The game of oil shipping

- a study of the market settings and the players' game

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Abstract

This thesis investigates the game of oil shipping; both the market settings and how the players play the game. An important characteristic of the oil shipping market is cycles in the spot freight prices. The cycles are created by the imperfect adjustment mechanisms of supply within the relatively short run, and by that the demand is not perfectly predictable. By a mathematical investigation, I show that the relatively low freight rates are stable equilibriums, and similar to Beenstock & Vergottis (1993), that the relatively high freight rates are unstable equilibriums. This is furthermore important information for the players, especially the shipping companies; the booms do not last forever, rather, those are relatively short and may turn down suddenly. And accordingly, investments in ships with the cycles to peaking prices are risky and not optimal. The optimally might rather be anti-cyclical investment strategies, outlined in the thesis. However, if all the shipping companies invested against the tide, the price differences on ships would decrease and hence, also the possible profits in second-hand trading. The relatively high freight rates would though only be influenced by anti-cyclical investments if the shipping companies met sudden booming demand with accordingly supply in aggregate. This is however not very likely, because of the difficulties in forecasting demand shocks a few years ahead, when ships have to be ordered due to the time-lag in new-building.

Additionally, for the banks and insurance companies which take part of the game, challenges with asymmetric information, moral hazard and adverse selection arise. How and possible solutions to this are examined in this thesis, and I also suggest further topics for more specific studies on this.

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1. Introduction

The shipping industry has such a long history like perhaps no other business today. It started with the first known sea-routes in the Arabian Gulf more than 5000 years ago, then following the expanding Mediterranean and European routes in the next thousand years.[1] And from this to the globalization from the fifteenth century onwards and up until today, the shipping industry has continually evolved. The progress was especially considerable from the eighteenth and nineteenth century onwards, while the ship technology was revolutionized and the shipping industry divided into cargo liners and tramp[2] segments to meet the transport needs due to the growing and more diverse international trade.[3] From the postwar period on, the specialization went even further into a liner shipping segment which managed the transport of general cargoes like manufacturing goods, a dry bulk shipping segment which managed the transport of cargoes like coal and grain, tanker shipping which handled the oil shipping and specialized shipping which handled the transport of cargoes like gas and cars.[4] This structure of the industry of liner, dry bulk, tanker and specialized shipping still remains today.[5]

In 2005, totally 7.0 billion tons of cargoes were transported by ships between 160 countries.[6] From 1999 to 2004, the annual average growth in shipping, no matter segments, was about 9%.[7] Liner shipping was the absolute most increasing shipping segment with an annual average growth on 22%[8], while for example China became an important world trade partner in goods.[9] Perhaps shipping is also one of the most global industries today, while it is actually the international trade that drives the shipping industry.[10] An example of the global characteristics is that maritime centers are found all over the world; in Rotterdam, Amsterdam, Antwerp, Oslo, Copenhagen, London, Southampton, Hamburg, Marseilles, Dubai, Aden, Mumbai, Hong Kong, Singapore, Shanghai, Tokyo, New York, Houston, Sydney, Melbourne, Cape Town and many other places.[11] Another example is the highly international competition due to the physically mobility of the ships and that shipping companies may choose their internationally flags freely, for example according to where the most favorable legal jurisdiction and best strategic positions are found.[12] Nevertheless, since this is a thesis about oil shipping, I will consider only the tanker segment in the following.

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[1] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 3-12
[2] Oil shipping was a part of the tramp shipping until the postwar period.
[3] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 12-35
[4] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 35-44
[5] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 35-44, 62
[6] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 48
[7] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 49
[8] ibid
[9] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 405-410
[10] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, chapter 10
[11] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 48, 360, 362 and 369
[12] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 48

Economical exploitation of oil began in the North East of USA during the beginning of the second half of the 19th century and in 1861, the first oil shipment took place.[13] However, it remained decades before oil substituted coal as a primary fuel, and thereby also for oil shipping as well as the oil industry to become major industries. In fact, in 1900, oil consumption counted for only 2.5% of the total world energy consumption.[14] During the first half of this century, the oil trade and thus, oil shipping increased, but the real boom happened first in the postwar period. Since most of the coal industry in the European industrialized countries had been destroyed during the war, the transition to oil became even easier from the 1950s onwards.[15] The price of oil remained also relatively cheap between 1950 and 1973, while oil production increased with a similar growth rate as the demand.[16] A major contributor to the growing oil production was the exploitations and rapid increase of production in the Middle East.[17] This meant also that the oil resources were farther away from the main consuming regions, and since the distances became even greater, this was good news for the oil shipping as well. In fact, between 1950 and 1973, there was an average annual growth rate of demand for oil shipping on 9.3%, compared with that of the last decades on around 3.5%, when annualizing for the volatilities.[18]

To meet the increasing demand, there was also a need for more efficient transport. So from the postwar period on, the average size increased and the technology of the ships were improved and thereby, the costs of transport decreased to only a fraction of the total retail price.[19] The increasing average size was a major contributing factor to the reduced costs by the economies of scale effects.[20] In 1955, the ships were on average size of 15000 dwt[21], while in 1970, the average ship size had increased by more than three times to 46900 dwt, and only five years later, in 1975, the average ship size had increased by more than five times since 1950 to an average ship size of 79300 dwt.[22] Moreover, the improved technologies and standardization led to less demand for labor and thereby, the significant labor costs of shipping was also reduced.[23] And the larger ships created an increased demand for capital.[24] So the oil shipping, as well as other shipping segments in the beginning of the postwar period, turned from being relatively labor intensive to relatively capital intensive.

During the last decades of the twentieth century, there was also a major shift in the ownership and structure of the business. By the late 1960s, the so-called "seven sisters", the oil majors

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[13] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 40

[14] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 42

[15] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 51

[16] ibid

[17] ibid

[18] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 51
Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 57

[19] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 260 in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional

[20] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 75-78

[21] dwt = deadweight tonnes. The common size measure of ships/fleet, see for example Stopford, Martin (2009)

[22] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 269-270

[23] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 35-36 74-75

[24] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 35-36

Exxon, BP, Shell, Mobil, Chevron, Texaco and Gulf Oil[25], dominated the oil shipping industry and this business was incorporated as internal divisions of those companies.[26] Actually, it was also a major business for them. However, by the collapse in tanker demand in the 1970s, the oil companies started to reduce their exposure to the business.[27] By the significant overcapacity at that time and the oil companies' reduction of ownership, the business changed from being a foreseeing one when spot market transactions counted for only 10% and long-term contracts for 90%, to a new, more uncertain situation where a share of nearly 60% of the capacity were traded on a daily basis with continually changing spot prices and 40% of the capacity were traded into long-term contracts with prices decided in advance.[28] In addition, the market became more competitive than it was with the decline of the shares of the major oil companies in the business and the increasing shares of shipping companies and shipping owners.[29] Also, at the late 1980s and beginning of the1990s, the oil companies reduced their exposure to the oil shipping business still further. The triggering factor for this was the environmental issue, which had come more in question by the Exxon Valdez accident in 1989 and the thereby strict governmental reactions and the Oil Pollution Act of 1990.[30] Thus, in the case of accidents, the oil companies were subjected to additional major costs and a possible destroyed reputation as well.[31] Those risks were instead transferred over to the increasing share of shipping companies/owners and the insurance companies.

Today, the oil shipping industry has become even more fragmented and the business is characterized by nearly perfect competition among the relatively large number of shipping companies and investors.[32] As 90%[33] of the shipping demand is met by the spot market nowadays, oil shipping is not what it once was, since the freight rates for periods are highly volatile and not fully predictable. The oil companies no longer have the potential to influence the rates, because oil shipping has primarily become an external business and the spot market is a very competitive market. But individual shipping companies/owners have no power to influence rates either. It is rather the freight rates with their volatile pattern which rule the

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[25] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 252 in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional
Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 42

[26] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 252 in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional

[27] See for example Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 265, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional

[28] ibid

[29] ibid

[30] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 265-268, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional

[31] ibid

[32] See for example Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 262, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional
McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 284-288

[33] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 266

market and cause challenges and opportunities for the shipping companies. This is something I will investigate in the further chapters.

1.2 Purpose

The purpose of this paper is to examine the oil shipping market; both the market settings of the oil shipping industry and how the participants of the game play. I outline the basics of demand, supply and price equilibrium of the industry based on previous studies and microeconomic theory, and analyze the characteristics of the equilibrium with a mathematical treatment according to general oil shipping market theory and for one purpose also according to a previous study by Beenstock and Vergottis (1993). Based on the results from this, I examine how the shipping companies, the banks, the insurance companies, the oil companies and the ship yards play the game, with the main focus on the shipping companies.

1.3 Delimitations

This paper is about oil shipping, and accordingly, I will not examine issues in other shipping segments like market positioning and cooperation within liner shipping. This thesis does not investigate financial investment theory within oil shipping, technical questions or governmental issues like environmental and tax regulations. Moreover, my main focus is to consider the market from the shipping companies' perspective, and hence, I will not concentrate on topics like shipyard subsidies; this is something I outline only shortly.

1.4 Methods and materials

This paper is mostly theoretical, but I have also added supplementary graphical illustrations. The examination is based on oil shipping market theory, in combination with basic microeconomic theory. I also do a mathematical investigation to identify the patterns of the cycles in the freight market. This analysis is based on oil shipping market theory as well and a previous examination by Beenstock and Vergottis (1993); I have outlined the mathematics to a greater extend and I have also given my own interpretations of some of the mathematics. Given the results from this discussion and analysis, I finally investigate how shipping companies, banks/lenders, insurance companies, oil companies and ship yards operate in the market. As mentioned above, my main focus is on the examination of the shipping companies.

1.5 Disposition

I have chosen to divide this thesis into two major blocks; first "the settings of the game", where I outline the market characteristics in detail, and then "playing the game", where I examine how the shipping companies, the banks/the lenders, the insurance companies, the oil companies and the shipyards play their game given the market settings. I found this subdivision logical, since the market settings are fundamental for the players. Finally, I summarize the results in chapter four and I end the thesis by suggesting possible further studies.

