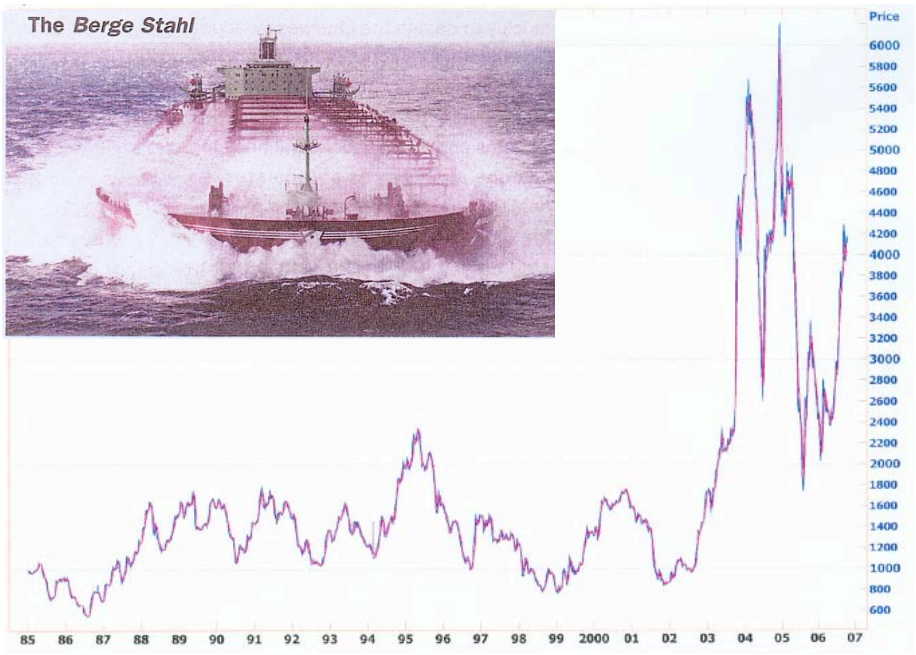
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Economics of Marine Transportation Industries
2.964

Assignment 2

Iron Ore Transportation in Capesize Bulk Carriers



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Submitted: 10/25/06

Abstract

Iron ore plays a key role in the global economy. It is essential for economic growth and its consumption per capita is indicative of a country's standard of living. As for most bulk cargoes, the vast majority of this commodity is transported by sea. Many countries therefore rely heavily on the transportation of iron ore in capesize bulk carriers.

The majority of iron ore is transported in capes. This is why the recent boom in the shipping market has been more intense for them as it is driven by China's expansion and demand for iron ore. The current project provides an overview of the factors that have influenced the earnings of capesize vessels in iron ore trades and their prices since their development in the 1970s.

Record breaking spot market rates, time charter rates, newbuilding prices, second hand prices and scrapping values have been achieved as a result of China's expansion and demand for iron ore combined with the short-run inelasticity of supply due to capacity constraints in shipyards and ports. Lack of belief in the market lasting at this level for many years has made prompt delivery newbuilding re-sales more expensive than orders and has narrowed the price gap between newer and older second-hand vessels.

Contents

1. Introduction

Iron ore as a commodity is crucial to economic development and its consumption per capita is an index measuring the standard of living. Many countries depend heavily on its transportation and since by large the sea separates producers from consumers, this makes marine transportation of iron ore a vital aspect of economic growth.

Marine transportation of iron ore has been increasing steadily for the past several years while China's expansion has caused a tremendous increase in demand since the start of the new millennium. Currently, 716 million tones (the vast majority) of iron ore are being transported by sea annually making it the largest dry bulk trade as shown in Fig 1.

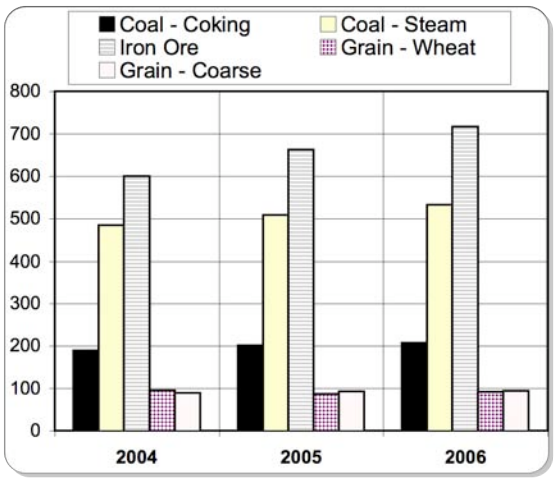


Fig 1: Seaborne Dry Bulk Trades in Mt for the years 2004 – 2006 [SSY 2006a]

At its origin, iron ore is extracted from the ground in mine fields and then transported to nearby ports via trains. It is then stockpiled onto big land surfaces within the ports and from there loaded onto ships by means of conveyor belts. Ships then transport it to other terminals in which it is unloaded using large grabs and then taken to close by steel plants (the final destination) by trains.

Iron ore is typically transported in large bulk carriers and the few existing Ore Carriers. Due to the high stowage factor of iron ore, these are more compact and have a capacity that often exceeds 300K DWT with only a modest increase in overall dimensions. This however renders them inefficient for the transportation of the high stowing coal and has made them less profitable. The largest one in the world is the *Berge Stahl*, built in 1986. It measures 343m long and its deadweight capacity is 364,767dwt. The majority of iron ore is thus transported in Capesize vessels.

