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Factors that affect the Freight Rates of Coal Trade between Australia and China for Panamax Vessels

By

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Abstract

The aim of this thesis is to name, explain and analyze the factors that affect the freight rates of coal trade between Australia, the biggest supplier of coal globally and North China, one of the largest importers of coal in Asia and in the world. The thesis has been divided into various chapters which aim at analyzing these factors through literature review and then focusing into the most important ones quantitatively.

A review of the different factors which affect charter rates has been done and the most important ones such as commodity demand and industrial activity have been used in order to build an analysis for the demand for coal in China as a result of growing industrial activity.

The required data related to the relevant charter rates and variables related to the industrial activity such as power consumption and steel production have been described. A qualitative analysis of the terminal facilities in the origin as well as the destination country has been done. In the methodology chapter the factors described above have been applied under correlation methodology to find the results.

Table of Contents

List of Figures

List of maps

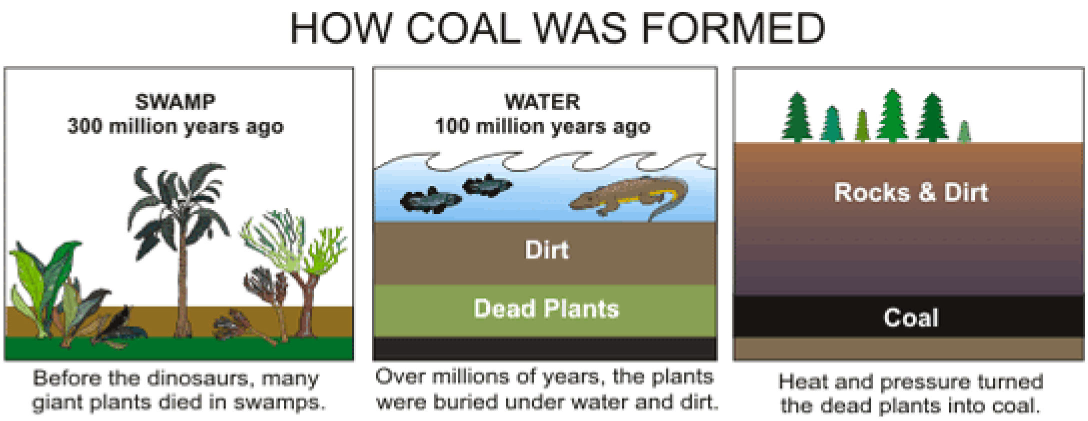
List of Tables

Chapter 1: Introduction to Thesis

1.1 Coal

Coal is a combustible black or brownish-black sedimentary rock composed mostly of carbon and hydrocarbons (Anon 1). Its formation takes millions of years and therefore it is a nonrenewable energy source. The energy stored inside coal comes from the energy stored in plants that lived millions of years ago, when the Earth was partly covered with swampy forests. For millions of years, a layer of dead plants at the bottom of the swamps was covered by layers of water and dirt, entrapping the energy of the dead plants. The heat and pressure from the top layers helped the dead plant remains turn into coal. Coal is extracted from the ground by mining, either underground by shaft mining the seams or in open pits.

Figure 1: How coal was formed



Source: National Energy Education Development Project (Public Domain)

1.2 Types of Coal

Coal is classified into four main categories, depending on the amounts and types of carbon it contains and on the amount of specific heat energy it can produce. The rank of a deposit of coal depends on the pressure and heat acting on the plant debris as it sank deeper and deeper over millions of years. For the most part, the higher ranks of coal contain more heat-producing energy.

Anthracite contains 86-97% carbon (Anon 1), and generally has a heating value slightly higher than bituminous coal.

Bituminous coal contains 45-86% carbon (Anon 1). Bituminous coal was formed under high heat and pressure. Bituminous coal is used to generate electricity and is an important fuel and raw material for the steel and iron industries.

Subbituminous coal has a lower heating value than bituminous coal. Subbituminous coal typically contains 35-45% carbon (Anon 1).

Lignite is the lowest rank of coal with the lowest energy content. Lignite coal deposits tend to be relatively young coal deposits that were not subjected to extreme heat or pressure, containing 25%-35% carbon (Anon 1). Lignite is crumbly and has high moisture content. The most common use of Lignite is mainly at power plants to generate electricity.

1.3 Coal & Its Uses

Coal is one of the most important energy sources for power generation, providing 37% of the world's electricity (Anon 1). Coal is also an essential redundant used in the metallurgical industries, where it is vital for 70% of world steel production (Anon 1). As the global population grows and living standards improve in the developing world, international demand for energy is increasing at a rapid rate. Coal is still the most abundant, widely distributed, safe and economical fossil fuel available that can meet this escalating energy demand. At current production levels, proven coal reserves are estimated to last 119 years. In contrast, proven oil and gas reserves are equivalent to around 46 and 63 years at current production levels respectively. Over 62% of oil and 64% of gas reserves are concentrated in the Middle East and Russia (Anon 1). Australia is the leading exporter of coal with 259 million metric tons exported for 2009 followed by Indonesia, Russia and Colombia as per the data shown in the table below.

Table 1: Main Exporters of Coal

	Total *of which*	Steam	Coking
Australia	259Mt	134Mt	125Mt
Indonesia	230Mt	200Mt	30Mt
Russia	116Mt	105Mt	11Mt
Colombia	69Mt	69Mt	-
South Africa	67Mt	66Mt	1Mt
USA	53Mt	20Mt	33Mt
Canada	28Mt	7Mt	21Mt

Sources: BP, IEA, World Steel Associations, SSY, WEC

On the other hand some of the top leading importing counties of coal are shown in the below table. The main importers are Japan, China, South Korea, India etc as per the data shown in the table below.

Table 2: Main Importers of Coal

	Total *of which*	Steam	Coking
Japan	165Mt	113Mt	52Mt
PR China	137Mt	102Mt	35Mt
South Korea	103Mt	82Mt	21Mt
India	67Mt	44Mt	23Mt
Chinese Tapei	60Mt	57Mt	3Mt
Germany	38Mt	32Mt	6Mt
UK	38Mt	33Mt	5Mt

Sources: BP, IEA, World Steel Associations, SSY, WEC

1.4 Major Importing Ports of Coal in China

1.4.1 Port of Qinhuangdao

Qinhuangdao Port was established in 1893. It is a seaport on the Bohai Sea in vicinity of Qinhuangdao, Hebei Province, China. Its geographical location is (119°36′26″E39°54′4″N) as is shown in the below picture. It is situated in the middle of Bohai Bay, and is an important hub for four economic zones including Northeast China, North China, Northwest China and Bohai Rim. Its distance from Beijing, the capital city of the country of china is no more than 300 kilometers (Anon 2).

Map 1: Port of Qinhuangdao

Source: Google Maps

Port of Qinhuangdao is the largest coal port all over the world with overall capacity of more than 200 million metric tons. It is strategically placed for transporting coal from the north to the south of China. The port handles yearly 200 million tons of coal, or otherwise the 50 percent of the Chinese coal (Anon 2). Qinhuangdao, the city where Qinhuangdao Port is located, was one of the 14 earliest coastal cities in the country founded for foreign trade, and the resulting open policies have provided beneficial conditions for the port's development.

It is equipped with almost the most advanced handling instruments across all ports in China, and benefits from the booming economic growth of the country. Despite its promising future, nevertheless, the port also suffers from some internal weaknesses and external threats, which are typical and worth of detailed study and analysis.

Qinhuangdao Port has lots of advanced handling equipment used to load and discharge different kinds of cargoes. Currently, the port has 57 berths in total, 36 of which are productive ones with annual throughout capacity of 1.3 hundred million tonnages (Anon 2). As far as coal handling equipment is concerned, port of Qinhuangdao has the most advanced handling equipment for coal operations all around the world. It consists of 21 berths of coal which include 3 lines of automotive railcar dumpers and positioners and various types of fixed coal handling machinery.

Qinhuangdao Port acquires a total number of 1.132 million square meters of warehouses and stockyards with overall capacity of 2.901 million tonnages. Among them, warehouse areas account for 77,000 m^2 with capacity of 104,000 tonnages, while stockyard areas account for 1,055,000 m^2 with capacity of 2,977,000 tonnages. 878,000 m^2 of yard areas are used for coal storage with capacity of 2,642,000 tonnages, which are the largest worldwide (Anon 2).

The average storage period for goods in the port is reduced because of advanced transportation methods and convenient connections. Direct shipment of coal amounts to be 6% of all handled in the port (Anon 2).

1.5 Major Australian exporting ports of Coal

1.5.1 Port of Newcastle

Port of Newcastle is situated around 160 kilometers northeast of Sydney at the mouth of the Hunger River on Australia's east coast (32° 54' 27" S 151° 46' 14" E). Born in 1801 as the Coal Harbour Penal Settlement, the Port of Newcastle grew up as an outlet for farm produce and coal (Anon 9).

The Port of Newcastle is the oldest seaport in Australia and the second largest in tonnage handled. Coal mining became the Port of Newcastle's major industry in the 1830s (the industry was gone by the early 1960s). The first Australian railway was opened in 1831 to transfer export coal to the Newcastle wharves (Anon 9). In the 1850s, an important copper smelter was established nearby, and a zinc smelter was built in the late 1880s.

In 1911, BHP Billiton, the world's largest mining company, chose the Port of Newcastle for its steelworks. Opening in 1915, the steelworks was the major employer for the area for 80 years, employing 50 thousand people for many years (Anon 9). The Port of Newcastle had a small shipbuilding segment which has been in decline since the 1970s.

The Port of Newcastle is the economic center for the Hunter Valley and much of northwestern New South Wales. It is the world's largest port for exports of coal, with more than 85 million tons of cargo moving through the port each year.

1.5.2 Port of Gladstone

The Port of Gladstone is Queensland’s largest multi-commodity port and the fifth largest multi-commodity port in Australia. It is the world's fourth largest coal exporting terminal. Port of Gladstone forms an integral part of the City of Gladstone in Central Queensland and it is located about 525 km north of Brisbane (23°49.61’S 151°34.6’E) (Anon 3).

The major exported commodities from this port are coal, alumina, aluminum, cement products and liquid ammonia. From the total exports of this port Coal exports consists the 70 per cent, each year more than 50 million tons of coal passes through the port of Gladstone. Other major imports of the port of Gladstone include bauxite and petroleum products as well as general cargo in containers (Anon 3).

1.5.3 Port of Kembla

Port Kembla Coal Terminal is a key coal exporting facility on Australia’s east coast, 72 km south of Sydney. It was opened in 1883 in order to ship coal from the mine at mountain Kembla. Today, it services two of the nation’s richest coal reserves, the Southern and Western coalfields of New South Wales, exporting high quality coking and steaming coal to all countries around the world (Anon 4).

PKCT is operated by a consortium of coal producers whose interests are best served by ensuring fast and reliable handling at the port. The coal terminal has a reputation for quick vessel turnaround times and for its ability to handle any sized cargo – from 5,000 tons barges to 166,000 tons bulk carriers (Anon 4). This is evidenced by the fact that Port Kembla Coal Terminal has been a dispatch port for several years.

1.6 Charter Rates

Charter Rate is the agreed cost of hiring a vessel to transport a cargo from one port to another. Spot charter rate, is the fare paid by the charterer to the owner for the carriage of a single cargo from one specified port to another. Spot charter rates typically include all expenses of operating the vessel, from fuel to crew, but exclude costs related to the cargo (e.g. inspection fees). Time charter rate is a daily rate of hire over a fixed period or trip(s), over which owners pay for the expenses of their vessels, such as maintenance and vessel insurance and the charterer is entitled to pay for the voyage costs, such as bunkers.

Charter rates are determined by many factors as for example by the demand for a specific cargo, the seasonality of a good, the price of fuel, the choke points vessels have to sail through, the market statement and congestion at ports.

- **Commodity Demand**: If the demand for a specific commodity is high then more ships are needed to transport the demanded quantity and therefore, charter rates also increase.

- **Seasonality**: Weather has a significant impact on both demand and logistics. For demand, cold weather increases the demand for coal and other energy creating raw materials. For logistics, cold weather frequently causes ice to block ports and low rivers to prevent travel. Both reasons increase the charter rates.

- **Fuel Prices**: Bunker fuel accounts for between a quarter and a third of the vessel's operating costs. Therefore, the higher the oil prices, the higher are the owner's expenses and that reflects in higher, more expensive charter rates.

- **Choke Points:** Nearly half of the world's oil passes through a few narrow shipping lanes. This includes the straits of Hormuz and Malacca, the Bosporus, the Suez and Panama canals. These choke points cause natural pause in ship supply, which means that only a certain amount of ships can pass through them each day. If something disrupts this flow, charter rates will increase.

- **Market Sentiment**: The freight rate index depends a lot on the market sentiment. For example, if there is a belief that there is going to be a global turndown or a recession in the market then charter rates will also decline or on the other hand will increase. Market opinion can greatly affect the freight exchange.