1.6 Previous studies

The tanker market has previously been examined in various studies. Pioneers of modeling the oil shipping market were Tinbergen (1934) and Zannetos (1966). But as outlined in the introduction, the oil shipping industry has changed dramatically since then. Among later studies are the so-called "Nortank" by Norman and Wergeland (1981), a theoretical and econometrical modeling of the market for the largest tankers, Strandenes (1984) who modeled the determinants of price in the freight and second hand markets, the so-called "Norship" by Strandenes (1986), a model of the freight, the second-hand, the new-building and the scrapping market and Beenstock and Vergottis (1993) who extended the model to an integrated market of all four; the freight, the second-hand, the new-building and the scrapping market. The study by Beenstock and Vergottis (1993) is still prevailing, and therefore, I have used this in my examination of the cycle characteristics of the market. In addition, this thesis refers to a range of later studies as well.

2. The settings of the game

2.1 Background

As indicated in the introduction, the oil shipping industry is characterized by nearly perfect competition. This is because of the many sellers and buyers in the market.[34] Each firm is small relatively to the total market share of demand and supply. Thereby, they have no abilities to impact the price and they act as price takers. The characteristic of nearly perfect competition is also caused by the fact that tanker service is a homogeneous service.[35] That is, the shipping companies offer equal services and the charterers is indifferent about which shipping company they charter from. Thereby, there will be no price differentiation, but a price as equilibrium of supply and demand. The competitive pattern of the industry is furthermore strengthened by the free entry and exit.[36] Theoretically, there are no impediments that serve to present difficulties for firms to either enter or exit the market. The possible primer limiting factor for entrance is the amount of own capital required. But compared to other industrial investments over the last decades, it is required relatively small amounts of own capital by the tanker owners.[37] In fact, the ship owners need to finance their business with only a modest share of own capital, while the rest are financed through loans from financial institutions which secure their loans in contracts or ships.[38] Moreover, the competitive patterns are strengthened by that the tanker owners and the charterers are assumed to have perfect information about the freight market.[39]

Oil shipping today is the most highly specialized segment of shipping.[40] The tankers are designed to carry liquid cargoes and specifically crude oil and oil products. Crude oil counts for the major[41] part of the oil transport, from oil fields to local refineries, while oil products counts for a minor[42] part of the total oil transport, from local refineries to local ports before transported by road or railway within the inlands. The crude oil carriers are the least complicated ships to build and operate of all ship types, but because of the high degree of specialization, they have no or only a very modest capability to be used in other segments.[43]

Furthermore, even though there is an average ship size as described in the introduction, the tankers are both of larger and smaller sizes than the average, depending on the types of ships.

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[34] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 284
[35] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 286-287
[36] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 287-288
[37] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 288
[38] ibid
[39] ibid
[40] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 267
[41] 72% in 2006 as a fraction of total dwt oil transported, See for example Stopford, page 57
[42] 27% in 2006 as a fraction of total dwt oil transported. The oil products transport has though increased more percent between 1995 and 2006; the oil products transport with 4.0% annually and the crude oil transport with 2.8% annually, See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 57
[43] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 267

As the table below shows[44], the VLCCs (very large crude carriers) are the largest ones with sizes over 200000 dwt, Suezmax tankers are the second largest with sizes of 120000-200000 dwt, Aframax tankers are the third largest with sizes of 80000-120000 dwt, the Panamax tankers are the fourth largest, or third smallest, with sizes of 60000 and 800000 dwt and the smallest ones are the Handys and small tankers of sizes between 10000-60000 dwt, or less than 10000dwt, respectively. Despite of the fact that there are different types of ships, I will treat the tankers as one average type in this thesis, to simplify and since this characterization of different ships will have no considerable impact on the models.

THE WORLD MERCHANT FLEET | 2.6

Table 2.5 Commercial shipping fleet by ship type, July 2007

No. Name	Size	Numbers	Mill. GT	Mill. Dwt	Dwt/ GT	Age	Comment
1. Bulk Cargo Fleet							
Tankers over 10,000 dwt	dwt						
1 VLCC over 200,000 dwt	Over 200,000	501	77.5	147.0	1.9	9.1	Long haul crude oil
2 Suezmax	120–199,999	359	29.0	54.2	1.9	9.1	Medium haul crude
3 Aframax	80–120,000	726	41.1	74.2	1.8	9.3	Some carry products
4 Panamax	60–80,000	329	13.2	23.0	1.7	8.8	Very short haul
5 Handy	10–60,000	1,496	33.0	53.1	1.6	13.5	Mainly products, some chemicals
6 Total over 10k		3,411	193.7	351.4	1.8		
7 Small tankers	<10,000	4,629	6.8	10.6	1.6	26.6	
8 **Total tankers**		**8,040**	**200**	**362**	**1.8**	**20.0**	

In this thesis, I use the term "shipping companies" as a denotation of both the ship owners and the shipping companies, because this simplifies the models and it makes also no differences to the models. However, there are some judicial and practical differences. A ship owner is an individual who owns one or more ships, and the ships are usually registered as one-ship companies where the owner has the controlling interest.[45] A shipping company is a legal organization which owns more ships; its executive officers are responsible for the operation decisions, the finance are held in company bank accounts and funds might be provided through external shareholders.[46]

Given these competition characteristics and assumptions, I will now investigate the market settings of the oil shipping industry. First, I outline the demand and supply factors, and how the price equilibrium is set by theory and some empirics, and then, I investigate the patterns of the cycles in the market by a mathematical analysis.

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[44] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 269. There is though one ship type, ULCC, ultra large crude carrier, that are not mentioned in the table, but other places in this and other books. The ULCC carries over 300000 dwt.
[45] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 281
[46] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 282

2.2 The demand for oil shipping

The driving force for oil shipping is oil trade.[47] Since the major oil consumption regions are also net importers of oil[48], there is a need for efficient oil transport as well. The more demand for oil and the longer distance between production locations and the consumers, the larger is also the demand for transport. In 2004, 2412 million tons oil was transported by tankers, and it has grown with an average of nearly 3% annually from 1970, but the growth rate has been volatile from year to year.[49] Of the total world oil trade in 2005, the oil trade over the Atlantic counted for 43%, while that over the Pacific and the Indian Ocean for 57%.[50] Furthermore, the Middle East exported 65% of the total and imported less than 1%, while North America and Western Europe imported 28% and 22% of the total respectively and exported 6% and 6.5%.[51] South and East Asia counted for nearly 11% of the total world oil exports and 19% of imports, China for 2.5% of total exports and 6% of imports and Japan for less than 1% of exports and 10% of imports.[52] In fact, the average haul of crude oil and oil products shipping was approximately 5000 miles between 1990 and 2000.[53]

The demand for oil shipping is actually characterized as a derived demand from demand of oil.[54] That is, oil shipping is not demanded for its own sake, but for the purpose to add value to oil as a commodity. While oil shipping is a part of the supply-chain, it is a factor input, and then, the Marshallian rules of factor demand apply.[55] Thereby, the elasticity of demand for oil shipping is lower, the lower the elasticity of demand for the final retail oil product. And the lower degree of substitutability between the oil shipping and competing transport services, the more inelastic is the demand for oil shipping. The oil demand has been shown to be relatively inelastic to price in short run, for -0.22 to -0.31[56], and thereby, the demand for oil shipping is also price inelastic, according to the Marshallian rules. And for the long-distance transport of oil, there are no other realistic alternatives to shipping today[57], which further strengthen the price inelasticity of oil shipping. Also according to the Marshallian rules, the demand for oil shipping is more price inelastic, the lower share the costs of oil shipping capture of the total

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[47] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 252, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional

[48] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 349

[49] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 439 and 443,
Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 261

[50] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 349, see only oil trade

[51] ibid

[52] Russia and Eastern Europe counted for 11% and the total world oil export and less than 1% of total imports, East Coast of South America counted for 12% of exports and also less than 1% of imports, West and North Africa for 12% and 10% respectively of exports and less than 1% and 2.5% respectively of the imports and Caribbean and Central America for 10.5% of exports and 3% of imports. Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 349

[53] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 261

[54] Ibid, page 259

[55] ibid

[56] Ibid, page 255

[57] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 252

supply chain costs of oil. Hence, while shipping costs count for a fraction on only 0.5-4% of the total retail price[58], so that even volatilities in the freight rates have no significant effect on the retail price, the demand for oil shipping is price inelastic. Finally according to the Marshallian rules, the demand for oil shipping is also more inelastic, the more inelastic the supply of tanker service is. The supply of tanker service is relatively inelastic in the short run, but in the long run, as I will outline in further chapters, the supply is relatively elastic since time-lagged new-building and scrapping adjusts. But while the costs of transports only count for a small fraction of the total retail price, this is a minor effect. So the conclusion is that the demand for oil shipping is highly price inelastic within a relatively short time frame.[59] However, within a relatively long time period, oil demand is less inelastic to price,[60] since it can be exchanged with other energy resources like coal and gas to some degree and also since technology can be improved to for example more efficient fuel drivers.[61] Thereby, the demand for oil shipping will also decrease if the oil prices increases and hence, the demand for oil decreases, in the longer run.

The world's demand for oil increases by approximately 2% annually[62], but it has also been shown to be relatively volatile during some time periods. For example, in 1979, it peaked to a level of 3100 million tonnes which was not reached again until 1990, and from 1979 to 1985 the level declined by around 10% to 2801 million tonnes.[63] In 1995, the level had increased to 3200 million tonnes, but this was just nearly the level of that in 1979.[64] Furthermore in 2000, the level was on 3500 million tonnes.[65] Of this total oil consumption, the OECD members consumed a major part, 62%, of the total oil consumption in 2000. However, this was a decline from a share of 74% in 1965.[66] From 1990 to 2000, there had been an increase of only 1.1% among all countries, when annualized for the volatilities.[67] But then, from 2001 to 2004, the total world oil consumption increased by approximately 2.5% annually.[68]

Trends in oil demand depend on a wide range of factors, and although both oil demand in the short run and demand for oil shipping has been shown to be relatively inelastic to own prices, demand is in fact relatively sensitive to changes in economic growth.[69] Thereby, the state and trends of growth in the world economy play a major role for the patterns of oil and oil shipping demand. Moreover, major regional developments like those of the Asian Tigers and China have played a significant role in the growth of oil demand and the pattern of the oil

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[58] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 74-75

[59] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 260

[60] It is found that the consumers changes their reaction to the real price by -0.58 to -1.02 in the long run: Dahl, C; Sterner, T.(1991): Analysing gasoline demand elasticities: a survey, Energy Economics, 13, p 203-210

[61] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 254-257

[62] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 253

[63] ibid

[64] ibid

[65] ibid

[66] ibid

[67] ibid

[68] Fearnleys oil and tanker market report 2004, page 55

[69] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 254-257

shipping industry.[70] The more those economies import from for example the Middle East to meet their energy needs, the larger the demand for oil shipping.