Fig 2: *Berge Stahl* - The World's Largest Dry Bulk Carrier [Van Dyck 2004]

Capes are designed for a fatigue life of about 30 years. Their trading life however is affected by both structural and economic factors. Life extension is worthwhile when the market (or the expected market) is such that predicted returns over the projected remaining ship life outweigh the required costs. They are used mainly in the transportation of iron ore and coal within specific trade routes. The prevalence of iron ore over other cape cargos is clear in Fig 3. The graph was constructed using data that was kindly provided by *Braemar Seascope* shipbrokers.

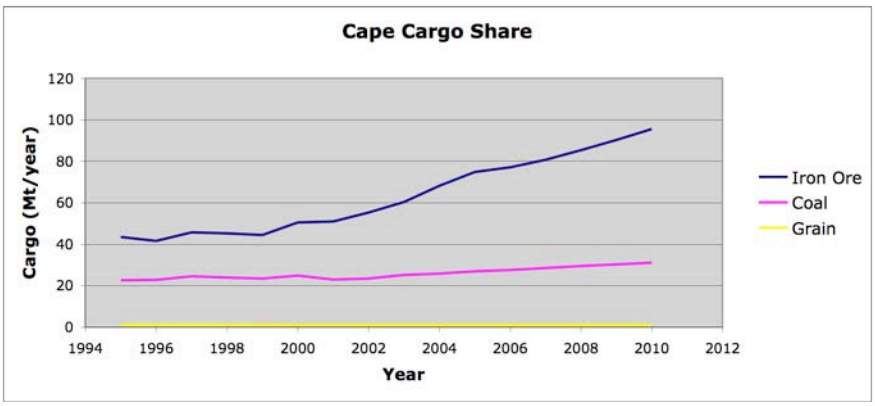


Fig 3: Capesize Trading Cargos [BS 2006]

2. Overview of the Dry Bulk Market over the Past 20 Years

Fig 4 shows how the dry bulk market has developed over the passed twenty years since the great shipping crisis in 1986. The main peaks and bottoms are then outlined below.

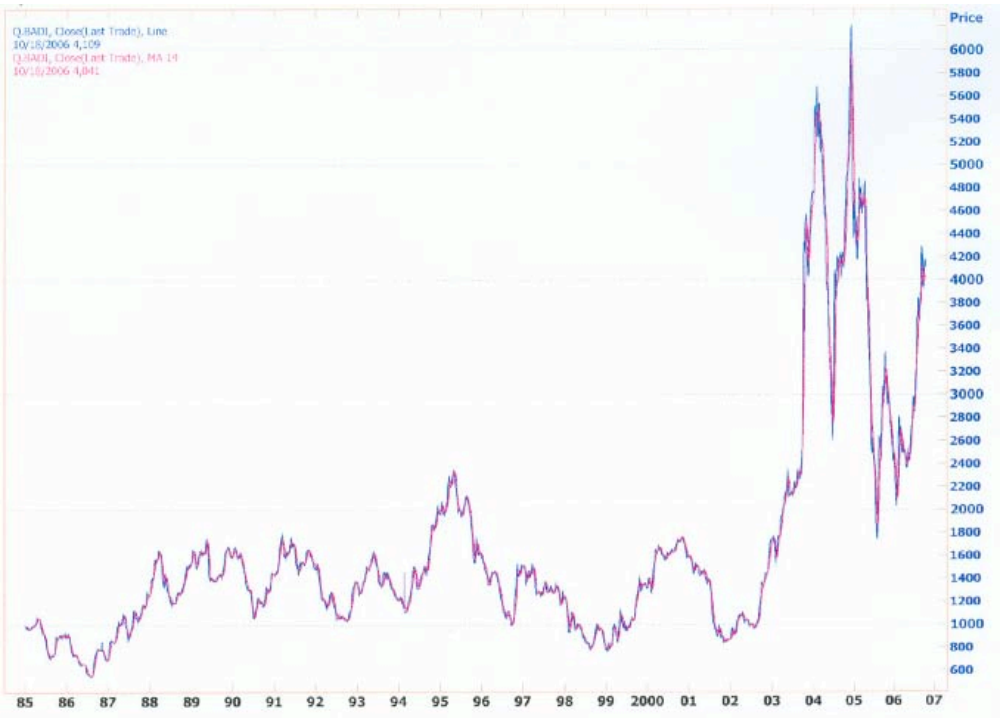


Fig 4: The Baltic Dry Index since the 1986 crisis [Reuters 2006]

1970s: The first capes are constructed in the late 1960s / early 1970s

1976: The 1973 oil crisis leads to a world crisis that results in the shipping crisis of 1976

1986: The 1979 oil crisis and the high interest rates of 1980/81 to counteract inflation lead to a world recession. This combined with the oversupply of ships results in the shipping crisis of 1982-1986

1988: Increasing demand as economies recover, combined with decreasing supply as yards shut down, lead to recovery of the shipping market towards the end of the 1980s

1995: Increase in demand from China leads to a boom in the shipping market

1999: The stock exchange crisis of 1998 in the Far East (the tiger markets) that was then followed by Russia and Brazil led to the 1999 crisis in the shipping market

2002: The 11th of September tragedy, which led to the economic depression and the Enron scandal that led to the deep stock market crisis, resulted in the 2002 shipping crisis

2003: The 2003 boom was wholly driven by China's expansion but America's demand in 2006 has led to an increase in backhaul rates

3. Market Equilibration

As discussed, shipping is a cyclical market. The large number of factors that affect it renders it almost impossible to make future predictions. Cyclical however implies not totally random.

