth of all countries that is kept as predicted from the UNCTAD and World Bank data base. Further down we can view the supply that is also kept as provided by our data.

Table 10: Medium demand increase

	China	Australia	Brazil	India	Africa	ROW
Yearly demand increase	5%	2%	4%	3%	2%	2%
Yearly supply increase	5%	2%	2.5%	6%	6%	3.5%

Source: Projections of GSIM model

This scenario can be true in case the development of China keeps its pace following an increase that is more or less predicted. Due to that increase people will demand for better quality of life, more infrastructure, new roads, transportations etc and that would lead to higher imported iron ore quantities and more and more quantities of steel produced.

Scenario 3 – High demand increase

Finally, the last scenario shows a boom in the Chinese demand side.

Table 11: High demand increase

	China	Australia	Brazil	India	Africa	ROW
Yearly demand increase	7.5%	2%	4%	3%	2%	2%
Yearly supply increase	5%	2%	2.5%	6%	6%	3.5%

Source: Projections of GSIM model

As we discussed in the introduction of this Chapter the biggest possibility for Chinese economy is to keep rising its demand expectations regarding iron ore. That increase was slowed down during the financial crisis period but it’s going to increase again its pace in the years to come. Chinese development is leading this demand and as long as China keeps increasing its construction and rural development demand will rise.

Moreover, in the supply side, China will follow a supply pace lower that the pace of demand. If development continues China can easily be transformed from a big exporting country to a country with and increasing demand for consumption. People are not going only to produce exporting products but as their quality of life increases they are going to also to consume bigger quantities.

Results

As we have already discussed in order to quantify the possible increase in the future trade of iron ore, we used three different scenarios implemented in the GSIM model. The results can be found in Table 12 below starting from the base year of 2010 and moving down to the outcomes of the three scenarios. We will only focus on the trade between China and the exporting countries of iron ore as well as to the quantities shipped from exporting countries to the rest of the world.

Table 12: Results of GSIM Model

2015	China
Scenario 1	
China	0.00
Australia	1,836,011,746.00
Brazil	219,896,615.40
India	580,613,480.10
South Africa	142,112,587.10
ROW	326,500,801.80
Scenario 2	
China	0.00
Australia	1,949,544,940.00
Brazil	242,328,477.70
India	615,362,668.60
South Africa	151,765,628.00
ROW	349,787,861.60
Scenario 3	
China	0.00
Australia	2,065,933,306.00
Brazil	265,659,095.10
India	650,980,090.60
Africa	161,656,812.70
ROW	373,693,574.20

Source: GSIM Model outcome

What it is of great importance is not the result itself but the percentage increase of Chinese iron ore trade in each of the three scenarios. As a result we can see in the table below that in 2015 a small increase of 2.5 per cent will lead to a 515 per cent increase in Chinese iron ore imports. On the other hand if Chinese demand increases in 7.5 per cent then this percentage is getting even bigger reaching a 580 per cent increase.

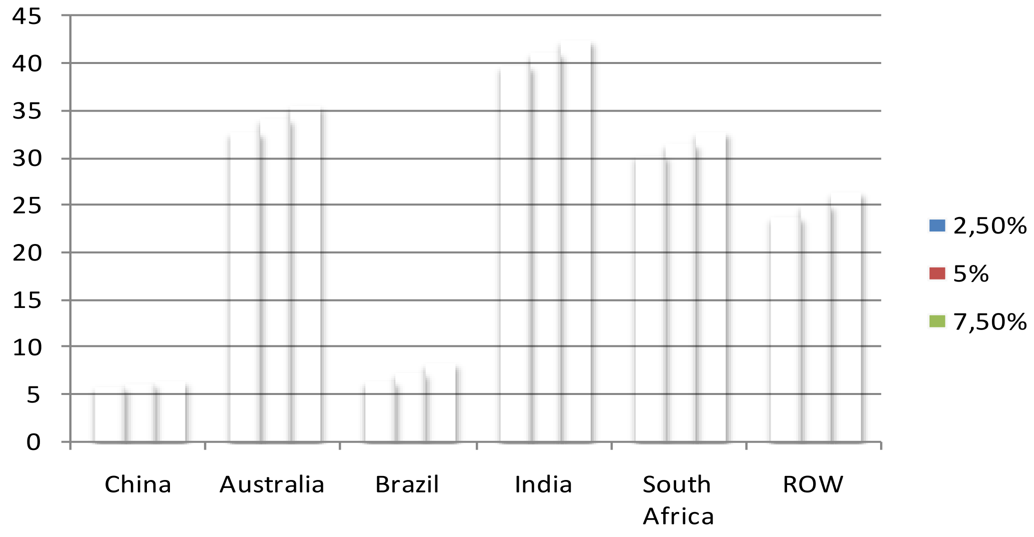
Table 13: Percentage increase on Chinese demand for iron ore

2015	China
Scenario 1	415%
Scenario 2	449%
Scenario 3	483%

Source: GSIM Model outcome

Moreover, we can take a look on the percentage increase on trade of the most important iron ore exporters in the three different scenarios.