The fact that oil is relatively little substitutable, especially for road vehicle, contributes further to the increasing demand for oil and oil shipping, at least in the short run.[71] However, the relatively long run trend, has been a change towards more energy efficient motor vehicles.[72] And consumers have become more environmentally concerned during the last decades, and this may continue to impact the patterns of oil consumption.[73] But this is the same characteristics as outlined above; the demand for oil and oil shipping is relatively price inelastic in the short run, but the demand for oil is less price inelastic in the long-run and thereby, if oil price increases in the long run, then the demand for oil and oil shipping decrease. Moreover, the oil demand is also affected by oil traders' future price expectations. If they expect that there is a risk of future increasing prices, they hedge by taking out forwards or futures contracts on the International Petroleum Exchange, and the current demand of both oil and oil shipping increase.[74]

From the post war period until today, oil has also been a strategic resource among regions. While significant shares of the world's oil resources are located in the Middle East and the former Soviet Union, political crisis and wars in those regions or between those and major oil consumer regions have had focal effects on both oil prices and demand and hence, also on oil shipping.[75] For example, by the Egypt-Israeli war in 1967, the Suez Canal was closed for eight years. Then, the supply could not meet the oil demand and the oil price peaked in 1973, before the world economic clash the same year.[76] Before the clash, the freight rates in the oil shipping also peaked, but with the clash, a depression hit the industry. Later, the 1981-1989 Iran-Iraq war, and the invasion of Kuwait by Iraq in 1990, also led to shortages in supply, peaking prices and recession in the world economy at the beginning of the 1980s.[77] And at this time as well, the freight rates in oil shipping reached peaks with the immediate shortages, but then, with the fall and stagnation of world economy, the freight rates fell sharply and difficulties hit the business again.

Over the long period, oil demand drives oil production.[78] However, for periods, oil production may be limited by the market leader of oil production, OPEC[79], and thereby, there are

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[70] Ibid, page 254 and 259
Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 127-130, 443
[71] See for example McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 290
Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 256-257
[72] ibid
[73] ibid
[74] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 257
[75] ibid, page 254 and 257
[76] ibid
[77] ibid
[78] ibid, page 258
[79] Tvedt, Jostein (2002): The effects of uncertainty and aggregate investments on crude oil price dynamics, Energy Economics, number 24, page 616
OPEC: "Organization of the Petroleum Exporting Countries", it is "an intergovernmental organization of currently 12 member countries in Asia, Africa and America", see www.opec.org

corresponding periods with excess demand and increasing prices. As outlined above, the demand for oil is relatively inelastic to price in the short run, but if this remains, this may capture a significant part of the incomes. Then, in the relatively long run, the demand can adjust so it decreases. Furthermore, less production implies less to transport and hence, the demand for oil shipping decreases. An extreme example of this was the situation from the early 1970s onwards to the crisis in 1973. The demand for oil shipping rose according to the demand for oil up to the crisis with record levels in freight rates, but then, the demand for oil shipping fell with the oil demand, and as an additional half of the fleet was delivered from the new building at the same time; there was a pitfall in the freight rates.[80] On the other hand, there may be excess production relative to demand as well. Then, the oil prices fell, and oil traders may increase their purchases. But lower oil demand among consumers will in general mean lower demand for oil shipping.[81]

2.3 Supply of tankers[82]

The supply of tankers is regulated through an integration of four markets; the new-building, the second-hand, the scrapping and the freight market. Through the new-building market, there is an increase of ship supply and outflow of cash, while through the scrapping market; there is an inflow of cash and reduction of ship supply. Through the second-hand market, the size of the fleet and balance sheet of individual shipping companies are altered, but not the total supply of ships in aggregate. A heating second-hand market may however contribute to increasing numbers of new-building orders, if the second-hand prices are high in relative to the new-building prices. Furthermore, in the freight market, ships are hired either through contract rates or spot rates, and this creates net income flow for the shipping companies. But if the spot rates are lower than the operation costs of ships, ships are instead laid up, and the ship supply decreases. The ships that have the highest operation costs are most often the older, and hence, those are the first ships to be laid up.

In the new-building market, shipping companies order new ships from ship yards, and the ships are commonly delivered within a few years. Shipping companies order new ships to increase their supply if they expect the freight rates to increase within a time frame of a few years. Furthermore, the demand for new-building often peaks in times of booms in the freight market; while the cash flows of the shipping companies are good and the availability of quality ships in the second-hand market to comparable prices are limited. But when the demand for new-building peaks, the prices do also, since the capacity of the ship yards is limited and the price follows equilibrium of demand and supply. Then, during the common pitfalls of the freight rate after booms, and in the following times of recession or even

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[80] See for example Stopford, page 157 or Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 253

[81] See for example Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 257-258

[82] The following examination is based on Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 154-160, 178-213
Lorange, Peter (2007): Shipping company strategies, first edition, Emerald Group Publishing Limited, p. 44-47
Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 99-101

depression, the orders of and prices on new-building fall sharply also, since low freight rates pressure the earnings and liquidity of shipping companies. It is also then that speculative shipping companies, which have good financial positions even within times of crisis, use this opportunity of low prices to order new ships; despite of the risk that the market will not have recovered when the new ships are delivered.

The figure[83] below shows the new deliveries as a percent of the total fleet in million deadweight tonnes, and the light blue pools represent tankers. During the boom in freight rates up to 1973, the total investments of the shipping companies in new building peaked as well, while with the following depression in the freight market, the total investments fell dramatically. During the new boom from 2003, the activity in new-building was increased considerably again.
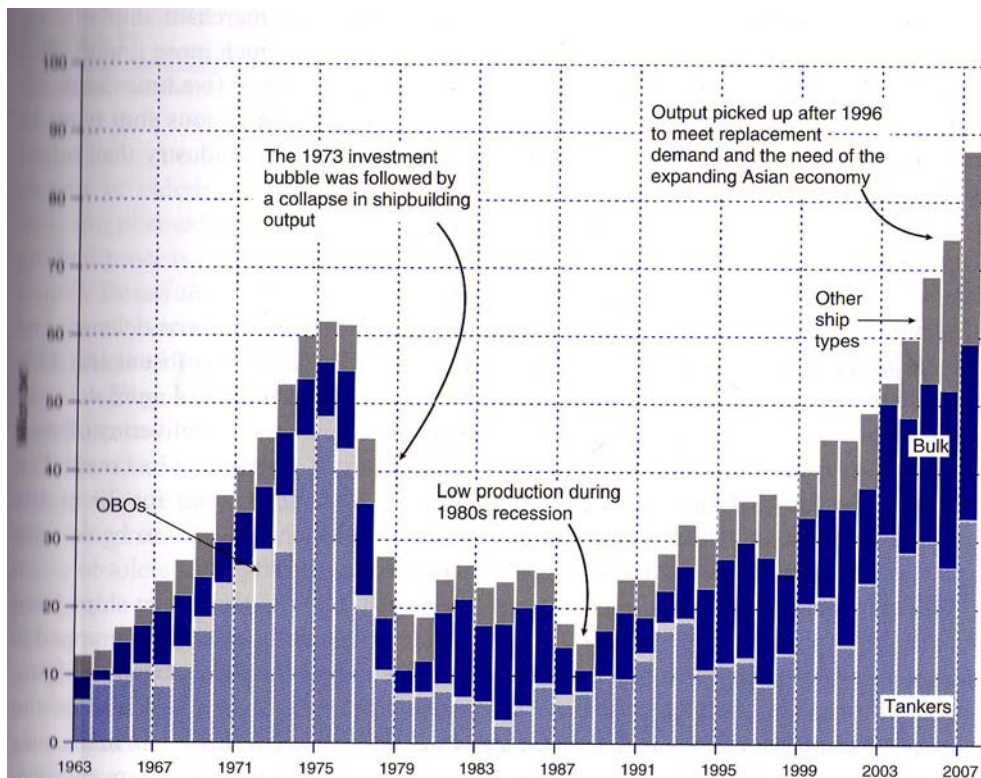

Figure 4.10
World shipbuilding deliveries by type, 1963–2007
Source: Fearnleys, Clarkson Research

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The second-hand market trading is created by expectations of the shipping companies and their immediate need for ships. During booms in the freight market, when most shipping companies want to take share of the peaking profits from the spot prices, the immediate need for ships peaks and thereby also the value of owning ships and the second-hand prices. However, as those prices increases, shipping companies may want to order new ships instead, because of lower relative prices on new-building. And so a heating second-hand market may trigger increasing supply of ships within some years. The second-hand market of ship trading

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[83] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 157

is also driven by price volatilities and the hope of shipping companies to capture high profits; the second-hand trading is an asset play. To buy cheap and sell dear is the major goal of this play. For the shipping companies that succeed, this has become an important profit source, with returns of up to more than a hundred percent. But in this game there are failures as well, those who time wrongly and buy at high prices and are forced to sell at low prices. I will outline this asset play in more detail in chapter 3.

The figure[84] below shows the correlating patterns between second-hand prices of five years old Panamax tankers and the short time freight rates. According to Stopford (2009), 73% of the variation in prices can be explained by earnings from short time charter rates, but while the earnings varied within extreme ranges during the boom from 2003, there were also wider gaps between those prices.