As for any good or service, the market price for a voyage or period charter is determined by supply and demand at any given location and time. In practice, equilibrium may never be achieved due to the high dynamics of the market but average prices and trends will always be governed by supply and demand. Fig 5 shows the trends and extrapolations of supply and demand for capes.

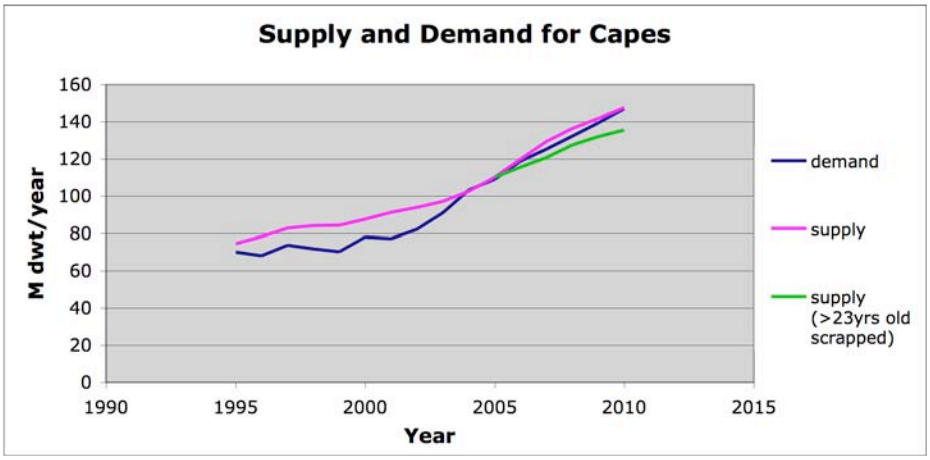


Fig 5: Tabulated Values of Capesize Supply and Demand from [BS 2006]

The demand projection (in million tones transported per year) is based on WTO (World Trade Organization) predictions about the industries related to capesize trades (mainly iron ore, coal and grain). The summation of the estimated demand for capesize deadweight capacity along the various trade routes gives the total demand curve shown. Estimates of GDP growth in major players such as China have also been incorporated, using historical correlations between GDP growth and the bulk carrier market.

The supply projection is based on the existing fleet and the capesize orderbook, which is known until 2010. The first curve assumes that there will be no capesize scrapping while the second one assumes that all capes above 23 years old will be scrapped. As the second scenario is highly unlikely, these two curves provide a useful upper and lower bound for supply over the coming years.

4. Demand – Iron Ore Trade

Transportation typically accounts for a small percentage of total cost and this makes demand for shipping relatively inelastic. Since there are a large number of companies owning capes and Panamaxes, but there are no competing transportation modes, this makes demand inelastic for the shipping industry as a whole, but elastic as perceived by each individual owner.

As in the past, China's expansion since the start of the century is the driving force behind the great increase in demand that has led dry bulk freight rates to unsurpassed values over the past few years. This is clearly demonstrated in Fig 6, which shows the annual imports by the largest importers and the world total since 1980. The largest importer in Europe is by far Germany (Rotterdam), followed by France, Italy and the UK [SSY 2006a]. Fig 6 and 7 were compiled using data from [SSY 2006a, SSY 2006b, SSY 2006c].

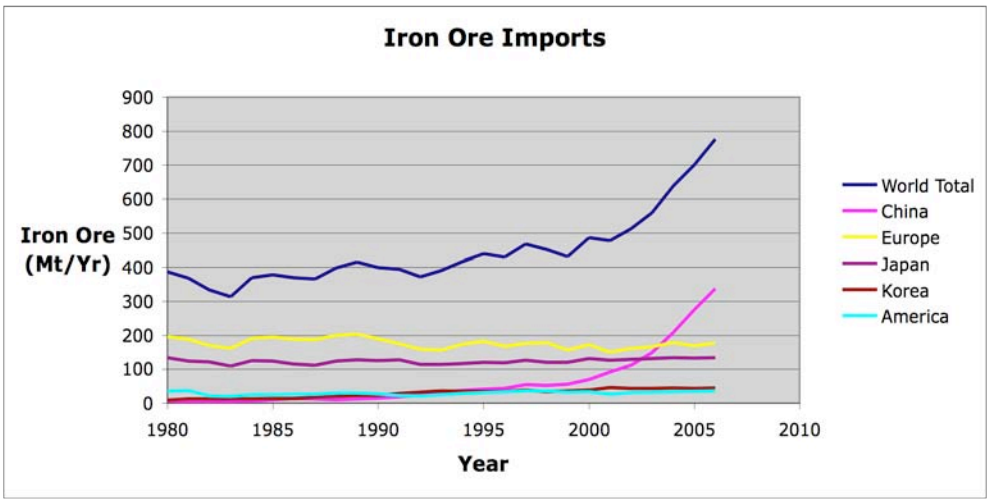


Fig 6: Annual Iron Ore Imports of today's 5 Largest Importers and the World Total Since 1980