- **Port Congestion/ Terminal Productivity**: The actual infrastructure of ports prevents more ships from entering the market. That happens because ports simply cannot handle more traffic. Until changes occur at ports and their terminals, there is upward pressure on dry bulk prices. As far as the terminal productivity is concerned, the higher the terminal productivity of a port, the lower the congestion would be, and therefore, the less the pressure on dry bulk prices.

1.7 Australia's Supply of Coal

Australia has abundant supply of coal of all kinds. 75 percent of the coal mined in Australia is exported outside, especially to the East Asian countries. The higher export rate of coal from Australia is due to the extra coal available after satisfying the local demand in within the country. One more reason is availability of high quality of coal having higher specific heat capacity. Also the price of coal is lower compared to the local prices of coal in other importing countries even if the transportation cost of coal from Australia to these countries is taken into account. Most of the coal mines in Australia are located in the eastern cost that is New South Wales and Queensland. The two types of coal can be broadly divided into brown and black coal. The brown coal is generally believed to be the inferior variety of coal with high moisture content and lower specific heat content. So this brown coal is generally used for power generation within the borders of Australia.

The black coal which is found in New South Wales and Queensland has lower moisture content and higher specific heat value. So as fuel the black coal is more valuable and hence is used for export. The demand for this black coal is also very high in all the importing countries. Black coal also can be sub-divided into two types. One of them is the thermal coal and the other is the metallurgical coal. The thermal coal is used in the power plants for power generation and the metallurgical coal is used in the steel plants for production of steel.

1.8 China's Demand for Coal

The demand for coal in China is expected to increase due to the growing economy. With increase in industrialization and improvement in living standard of the population, the demand for power consumption will increase and hence the demand for coal. The demand for steel also has been growing sharply due to the increase in demand for real estate. This will also lead to an increase in demand for higher quality coal or coke. Overall the demand for high quality coal is expected to increase in China in the coming years. China has huge coal reserves. But still it is believed that China has to import more coal Australia to satisfy the higher demand especially when the domestic coal is rising. The coal is transported in ships from Australia to China. So the demand for coal would affect the transportation cost also.

Transportation is a derived demand and hence the price paid for transporting this coal would depend on the derived demand. In bulk shipping the price paid for this transportation is called as charter rates. They can be different charter types like the voyage charter and the time charter. The charter rates will depend upon many factors and these factors would be studied as a part of this thesis.

The major dry bulk carriers' sizes are the following (Anon 6):

- **Handy and Handymax**: the Handy and Handymax vessels have deadweight less than 60,000 (Anon 6). These ships carry mostly grains and minor bulks including steel products, forest products and fertilizers. These two types of vessels are the most suitable for small ports that have length and draft restrictions. They are also very suitable for ports that lack transshipment infrastructure.
- **Panamax**: Panamax vessels have the most suitable and acceptable size to transit the Panama Canal. This size can be found to both freighters and tankers. The dimensions of these vessels are restricted to a maximum of 275 meters for lenght, and widths no more than 32 meters. The average size of Panamax vessel is about 65,000 deadweight (Anon 6). These ships usually carry coal and grain and less frequent minor bulks, as for example steel products, forest products and fertilizers.
- **Capesize**: the Capesize vessel are not capable of using the neither the Panama nor the Suez Canal, due to their large size. These ships serve deepwater terminals, handling raw materials, such as iron ore and coal. As a result, the Capesize vessels sail through Cape Horn or the Cape of Good Hope. Their size ranges between 80,000 and 175,000 deadweight (Anon 6). Due to their size there are only a small number of ports around the world with the suitable infrastructure to accommodate so large ships.

As described in sections above the charter rates depend on various factors. The most important factor is the demand of commodity in a particular region drives the import of the commodity from another region where it is available in abundance. At the same time the size of the ships carrying the cargo is very important determinant of the charter rates. In simple words the charter rates change with the change in size of the ship. If a company wants to reduce its cost of sea transport, it might go for bigger vessel like cape-size vessel in order to achieve economies of scale in transportation. But at the same time the inventory cost for the company will increase. Another important factor which determines the size of the ship is the ports of handling. The question here is whether the port has enough natural draught to handle the bigger ship or the terminals are productive enough to give a faster turnaround to the bigger ship and provide net benefit in terms of economies of scale of the larger ship.

1.9 Research question

The main objective of the thesis is analyzing the various determinants which are affecting the charter rates in a particular route for a particular cargo for a particular kind of ship. All the points discussed above would play important role in determining the objective. The cargo being carried, the ports or terminals being used and the ship size are the constant factors in this study. The fluctuating charter rates are the dependent variable. So the main research question of the thesis would be

What are the important factors which affect the charter rates for coal transport form Australia to North China ports in Panamax size vessel?

The sub- question will be as follows:

Why do the charter rates for the above mention trade fluctuate and to what extent does the important factor affect the charter rates?

What are the factors which affect the charter rates?

To what extent the demand for coal and industrial activity affect the charter rates?

The main research question and sub-question will main points of discussion in this thesis.

1.10 Data and Methodology

All the qualitative data related to the port and the terminal serving the mentioned route would be required for the analysis. The charter rates of the Panamax ships carrying coal from Australia to North China for particular time period would be required. The data set for all other factors which affect the charter rates economic growth figures, demand for coal in china, China's electricity consumption from coal resources, steel production data.

The methodology used will be to find a correlation between the charter rates and the different factors which is believed to have affected the charter rates for a particular time period. This will help to determine the factor which directly affect the charter rates or the factors which are inversely proportional to the charter rates. This methodology will also help to determine how strongly the factors are related to the charter rates. So the thesis would help the shipping company and the shippers to have a knowledge base about the different factors which are affecting the charter rates of coal from Australia to North China for a Panamax vessel. Hence they would be able to plan their shipments in a more optimized manner.

1.11 Structure of the Thesis

The thesis has been divided into the following structure in form of different chapter as follows

Chapter 2 – Supply of vessel and the factors affecting charter rates in general.

Chapter 3 – Understanding the growing demand for coal in China and the abundant supply of coal in Australia.

Chapter 4 - Collection and description of the relevant data as per the review done in previous chapters to be used in the methodology in Chapter 6.

Chapter 5 – Important coal handling ports and terminal in Australia as well as China.

Chapter 6 – Quantifying the analysis by using correlations to find out the significant factors affecting the charter rates.

Chapter 7 – Conclusion and scope for further research.

Chapter 2: Literature review of Supply of Sea Transport and Charter Rates

2.1 The Supply of Sea Transport

The supply of the ship changes at a very slow rate compared to the change in demand. The supply of shipping depends on many important factors which will be discussed in this chapter. The most important factors which affect the supply of the ships within the shipping market model are productivity of the ship building yard, productivity of the fleet, total world fleet, number of scrapping done in the demolition market, loss of ships due to accidents and other such factors and revenue earned through freight rates (Stopford, 2009).

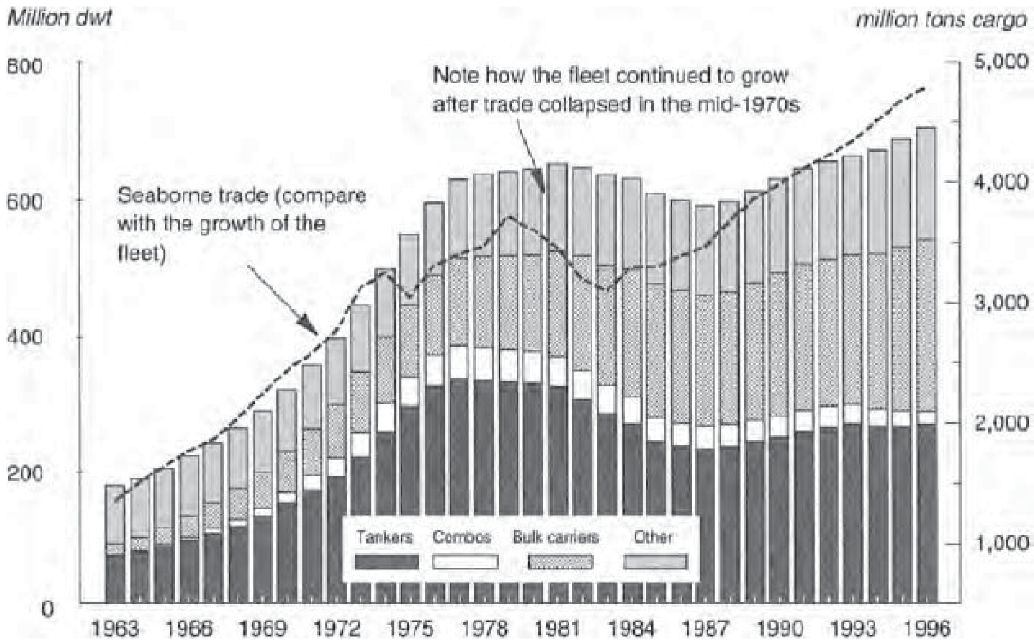
Most importantly the decision makers in the shipping industry are the responsible parties who control the supply of ships in the industry. In the shipping industry there are various decision makers involved such as the ship owners, charterers, banks which finance the shipping industry and other regulatory bodies which make rules for the industry.

The ship owners are the most critical in this decision making process. Sometimes the ship owners hire managers who have expertise in this field to take such decisions. As per the economic condition and predictions the ship owners or the managers have to decide whether to buy new ships, buy second hand ship, and recycle the old ship or layup a ship. The charterers or the shippers are the clients of the ship owners so they are very important determinant of the overall business environment. It can be said that the supply of ship is affected by the growth in demand of business for charterers. Suppose there is huge mining contract earned by a mining company to transfer iron ore from Brazil to China. It would require probably cape-size vessel to transfer the iron ore from Brazil to China. This would give a surge to the cape size vessel supply.

At same time one more important concept to be kept in mind for the shipping industry is that most of vessels are built to satisfy the demand in a particular route. An economically optimal size of a vessel has to be determined in a particular route. Taking forward the same example the same cape-size iron ore vessel selected for the Brazil-China route cannot be deployed in the Brazil Europe trade route. The banks which invest in ship financing are the most important vendors of the ship owners. The banks provide the capital to the ship owners to buy the huge capital intensive product such as ship. In case of banks the interest rate for lending a loan is an important parameter since it would affect the decision of the ship owner whether to invest such capital with high interest rate. If the market conditions are very bad, the ship owner might also have to scrap the ship to pay back the loan. The regulatory bodies such as the International Maritime Organization (IMO) are an important external party who even do not have direct involvement in the business can affect the supply market. The international body such as IMO makes regulation or some times change the existing rules in order to improve the safety standards or maritime environment protection which can affect the supply of the ships. The phasing out of the single hull oil tankers can be taken as such an example. This forced many oil tankers shipping companies to order for new double hull tankers and scrap their single hull tankers before the due date.

The existing merchant fleet also affects the supply of the ships. The graph below shows the growth in the size of the fleet from 1963 to 2005. It can be observed that there has been an increase in the size of the fleet from 82 million DWT in 1963 to 740 million DWT in the year 2005. At the same time the type of vessel and their proportion also keeps changing with time.

Figure 2: Development of Merchant Fleet from 1963 - 2005



Source: Stopford (2009)

The growth in economy, subsequently the increase in demand for certain commodities is an important determinant for the size of the merchant fleet. In the 1960s there was a huge demand for oil tankers in order to transport oil across regions. The existing supply of tankers at that particular point of time was not enough to satisfy the demand in the market. Even though the ship yard capacity was increased, still it was not enough to meet the market demand. As a result the second hand market for oil tankers was very active and tankers were even sold double the value of their purchase price. This booming market also increased the freight rate to high levels which resulted in an increase in profit levels. Ship owners were able to pay back their loans at a very quick rate.

The size of ships also kept changing with time. In order to achieve economies of scale with time there were larger ships. As a result there were different groups of ships in dry bulk as well as liquid bulk. More types of ships were seen in the dry bulk sector such as Handymax, Suexmax, Panamax and Cape size vessels. The market dynamics of a particular route changes due to the increase in the size of the ship. In a specific route it is economically not possible for vessels of different size to compete since the larger ship would reduce the freight rate by a great extent.

In the shipping cycle the demolition market is an important part of the whole market. In the demolition market the ships are scrapped. The scrapping is mostly undertaken due to economic factors. It also depends on the price of scrap steel in the scrap second hand steel market. Another important count is the number of vessel lost in the high seas due to accidents or fatalities beyond any economic control. As a result the above two factors the overall count of the supply of vessel reduces. An example of a extreme case is the year 1982, when the number new vessels scrapped were higher in number than the number of vessels delivered to the market.

It is difficult to predict at what age the ship would be scrapped. The factors are the present age of the ship, the cost of scrapping, the revenue earned through scrapping, present charter rates, prediction or expectation about the growth in market and other technical factors.

The important factors which affects the productivity of the fleet are the speed of the vessel, time spent in the port, utilization of dead weight and number of loaded days in the sea.