Figure 5.10
Correlation of second-hand price and freight rate (five-year-old
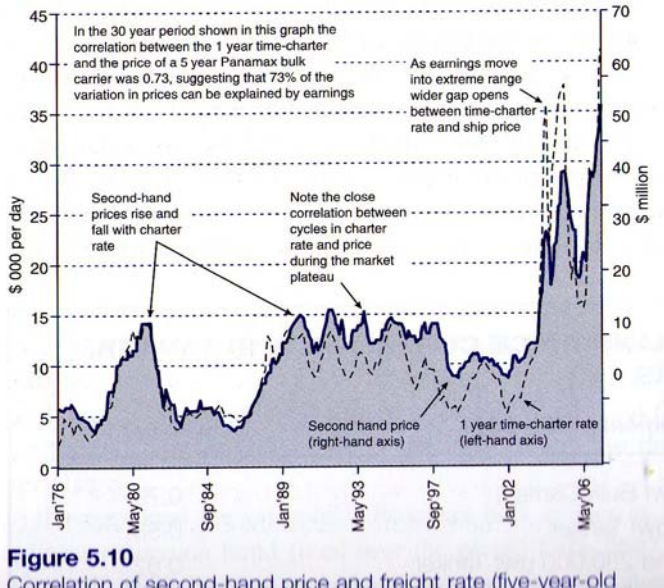
I have also made a graphical illustration which shows the patterns of both the second-hand prices of five years old VLCCs and the spot freight rates. The data I have used is from Fearnleys.[85] The measuring unit for second-hand ships is million US dollars per ship, and for the freight rates, million US dollars per tonnes miles. This is similar to the figure of Stopford. The blue line is the freight rates and the pink is the second-hand prices on five years old average VLCCs. The lines seem to follow a similar trend, but the freight rates are sometimes more volatile, especially at the highest levels of earnings. This is similar to Stopford's figure, and hence, it seems to be an analogous relationship between second-hand prices and freight rates, regardless of ship types.

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[84] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 204
[85] Reference: Sven Bjorn Svenning, Head of Fearnleys research and consultants

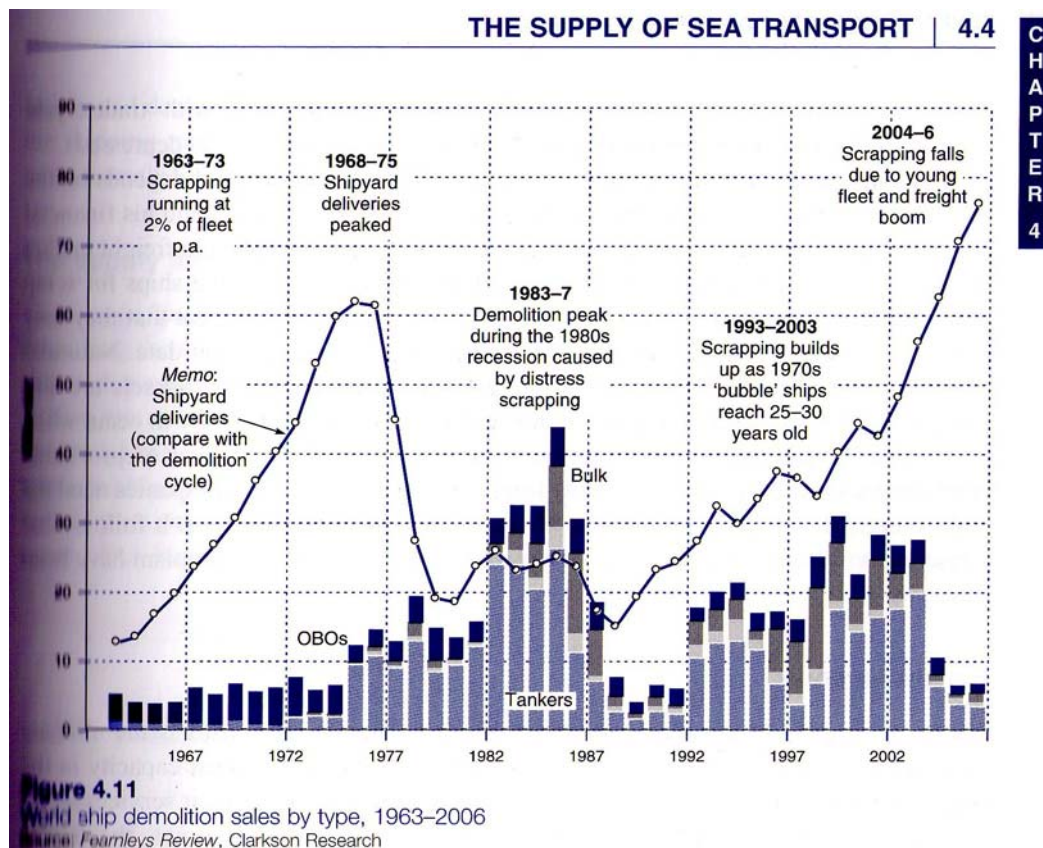**Second hand prices and freight rates avarage size VLCCs**
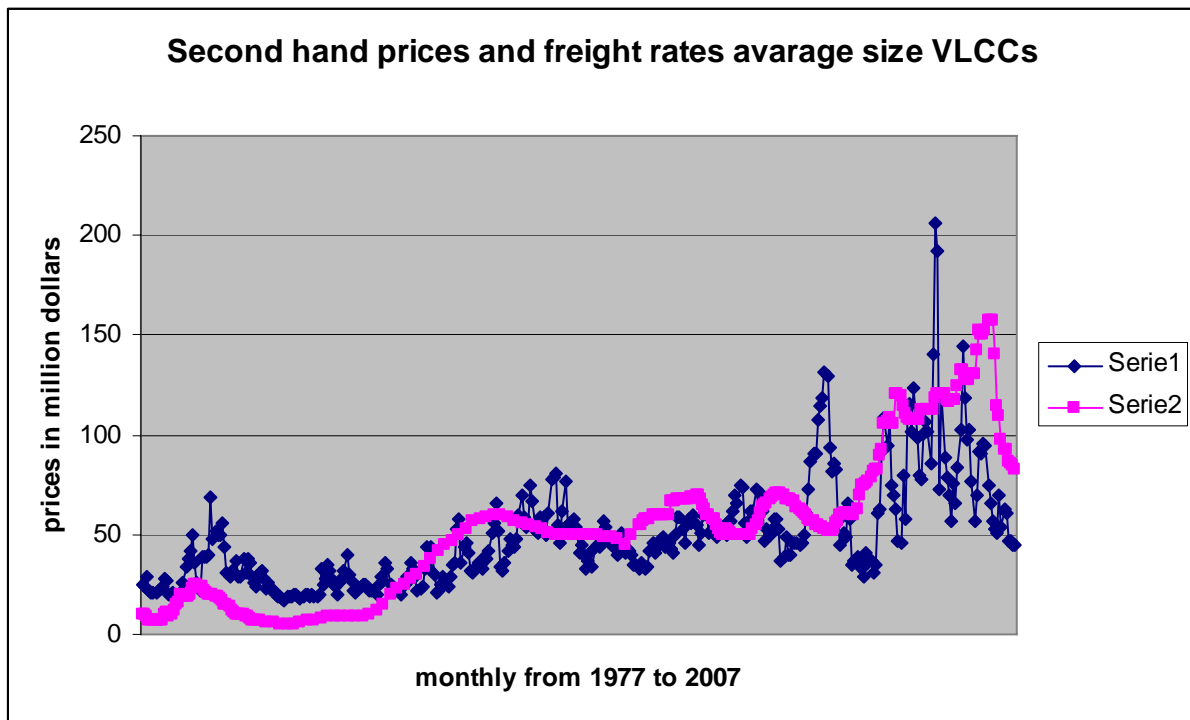
In the scrap market, ships are sold for demolition to scrap yards, which will decrease the supply of ships. Most of the scrap yards are located in the Far East like India, Pakistan, Bangladesh and China, and the steel is used for constructions and infrastructure building etc. in those countries. Prices of scrapping depend on the availability of ships for scrap and the demand for scrap metal, and those can be relatively volatile. Within times of pitfalls after booms, the scrapping prices paid to the ship owners are often relatively low, since more shipping companies have to improve their liquidity and an increasing number of ships are sent to scrapping. During the booms, the opposite is the case, because then, few ships are sent to scrapping, as it might be profitable for the shipping companies to operate with older ships in the spot market. The lower demand for scrapping in those periods is also due to better financial positions of most shipping companies at that time. But the economic life time of a ship is commonly no more than 25 years, and even before that, a range of costs can become excessive, for example through repairs, replacement of steel plates and parts, insurances and the existence of more efficient fuel consuming technology, so that older ships become relatively fuel inefficient long before the age of 25. The costs may be higher than that of the incomes from higher freight rates, and thereby, scrapping is the only solution anyway.

In the figure[86] below, the light blue pools are the percent of scrapping of the total fleet in million deadweight tonnes, and the line is the percent of new-deliveries of the total fleet in million deadweight tonnes. The figure shows that the deliveries peaked in 1968-75 during the boom up to 1973. Due to the time-lag in new-building, the orders placed just before the clash in 1973, were delivered during the following depression. While the shipping companies came in liquidity squeezes with the depression, the scrapping rate increased, and from 1983 to 1986, over 20% of the remaining total fleet was sent to scrapping every year. When the ships from the booming orders/new-building in 1970s reached 25-30 years old in 1993 to 2003, there was

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[86] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 159

also a boom in scrapping. But then, during the new freight boom from 2004 to 2007, ships sent to scrapping as a percent of the total fleet, fell to a minimum once again.

Figure 4.11
World ship demolition sales by type, 1963–2006
*Source: Fearnleys Review*, Clarkson Research

In the freight market, shipping companies trade their ships either into contracts or in the spot market. The contracts take the form as voyage contracts, where the shipping companies contract to carry cargo for an agreed price per tonne, or forward freight agreements, which are contracts settled against the value of a base index on the date specified in the agreement. Longer-term contracts create advantages of less risks and more predictability for the shipping companies. Through those contracts, the shipping companies might forego chances of high levels of profits when booms occur, but they also protect themselves against sudden losses when recessions in the spot freight market occur. In the spot market, shipping companies lend out the ships on a daily basis and the freight rates are decided according to the current spot rate recorded in US dollars per tonnes miles, also called Worldscale.[87] By doing this, the shipping companies capture the profits of possible high freight rates, but they might also risk periods of recessions/depressions and considerably reduced incomes.