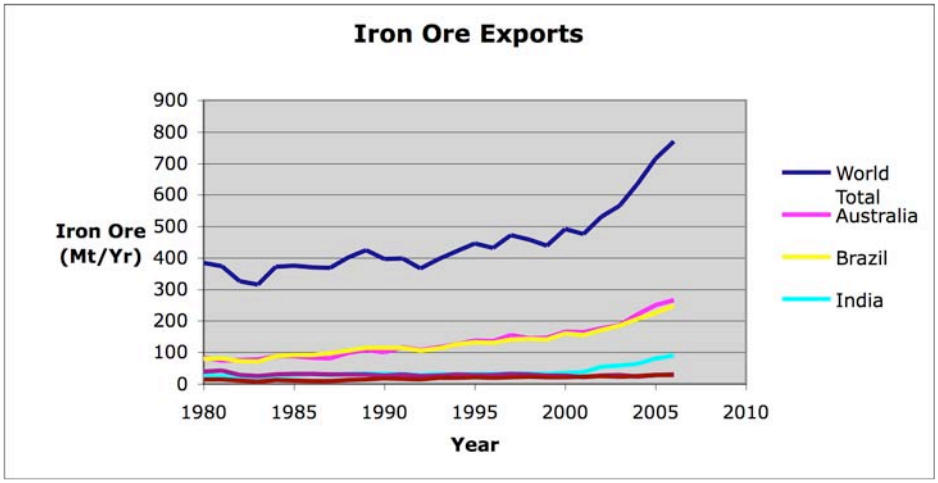


Fig 7: Annual Iron Ore Exports of today's 5 Largest Exporters and the World Total Since 1980

The demand for marine transportation of iron ore is forecasted to keep increasing for a number of years as illustrated in Fig 8. China is expected to continue expansion throughout the current decade and other countries such as India or Brazil are expected to follow.

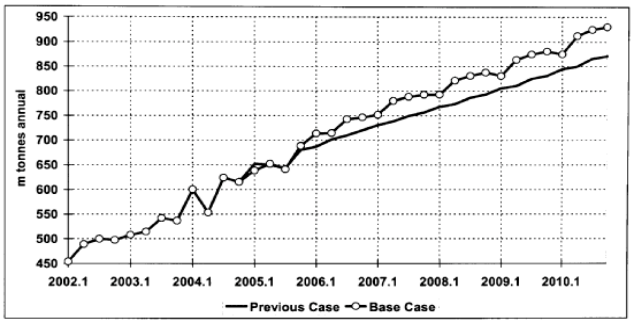


Fig 8: Total Global Iron ore Imports for the Current Decade [Marsoft 2006]

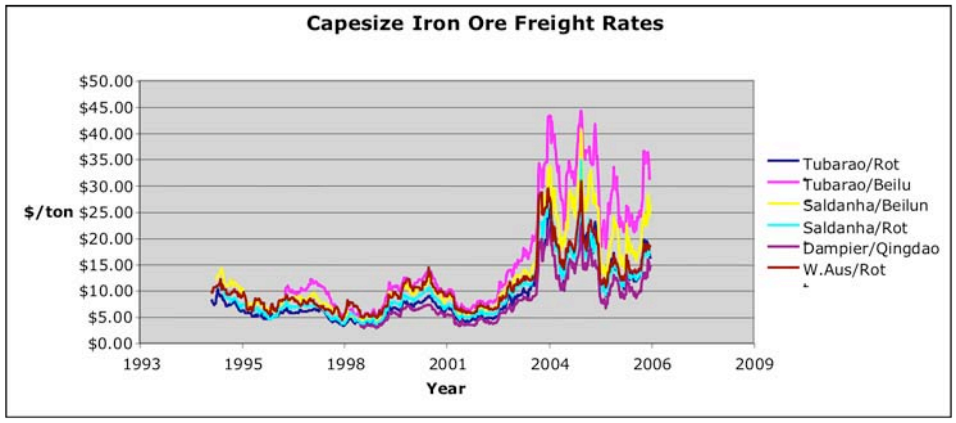


Fig 9: Capesize Iron Ore freight rates along Main Routes to Rotterdam and China [SSY 2006c]

Fig 9 shows freight rates for the main iron ore cape routes to Rotterdam and China since 1998. As shown, these are closely related and run approximately parallel. This is because they constitute very close substitutes for owners. An increase in freight rates along a particular route leads to a corresponding increase in quantity along that route and a decrease in supply along the remaining ones. This forces freight rates along other routes to follow the trend. The most expensive route appears to be from Brazil to China and the cheapest one in $/ton is from Australia to China. One however should consider the fact that a shorter distance corresponds to a higher T/C per day equivalent and this is the effective price seen be suppliers (shipowners).

5. Supply – Shortage

5.1 Capesize Fleet, Scrapping and Newbuildings

The supply of ships is controlled through ordering and scrapping of vessels. Following the increase in demand over the past several decades, supply has adjusted and the world fleet of capes has increased steadily since their development in the late 1960s as illustrated in Fig 10.

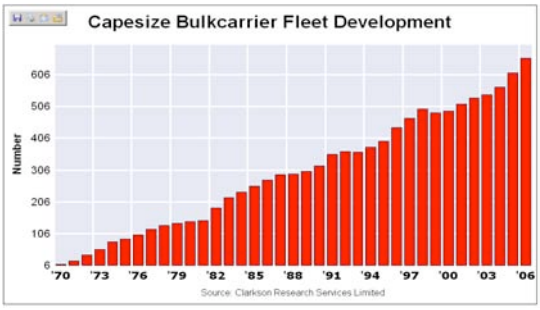


Fig 10: The *Capesize Fleet* Development since 1970 [Clarksons 2006a]

There are currently 691 capes in the world fleet, 171 on order and only 1 has been scrapped since last year [Clarksons 2006a]. Low scrapping due to the high opportunity cost of the good market has pushed scrapping prices up. The record price was broken two weeks ago at $475/ltd and again last week by a Bergen product tanker that was sold for $481/ltd [Lillestolen et al 2006].