Figure 8: Increase of iron ore exports in the three possible scenarios



Source: GSIM Model outcome

According to figure 8, the biggest increase in trade will be witnessed in countries with bigger supply than demand growth. As a result in the years to come India will establish its role in iron ore trade and that increase will also be followed by South Africa. In the trade of iron ore, smaller players will also be witnessed entering the market, as the rest of the world is also increasing its iron ore supply. Australia and Brazil will hold their position as major iron ore exporters and the most probably the trade of iron ore will remain an oligopoly, as the percentage which the major players hold in their hands will be kept.

5.5.2 Scenarios of tonnage supply

On the supply side, Clarksons have predicted that for 2011 there will be a 13 per cent increase in Capesize vessels fleet. A slower development will follow at 2012 with an increase of 11 per cent while in 2013 it will rise again to 13 per cent, due to the big number of newbuilding vessels entering the market. From 2013 and beyond they believe that due to the downturn of the shipping industry, scrapping rate is going to rise and shipbuilding will reduce. As a result they predict a 6 per cent for 2014 and a 5 per cent for the years beyond that.

As far as scrapping rate and losses is concerned, we used data from Clarksons website in order to see that there is an increase in that rate through 2011, reaching a 0.5 per cent. Further on, because new deliveries of vessels will be entering the market this rate will also decline but still holding a 0.3 per cent for 2012. Finally this rate will be more stable after 2013 keeping a 0.15 per cent.

Those finding can be summarized in the table below when we can see in number the growth that is going to follow in vessels tonnage the next 5 years.

Table 14: Projections on tonnage supply

	Capesize vessel tonnage	Newbuilding rate	Losses and Scrapping Rate
2011	232,904,300.00	2.1	-0.05

2012	258,523,773.00	1.5	-0.04
2013	292,131,863.49	1	-0.03
2014	309,659,775.30	0.8	-0.015
2015	325,142,764.06	0.5	-0.015

Source: UNCTAD and Clarksons database

5.5.3 Scenarios of future predictions

Some main assumptions should be followed in order for as to be able to combine the outcomes of the multiple regression analysis, of the GSIM model and of the future supply predictions in order to reach a possible upcoming result regarding the future of iron ore dry bulk market.

In table 15 we can witness the present situation (2010) and the situation in 2015 using the three possible scenarios mentioned in GSIM model. We have to remind you though, that in order for the outcomes of the regressions to be percentages we turned our data into logarithms leaving unchanged, the rates, the indexes and the growths. In respect of simplicity though, the data presented in table 15 are in their original state.

Table 15: Assumptions on projections

	GTio	LPI	SPio	NBR	ChGDP	$Xio^{AUSBRAZ}$	LSR	ChxGDP
2.5%								
2010	995,470,000	3.64	152	0.02	4,832,136	708,350,000	0.022	29
2015	3,458,889,628	4.24	117	0.05	5,467,118	2,311,085,172	0.015	32
5%								
2010	995,470,000	3.64	152	0.02	4,832,136	708,350,000	0.022	29
2015	3,655,698,808	4.4	117	0.05	6,167,166	2,442,531,074	0.015	32
7.5%								
2010	995,470,000	3.64	152	0.02	4,832,136	708,350,000	0.022	29
2015	3,858,131,510	4.6	117	0.05	6,937,156	2,577,793,357	0.015	32

Source: own estimates using regression analysis, GSIM and projection outcomes

We can see in table 15 that the new building rate and the loss and scrapping rate that will be used in our predictions were part of the Clarksons projections calculated in chapter 5.5.2. However, the numbers used in our equations will be cumulative prices from 2010 till 2015. As we have already mentioned, shipbuilding is a procedure that takes several years. As a result the SIN data base has all the orders that have been put in the shipyards with a delivery within the following decade. This can give us a very concrete prediction regarding 2015 and we can see that compared to the new building rate of 2010 there will be a decrease in tonnage entering the market from 2015 and beyond.

Global iron ore trade and the sum of Australian and Brazilian iron ore exports is an outcome of the GSIM model generated in 5.5.1. The calculations we performed regarding global iron ore trade, gave us the number of iron ore that will be demanded between the countries in 2015.