During times when the rates are high, the companies may earn high profits. At this time approximately all available ships are taken out of lay-up and the prices in the second-hand and new-building market commonly peak, since most companies want to take part of the feast. If instead, the spot rates are lower than the operation costs of ships, those ships are laid up, and thereby, the supply is reduced for a short while.

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[87] The common measure, see for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge

The following figure shows the lay-up percent as a share of the total fleet supply in million deadweight tonnes from 1970 to 2004. It is based on statistics from Fearnleys.[88] The figure shows a peak in lay-up in 1975, while there was a depression in the freight rate market after the crash in 1973, and thereby, the costs of operating ships were not covered by the incomes from freight rates. There was also a record level of lay-up of over 70% in 1983, due to a sudden recession in the freight rates.
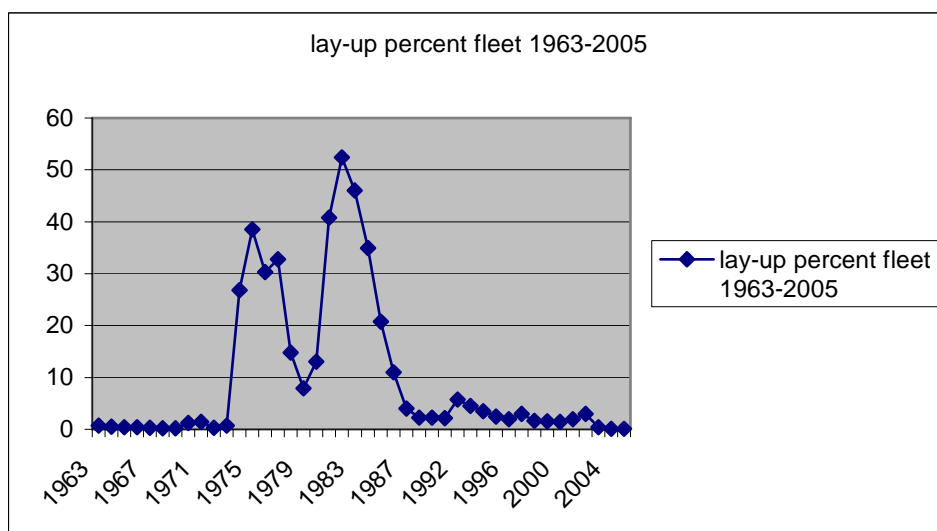
So to conclude, when prices are expected to increase, the second-hand prices generally increase; the orders in the new-building market increase and the scrapping of ships decrease. The supply of ships is also regulated in the short run by the moving of ships in and out of lay-up. In addition, the shipping companies may also increase the supply by increased productivity. That is, they may increase the tonnes of cargoes per voyages through operating with larger ships or filling the ships up to the limit, or they may increase the speed on each voyage. Increasing the supply by this way is typically done during times when freight rates are relatively high.

2.4 Equilibrium of supply and demand

The spot freight rate continually settles at equilibrium of supply and demand.[89] Within the relatively short run, shipping companies cannot respond with increasing supply through new-building or decrease supply through scrapping.[90] They may instead respond to prices by moving ships in and out of lay-up. As an example, see the figures[91] below. The unit on the

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[88] Reference: Sven Björn Svenning, Head of Fearnleys Research and Consultants

[89] See for example Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 270, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional

[90] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 165

[91] From Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 165

figure to the left is $ per ton. At point A, the demand is relatively low and the most in-efficient ships are laid up. Then the freight rate settles at F_1. Then, there is a major increase in demand on 50% to point B and all the ships are moved out of lay-up. The freight rate increases though only slightly to F_2, because the demand is nearly met by this immediately supply from lay-up. However, when demand increase with 15% to C, all current supply of ships is already in operation and the only way to increase the supply within a relatively short time frame to meet the demand, is to increase the productivity through filling up each ship up to maximum and through increasing the speed. But this does not meet the increasing demand, and thereby, the price increases with as much as 270%. Finally, when demand still increases and there are no more supply capacity available, charterers, that is most likely oil companies, bid against each other for the available capacity. If the transport is needed badly, the freight rates can go to sky levels. And high freight rates trigger often desperate investment activities by both the shipping companies and the charterers. The situation of relatively extreme high freight rates is though not sustainable and at some level it will say stop. The characteristic of this process, I will analyze in chapter 2.3 by a mathematical treatment.

Note: The supply function shows the amount of sea transport offered at each freight rate

Figure 4.14
Short run equilibrium: (a) short-run supply function; (b) short-run adjustment
Source: Martin Stopford 2007

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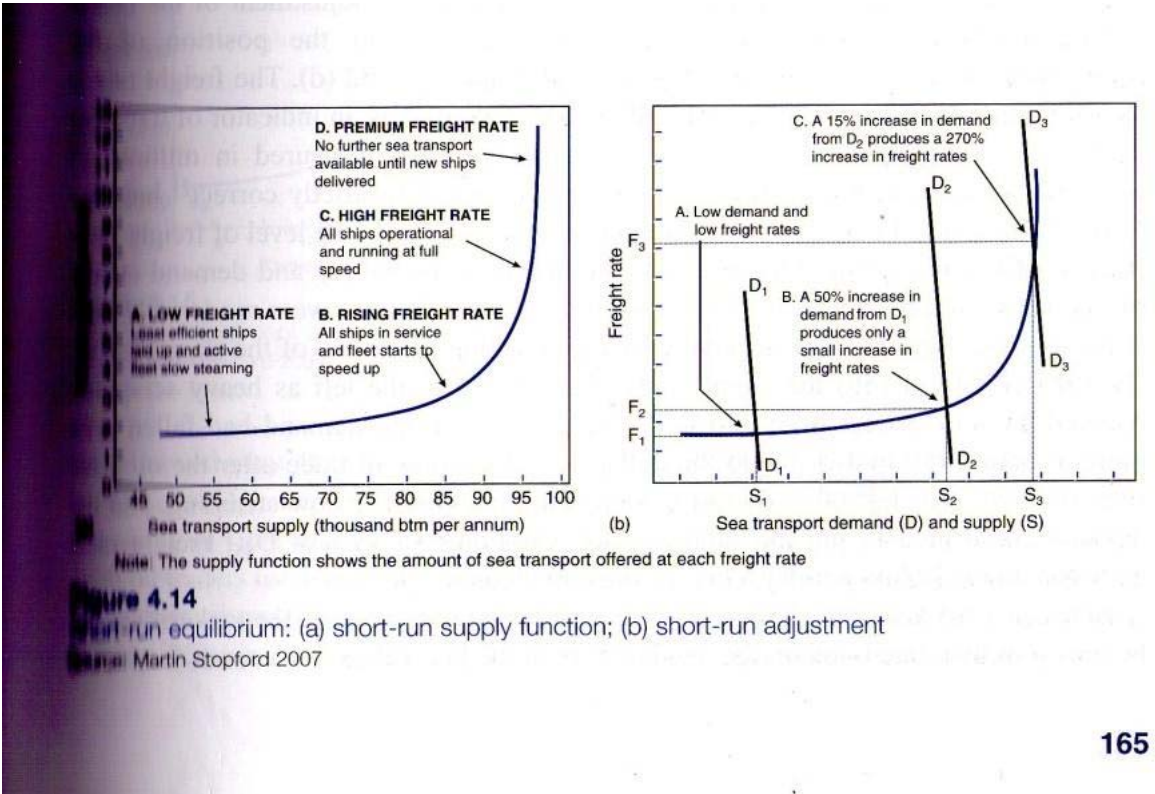
Within the relatively long run, shipping companies can adjust supply through both new-building and scrapping according to the demand.[92] As freight rates change, the supply is adjusted through the new-building, the second-hand and the scrapping market. For example, when freight rates fall during a recession, the profitability of operating ships also falls, and so does the second-hand value of the ships then.[93] Ships which cost more to operate than the rate of the current spot prices are subsequently scrapped to improve the liquidity of shipping

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[92] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 166
[93] ibid

companies. By then, those are removed permanently from the market and the excess surplus of supply is reduced. Decreasing second-hand prices may also trigger the use of tankers as oil storages and in this way, the available supply of ships is reduced and thereby, the second-hand prices increases.[94] This may furthermore result in that fewer ships have to be scrapped to improve the shipping companies' need of capital as freight rates decrease. Conversely, excess demand relatively to supply increases the spot freight rates. Then, shipping companies want to increase their fleet, and in the first place through the second-hand market, to get the chance to take part of the current relatively high freight rates. When there are more buyers than sellers in the second-hand market, second-hand prices rise until used ships become more expensive than new-building. Then, the orders for new-building will most likely increase, and the prices in new-building as well. Moreover, within two or three years,[95] the ships are delivered and increasing supply adjusts the freight price equilibrium.

An example on the relatively long term mechanisms is shown in the following figures.[96] The units on all the figures are thousand $ per day, and the figures to the left are similar to those to the right; the numbers are $6000, $15000, $ 28000 and $44000. In 1980, shown in figure a, the demand of tanker service was almost equal to the supply capacity. From 1982 to1985 the supply curve moved to the left due to heavy scrapping that reduced the ship supply from 320 to 251 million ton deadweight, but the demand fell even more to below 150 million ton deadweight while there was a collapse in the crude oil trade after the oil price peak chock in 1979. The excess 60 million ton deadweight was laid up and the speed of tankers was extensively slowed down. Then, the demand curve intersected the supply curve at D_{85} and the spot freight rate was on about $7000 per day in average, as shown in figure 4.15b. In the late 1980s there had been an increase in the new-building orders, while between 1985 and 1991, the scrapping activity peaked also, so the supply curve moved only modest to the left to S91. An increasing oil trade increased the demand for tanker service by 30% within this time period to D91. Then, the equilibrium freight rate should have been at about $15000 per day. But because of the Kuwait War, there was a temporarily misbalance in the supply relative to the demand and the freight rate increased to $29000 per day, shown in figure c. Due to still heavy deliveries from the orders from the 1980s, the supply increased, and by the end of the war in 1992, the temporary shortages disappeared, so the freight rates fell to $15000 per day, as shown in figure d.