Speed of the vessel is the rate at which the vessel is moving to cover the distance from the point of origin to the point of destination (Stopford, 2009). Generally the container ships move at a faster rate which is around 25 knots when compared to bulk carrier which have an average speed of 13 knots. This is done in order to meet the business requirements which are different since container logistics requires faster logistics. More speed mean larger engines which again leads to more fuel burnt. With the increase in the speed the rate at which fuel burns increases per unit of cargo carried. So the ship owner might reduce the speed of the ship to reduce the cost since bunker cost is a very important cost to consider while operating a ship. Due to the reduction of the speed the productivity of the ship reduces. The speed also reduces due to increase in the fouling of the ship hull.

The productivity of the port or the respective terminal is a very important factor which even affects the productivity of the vessel. The ship owner would want the ship to spend the maximum amount of time in the sea by carrying cargo. This can happen only if they spend lesser time in ports. So the factors which can affect the port performance are terminal productivity, congestion levels and many other services.

Technically as well as theoretically the ship should be loaded with cargo up to 95% of the total with it can handle. The rest 5% is occupied by stores, ballast, bunker and other basic supplies. In practice due to many factors, such utility of the vessel dead weight is not seen. So there is a scope for the vessel operator to plan in such a way that it is best utilized to its optimum capacity. More the cargo carried more is the productivity or the utility of the vessel.

Freight rates are the source of revenue for the ship owners. If the freight rates are high, it encourages the ship owners to invest more in ship supply at least in short term. At the same time higher freight rates also motivate the banks to lend loan to the ship owners to buys ships.

2.2 Seasonality Affecting Spot and Time Charter Freight Rates

The seasonality in the dry bulk freight rates can be broadly divided into deterministic and stochastic seasonality (Kavoussanos, 2009). There is no evidence in terms of data for stochastic seasonality but the deterministic seasonality is found to vary from 18.25 % to 15.3 % in individual months within a year (Kavoussanos, 2009). The freight rate in the spot market is higher for bigger vessel.

As a result of high and low elasticity of supply under the different market condition, there is more seasonal fluctuation in the freight rates.

There is a supply side for the maritime cargo transport and there is the demand for maritime cargo transport. When both the supply and demand interacts the freight rates are determined. The demand for maritime trade is like the demand for any other transport means. It is a derived demand. There are seasonal factors which affect the demand for grain. The seasonal factors affect the freight rate in the shipping industry (Denning, 1994).

The dry bulk cargo is affected by the characteristics of the cargo being transferred by a vessel. In reality the dry bulk sector can be divided into number of smaller cargo units based on the type of ship and flexibility.

The freight rates change with the change in different months or seasons in a year. They general trend is that the freight rates rise during the start of the spring season that is during the month of March and April and they tend to decline during the month of June and July. At the start of September and October the freight rates of Panamax as well as handymax vessel again show a rise. It can be seen that the freight rate vary in a different way for different cargo and different size of vessel. So a shipping company having a larger profile of cargo as well as different ships can plan in a way to avoid major dip in revenue. It is also seen that there is more seasonal fluctuation when the market is improving compared to the period when the market is declining.

2.3 Factors that affect Charter Rates

The charter rates basically depend on various factors which will be explained in detail below.

2.3.1 Commodity Demand

The commodity demand in a particular region or a country is a very important determinant of the charter rates. If the commodity demand is high then the charter rates are bound to increase. Demand for transport is a derived demand. With the increase in commodity demand the demand for maritime transport to that particular region will increase. This commodity can be of many kinds. It can be a direct demand for the commodity in form of raw material for industries. For example coal is used as a raw material for generation of power in a power plant and it is also used as a raw material for production of steel in a steel plant. So an increase in power consumption in a particular region would increase the demand for coal. Similarly an increase in demand for finished products would increase the demand for container transport to a particular country. The commodity demand is generally co-related to macro-economic parameters like GDP (Gross Domestic Product), GDP per capita, growth in GDP per capita, consumption power etc. Generally a boost to the economy leads to increase in commodity demand keeping. So when there is an increase in commodity demand and the domestic supply does not grow at the same rate, there will an increase in imports. Here is where there will be an increase in demand for maritime transport by sea. If the supply of vessels is constant with increase in demand the price will increase and hence the charter rates.

2.3.2 Domestic supply and prices

Domestic supply of commodities is a very important parameter which affects the charter rates. If the domestic supply does not meet the demand even if it is constant then it leads to import of commodity. So there is an increase in demand for maritime transport and hence an increase in charter rates with constant ship supply. Domestic supply can be affected due to many factors. It can be due to labor problems, infrastructural issues or weather conditions and all these factors can have different levels of implications. The most common example of fluctuation is domestic supply in grains or agricultural products. The production in agriculture is highly dependent on weather conditions. If there are unfavorable weather conditions, then this might have huge implication on agricultural production especially in places with limited means of irrigation.

The prices in the domestic market are also related to supply and demand for a particular commodity in local conditions. At the same time it also depends on the availability of certain resources. Some resources are abundantly available in a particular region and hence the price of the commodity is also cheaper in that region. If there is scarcity of resources then the domestic prices are generally high and hence this is an incentive to import products from regions having the same resources in relatively more abundance. Hence this increase in trade leads to an increase in demand for maritime transport and hence affects the charter rates.

2.3.3 Seasonality

The effect of weather is both on the commodity demand and the logistics infrastructure. The demand for certain kind of commodities changes with season. This fluctuation leads to fluctuation in imports also. For example, in winter in case of cold countries there is higher demand for power consumption. This higher power consumption leads to more consumption of coal in that region. So there will be an increased demand of coal which might lead to more import. This will increase the demand for maritime transport by sea and hence affect the charter rates in that season.

Seasonality also affects the logistics and infrastructural facilities of an area. This makes the whole process of transportation costlier in terms of response as well as efficiency. For example the sea is frozen in North Sea during winter which makes the transit of vessels through the sea much tougher and expensive. The ports are also frozen which makes the process of berthing much tougher. All these factors have an adverse effect on the Supply Chain in terms of time and cost. Hence it will have an effect on the charter rates.

2.3.4 Industrial activity

An increase in industrial activity leads to more demand for raw material for production purpose. Hence it increases the demand for maritime transport hence has an effect on the charter rates. Increasing industrialization also has an indirect effect on the available employment. This leads to an increase in number of employments as well as income of the population as a whole. This leads to an increase in the consumption capacity of the consumers of the society. As a result of this the demand for finished goods and semi-finished goods increases. There is more demand for containerized goods and hence there is an effect on the charter rates of containerized goods. Hence it can be observed that there is a two-fold effect of increase in industrialization. There is initially an increase in raw material demand such as iron-ore, coal, oil and then with time a further increase in demand for finished goods.

2.3.5 Fuel price

The charter rate is an important parameter for the shipping company when it comes to measuring profitability. The cost for the shipping company is the capital expenses and the operational cost of moving the ship. The bunker used for propelling the ship constitutes a major part of the operating cost of a ship. If there is a fluctuation in the fuel prices, it also affects the operating cost of a ship. So keeping the demand for maritime transport constant, it can be observed that with an increase in fuel price, there will be an increase in charter rates to maintain the same margin of profitability.

2.3.6 Choke points

The choke points constitute the critical junctures in the sea route through which the ship has to pass. The examples of such points are the Suez Canal, Panama Canal, Malacca strait. If there is disruption in these choke points then the vessel has to choose a longer and more costly route. So a major hindrance in these choke points will lead to an increase in charter rates. It has also been seen historically that any disruption in these choke points leads to huge increase in charter rates.

2.3.7 Market sentiments

Shipping is a global business. So any apprehensions related to global economy also affects the shipping business. The shipping business ties up the whole international trade mechanism. Any recession in a major economy has an effect on the charter rates on major routes. The market sentiments have an effect on the Baltic dry index. In 2008-2009, there was a recession in the global economy. This had a huge adverse effect on the containerized trading. And first time since the containerized trade started there was a huge drop in revenue for the container shipping company confirming the negative implications of global economy down-turn on liner shipping.

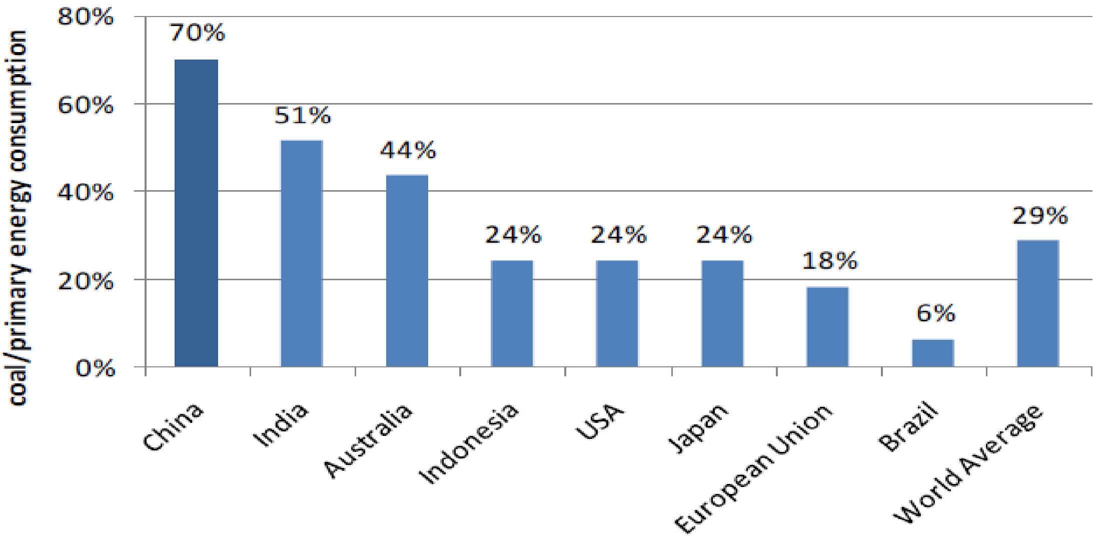
Chapter 3

3.1 Demands for Coal in China

There has been considerable growth in the Chinese economy in the recent times. This has been a focus of study for many economists. This high rate of economic growth has created more demand for energy consumption in many forms which has led to more concern for environment. The reason is that most of the energy consumption is done through fossil fuel which causes emission of pollutants into the atmosphere. This economic growth is expected to sustain in near future and there are also expectations that it will even increase more which has led to studies about estimating the demand for coal in the future.

In recent times the Chinese economy has been growing at an average annual growth rate of 9.5% (Cattneo at al., 2011). As a result of this the total GDP and the GDP per capita has multiplied by 10 times in 25 years. This economic growth has led to a growth in industrialization, urbanization and motorization (Cattneo at al., 2011). In the year 2004, the rate of growth in energy consumption was 18.3%. This made China the second largest consumer of energy after the United States of America (US) and the largest energy consumer in Asia.

Figure 3: Comparative Coal Dependence of Primary Energy Consumption in 2007



Source: BP Statistical Review of World Energy 2008

At the beginning of the 20th century, the only source of energy consumption was coal. With time, China started using other fuel sources such as oil and gas for production of energy with new and advance technologies. Despite these changes coal still remains the most important fuel to be used for energy production.

China has witnessed a high growth rate in manufacturing industries in last couple of decades which requires the highest share of energy production. In terms of percentage the heavy manufacturing industries consume 80% of the total energy produced. In case of a balanced economy, there is a balance between the manufacturing and service sector. But the case of China has been different since it is heavily tilted in the direction of manufacturing industries. So the power consumption requirement in China is even more. If a better balance is developed in future, China can save energy resource and at the same time protect environment for better sustainability of future generations.

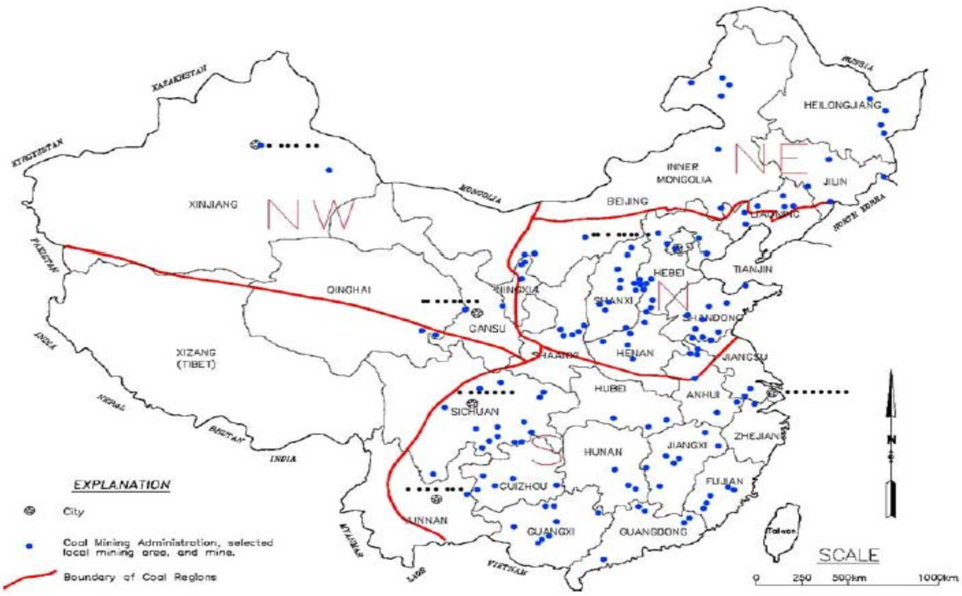
3.2 Spatial nature and Distribution of China's industrial coal demand

The distribution of the manner in which the power is generated differs from place to place in China which mainly depends on the source of energy. Most of the hydro electricity power generation projects are located in center and south China. The reason is that these two regions have the apt topographical features which enable the construction of multipurpose projects. On the other hands the North and the North Eastern part of China have a great number of thermal power plants as these areas have numerous amounts of coal reserves.