Historically in the dry bulk industry, owners order more ships as earnings increase and fewer when earnings are decreasing. As a result, the change in deliveries with time has been almost out of phase with the change in earnings as illustrated in Fig 11.

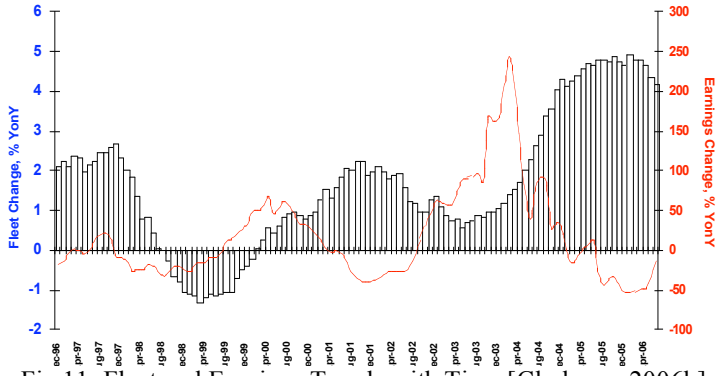


Fig 11: Fleet and Earnings Trends with Time [Clarksons 2006b]

This phenomenon is also observed in capes >120K DWT whose orderbook has been approximately in phase with the market as shown in Fig 12. This results due to the limited capacity of shipyards that makes supply inelastic in the short-run.

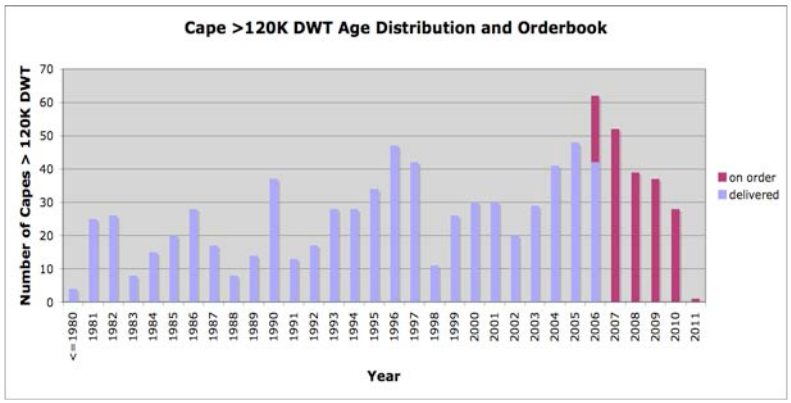


Fig 12: Capesize Orderbook In Phase with the Cape Freight Market – Using data from [BS 2006]

Though a berth is only occupied for two months during construction, before which the ship is in block stage, the next available berth in the Far East is in 2010. The inability of shipyards to cope with increasing demand has led to high prices and long delivery times. Japan recently quoted a figure of $70m for 2010 deliveries. As shown in Fig 13, orders have been made for 2011.

5.2 Congestion at Ports

Port capacity is another example of capacity constraints that make supply inelastic in the short-run. This is demonstrated by the resulting congestion of ships at terminals. Delays of up to two weeks are not uncommon while charter rates have in the past exceeded and are again approaching $100K daily. Fig 13 shows the average mid-month delays at iron-ore terminals in Australia.

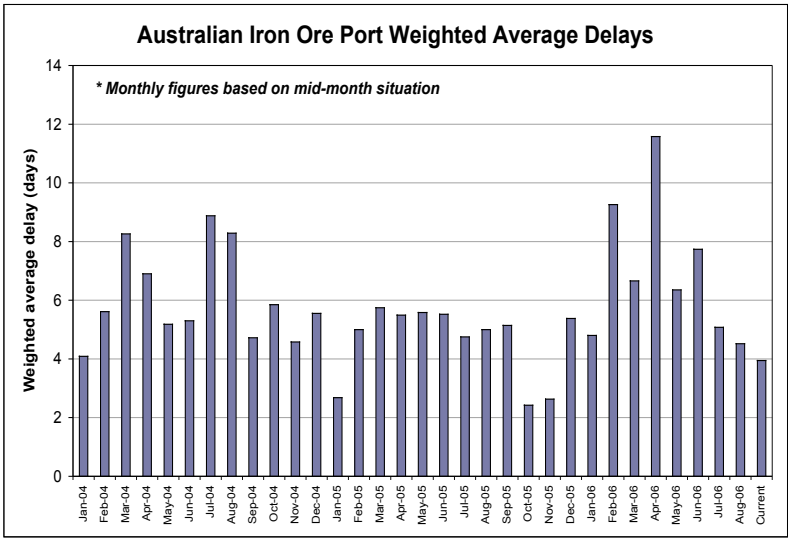


Fig 13: Australian Iron Ore Port Congestion Indices [SSY 2006b]

According to a study performed by [Clarksons 2006b], congestion in capesize iron ore terminals corresponds to a decrease in supply by about 28% for ships discharging in China. Congestion may be affected by several factors such as the Chinese New Year or bad weather.