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[94] ibid
[95] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 107; It takes usually less time when demand for new-building are relatively low, and it may take more time during booms
[96] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 167

VLCC fleet supply/demand functions

In 1980 the tanker market was close to balance

VLCC fleet supply/demand functions

About 82 m. dwt of tankers scrapped 1982-85 but demand fell faster

(b)

VLCC fleet supply/demand functions

(e)

VLCC fleet supply/demand functions

Storage increased demand in 1991

VLCC fleet supply/demand functions
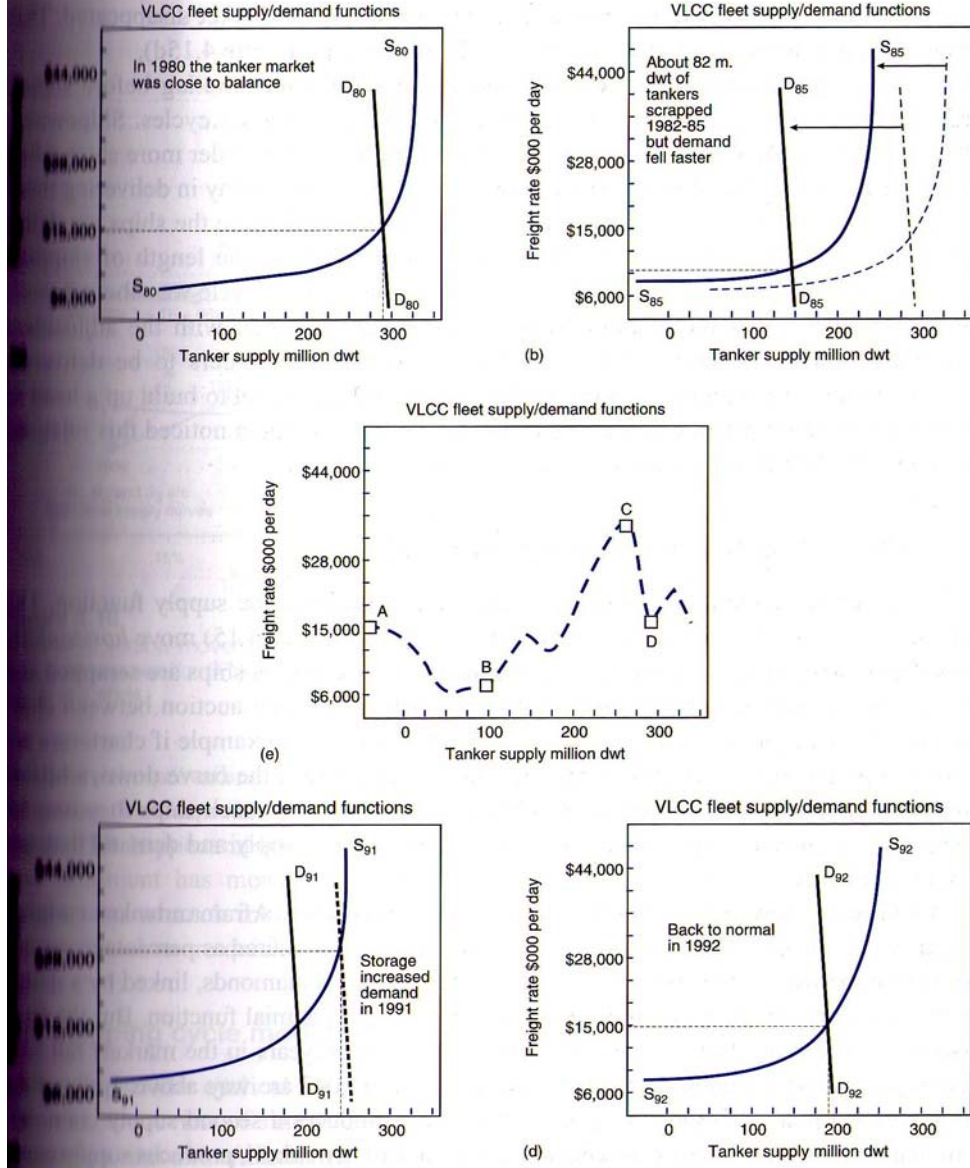
Back to normal in 1992

(d)

Figure 4.15
Long term adjustment of supply and demand, 1980–92
Source: Martin Stopford 2004

The time-lags in new-building and scrapping means that supply cannot meet demand over the current capacity, and this creates the characteristic market cycles in shipping.[97] Those cycles happen on a regular basis, but none of them are identical in length, timing or pattern. They have shown to last from three to twelve years, with an average of eight years during the last five decades.[98] In the figure below[99], the patterns of the freight rate cycles in oil shipping from

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[97] See for example Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, page 261-262, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional
[98] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 130
[99] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 119

the post-war period up to 2008 are shown. The measure unit on the vertical axis is in Worldscale.

Bulk shipping market cycles, 1947–2008
Martin Stopford from various sources
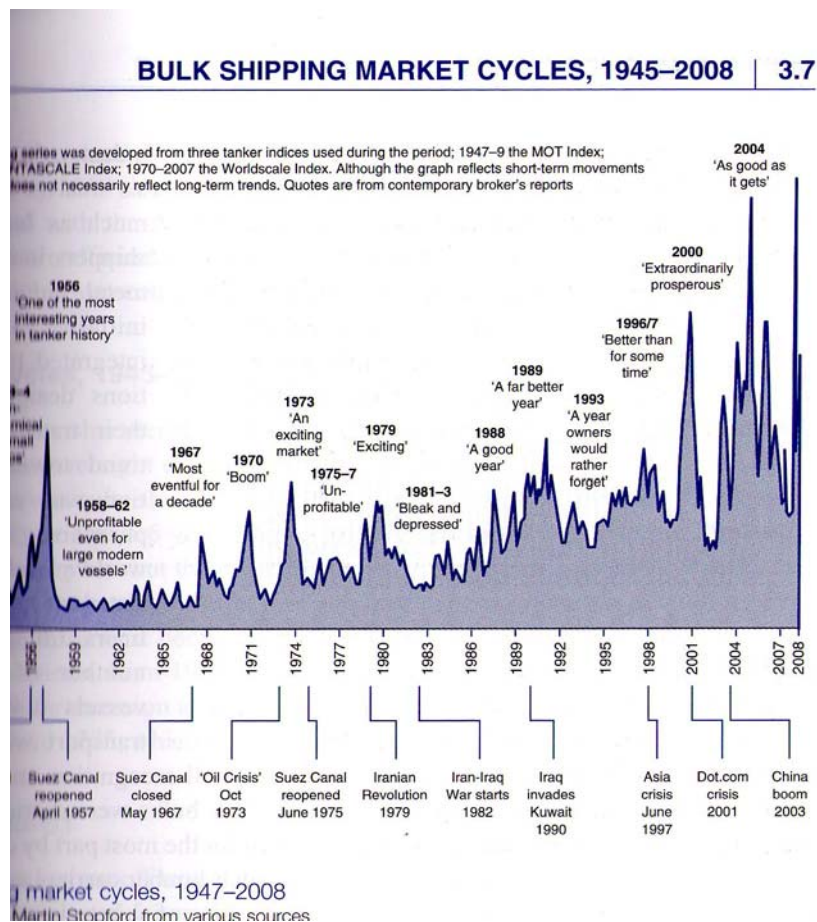
The figure shows that the peaks happen suddenly and that they are followed by a sudden pitfall. From the figure it seems that the larger the peaks are, the larger are also the following pitfalls, and that within the periods of the lower freight rates, the absolute changes are smaller. This creates the following hypothesis:
- The periods of low freight rates are stable equilibriums
- The periods of relatively high freight rates are unstable equilibriums

The mathematical treatments for the investigation of the stable equilibrium are based on oil shipping theory and this is my own mathematical treatments and analysis. The mathematical examination of the unstable equilibrium is based on a study by Beenstock and Vergottis (1993), but I show the mathematical treatments, which they do not, and I do also my own interpretation of some of the mathematical results.

2.5 The periods with relatively low rates as stable equilibrium

Generally, market equilibrium is a state where economic forces are balanced, and in absence of external influences, the equilibrium values will not change. It is the point at which the quantity demanded and the quantity supplied is equal. Equilibrium is stable if small deviations from the equilibrium point cause economic forces to lead the market to return to the equilibrium point. This means that economic forces lead to a convergence process to the equilibrium point when a deviation has occurred. For example, if the initial price in a competitive market deviates from the equilibrium price, then there will be a demand or supply surplus. If the surplus is a demand surplus, then the price increases and converges to the equilibrium price. If the surplus is a supply surplus, then the price decreases and converges to the equilibrium price.

According to the discussion above, the problem is then to show that if small deviations occur in the freight rate, it will converge to the equilibrium point. If the market price converges to the equilibrium, the equilibrium is stable. One method might be through cobweb investigation[100], due to the fact that the spot rate fluctuates around an underlying trend and the equilibrium seems to be stable at the same time. Another method might be through a mathematical examination of the impacts of the competitive pressure due to the almost perfect competition in oil shipping.[101]

The demand and supply functions are generally non-linear, and they could be approximated by Taylor-series. If higher-order terms in the Taylor-expansion are ignored, then the demand and supply functions could be approximated by linear functions. Therefore, it is assumed here that the supply and demand functions are given as linear approximations to the real demand and supply functions.

$$x_t^D = demand\ at\ time\ t$$

$$x_t^S = supply\ at\ time\ t$$

$$p_t = market\ price$$

$$x_t^D = ap_t + a_0, a < 0, a_0 > 0$$

$$x_t^S = bp_{t-1} + b_0, b > 0, b_0 > 0$$

$$x_t^D = x_t^S$$

This gives the difference equation

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[100] The idea about checking by cobweb examination, I got from McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 298-304
And Zannetos (1966): The theory of oil tankship rates, The MIT press, page 186-191
[101] The idea about checking this is due to the competition characteristics in oil shipping market outlined in 2.1-2.2

$$ap_t + a_0 = bp_{t-1} + b_0$$

$$p_t - \frac{b}{a}p_{t-1} = \frac{b_0 - a_0}{a}$$

This difference equation has the characteristic equation.[102]

$$r - \frac{b}{a} = 0$$

So the general solution to the difference equation is[103]

$$p_t = c_1 \left(\frac{b}{a}\right)^t + c_2$$

If the system has a stable equilibrium p*, then

$$ap* + a_0 = bp* + b_0$$

$$p* = \frac{b_0 - a_0}{a - b}$$

If it has been a disturbance so that the system starts in another point than the equilibrium price, then the initial price is now p_0 and I check if the market price converges to equilibrium point.

$$c_1 = p_0 - c_2$$

If there is convergence, then

$$p* = \lim_{t \to \infty} p_t = c_2$$

Then, it is easy to verify that the general solution of the difference equation is

$$p_t = \left(p_0 - \frac{b_0 - a_0}{a - b}\right)\left(\frac{b}{a}\right)^t + \frac{b_0 - a_0}{a - b}$$

$$p_t = (p_0 - p*)\left(\frac{b}{a}\right)^t + p*$$

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[102] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, page 412
[103] ibid

The condition for convergence, that is the condition for a stabile equilibrium, is that |a|>|b| This condition means that the absolute value of the slope of the demand schedule is greater than the absolute value of the slope of supply schedule. In the freight market the demand curve is almost inelastic in the periods with lower freight rates and therefore, a is approximately equal to zero, the short term supply curve is almost perfect elastic below full capacity and thus, b is big. The conclusion of this is that in the freight market |a|<<|b|. The fundamental cobweb criteria, see figure[104] below, can therefore not give definite conclusion of stability in the market equilibrium.