The map below shows the concentration of the coal producing region in China. The blue dots indicate the regions where maximum amount of coal is being produced. It can be seen that most of the coal mines are located in the north and the north eastern part of the country as per the map below. These are together amount to a total mining of 10 million metric ton annually (China Energy Data book, 2004). The top coal producing areas are Shanxi, Shandong, Inner Mongolia, Anhui, Shaanxi, Henan, Heilongjiang and Liaoning (China Energy Data book, 2004).

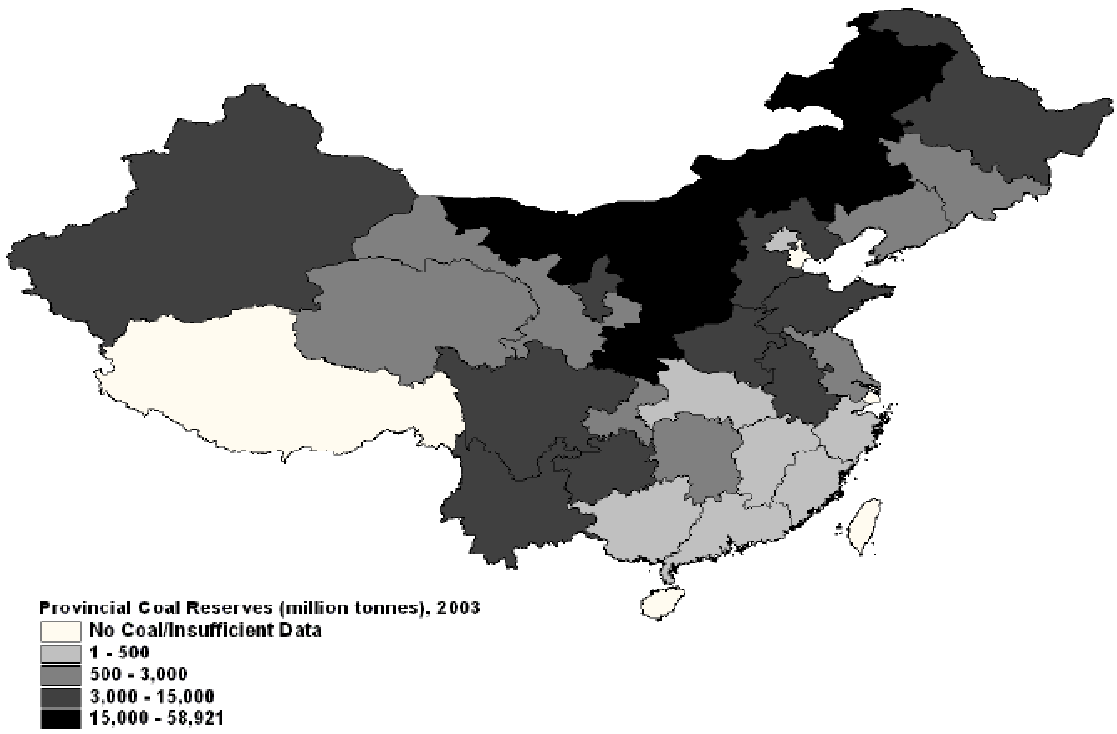
At the same time the highest demand for coal are from the following provinces; Shanxi, Hebei, Shandong, Jiangsu, Henan, Lianoning, Guangdong, Inner Mongolia, Anhui and Zhejiang. So it can be said that the provinces where the demand for coal is highest are located close to the areas where there is more production of coal.

Map 2: Location of the Major Coal Mines in China



Source: Cattaneo et al. (2011)

Map 3: Distribution of Chinese Coal Reserves in metric tons, 2003



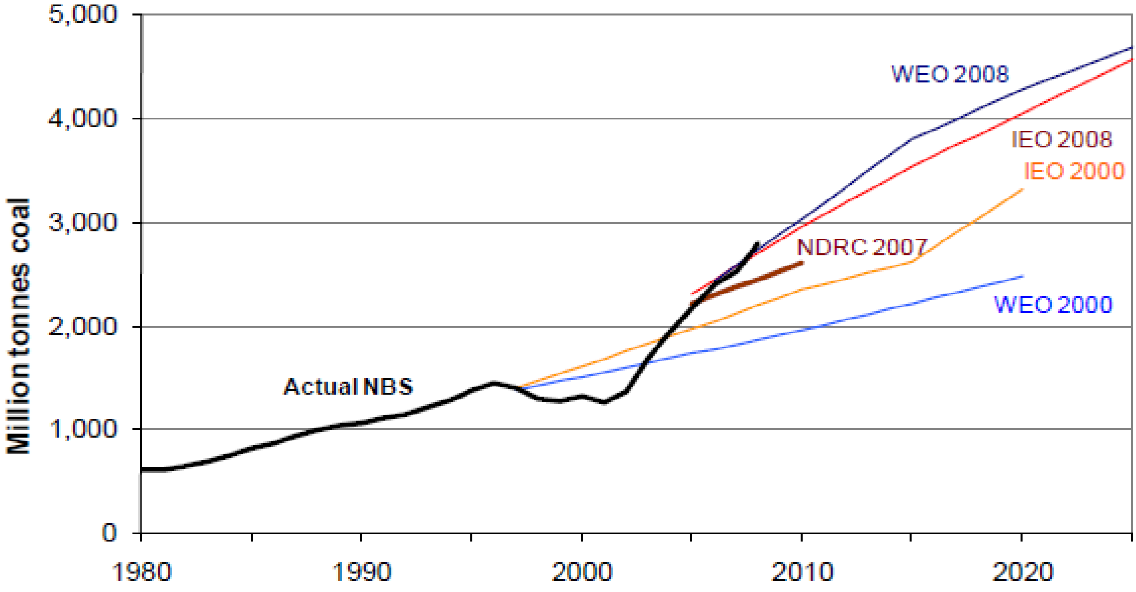
Source: Aden et al. (2009)

The map above illustrates that most of China's coal reserves are concentrated in the provinces of Shanxi and Inner Mongolia (Aden et al., 2009).Coal quality becomes a very important parameter. A higher quality of coal has higher specific heat so more power can be generated with even lesser mining of high quality coal when compared with same quantity of lower quality. It has been found that the best quality of coal in China is found in Gansu, Ningxia, Shaanxi and Shanxi. In terms of proportion 54 % of the total coal reserve in China is bituminous coal, 29 % is sub-bituminous and 16% is lignite (Aden et al., 2009). These are quantified on basis of volume. The province of Shanxi accounts for about 31% of the total coal reserves.

3.3 Historical and Forecasted Chinese Coal Consumption

Since the year 2001, the average rate of growth in the consumption of coal has been more than 10%. In the year 2007 the total consumption of coal in China was reported to be 2.500 million tons. IEA and WEO have forecasted the amount of coal to be consumed in the year 2010. The National Development and Reform Commission (NDRC) has reported the coal consumption to be somewhere around 4.7 billion tons (Aden et al, 2009).

Table 3: Historical and Forecasted Chinese Coal Consumption



Data Source: NBS

3.4 Chinese imports and exports of coal

The table below shows the import value of coal through annual time series between years 1999 to 2011. Considering the present status and trend China is the largest importer of coal in Asia and one of the largest importers globally. A steady increase in the coal import level can be seen through the years. The major reason has been increase in population level. More importantly the standard of living of the growing population also has been increasing as they require more and better infrastructure, housing and transportation. All this has led to increase in the urban population which requires more energy when compared to rural population.

Table 4: China Seaborne Coal Imports in Million tons

Date	China Seaborne Coal Imports in million tons
1999	1.66
2000	2.11
2001	2.47
2002	10.97
2003	10.32
2004	16.90
2005	23.38
2006	35.77
2007	47.87
2008	39.20
2009	125.91
2010	167.75
2011	60.92

Source: Clarksons Database

China is also an exporter of coal. But it can be seen from the table that the export levels coal in China has been decreasing with time. This has resulted due to increase in demand for coal in China.

Table 5: China Seaborne Coal Exports in Million tons

Date	China Seaborne Coal Exports in million tons
1999	36.81
2000	54.74
2001	89.73
2002	83.60
2003	93.54
2004	86.31
2005	71.45
2006	63.09
2007	52.91
2008	45.15
2009	22.36
2010	18.93
2011	8.04

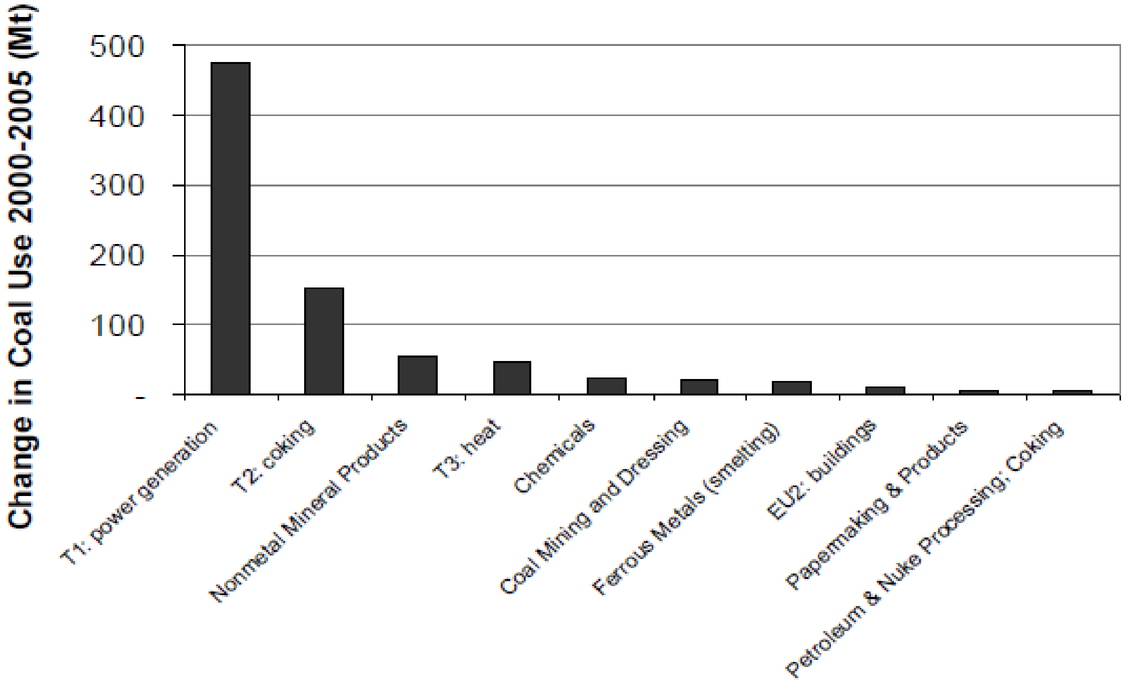
Source: Clarksons Database

3.5 Factors that Affect the Chinese Demand for Coal

With the increase in population the demand for real estate infrastructure has increased. For the construction of real estate projects steel and cement are major ingredients. For the production of steel a superior quality of coal is required as a raw material. This is called as coking coal. For the production of steel as well as cement huge amount of energy is required.

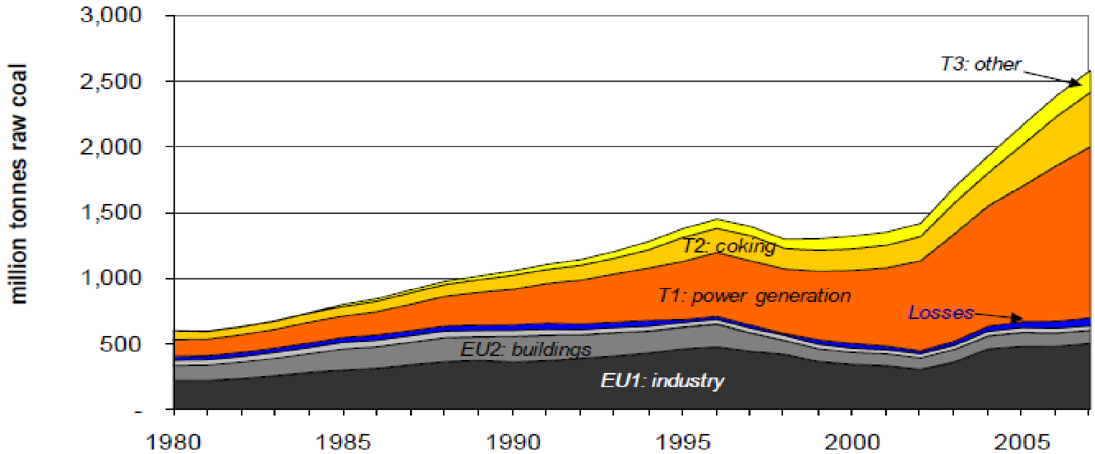
This energy is generally obtained from the production of power in the thermal power plants. Moreover due to more urbanization the power consumption increases due to the requirement of more electricity. The more urban society is also more consumerist society which results in more industrialization, hence more power consumption. The following graph shows the increase in consumption of coal from the year 1980 to 2007.