Further increasing loading rates can reduce the problem, but this is dangerous particularly for older vessels that have a lower deballasting capacity. Peak loading rates of up to 16,000–18,000t/hr have been achieved in Ponta de Madeira (Brazil) while some ports are aiming in the future to go up to 32,000t/hr [Ferguson et al 1993]. Though average rates are usually close to 50% of peak values, high loading rates are known to be the cause of serious failures and ship losses [Corbett 2006, Isbester 1998, Intercargo 1998, IACS 1997, MER 1997].

Congestion can be effectively improved by newer ships with high deballasting rates; larger ships that will reduce the number of berthing/unberthing delays; more loaders, loading terminals and births that will increase turnover; higher storage capacity at terminals that will buffer against inland accidents, bad weather etc.; Aligned improvement of inland trasportation, loading and discharging ports to avoid bottlenecks etc. Both Ponta de Madeira in Brazil and the port of Dampier are adding one terminal each this year. It is important to understand however that these solutions may be effective in the short-run, but they involve heavy investment and will be a huge loss in the long run if Chinese demand drops or the world economy goes into recession.

5.3 Age Limit on Ore-Trading Capes

High-density like iron ore have been the cause of several dramatic casualties in the past with not enough reaction time to even send a distress signal. Examples include the capes *Alexandre P., Pasithea* and *Algarrobo,* all of which disappeared virtually without trace in 1990 while loaded with iron ore [LR, Peckham, Ferguson 1991a] and the *Mineral Diamond* in 1991 again with iron ore. Most recently, only 7 out of the crew of 33 were rescued after the rapid failure and sinking of *Alexandros T.* in May off the coast of Port Alfred in South Africa. The ship was transporting iron ore from Brazil to China – a very common route. Naturally, this has attracted public attention and has been of great concern to many involved in shipping. Cargo owners and charterers have recently responded by introducing a 25-year age limit on vessels that are allowed to transport iron ore. This will force the older vessels out leading to a reduction in supply that will counteract the effect of deliveries and perhaps push the rates up over the coming years.

5.4 The Effect of Crude Oil

The increasing price of crude oil translates to an increase of bunkering costs for shipowners. It therefore shifts the supply curve to the left and increases price (freight rates). The increase in operating costs alone would reduce output and revenues if demand were elastic. More importantly, the demand for coal transportation increases as many factories around the world switch to coal. This pushes freight rates up as capes also transport coal (Fig 3). Fig 14 shows crude oil prices superimposed on the Baltic Dry Index (BDI).

Fig 14: Baltic Dry Index (blue) and Crude Oil (red) [Investment Tools 2006]

5.5 Supply and Elasticity

As mentioned earlier, port and shipyard capacity constraints make supply inelastic in the short-run. The distance between the location of ships and the ports where they are needed has the same effect. The number of ships that can arrive at a given location is inversely related to time. Unexpected accidents or events that affect supply locally can have a dramatic impact on prices. In 2005 for example, VLCC rates exceeded $200K/day for about a week due to a Suez grounding.

Ship owners on the other hand, are faced with a number of alternative trades such as coal or grain trades so the quantity of ships available for trading iron ore will decrease substantially following a decrease in iron ore freight rates. This increases price elasticity of supply.

6. Capesize Earnings

The Baltic Index for capes has closely followed the dry bulk market with the only difference being that the current boom over the last few years is more intense for capes. This is because it is driven by China and iron ore imports while the majority of iron ore is transported in Capes. Fig 15 shows the daily earnings of capes for the main trading routes since 2002.

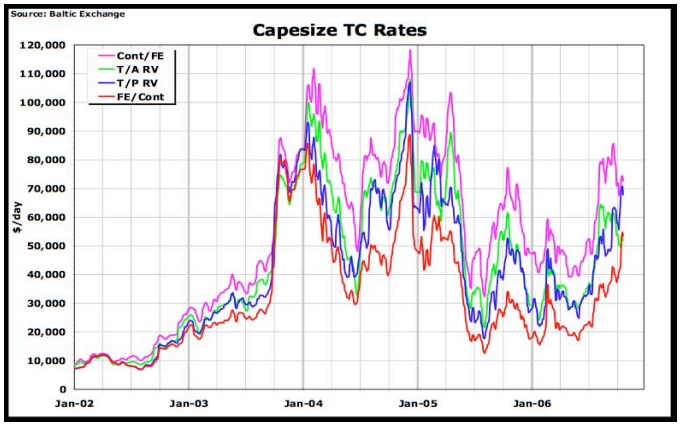


Fig 15: Cape Daily Earnings along the Main Routes since 2002 [Baltic Exchange 2006]

China's demand for iron ore, which is currently driving the market, has created flow irregularities. Capesize earnings are therefore significantly higher along front hauls (Atlantic to Pacific) compared to backhauls (Pacific to Atlantic). The gap between them however has narrowed lately as a result of America's increasing demand. This is demonstrated in fig 16, which shows the daily earnings for transatlantic and transpacific rounds and front-haul and backhaul voyages.