Figure[105]: Converging cobweb
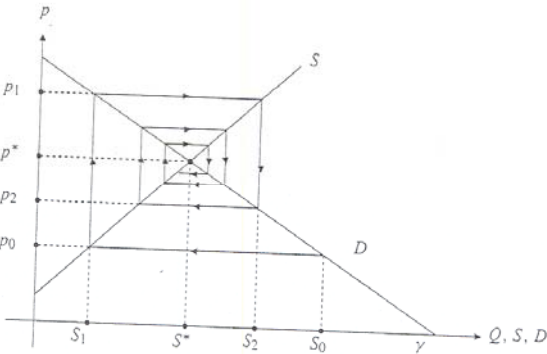
Then, I try with the competitive pressure to show stability in market equilibrium. In a competitive market, equilibrium is created by the condition that supply equals demand. If a change in the demand and/or supply schedules triggers a demand or supply surplus, then the competitive process will drive the market situation towards the equilibrium price. The process can be illustrated in this way. Given that the competitive markets behave according to the supply and demand rules of competitive pressure, then

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[104] Source: McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 299
[105] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, page 397

$$p = p(t)$$
$$D = demand$$
$$S = supply$$

$$\dot{p} = H(D - S)$$
$$\dot{H}(t) > 0$$
$$H(t) > 0, t > 0$$
$$H(t) < 0, t < 0$$
$$H(0) = 0$$

Here $H = H(t)$ is assumed to be a monotone increasing function with continuous first derivate. This means that if there is a demand surplus, then the price will increase and if there is a supply surplus, then, the market price will decrease.

If the derivate of H is relatively small near the origin, then this process is slow. If on the other hand the derivate of H is large, then the price adjustment process is rapid. The adjustment process may be slow in a market where the information on market conditions spreads slowly and very rapid if full information on the market condition is almost immediately available in the market. The fact that the process is administrated by special agents, shipping agent brokers, so there is actually one market place, cause the information about freight market prices to spread rapidly. Then, the surplus, the competitive pressure towards equilibrium increases according to the difference between demand and supply. This difference is either a demand surplus or a supply surplus. This surplus is growing very rapidly if there is a shift of any kind, because the shape of the demand and supply schedules in the periods of lower freight rates of these schedules. So if the market price has deviated from the equilibrium point, then there will be strong market forces driving the price back to equilibrium. Therefore, I conclude with this result from the discussion: The market equilibrium in the lower part is a stabile equilibrium.

2.6 The periods with relatively high rates as unstable equilibrium

In the following, I do a mathematical examination according to a study by Beenstock & Vergottis (1993)[106], but I show the mathematics to a further detail than B&V and I also do my own analysis of the mathematical results. The BV model is a model where there exist only one type of ships[107], hence one market segment, and possible that of tankers. Furthermore, it

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[106] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, chapter 3

[107] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 101

is assumed to be perfect competition in the freight market as well in the markets for ships both on the demand and supply sides.[108] Thereby, this model is highly applicable to the oil shipping segment. Due to the competitive requirements, this model is perhaps also best suited for this segment, rather than for example liner shipping, where the market is characterized by oligopoly competition. The BV model also assumes optimizing economic behaviour in all four interdependent shipping markets: the freight market, the shipbuilding market, the market for second hand ships and the scrap market.[109] The model is used for explaining how freight rates, ship prices, shipbuilding and scrapping are determined in terms of various external factors in these markets. The external factors are demand for freight, fuel prices, operating costs, laying-up costs, cost of capital, shipbuilding costs, scrap prices, steel prices etc.[110] The demand in the freight market is assumed to be completely inelastic with respect to freight rates. Therefore, freight demand is treated as an exogenous variable. This is a relevant approach, because of the demand characteristics of the demand for oil shipping outlined in chapter 2.2. On the supply side in the freight market, the shipping companies maximize profit given their production functions, freight rates and bunker prices.[111] In the shipbuilding market, the shipyards maximize their profits given their production capacity, the level of ship prices and their shipbuilding costs. On the supply side in the scrap market or the demand of new building and second-hand markets, the shipping companies operate to achieve the best returns through optimizing the amount of ships given their expectation and risk management.[112] Moreover, the model has its focus on the interactions among the four markets. In the following, I concentrate on the part of the model that explains the equilibrium patterns.

The model
The model consists of eight equations[113]:

- equilibrium in the freight market: (1)
- supply of shipping services (2)
- profit for the shipping firms (3)
- price of ships (4)
- output from shipbuilding industry (5)
- condition for steady state equilibrium (6)
- scrapping equation (7)
- net capital growth (net fleet growth) (8)

The equations are transformed to log-linear form and the variables are in logarithmic form. Then, the equations are approximated by a Taylor-approximation. The result is the following

[108] ibid
[109] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 98
[110] ibid
[111] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 102
[112] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 105-113
[113] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 114

(1) $\triangle q = \Delta K$

(2) $q = K + \gamma F - \gamma P_b$

(3) $\pi = (1 + \gamma)F - \gamma P_b$

(4) $P = \pi - r$

(5) $D = \mu_1 P_n - \mu_1 P_1$

(6) $P_n = P$

(7) $S = -\mu_2 P + \mu_2 P_s$

(8) $\triangle K = D - S$

All the variables are in logarithms. The variables (logarithms of) of the model are

$q = demand$

$K = the\ kapital\ of\ the\ fleet$

$F = freight\ rate$

$\pi = profit\ of\ the\ shipping\ firms$

$r = rent = \exp ected\ returns\ on\ other\ assets$

$P = price\ of\ ships\ in\ steady\ state$

$P_n = future\ price\ of\ ships\ in\ period\ n$

$P_b = fuel\ price\ (bun\ker\ price)$

$P_s = price\ of\ scrap$

$D = output\ in\ shipbuilding\ industry$

$S = scrapping$

$\triangle K = net\ growth\ of\ the\ fleet$

$\triangle q = growth\ of\ demand$

This is the basic model. Beenstock and Vergottis derive two different versions of it, one with discrete time and one with continuous time.[114] For the purpose of analysing stability or instability, that is convergence or divergence, the continuous version is the most relevant one.

The continuous version of the model is a little bit more compact consisting of five equations. This reduction in the number of equations is a result of substituting of equations. The model is given by the following equations[115]

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[114] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 121, 127

[115] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 127

(9) $q_s = q$

(10) $q_s = K + \gamma F - \gamma P_b$

(11) $\pi = (1 + \gamma) F - \gamma P_b$

(12) $P = \alpha_1 \pi + \alpha_2 \dot{P} - \alpha_3 r$

(13) $\dot{K} = \mu P - \mu_2 P_1 - \mu_3 P_s$

Here, the variable with a dot is the time derivate of the variable. Equation (9) is the equilibrium in the freight market (q^s is the supply and q is the demand in the freight market). Equation (10) is the same as equation (2), the supply equation in the freight market. Equation (11) is the relationship between maximum profit, the freight rate and the fuel price. Equation (12) gives the equilibrium price in the second-hand market for ships as a function of profit, the expected capital gain and the alternative returns to capital. Equation (13) is derived by combining the new-building supply function, the scrapping function and the net growth equation for the fleet (the fleet capital).[116]

In this version of the model it is assumed that delivery of new ships is instantaneous, the prices for new and second-hand ships are identical.[117] The constant μ in equation (13) represents therefore a composite effect of ship prices on fleet growth.

When analyzing the BV model, I introduce a new endogenous variable according to Beenstock&Vergottis[118], defined by

$$x = q - K$$

This variable is the logarithm of the ratio between demand and the fleet size, the logarithm of the freight market balance. This is a standard practice in dynamic economic models.[119] This variable is a constant in the steady state. By analyzing the changeability of this variable it is possible to study convergence and eventually non-convergence to the steady state solution.