Table 6: Drivers Increasing Chinese Coal Use



Source: (Aden et al., 2009)

Table 7: Chinese Coal Consumption from 1980-2007



Source: NBS, 2007

EU1 = Industry
EU2 = Commerce + Other (government) + residential
T1 = Power Generation
T2 = Coking
T3 = Heating + Gas Production

Another important factor to be considered here is the rapid increase in export levels of industrial products in China. Most of the manufacturing products supplied to the western world are from China. This was mostly due to the rapid increase in containerization and the revolution in the Information Technology sector. The whole process of the global supply chain which starts from the manufacturing plant in China and ends at the retail store in the western world, where a lot of activities take place. The major activities are the manufacturing, transportation, warehousing and distribution. All these process require considerable amount of energy in form of power. The manufacturing of these products requires a huge power consumption which has resulted in the increase in consumption of coal.

3.6 Australia’s Supply of Coal

Australia is enriched with great amount of natural resources in form of mineral, coal etc. Compared to the population living in Australia, the amount of available natural resources is very high. This logically makes a large exporter of dry bulk raw material. Most of the coal in Australia is found in New South Wales, Victoria and Queensland. 75% (Anon 7) of coal mined in Australia is exported to the countries where it is required. The major importing countries of Australian coal are located in the East Asia such as Japan, China and Korea. For most of its domestic power requirement Australia uses coal. 85% of the power generated in order to produce electricity is done through thermal power plants whose main fuel resource is coal. To confirm the trend statistically, in the year 2008-2009, 487 million tons was mined in Australia. Out of these 487 million tons, 261 million tons were exported out of the country (Anon 7).

3.6.1 Coal mining methods

Coal is mined in open-cut mining. The coal is covered by rock. In case of open-cut mining this rock is blasted first. Then these rock pieces are removed with the help of huge draglines or hydraulic shovel and then loaded into trucks. In recent years due to the better techniques and availability of modern equipments, the depth of mining has been more than earlier times. The depth of mining has exceeded 60 m which was considered to be maximum achievable depth for a number of years (Anon 7).

Bord and pillar or longwall method is used for mining operation in Australia. In case of bord coal is extracted by a series of parallel tunnels. A right angle intersection method is used to create a block of coal which is then extracted in the second stage of mining. The longwall method is bord method as in this case the complete coal block is first extracted and then the roof is allowed to collapse. It has been found that the longwall method is more productive than bord and pillar method. More productivity means that more coal can be extracted in the longwall method when compared to the other method using the same amount of effort.

In 1990s the highwall mining method was introduced in Australia. This is a kind of second process after the open-cut mining. The open-cut mining process leaves a void which is again used by the highwall mining method to go even deeper.

3.6.2 Resources and deposits

The important criteria to judge a mining is to find out how close is the coal seam to the surface. As per Australian Coal Association, the seams of coal in Sydney-Gunnedah basin, New South Wales are closer to the surface when compared with other mining regions (Anon 7). So it is easier to mine in this part of New South Wales and also there is a reduction in mining cost.

In the eastern part of the country the mines are located in the hunter valley which stretches from Newcastle in the south to Muswellbrook in the north and most of these mines are open-cut mines. There is another important area of mining in Yarrawonga close to Gunnedah. The mines located in Appin, Tahmoor and Metropolitan mostly produce coking coal which is an important item of export (Anon 7).

Mines in Ulan and Springvale mostly produce thermal coal. The hunter valley provides option for mining of both soft coal and thermal coal. Since 1970s the mining in Queensland is rapidly growing. Goonyealla and Kestrel mines mostly produce coking coal which is an import export product as mentioned before (Anon 7).

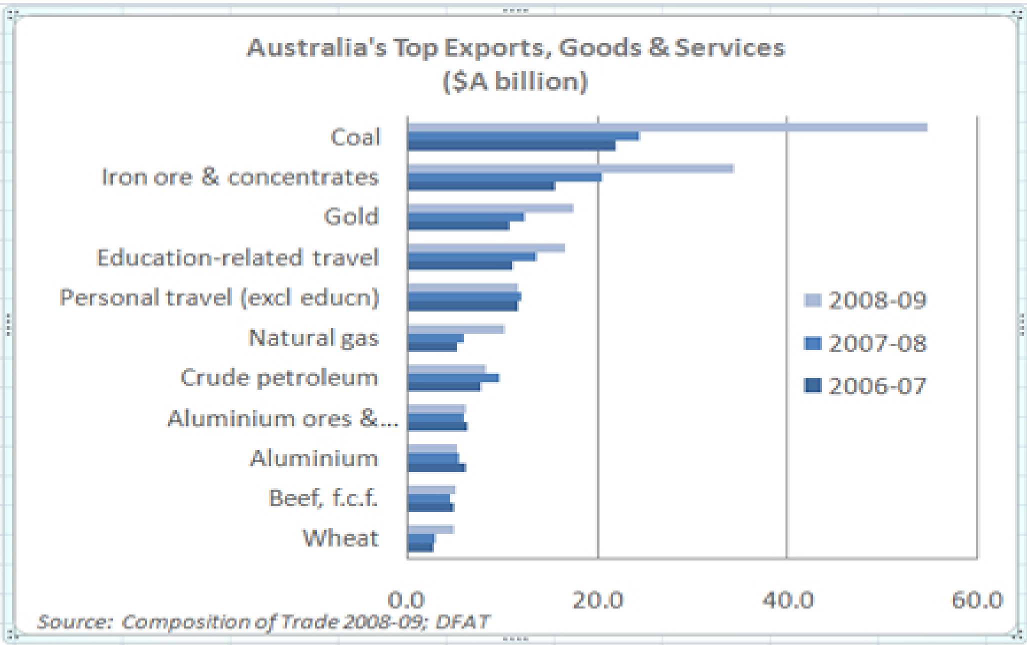
In recent times thermal or steaming coal also has become an important export product. This has happened due to growing demand of steaming coal which is required for increasing power consumption in some of the countries. So mines which are rich in steaming coal such as Newslands and Roleeston located near Brisbane have also become important mines in terms of export of coal. Callide Basin is also an important mine for thermal coal.

In the year 2009 it was reported that 43.8 billion tons of black coal has been estimated to be practically as well as economically feasible to be extracted from underneath surface in Australia. Out of this huge amount 96% was reported to be available in New South Wales and Queensland. 7% of the total black coal is estimated to be located in Australia. It ranks fifth in the world. The age of the brown coal found in Australia ranges from 15 million years old to 50 million years old. Victoria is the major location where brown coal is found in Australia (Anon 7).

3.6.3 Coal Exports of Australia

Globally Australia is one of the biggest exporters of coal in the world. As it is a well known fact that Australia is very rich in mineral resources so it exports lot of these mineral resources. But still black coal accounts for about 23% of the total exported merchant products as well as services in the year 2008-2009 as per Australian coal industry (Anon 8). Also it can be seen as per the figure below the coal export in the year 2008-2009 has increased significantly when compared to other years. For all the three years for which the data has been shown the coal export seem to be the dominating product when compared with other products and services.

Table 8: Australia's Top Exports

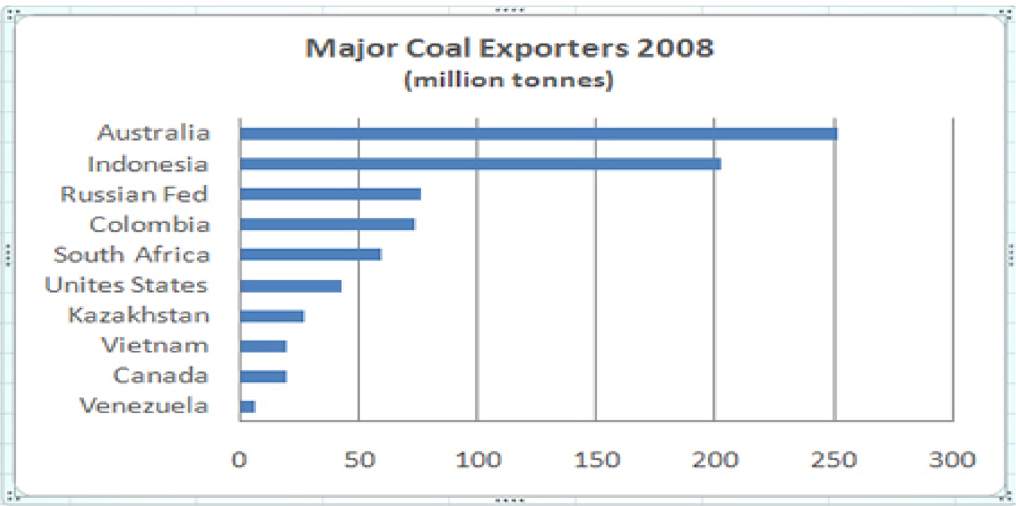


Source: Composition of Trade 2008 – 2009; DFAT

In the year 2008-2009 the coal trading market accounted for 941 million tons. Broadly the 941 million tons can be divided into 730 million tons of thermal or steaming coal and 211 million tons of coking or metallurgical coal. It can be seen from the graph below that Australia was the major exporter of coal accounting for almost 261 million tons which was about 28% (Anon 8) of the total world trade.

If the world trade for coal is further divided into thermal and coking coal then the Australia's share of Trade is 19% in case of thermal coal trade and 59% in case of coking coal trade. Other important exporting countries are Indonesia, Russia, and Columbia.

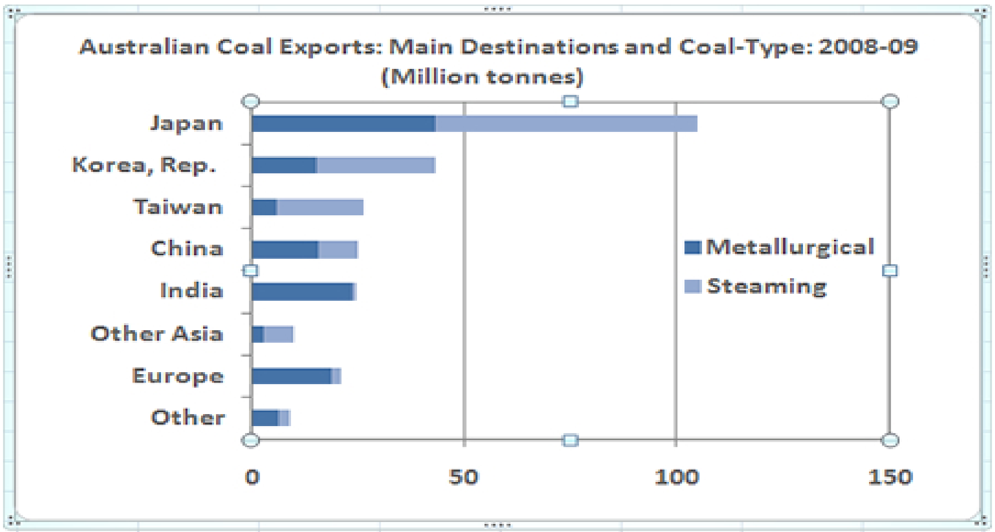
Table 9: Major Coal exporters in million tons



Source: Key World Energy Statistics 2009, IEA

As seen from the graph below Japan is the most important coal importer from Australia accounting for almost 40% of the total imported coal (Anon 8). The other important countries are Korea, China, Taiwan and India. In case of the East Asia countries the coking and thermal coal import proportions are almost equal. In case of India and Europe tit can be clearly observed that the proportion of Coking coal import is much more than the proportion of thermal coal.

Table 10: Main Destinations of Australian coal exports



Source: Coal Services Pty Ltd and Queensland Department of Mines and Energy

Chapter 4: Data Collection, Description and Analysis

4.1 Introduction

In this chapter all kind of data related to this thesis would be discussed. The data sources and the definition of the data would be discussed. The required data collected as a part of this chapter would be used in the methodology of the next chapter. Also some of the data has been used to look into the trend. The data also helps to justify the methodology being used. Most of the data is in time-series. A consistent time-series would be used so that a possible comparison can be made if required.

4.2 Charter Rates

This is most important data set in this chapter. The reason is that we are trying to find the factors which affect the charter rates. With respect to charter rates different kind of data has been collected. All these type of data will be discussed in this chapter and depending on the data analysis done in this chapter an appropriate data set would be selected for the methodology in the next chapter. The reason for discussing a variety of charter rates in this chapter is to provide a more holistic approach to the final data set of charter rates which will be used in the methodology in the next chapter.