We can see that in each case of Chinese GDP growth we also followed a projection of the three scenarios. We assumed a GDP increase of 2.5 per cent in the first case, a 5 percent in the medium case and finally a 7.5 per cent in the last scenario.

Another factor that will also change in each different scenario is the LPI index. Chinese growth will have a different impact on the development of logistics services in each of the previous simulations. As a result we assume a 16 per cent increase in LPI index when the Chinese growth follows a demand growth of 2.5 per cent. In case of the 5 per cent medium demand growth we will assume that the LPI index is also becoming higher, following an increase of 20 per cent and finally in our last simulation of the highest demand boom, we will use a logistic performance index which will be30 per cent higher than the one used in 2010.

In case of the spot prices of iron ore trade, we will assume a 5 per cent yearly decrease in its value, because of the increase that will be witnessed in its supply. As we already analyzed in chapters 2, the exporting countries of iron ore are becoming more and more powerful resulting in more quantities produced. This increase in supply will push spot prices further down. Moreover, the private huge vessels used by big iron ore companies (e.g. Vale) will minimize the spot trade of iron ore.

Finally, regarding the percentage of Chinese exports over GDP, we can see in our data that this percentage used to be almost 40 per cent in 2007. After the financial crisis there was a drop in demand for Chinese products and as a result this percentage witnessed a sharp fall of almost 15 per cent. As a result we will assume that the future economy will continue to be stable and the Chinese exports will steadily rise again reaching a percentage of 32 per cent.

Taking into consideration the data mentioned above, we will use our equations with the significant coefficients mentioned in chapter 4 in order to reach an outcome regarding freight rates. As we also mentioned in chapter 4, in our equations we will use only the variables that have a significant coefficient in the multiple regression analysis. As a result some of the variables that do not have a great influence on the independent variables are left out.

We will start by estimating the percentage change of the price of iron ore. As we can see in the table below (Table 16) a 2.5% increase in trade would lead to a 0.2 decrease in the price of iron ore. On the other hand, the medium and high scenario we will produce an increase of 0.8 and 2 per cent respectively.

Using the percentage changes of iron ore as inputs in the Chinese demand for iron ore equation we will witness the increase in traded quantities in all of the three scenarios. As we can see minor differences exist between them (22.6, 22.7 and 22.8 per cent). In all of the three scenarios the Chinese demand for iron ore will have almost the same increase due to the fact that a five years period is not enough to generate more traded quantities even if the demand exists.

As a result we come to our final outcome. We will use the percentage changes of the equations of the iron ores' price Y_1, iron ores' demand Y_3, and all of the significant coefficients mentioned in chapter 4 as inputs to the equations of freight rates. The results are described in table 16 below.

Table 16: Future percentage changes

2015	Low (2.5%)	High (5%)	Medium (7.5%)
Price of iron ore %	-0.2	0.8	2
Chinese demand %	22.6	22.7	22.8
Freight Rates %	2	6	10

Source: Regression analysis and GSIM Model outcome

Knowing all the data in the base year of 2010, we are finally able to reach the outcomes found below in which we have the 3 possible price, demand and freight rates scenarios for the year 2015.

Table 17: Price, demand and freight 2015 predictions

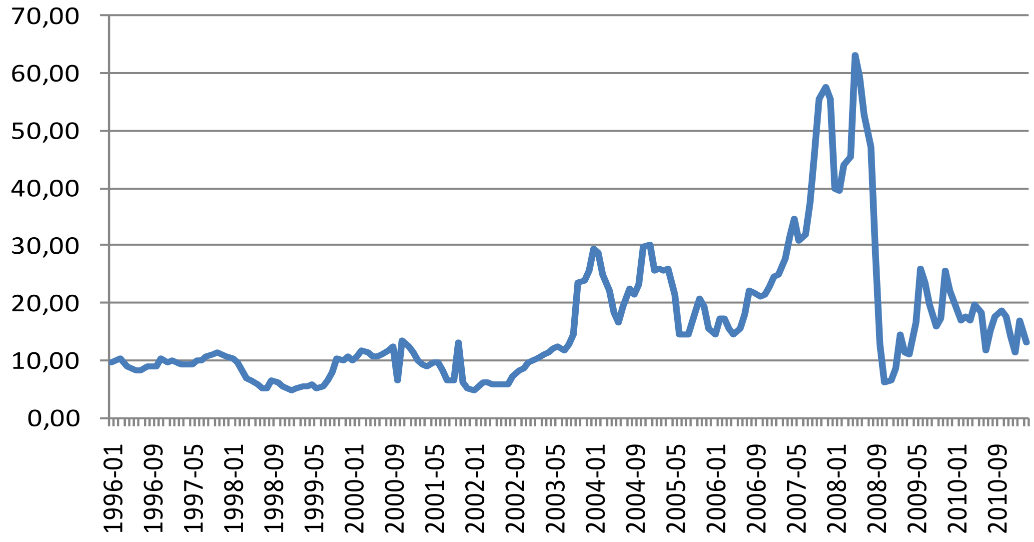
2015	Low (2.5%)	High (5%)	Medium (7.5%)
Price of iron ore ($/ton)	145	147	149
Chinese demand (tons)	738,738,560	739,341,120	739,943,680
Freight Rates ($/ton)	17.9	18.2	19