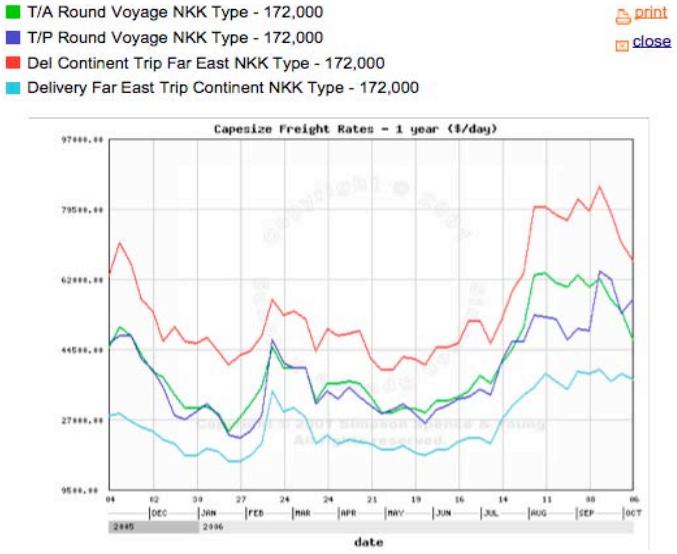


Fig 16: Daily Cape Earnings for Trans-Atlantic/Pacific and Front/Back-Haul Voyages [SSY 2006d]

Time charter rates are usually lower than the spot market and decrease with t/c length. This is because they provide a steady, long term and secure income, which is highly valued, particularly by IPOs. For a given period length, the rate depends on charterer reliability and the number and quality of assets they own. More importantly, t/c rates depend on market expectations. Today they are below spot rates and decrease significantly with period length, as most don't expect the market to last very long. They were higher than the spot market in 1983 when people were optimistic.

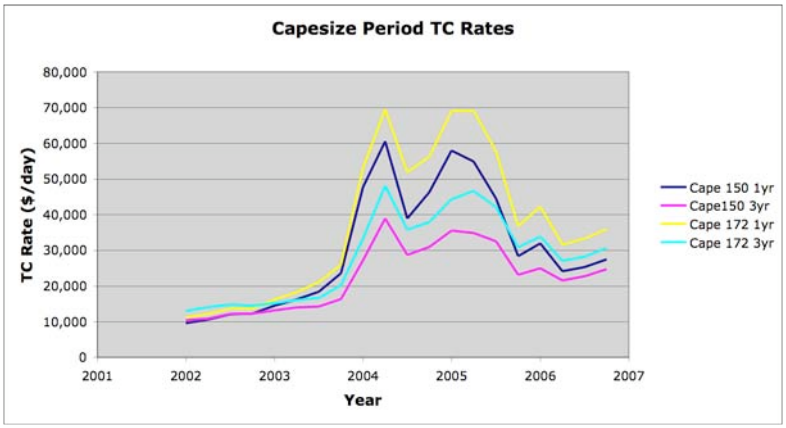
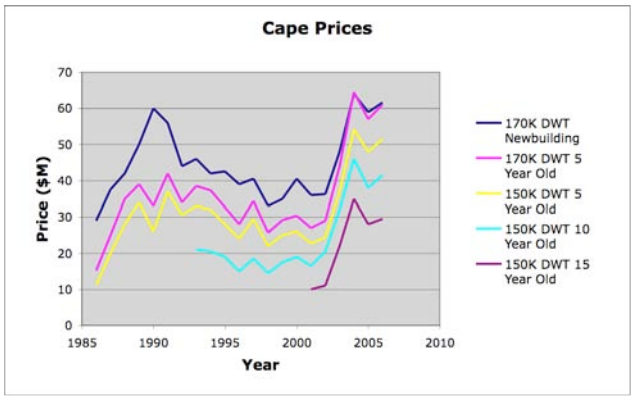


Fig 17: Capesize 1-Year and 3-Year Time Charter Rates since 2002 [BS 2006]

7. Cape Prices

The ratio of price between of older and newer ships increased steeply in 2003 after being relatively steady for a long time. Furthermore, the newbuilding has become cheaper than the secondhand. This can be seen in Figures 18 and 19.



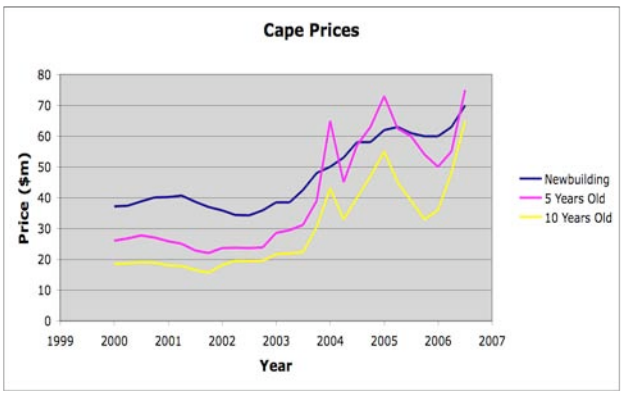


Fig 18&19: Capesize Price Trends - using data from [Clarksons 2006c] & [BS 2006] respectively

This phenomenon is explained by the fact that people generally value the next three years much higher than those beyond that. In other words, people do not expect the market to last at this level for many years. This is also why t/c rates are lower than spot rates and decrease significantly with period length. The following recent Cape and PMX S&P transactions clearly illustrate this:

- Diana paid $91m for an SWS Cape resale to be delivered in Dec. 2006
- Transmed sold its last Bohai Capesize newbuilding (Delivery in Nov. 2007) for $81.5m
- Golden Union ordered a 177Kdwt Cape in Waigaoqiao for $61m (delivery in 2010)

Looking at these prices, each year until 2010 is valued at around $10m for capes. This is reasonable as one can charter a cape for the next three years to earn significantly more than that. What is most remarkable is that assuming a 30-year life, the following 30 years (looking at the Golden Union order) are discounted at a rate of only around $2m per year.