This thesis major aim is to find out the factors which affect the charter rates. The factor which generally affect the charter rates were discussed in chapter 2. Now in this section of the chapter the available values of the charter rates in different routes specifically for coal would be studied. At the same time different kind of chartering and their differences would be observed. All this would be required to finally narrow down the research to the specific required data.

4.2.1 Charter rates in terms of different duration of time charter

The time charter has been discussed in the introduction chapter. The time charter is generally of longer duration. It can be a good deal for the ship owner as well as the charter depending upon the state of the market. The data available consists of four kinds of time-charter. These are the 6 months time charter, 1 year time charter, 3 years time charter and 5 years time charter. Mostly Panamax and Post Panamax vessels are used for trade in this route. So the ship size will vary from 60,000 DWT to 90,000 DWT.

For the time charter of bulk carriers 6 months, 1 year, 3 years and 5 years of time charter were considered for the analysis. Two sizes of vessel were taken which are 65,000 DWT and 75,000 DWT. The vessels of this size were considered since they are used for carrying coal from Australia to China. The charter rates were calculated with $/day which is the case of all standard time charter. The source of the data is Clarkson database.

The data set for a vessel of 65,000 DWT with a 6 month time charter has been considered. The time period of the data is 1989-2011 annually. The average value of the time charter is found to be 15,299 $/day. The maximum and minimum values are 46,075 $/day and 6381 $/day respectively giving a range of 39,694 $/day. The standard deviation is 10,726 $/day.

The data set for a vessel of 75,000 DWT with a 6 month time charter period has been taken into account. The time series under which the data is available is form 2001 to 2011 at an annual frequency. The average value of the time charter is found to be

28,367 $/day. The maximum and the minimum value for the data set are 58,796 $/day and 8837 $/day respectively with a range of 49,959 $/day. The standard deviation for the data set is 16,883 $/day.

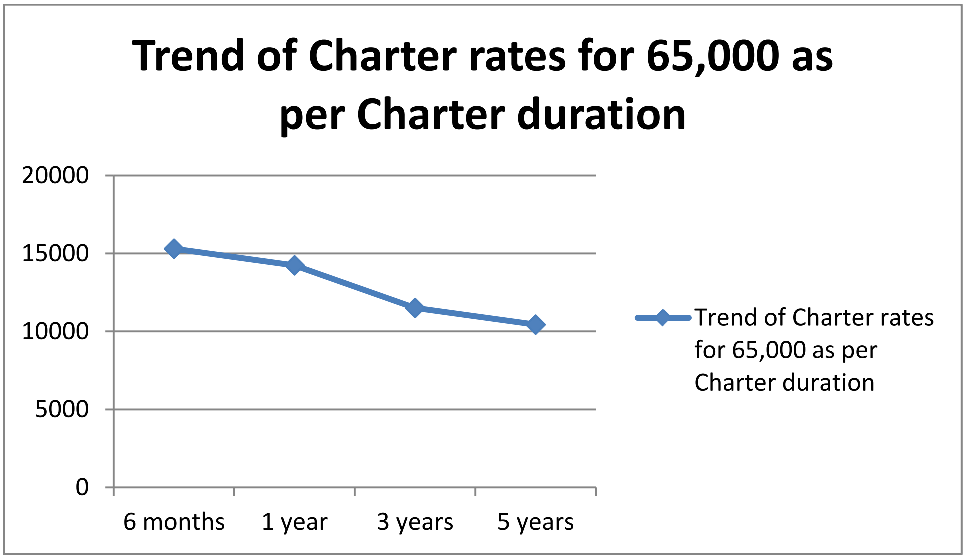
Similarly a 1 year time charter for a 65,000 DWT was considered. The time series was from 1989 to 2011 with a annual change. The average value for the data column was found to be 14,235 $/day. The maximum and minimum value of the data set were 44,697 $/day and 6401 $/day giving a range of 38,296 $/day. The standard deviation of the data set was found to be 9800 $/day.

A table has been constructed below to display similar kind of values as described above for other categories of time-charter

Categories of Time Charter	Average Value in $/day	Maximum Value in $/day	Minimum Value in $/day	Range in $/day	Standard Deviation in $/day
1 year 75,000 DWT $/day 2001-2011	25,783	55,637	8,612	47,025	15,788
3 years 65,000 DWT 1989-2011	11,502	28,837	6,388	22,449	5,764
3 years 75,000 DWT $/day 2001-2011	20,456	44,356	9,123	35,233	11,504
5 years 65,000 DWT $/day 2008-2010	10,434	15,683	6,642	9,041	4,693
5 years 75,000 DWT $/day 2008-2010	19,808	31,083	14,974	16,109	7,648

In the table above it can be seen the high value of standard deviation and range for all the cases. This shows that the charter rates are very fluctuating in nature. The duration of the charter rates clearly affect the charter rates. The more the duration the lower are the average rates through the same time series.

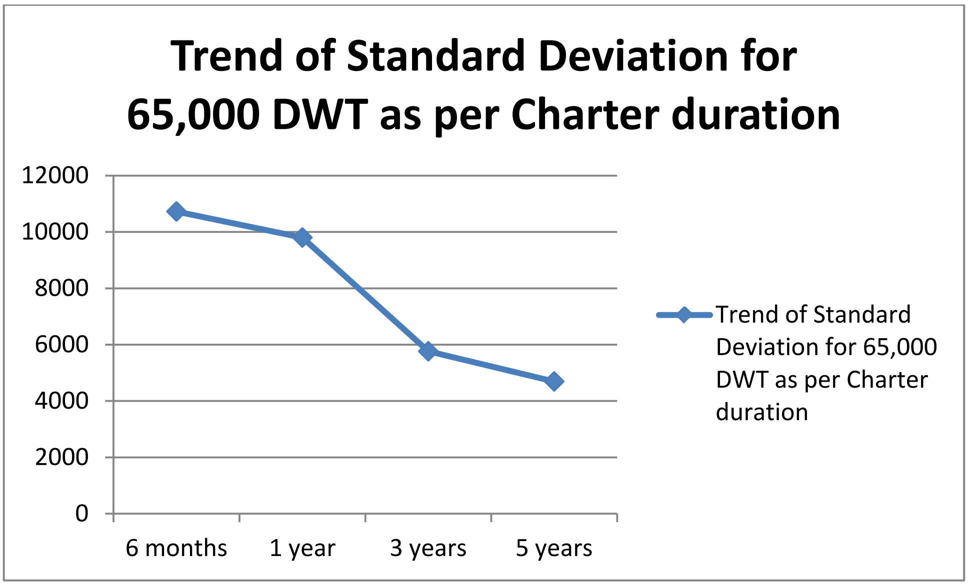
Table 10: Trend of Charter rates for a Vessel of 65000 tons deadweight as per Charter Duration



Source: Clarksons Database

The trend line above clearly shows a dip in charter rate value with the maximum average value being 15,299 $/day for 6 months time charter and the minimum average value being 10,434 $/day for 5 years time charter. The dip from 3 years to 5 years is lesser since the time series for the 5 years data has lesser values and very recent ones but still it matches with the trend.

Table 11: Trend of Standard Deviation for a Vessel of 65000 tons dwt as per charter Duration



Source: Clarksons Database

In the graph above a similar trend can be observed. The standard deviation reduces with increase in the duration of the charter period. The maximum value being 10,275 $/day for a 6 month charter period and the minimum value being 4,693 $/day for a 5 year charter period. This shows that with the increase in charter period duration the level of fluctuation in the charter rates reduces.

4.2.2 Charter rates in terms of Baltic index

The Baltic index is a means of tracking the change in freight rates. It shows the varying of the freight rate. As it is a moving index, it helps to predict future.

The data being considered from the Baltic index is the for the Panamax vessel. It is the average of the all four time charter routes. It is measured in $/day. The time series starts from 1998 to 2011. The average value of the mentioned index is found to be 22,129 $/day. The maximum and minimum values of the data set are 56,816 $/day for the year 2007 and the minimum value of the data set is 6,213 $/day. It gives a range of around 50,603 $/day. The standard deviation of the data set is 15,643 in $/day. This again shows high level of fluctuations in the charter rates.

4.2.3 Panamax coal Voyage earnings

The Clarkson provides with many sets of data related to coal voyage by Panamax vessels. All these earnings are calculated as $/day. The data is available for many routes, but some of the routes will be chosen for data analysis which are close to the route of study

The Panamax coal voyage from Newcastle to Japan has been taken into consideration. Newcastle is one of the most important coal export hubs in Australia and Japan is one of the most important coal importers. So this route is quite important in terms of coal trade. The time period for the available data set is 1998-2011. The mean value of the data set is 20,568 $/day. The maximum and minimum value in the data set is 52,606 $/day in the year 2007 and the minimum is 6,831 $/day in the year 1999. The range of the data set is 45,775 $/day. The standard deviation of the data set is 13,864 $/day. As the range and standard deviation show high values, it can be said that the charter rates from Newcastle to Japan are volatile in nature.

The Panamax coal voyage from New South Wales to Continental Asia in a 70,000 DWT has to be considered. As already discussed, New South Wales in Australia has huge amount of coal storage. At the same time there is huge demand for coal in Asia continent. The data is available for the period 1998-2011. The mean value of the data is 16,958 $/day. The maximum value is 43,524 $/day for the year 2007. The minimum value is 4,695 $/day in the year 2011. The range of the data set is 38,829 $/day. The standard deviation of the data set is 11,874.

4.2.4 Spot rates

There is another kind of chartering called as the voyage charter. In this form of chartering the charter rates are decided at the spot. So it is called as spot charter rates. In this case the distance and destination are already decided. So the spot rates are measured in terms of $/ton. These spot rates are more prevalent when the markets are highly unpredictable. The ship owner as well as the charterer goes for voyage charter since they feel it is highly risky for them to go for a long term time charter.

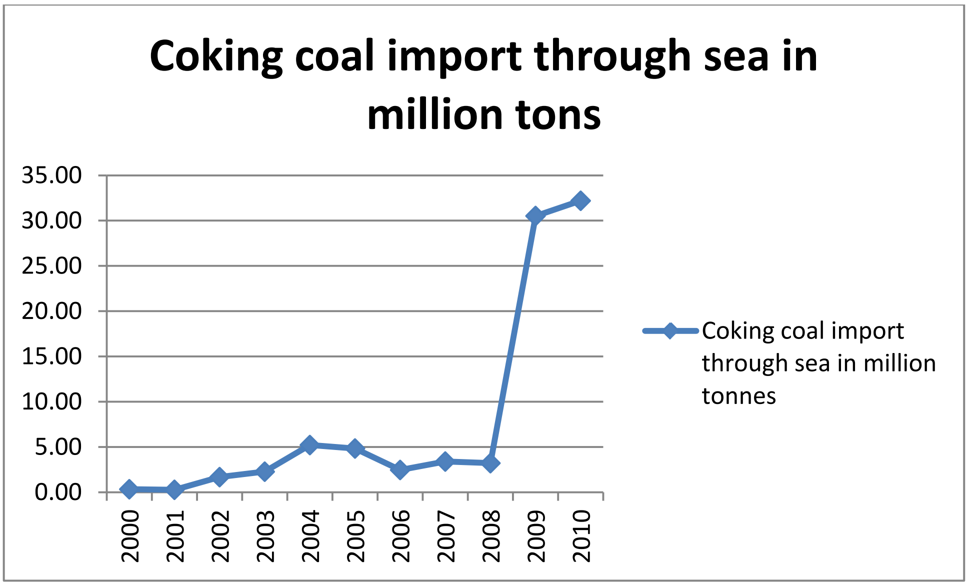
In this case also the route of Newcastle to Japan in a 70,000 DWT has been considered. It is measured in terms of $/tonnes. The time period of the available data is 1991-2011. The mean value of the data set is 13.81 $/tonne. The maximum value of the data set is 34.24 $/tonne in the year 2007. The minimum value of the data set is 6.00 $/tonne in the year 1998. So it results to give a range of 28.24 $/tonne. The standard deviation of the data set is found to be 7.8 $/tonne. The spot rates seem to fluctuate even more compared to time charter with a very high range and standard deviation.

4.3 Chinese coal import data analysis

In this section the data related to Chinese import and export will be discussed and analyzed. This will be an important part of the thesis as it would be important to understand the general trend in the import of coal into China. As discussed in the previous chapter, coal can again be divided into two varieties. One is the coking coal and the other is the steam coal. Both this varieties of coal are imported by China.

The data is available for Chinese imports of coking coal done through sea. The source of the data is Clarkson database and it is measure in million tones. The data is available for the time period from 2000 to 2010.