Source: Regression analysis and GSIM Model outcome

With the use of Equation 3 and the combination of the GSIM model, we finally managed to take a look into the future of Chinese iron ore freight rates. In 2010 the freight rate of iron ore in the Capesize voyage market was around 17 dollars per ton. According to our results this number will not change a lot in 2015 even if the Chinese demand witnesses a big shock.

We should also take a look into the history of freight rates. In figure 9 below we can see how the capesize voyage iron ore market has been moving from 1996 till 2010.

Figure 9: Capesize voyage market freight rates



Source: Data gathered from Clarksons website

In the graph above we can see that iron ore freight rates were always moving in rates closer to 20$ per ton and that they are also performing cycles like the shipping market. However, the huge increase witnessed from mid 2006 to the start of 2008 was unique phenomenon which was followed by a disaster.

Having all the data mentioned in the previous chapters and also knowing that in the years between 2010-2015 the new building rates are going to be higher, the quantities traded with China are going to be lower than the ones traded in 2015 and knowing that the LPI index is increasing year by year, we can hardly say that if the Chinese demand is not sharp, then the years between 2010 and 2015 will witness a downward move on freight rates. We are now in the middle of 2011 and we can see that freight rates are even lower than the ones of 2010.

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Chapter 6 – Overall findings and conclusions

6.1 Main conclusions and findings

In chapter 4 we used the method of multiple regressions in order to find the coefficients of the variables of the three main equations used in our analysis. Through the use of that method we can now observe the positive or negative relationship existing between our variables but also we are able to analyze the effect of endogenous and exogenous factors affecting each equation.

In order for us to use those outcomes and to take a good look into the future we used in chapter 5 the GSIM model which provides a mechanism of future demands prediction growth. Additionally, from the supply point of view, we used the projections of Clarksons Inc in order to reach an outcome regarding future tonnage supply.

The main purpose of this research is to see if the Chinese demand for iron ore, that will follow the next five years will provide enough stimulus to the freight market of dry bulk vessels and if it will be able to give an encouraging outlook to the markets by leading the shipping cycle in a positive turn.

Looking again in our equations we have the following significant coefficients:

<u>Price of iron ore</u>

Global iron ore trade (GTio): -8.5

Logistic performance index (LPI): 8.5

Spot iron ore price (SPio): 0.16

New building rate (NBR): 0.007

<u>Chinese demand for iron ore imports</u>

Chinese GPD (ChGDP): 0.34

Australian & Brazilian Exports ($Xio^{AUSBRAZ}$): 0.33

Price of iron ore (Y2): 0.41

<u>Freight rates</u>

Newbuilding rate coefficient (NBR): 0.05

Chinese demand for iron ore (Y2): 0.74

Losses and scrapping rate (LSR): 2.13

Logistic performance index (LPI): 1.93

Chinese exports as a percentage of GDP (ChXGDP): 0.08

Through the combination of the GSIM model, the aforementioned coefficients and the tonnage projection we were able to run all the three equations (price, demand, freight rates) and generate an outcome regarding the future percentage change of the three interdependent variables. In compliance with our outcomes the price of iron ore will witness small changes of +/- 2 percent depending on the applicable scenario.

This percentage showed us the way in running the second equation of Chinese demand for iron ore. The result, however, was not as moderate as it would be expected as the iron ore trade of the next five years, is very hard to have a very sharp increase due to the newbuilding vessels entering the market and the stable production of the main exporters.

Finally using the two percentages, combined with the cumulative increase of newbuilding vessels and scrapping rate we were able to make a prediction of the percentage increase of freight rates.

The low scenario would lead to an increase of 2 per cent and to freight rates of almost 18$ per ton. The medium scenario would half almost the same results with a 6 per cent increase and an 18.2$ per ton freight rates. Finally the higher demand would lead to a 10 per cent increase generating freight rates of 19-20$ per ton.

We can see that all of the three scenarios are unable to generate freight rates that would provide great benefits to shipowners. However, the analysis of the history of freight rates revealed that situations like the ones witnessed in 2006-2008 are very hard to find.