A t/c attachment may increase or decrease a ship's value depending on the t/c rate compared to the current market, the length of the t/c contract, the trustworthiness of the charterers and the number and kind of assets which they have etc.

There is a time lag between freight rates (spot market) and ship values. The fact that it takes longer to sell a ship than to charter it has little relevance. People usually wait after a market change and often perceive new levels as temporary. It takes a far more sophisticated decision to sell a vessel than chartering it. That is also why the time lag is smaller between prices and long t/c rates.

Optimism or pessimism about the future of the market and the owners' position regarding ships and capital is what drives ship prices. After a good market, there is a lot of money and optimism so it may take a considerable time of a bad market to depress expectations and for prices to drop.

8. Conclusion

Since the development of capes in the late 1960s, their market has been closely correlated with the dry bulk market. Due to China's expansion and great increase in demand for iron ore however, the boom is more significant for capes that account for the great majority of iron ore transportation.

The inelasticity of supply globally in the short run due to the limited capacity of yards and ports, and to a lesser extent locally due to the limited mobility of ships, has led to exceedingly high spot and t/c rates. Record-breaking newbuilding, second hand and scrapping prices have followed.

Most do not expect the market to last at the current levels for long and this has made the second-hand more expensive than the newbuilding. It has also narrowed the gap in prices between older and newer vessels. Spot rates are also significantly higher than t/c rates and the difference increases with t/c period length. All this indicates that a market drop is expected over the next few years. Even if that happens however, ship values are unlikely to drop for a relatively long time.

9. References

Baltic Exchange (2006) ***The Baltic Exchange Website***
http://www.balticexchange.com/
Accessed 10/18/06
Last Updated 10/18/06

BS (2006) Numerical data provided by *Braemar Seascope Ltd.* shipbrokers. - Private Correspondence, Oct 2006

Clarksons (2006a) ***Shipping Intelligence Network 2005*** (Clarksons Website)
http://www.clarksons.net/markets/
Accessed: 10/19/06
Last updated: 10/17/06

Clarksons (2006b) Clarksons' "*Cape dwt"* powerpoint presentation ***Quintana Presentation***, October 2006 Clarksons Ltd

Clarksons (2006c) Numerical data provided by *Clarksons* shipbrokers. - Private Correspondence, Oct 2006

Corbett, A. (2006) ***Big Questions on Capesize Sinking***, Tradewinds, 12 May 2006, Off Course, pp. 42

Ferguson, J.M., Cheng, Y.F., Purtle, B. (1993) ***On Bulk Carrier Safety***, Lloyd's Register Technical Association, Paper No.5 Session 1992-93

IACS (1997) ***Bulk Carriers – Guidance and Information on Bulk Cargo Loading and Discharging to Reduce the Likelihood of Over-Stressing the Hull Structure***, International Association of Classification Societies (IACS), 1997

Intercargo (1998) ***INTERCARGO Casualty Review 1998***

Investment Tools (2006) ***BDI Baltic Dry Index & Freight Rates***, Investment Tools.Com
http://investmenttools.com/futures/bdi_baltic_dry_index.htm
Accessed: 10/17/06
Last Updated: 10/05/06

Isbester, J. (1998) ***The Concerns of Mariners***, Eagle Lyon Pope Associates, Presented at the Royal Institution of Naval Architects (RINA), International Conference on Design and Operation of Bulk Carriers, London, 30 April & 1 May 1998

Lillestolen, T., Hine, L., Gousas, Y. (2006) ***Scrap Prices set New Record***, Tradewinds, Oslo, London and Athens, published: 20 October 2006

LR ***Casualty Return***, An annual publication by Lloyd's Register

Marsoft (2006) ***Dry Bulk Market Report***, Markets Finance Strategy, Maritime Advisers Marsoft,

Boston, July 2006

MER (1997) ***Loss Contributory Causes***, Marine Engineers Review, pp. 22, April 1997

Peckham R. ***Bulk Carrier Casualties – An Issue of Outmost Concern***, Bulk Shipping pp.9

Reuters (2006) ***Reuters Website***
https://3000xtra.glbl1.reuters.com/asp/login.asp
http://www.nymex.com/lsco_fut_csf.aspx?product=CL
Accessed: 10/19/06
Last Updated: 10/19/06

SSY (2006a) ***Dry Bulk Forecaster***, Simpson, Spence and Young (SSY), SSY Shipbrokers Ltd. August 2006

SSY (2006b) ***Australian Port Congestion Indices***, Simpson, Spence and Young (SSY), SSY Shipbrokers Ltd. September 2006

SSY (2006c) Numerical data provided by *SSY Shipbrokers Ltd*. – Private Correspondence, Oct 2006

SSY (2006d) SSY Shipbrokers Ltd. website, ***Market Information Hub – Dry Cargo***
http://www.ssyonline.com/Market_Information/Dry_Cargo/index.html?PHPSESSID=51d35727ab23623fb758ab1a5be903d8#
Accessed: 19/Oct/2006
Last Updated: 19/Oct/2006

Van Dyck, P. (2004) ***Big is Beautiful in the World of Ore Carriers***, The Motor Ship, May 2004, pp.16