Table 12: Coking Coal Import Through Sea in million tons

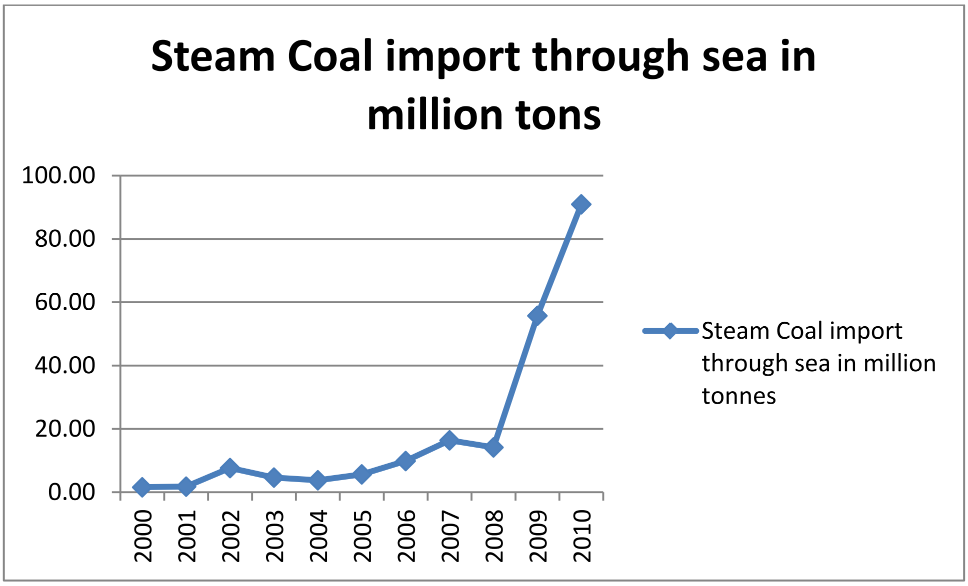


Source: Clarksons Database

As seen above in the graph, it reflects the amount of coking coal imported by China through the time period 2000-2010. In general the graph shows an increasing trend, but in the year 2009, there is a very sharp increase in the amount import of coking coal. In 2010 also the level of imports is maintained with a slight increase.

There is data available also for import of steam coal through sea. The source of the data is Clarkson. The quantity is measured in million tones. The time period of the available data is from 2000-2010.

Table 13: Steam Coal Import Through Sea in million tons



Source: Clarksons Database

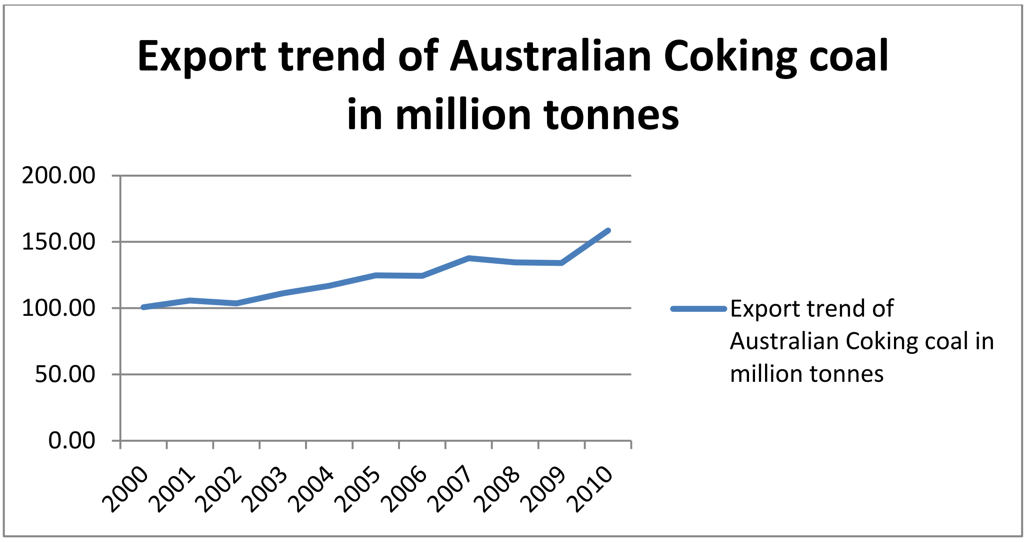
The trend line above shows a general increase in the steam coal import to China. There is a sharp increase in quantity imported in the year 2009. The sharp increasing trend continued in the year 2010. This show there might be more potential for steam coal import in future. It is probably due to increase the requirement in power consumption.

4.4 Australian coal supply data

In the thesis the focus is on Australia as a coal supplier to China. So in this section supply of coal from Australia will be analyzed. In other words the export of coal from Australia to the other countries will be considered. In this case also both coking coal and steam coal data has been considered for analysis.

The data is available for the export of coking coal from Australia through sea voyages. It has been measured in terms of million tones. The time series for the available data is 2000-2010.

Table 14: Export Trend of Australian Coking Coal in million tons

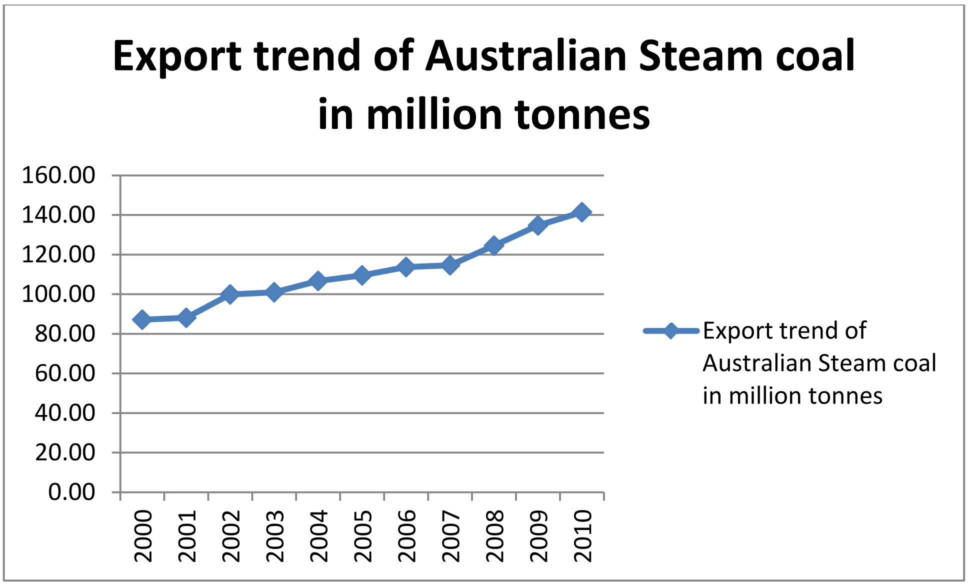


Source: Clarksons Database

The graph above shows the increasing trend of the export data of Australian coking coal. A consistent growth in the export volume can be observed in the trend line. There has been a slightly sharper rise in the export volume in the year 2010 compared to other years.

Similarly the data is also available for the export volume of the steam coal. The values are measured in terms of million tones. The data is available for the time series 2000-2010.

Table 15: Export Trend of Australian Steaming Coal in million tons



Source: Clarksons Database

The graph above again displays a similar growing trend of the export from Australia of steam coal in million tones. The growth in export volume looks to be quite consistent with the time series.

4.5 Data representing the determinant of demand for coal in China

In this section some of the data field would be discussed which are expected to be determining factors in the China which determine the demand for coal in China. All these factors are expected to have an implication on the charter rates.

4.5.1 Energy consumption through fossil fuel as a % of total energy consumption

Fossil fuels are the most important source of energy consumption. It consists of coal, oil products and natural gas. Coal is one of the most important part of the fossil fuel family. The indicators have been collected from the World Bank data indicators. These indicators have been calculated on the basis of the data provided by the 'International Energy Agency'. The data is available from the year 1971 to 2008 for China.

4.5.2 Carbon-dioxide emission from solid fuel (coal) consumption

This data would indicate the amount of carbon-dioxide which is being emitted due to the combustion of the coal. When coal is used as means of fuel, its combustion leads to emission of carbon-dioxide. So if there is an increase in coal consumption, this indicator would show increased value due to the increased emission of Carbon-dioxide. The data is available from 1960 to 2008. The data has been collected from the World Bank development indicators. These indicators have been developed on the basis of 'Carbon-dioxide Information Analysis center, Environmental Science division, Oak Ridge National Laboratory, Tennessee, United States.'

4.5.3 Electricity production from coal sources

This data refers to the power generated by using coal as a combustible fuel. It can be different variety of coal such as brown coal. The value of the date is measured in kwh. This data set would exactly let us know the amount of electricity produced from coal. So higher is the value of the data set, it indicates more usage of coal as fuel. The availability of data ranges from 1971 to 2008. The data has been collected from 'World Bank development indicators'. These indicators have been developed based on the data of 'International Energy Agency'.

4.5.4 Electricity Power Consumption

In simple words, it is the amount of power consumption in for of electricity. It includes the electrical power production by a power plant. It excludes all the losses due to the loss of power during transmission. It is measure in KWh. As already discussed most of the power is generated with coal combustion in thermal power plants. An increase in power consumption would lead to a higher demand for coal in China. The data is available from the year 1971 to 2008. The data indicator has been collected from 'World development indicators'. These data indicators have been developed based on the data collected from 'International Energy Agency'.

4.5.5 Quality of Port Infrastructure

In the literature review earlier, there was a point about the choke points. These choke points are mostly different nodes in the Supply Chain. In this case the ports can be a choke point. It would depend on the quality of the port infrastructure. The data is based on surveys done and hence it takes into account the opinion of executives who use port services on a regular basis. The survey has been quantified on numeric basis which ranges from 1 to 7. 1 indicates very poor quality of underdeveloped infrastructure in the port and 7 indicates very high and advanced quality of port infrastructure. The data is available for both Australia and China from 2007 to 2010. The data has been collected from 'World development indicators'. These indicators have been developed on the basis of data collected from 'World Economic Forum, Global Competitiveness Report'.

4.5.6 Asian steel production data

The data related to steel production in Asia is available. The source of the data is Clarkson database. The value of the data has been measured in million tones. The data is available for the time period 1995 to 2011 till date. The production of steel is an important parameter in judging the demand for coal. The reason is that steel production requires power. Most of the larger steel plants have their captive power plants which are used to generate the required power for the steel production. These captive power plants are mostly thermal power plants which use coal as a fuel for power production. More over coking coal is also used for during the production process of steel.

Chapter 5: Ports and Main Port Terminals of Coal in North China and Australia

5.1 Port of Qinhuangdao

There has been a deliberate attempt by China to improve its existing coal handling ports and also construct new coal handling terminals to facilitate its coal trade, both export as well as import. The infrastructure facilities of these coal handling terminals are being improved by equipping the terminals with more number of dumpers, stackers, shiploaders and re-claimers. In the year 1985 the port of Qinhuangdao was developed in the year 1985. IHI was involved in it construction in collaboration with many other Chinese partners. The loading capacity of the terminal is around 20 million tons annually in terms of ship-loading and car-unloading capacity. The storage yard is capable of storing 1 million ton of coal piling in terms of yard storage capacity (Anon 2).

Qinhuangdao port is located in the important Haigang district, Qinhuangdao City, Hebei Province. It has a central location in the Circum Bohai Sea Region. It is a very important port for China as well as Bejing. In terms of latitude and longitude its exact location is 39°54'4'' N and 119° 36'26'' E respectively (Anon 2). It is the largest port in terms of total energy trade. The major commodities which are traded through Qinhuangdao port are coal and crude oil.

In terms of hinterland transportation facility Qinhuangdao Port is very much developed. It has connection of more than 170 km of railway connection and is also close to Jingsen expressway. It is directly connected by means of railway connection to Jingshan, Jingqin, Daqin and Shenshan. The railway connection has very important role to play in the inland transportation since 65%-75% (Anon 2) coal is transported through railways.

As mentioned above most of the cargo in Qinhuangdao Port is transported with the help of railways. This has been possible due to the availability of both state owned railway facility as well as the private companies. The port has its own railway company which is equipped with 32 diesel locomotives and 361 vehicles (Anon 2).

There are two main roads connecting to the ports. These are 53 km long. One of the roads is 12 meters wide and other is 7 meters wide. These are located just behind the break bulk terminal.

5.1.1 Hinterlands

Qinhuangdao Port has the ideal combination geographical and economic position due to its natural geographic position and its presence close to the business heartland of China. Qinhuangdao Port is a part of the Northern Economic zone and part of the Bohai Economic circle.

The Qinhuangdao Port not only serves China as a port but it also serves some of the neighboring countries which have high demand for coal. Domestically it serves the provinces of Shanghai, Shandong, Guangdong, Guangxi, Zhejiang, Jiangsu, Fujian, Hainan and Liaoning which constitutes around 80% of its coal trade. Rest of the 20%

coal is exported to Japan, Europe, Taiwan, Southeast Asia, and Hong Kong of China (Anon 2).

5.1.2 Port Development

The Port Authority of Qinhuangdao Port was established in the year 1898. It is one of the largest ports of the world. It is a large state owned company which is administered, managed and controlled by the central government (Anon 2). In the year 1999 the port signed contract with 37 domestic coal trading and mining companies. So in the year 2000 the coal handling in the port exceeded the 90 million mark and reached 97.43 million tons.

5.1.3 Storage and Yard Capacity

The handling capacity has to be matched by the storage capacity. The total area of storage in the port is 1.132.000 meter square (Anon 2). The coal storage has an area of 878.000 square meter and capacity of 2.642.000 tons (Anon 2).