Concluding I would like to remind you that we are in the middle of a shipping cycle. Its duration is unknown as its lasting period can vary from a few years to decades. However what we have learned looking back into the shipping history is that the feeling of the shipowners is the one that can end or save the market. As Prof. Haralambidis had many times mentioned in his lectures "A good ship-owner is the one who can ride the cycles". Decisions that can change the present situation can always be taken, leading to a different future which remains unknown for now. However, through our analysis we tried to predict a possible future outcome, taking into account the present situation

6.2 Limitations and areas for further research

Through our research we came across several limitations which we needed to overcome and would be of great interest for a further research. First of all we analyzed the macroeconomic determinants of freight rate and as a result a more holistic approach would be to additionally study microeconomic determinants like the laycan, vessels age, size, etc. The effect microeconomic determinants have on freight rates hasn't been widely analyzed and it would give another perspective to our study.

Data limitation regarding the average haul did not let us to include this variable into our equations. Our efforts to communicate with different sources regarding those data did not pay out. As a result a more concrete analysis could also be performed including the aforementioned factor.

GSIM model being a partial equilibrium model, keeps the rest of the factors steady. As a result, we can say that the use of a general equilibrium model would give a stronger outcome to our research, offering the possibility of comparing resemblances and dissimilarity to both results.

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Annex

Regression on Chinese Demand of iron ore

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	9,915647942	2,947252741	3,364369742	0,001291
ChiGDPPP	0,345178	0,177851211	2,998532114	0,023410
Xaus/bra	0,329692941	0,150138862	2,195920076	0,031672
Price IO	0,4115886	0,11149576	3,691517965	0,000458
Resid Y2	-0,347722882	0,22418749	-1,551036065	0,125749

Regression on the Price of iron ore

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	128,3407456	11,82845815	10,85016694	3,14E-16
Global	-8,488621904	0,749223278	-11,32989611	4,91863E-17
LPI	8,503389408	0,522259523	16,28192313	1,26916E-24
spot	0,159135335	0,032441606	4,905285361	6,55603E-06
Newbuild	0,007038927	0,00674676	1,043304825	0,300671925

Regression on the iron ore freight rates

	Coefficients	*andard Err*	*t Stat*	*P-value*
Intercept	-15,23949612	5,459726	-2,79126	0,007031
Price IO	-0,312434214	0,363632	-0,8592	0,393648
New vess	-0,050354025	0,025022	-2,01236	0,048678
y2	0,730892407	0,362258	2,017601	0,048112
Scrap	-2,137356929	0,317596	-6,7298	7,22E-09
LPI	1,927711693	1,204663	1,6915	0,094805
CapeZWGr	-0,000361534	0,000336	-1,07628	0,28611
exports	0,082455802	0,018218	4,526019	2,9E-05
Res_eq1	-0,341173108	0,320048	-1,06601	0,290691
Res_eq2	0	0,556204	0	1

GSIM Model Results

2010

	China	Australia	Brazil	India	South Africa	ROW
China	0	0	0	0	0	40000
Australia	265500000	0	0	0	0	136350000
Brazil	130900000	0	0	0	0	175600000
India	96700000	0	0	0	0	6400000
South Afri	29600000	0	0	0	0	18371460
ROW	79860000	0	0	0	0	56148540

2015 - LOW

	China	Australia	Brazil	India	South Africa	ROW
China	0	0	0	0	0	54512,44973
Australia	1836011746	0	0	0	0	43114515,22
Brazil	219896615,4	0	0	0	0	212062295,3
India	580613480,1	0	0	0	0	6081553,4
South Afri	142112587,1	0	0	0	0	27593372,92
ROW	326500801,8	0	0	0	0	64848148,14

2015 - MEDIUM

	China	Australia	Brazil	India	South Africa	ROW
China	0	0	0	0	0	55283,71097
Australia	1949544940	0	0	0	0	41069666,04
Brazil	242328477,7	0	0	0	0	209587990,4
India	615362668,6	0	0	0	0	5878683,879
South Afri	151765628	0	0	0	0	27017017,64
ROW	349787861,6	0	0	0	0	63300590,2

2015 - HIGH

	China	Australia	Brazil	India	South Africa	ROW
China	0	0	0	0	0	56056,40684
Australia	2065933306	0	0	0	0	39151779,62
Brazil	265659095,1	0	0	0	0	207049176,9
India	650980090,6	0	0	0	0	5686740,505
South Afri	161656812,7	0	0	0	0	26459900,17
ROW	373693574,2	0	0	0	0	61804977,93