5.1.4 Handling Machinery and Handling Capacity

Qinhuangdao Port consists of 7 stevedoring companies and one travelling - transporting machinery company (Anon 2).

5.2 Port of Kembla

The port of Kemble is significant in terms of location. It is located 80 km south of Sydney. It is connected to all the major cities of Australia through highways and railways. In the year 2007-2008, 27.3 million tons of cargo was handled in the port (Anon 5). It is one of the major industrial ports of Australia. It is closely situated to the major steel production zone. There is also a fertilizer manufacturing plant inside the harbor. It consists of a grain and coal exporting terminal.

Port of Kembla is involved more in the transport of bulk cargo when compared to other type of cargoes. The main commodities are coal, iron ore, grains. The two companies involved in the operations of the port are P & O automotive and General Stevedoring. These companies run their operation in the AAT terminal which is located in the inner harbor and the Gateway jetty which is located in the outer harbor respectively.

5.2.1 AAT Terminal

AAT terminal is the most important terminal of the port of Kembla. It consists of 4 berths. It is designed for all kind of terminal operation, as for example break bulk cargo. The area covered by the terminal is around 44 hectares, with a total length of 980 m.

Chapter 6: Analysis and Results

6.1 Introduction and Methodology

This chapter would consist of the main methodology part of the thesis. The data which was shown in chapter 4 would be used to do a quantitative analysis. The data as shown in the previous section is a historical data set at an annual frequency.

Correlations will be used as a methodology in this thesis. Correlations are a statistical tool used to find out the relationship between two sets of data. In simple words, it is used to find out the dependence of one set of data on the other set of data.

Correlation was used as a methodology in the thesis since it matches with the requirement of the thesis. The main objective of the thesis was to find out the major factors which affect the charter rates.

In the data section many different charter rates were discussed. Broadly classifying there was time charter and spot rates. In this case the time charter would be considered. There were different kinds of time charter. In this case the time charter for Panamax vessel was considered. The charter rates of coal vessel from Australia to Japan are available which closest route to the present research is. The Baltic index with the average of all the four kind of time charter is available.

6.2 Baltic index and NSW-Japan coal voyage comparison for Panamax vessel

The Baltic index and the charter rates between Australia to Japan have been compared. Both variables are based on charter rates measured in $/day for Panamax vessel. A correlation was developed between both variables. The time series of the data is from 1998 to 2010.

Table 16: Correlation between Baltic index and the charter rates

	Baltic index of Panamax vessel with average time charter of the 4 time charter for Panamax vessel in $/day	Panamax coal voyage charter rates from NSW to Japan
Baltic index	1	
NSW-Japan	0.9929	1

In the table above a high value of the correlation can be observed. So a correlation of 99.29 % shows that both charter rates change in a simultaneous manner. This correlation has been done not to find the dependency factor but in order to find the similarity of both the discussed variables. So in this analysis the Baltic index will be considered as the charter rates. One reason is because it is very much similar to the New South Wales - Japan coal route charter rates. The data is also very close in value and the rate at which changes is also identical which has been proved by this high level of correlation. Another factor is that the Baltic index takes into account all four kinds of chartering.

6.3 Charter rates and Electrical power consumption

In this case the data has been described in section 4.2.2 for the mentioned charter rates and in 4.5.4 for the Electrical Power consumption. The correlations have been measured for the time period 1998 to 2008. The following table shows the result obtained.

Table 17: Correlation between Charter Rates and Electrical Consumption

	Charter Rates	Electrical Power consumption
Charter Rates	1	
Electrical Power Consumption	0.9127	1

In the table above the value of the correlation can be observed which is also quite high around 91.27%. This shows a high level of correlation between the charter rates and electrical power consumption. With increase in the electrical power consumption the charter rates are expected to increase. The reasons were discussed in several sections in the thesis. For production of electricity coal is the major resource so more power consumption leads to a higher demand of coal and hence a increase in the import of the coal. As a result the charter rates increase with the increase of electrical power consumption.

Also, the Pearson correlation coefficient value has been calculated for the above variables. The value of the Pearsen coefficient was found to be 90.32% for the variables of charter rates and electrical power consumption, which is also a high number. Both these correlations show high value of correlation between these factors.

6.4 Charter rates and electricity production from coal

The data for the two variables Charter rates and electricity production from coal has been described in section 4.2.2 of chapter 4 and section 4.5.3 of chapter 4. The time period for the measurement of the correlations is from 1998 to 2008. The following table displays the result of the correlation.

Table 18: Correlation Between charter rates and Electricity Production from coal as a fuel

	Charter Rates	Electricity Production from coal as a fuel
Charter Rates	1	
Electricity Production from coal as a fuel	0.9115	1

The table above shows the correlation between the Charter rates and the Electricity production from coal as a fuel to be 91.15%. This analysis is more specific to the research question of the thesis. Here only electricity production from the usage of coal has been considered. Other uses of coal have not been considered. So with an increase in the coal based electrical power generation the demand for coal will increase and hence the charter rates for the coal carrying Panamax vessels.

Moreover, the Pearson Correlation Coefficient value has been calculated for the above variables. In this case, the value of the Pearsen coefficient was found to be 90.21% for the variables of charter rates and electricity production from coal. The value of the correlation is also a high. This signifies that there is a high value of correlation for these two factors.

6.5 Charter rates and Fossil fuel energy consumption

In this case the data variables used for this analysis has been described in section 4.2.2 for the charter rates and section 4.5.1 for the fossil fuels energy consumption. The data is available for the time period 1998 to 2010.The following table gives the correlation result between both the parameter.

Table 19: Correlation between Charter rates and Fossil Fuel Energy consumption

	Charter Rates	Fossil Fuel Energy Consumption
Charter Rates	1	
Fossil Fuel Energy consumption	0.8793	1

In the table above the correlations between the discussed variable has been mentioned as 87.93%. This shows a strong correlation between both the factors. Cola is one of the fossil fuel but it is one of the major fossil fuel. So with an increase in consumption of fossil fuel for energy consumption the demand for the coal would also increase and hence the charter rates for the coal supplying Panamax vessel.

Again in this case, the Pearson Correlation Coefficient value has been calculated for the above variables of charter rates and fossil fuel energy. The value of the Pearsen coefficient was found to be 86.56% for these variables. The value of the correlation is less than the previous values but also quite high. This signifies the high correlation between the two factors.

6.6 Charter rates and Asia steel production

The two variables that is the Charter Rates and the Asia steel production have been described in section 4.2.2 and section 4.5.6 respectively. The time period for which the data has been considered is from 1998 to 2008. The following table shows the results of the correlation analysis.

	Charter Rates	Asia Steel Production
Charter Rates	1	
Asia Steel Production	0.9076	1

A high value of correlation has been found between Charter Rates and the Asia steel production. The correlation value is around 90.76 %. The data for Asia steel production has been considered since China is the largest producers of steel in Asia. With an increase in steel production the demand for both variety of coal increases. The demand for steam coal increases due to the more power requirement in a steel plant. At the same time the demand for coking coal also increases due to its use in the production process. As a result it can be said that the charter rates of coal carrying Panamax vessel would increase with the increase in the steel production.

Finally, the Pearson Correlation Coefficient value has been calculated for the above variables of charter rates and Asia steel production. In this case, the value of the Pearsen coefficient of correlation was found to be 90%. The value of the coefficient of correlation is also quite high. This indicates that there is a high value of correlation for these two factors.

Chapter 7: Conclusion

7.1 Conclusion

In this chapter the summary of all the chapters will be described. The objective of the thesis was to find out the important factors which affect the charter rates of coal carrying Panamax vessel form Australia to China.

In Chapter 2 a literature review of the supply of ships and the factors affecting the charter rates was done. As per the review the supply of ships is mostly affected by the economic growth and the increase in commodity trade. Moreover the supply of the vessel is also affected by the demand for a special cargo vessel, productivity of the fleet and the freight rates. A literature review was done on the factors affecting the charter rates in shipping industry. The most important factors which were found to affect the charter rates were demand for commodity, price of the commodity in the domestic market, seasonality, industrial activity, price of the bunker, choke points in the nodes of the supply chain and market sentiments.

In chapter 3 two broad topics related to the thesis were analyzed. In chapter 2 it was found out that the demand for commodity and industrial activity are considered to be the important factors which affect the charter rates. So in chapter 3 the demand for coal in China and the supply of coal from Australia was analyzed. As per the literature review done on the demand for coal in China, the most major factor which affect the demand of coal was found to be industrial activity. This industrial activity has been increasing due rapid economic growth and increase in population. The major requirement of this rapid industrialization has been more power consumption and steel production. Power generation is essential for enhanced industrial activity and incremental steel production is required for new real estate and infrastructure projects. Both the factors above have resulted in increase in demand for coal in China. The supply of coal from Australia was analyzed in the next section. It was found that modern techniques used in mining process and more exploration of new mining sites has resulted in an increase in the supply of coal from Australia. A export commodity analysis showed coal as the leading export commodity in Australia. Moreover it was found that Australia is the leading coal exporting country of the world. And the most important destination market for Australian coal was found to be South east Asia with China being a significant part of the coal trade mesh of Australia to South East Asian countries.

In Chapter 4 the data required for the thesis was described along with the sources. Some of the trend graphs were also shown. Different kinds of charter rates were analyzed. This included time charter rates for Panamax vessel, spot rates, and major coal trading Panamax time charter rates. In the next section the import values of coking coal and steam coal were analyzed in the time series with an annual frequency. A sharp growth in the import levels were observed in recent years. The export volume of coking and steam coal in Australia showed a very consistent increasing trend. Some other variable data set such as electricity power consumption and steel production were described in next section in compliance with the literature review done in chapter 2 and 3.

In chapter 5 a review of the different terminals in China as well as Australia were described to understand the growing facility and technology which would enhance the trade of coal between Australia and China. The facilities complied with economies of using Panamax and post Panamax vessel.

In chapter 6 all the data set collected in annual time series were used to find the correlations. Correlations were found between charter rates and the expected factors affecting demand for coal in China as per the review in Chapter 3. As per the high values of correlations found between charter rates and several variables related to power consumption in China, it can be said that the growing industrial activity is affecting the charter rates. Three different variables related to energy or power consumption were studied under the correlation methodology and all the three results showed high level of correlations with more that than 90% correlation in two of the cases. Moreover another set of correlation done between steel production and charter rates which also showed a value just above 90 %, hence confirming an directly incremental relationship between growing industrial activity and the charter rates.

7.2 Scope for Further Research

In this thesis the focus was mostly on the demand for coal in China and as expected it had a significant impact on the charter rates. There were several other factors which were discussed in the literature review section and can undertake for further research. The factors that might be affecting the charter rates are domestic pricing structure in China and the supply of coal from Indonesia.

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APPENDICES

Appendix 1: *Correlation of Charter rates and electricity power consumption*

YEAR	CHARTER RATES	ELECTRICAL POWER CONSUMPTION
1998	6213	1,08025E+12
1999	7422	1,14482E+12
2000	11102	1,25408E+12
2001	8767	1,36075E+12
2002	7809	1,51715E+12
2003	20063	1,77713E+12
2004	35736	2,0559E+12
2005	24701	2,32475E+12
2006	23778	2,67565E+12
2007	56816	3,06959E+12
2008	49014	3,25228E+12

	Column 1	*Column 2*
Column 1	1	
Column 2	0,912745173	1

Appendix 2: ***Correlation for Charter rates and electrical production from coal***

YEAR	CHARTER RATES	ELECTRICAI PRODUCTION FROM COAL
1998	6213	8,83712E+11
1999	7422	9,6438E+11
2000	11102	1,06214E+12
2001	8767	1,12205E+12
2002	7809	1,27138E+12
2003	20063	1,51552E+12
2004	35736	1,71378E+12
2005	24701	1,97177E+12
2006	23778	2,30103E+12
2007	56816	2,65577E+12
2008	49014	2,73328E+12

	Column 1	*Column 2*
Column 1	1	
Column 2	0,911569054	1

Appendix 3: ***Correlation for Charter rates and Fossil Fuel Energy Consumption***

YEAR	CHARTER RATES	FOSSIL FUEL ENERGY CONSUMPTION
1998	6213	79,21489154
1999	7422	79,24945077
2000	11102	79,25304452
2001	8767	78,75593003
2002	7809	80,14677079
2003	20063	82,2546892
2004	35736	84,26214052
2005	24701	85,20954225
2006	23778	86,19774225
2007	56816	86,58470403
2008	49014	86,91445535

	Column 1	*Column 2*
Column 1	1	
Column 2	0,879398532	1

Appendix 4: *Correlation for Charter rates and Asian Steel Production*

YEAR	CHARTER RATES	ASIAN STEEL PRODUCTION
1998	6213	761405,00
1999	7422	770201,00
2000	11102	828301,00
2001	8767	824592,00
2002	7809	883634,05
2003	20063	945347,91
2004	35736	1032326,11
2005	24701	1105168,60
2006	23778	1216661,00
2007	56816	1316898,00
2008	49014	1301663,00

	Column 1	*Column 2*
Column 1	1	
Column 2	0,907690577	1