Here the analysis is first carried out in the *(x, P)* space by analyzing a system of simultaneous linear differential equations. The system of simultaneous linear differential equations is derived from equations (9) – (13). First by combining (9) and (10)[120]

$$q = K + \gamma F - \gamma P_b$$

$$F = \frac{1}{\gamma}(q - K) + P_b$$

$$F = \frac{1}{\gamma} x + P_b$$

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[116] ibid

[117] ibid

[118] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 128

[119] ibid

[120] ibid

By combining this with (11) gives[121]

$$\pi = (1+\gamma)F - \gamma P_b = \frac{1+\gamma}{\gamma}x + (1+\gamma)P_b - \gamma P_b$$

$$= \frac{1+\gamma}{\gamma}x + P_b$$

$$\pi = \beta x + P_b$$

$$\beta = \frac{1+\gamma}{\gamma}$$

Combining this with (12) gives

$$P = \alpha_1 \pi + \alpha_2 \dot{P} - \alpha_3 r = \alpha_1(\beta x + P_b) + \alpha_2 \dot{P} - \alpha_3 r$$

$$P = \alpha_1 \beta x + \alpha_1 P_b + \alpha_2 \dot{P} - \alpha_3 r$$

By derivation one gets with help of equation (13)

$$\dot{x} = \dot{q} - \dot{K} = \dot{q} - (\mu \dot{P} - \mu_2 \dot{P_1} - \mu_3 \dot{P_s})$$

$$\dot{x} = \dot{q} - \mu \dot{P} + \mu_2 \dot{P_1} + \mu_3 \dot{P_s}$$

Summing up these results:[122]

$$\dot{x} = \dot{q} - \mu \dot{P} + \mu_2 \dot{P_1} + \mu_3 \dot{P_s}$$

$$P = \alpha_1 \beta x + \alpha_1 P_b + \alpha_2 \dot{P} - \alpha_3 r$$

$$\dot{x} = -\mu \dot{P} + \dot{q} + \mu_2 \dot{P_1} + \mu_3 \dot{P_s}$$

$$\dot{P} = -\frac{\alpha_1 \beta}{\alpha_2}x + \frac{1}{\alpha_2}P - \frac{\alpha_1}{\alpha_2}P_b + \frac{\alpha_3}{\alpha_2}r$$

The last two equations may be written in matrix form[123]

$$(14)\quad \begin{bmatrix} \dot{x} \\ \dot{P} \end{bmatrix} = \begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1 \beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix} \begin{bmatrix} x \\ P \end{bmatrix} + \begin{bmatrix} \dot{q} + \mu_2 \dot{P_1} + \mu_3 \dot{P_s} \\ -\dfrac{\alpha_1}{\alpha_2}P_b + \dfrac{\alpha_3}{\alpha_2}r \end{bmatrix}$$

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[121] This is something I show, but the final result is the same as in Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall
[122] Beenstock, Michael; Vergottis, Andreas (1993): Econometric Modelling of World Shipping, first edition, Chapman & Hall, page 128-129
[123] From now on, it is my own mathematical treatment and analysis

The derivate q is the growth rate of demand and is treated as an exogenous variable here. I will therefore give it a new symbol R that is the growth rate of demand in the freight market, so $\dot{q} = R$. Then (14) may be written

$$(15) \quad \begin{bmatrix} \dot{x} \\ \dot{P} \end{bmatrix} = \begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1 \beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix} \begin{bmatrix} x \\ P \end{bmatrix} + \begin{bmatrix} R + \mu_2 P_1 + \mu_3 P_s \\ -\dfrac{\alpha_1}{\alpha_2} P_b + \dfrac{\alpha_3}{\alpha_2} r \end{bmatrix}$$

System (15) will also of convenience be written

$$(15a) \quad \begin{bmatrix} \dot{x} \\ \dot{P} \end{bmatrix} = \begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1 \beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix} \begin{bmatrix} x \\ P \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$$

where

$$\begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} R + \mu_2 P_1 + \mu_3 P_s \\ -\dfrac{\alpha_1}{\alpha_2} P_b + \dfrac{\alpha_3}{\alpha_2} r \end{bmatrix}$$

This matrix differential equation is the basis for my analysis.

The equation (15) has equilibrium point given by the condition[124]

$$(16) \quad \begin{bmatrix} \dot{x} \\ \dot{P} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

At this equilibrium point, both x and P are constants. The equilibrium point is also a stationary point. This means that the shipping fleet increases with the same rate as the demand, and that the price of ships is constant as long as there is no shift in exogenous variables. The stationary point is therefore a steady state for the shipping industry.

The next question is how the system behaves in the neighbourhood of the stationary point and how it evolves when starting from an initial position different from the stationary point. The question can be analyzed by a state phase analysis of the differential equation system or by analytic methods.

I will start with an analytical approach and thereafter illustrate the analysis with a phase diagram. The first question is concerned with which type the stationary point is. According to

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[124] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, p.243

Sydsaeter & Hammond[125], there are four types of stationary points: sink, source, saddle point or centre. This question is analyzed with the spectral values of the coefficient matrix

$$(17) \quad A = \begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1\beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix}$$

The spectral values (λ) of this matrix is given by the equation

$$|\lambda I - A| = \det[\lambda I - A] = 0$$

where "det" is the determinant of the matrix in the parenthesis. Now

$$|\lambda I - A| = | \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1\beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix} | = | \begin{bmatrix} \lambda & \mu \\ \dfrac{\alpha_1\beta}{\alpha_2} & \lambda - \dfrac{1}{\alpha_2} \end{bmatrix} |$$

$$|\lambda I - A| = \lambda(\lambda - \frac{1}{\alpha_2}) - \frac{\alpha_1\beta\mu}{\alpha_2} = \lambda^2 - \frac{\lambda}{\alpha_2} - \frac{\alpha_1\beta\mu}{\alpha_2} = 0$$

$$\alpha_2\lambda^2 - \lambda - \alpha_1\beta\mu = 0$$

The characteristic equation[126]

$$(18) \quad \alpha_2\lambda^2 - \lambda - \alpha_1\beta\mu = 0$$

has the solutions

$$(19) \quad \lambda = \frac{1 \pm \sqrt{1 + \alpha_1\beta\mu}}{2\alpha_2}$$

Both of the two solutions of the characteristic equation are real, one is positive and one is negative. This can be seen directly from the formula for the solutions. Since the coefficients in the radical are all positive, then the radical is positive and greater than one and hence the square root is also greater than one. Since the coefficient in the numerator is also positive, it follows that one solution is positive and the other is negative. This could also easily be seen directly from the characteristic equation because their product is negative given that they are real. That they are real follows from the fact that the radical in formula (19) is positive. The product of the two solutions is

$$\lambda_1 \cdot \lambda_2 = -\frac{\alpha_1\beta\mu}{\alpha_2}$$

[125] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, p.245
[126] See for example Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall

Since the spectral values (λ_1, λ_2) of the coefficient matrix A of the equation system (15) is real and have different signs, one negative and one positive, then it follows that the stationary point is a saddle point.[127]

The stationary point (x_∞, P_∞) is given as the solution of

$$\begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} \dot{x} \\ \dot{P} \end{bmatrix} = \begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1 \beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix} \begin{bmatrix} x \\ P \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$$

$$\begin{bmatrix} 0 & -\mu \\ -\dfrac{\alpha_1 \beta}{\alpha_2} & \dfrac{1}{\alpha_2} \end{bmatrix} \begin{bmatrix} x \\ P \end{bmatrix} = -\begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$$

Analytical solutions in the time domain of the matrix equation:

The equation system (15) can be solved in the time domain.[128] For this purpose let

$$\lambda_1 = \frac{1 - \sqrt{1 + \alpha_1 \beta \mu}}{2\alpha_2}$$

$$\lambda_2 = \frac{1 + \sqrt{1 + \alpha_1 \beta \mu}}{2\alpha_2}$$

Since the coefficient matrix A has two different spectral values, it has two different linear independent spectral vectors **v** and **u** given by

$$v = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}, u = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$Av = \lambda_1 v$$

$$Au = \lambda_2 u$$

This means that

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[127] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, p.245

[128] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, p.241-242

$$v = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}, u = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$Av = A \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \lambda_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \lambda_1 v$$

$$Au = A \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \lambda_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \lambda_2 u$$

The general solution of (15) is[129]

$$(20) \quad \begin{bmatrix} x \\ P \end{bmatrix} = c_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} e^{\lambda_1 t} + c_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} e^{\lambda_2 t} + \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$

where (x_∞, P_∞) is the stationary point and c_1, c_2 are arbitrary constants.

Let the starting point (initial point) at time t = 0 be

$$x(0) = x_0$$
$$P(0) = P_0$$

Then the equation (15) has a unique solution given by

$$\begin{bmatrix} x_0 \\ P_0 \end{bmatrix} = c_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} e^{\lambda_1 0} + c_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} e^{\lambda_2 0} + \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$

$$= c_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} + c_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} + \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$

$$c_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} + c_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} x_0 \\ P_0 \end{bmatrix} - \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$

$$c_1 v_1 + c_2 u_1 = x_0 - x_\infty$$
$$c_1 v_2 + c_2 u_2 = P_0 - P_\infty$$

Since the two spectral vectors are linear independent, this equation has a unique solution. Let the solution be called C_1, C_2. These constants are the solutions of

$$(21) \quad C_1 v_1 + C_2 u_1 = x_0 - x_\infty$$
$$C_1 v_2 + C_2 u_2 = P_0 - P_\infty$$

Then, the solution starting from the point (x_0, P_0) can be written

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[129] Sydsaeter, Knut; Hammond, Peter; Seierstad, Atle; Strom, Arne (2008): Further Mathematics for Economic Analysis, Second edition, Prentice Hall, page 271, 239, 241

$$(22) \begin{bmatrix} x \\ P \end{bmatrix} = C_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} e^{\lambda_1 t} + C_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} e^{\lambda_2 t} + \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$

where C_1, C_2 are definitive values satisfying equation (21) and not arbitrary constants.

The stability conditions:
1. For initial points for which C_1, C_2 are both zero, that means that the starting point is the stationary point. Then

$$\begin{bmatrix} x \\ P \end{bmatrix} = C_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} e^{\lambda_1 t} + C_2 \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} e^{\lambda_2 t} + \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$
$$= 0 \cdot \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} e^{\lambda_1 t} + 0 \cdot \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} e^{\lambda_2 t} + \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$
$$= \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix}$$

This means that if the starting point is the stationary point, then the solution will remain in this point. This result is nothing new; it is only how the stationary point is defined.

2. For initial points for which C_1, C_2 are both different from zero the solution diverges which mean that the system is unstable. This follows from the fact that one of the spectral values is a positive number. It was earlier shown that $\lambda_2 > 0$. The consequence of this fact is that

$$\lim_{t \to \infty} e^{\lambda_2 t} = \infty$$

Therefore the solutions diverge and the system is unstable.

3. There are other points than the stationary points that are stabile. Since $\lambda_1 < 0, \lambda_2 > 0$ it follows that

$$\lim_{t \to \infty} e^{\lambda_1 t} = 0$$
$$\lim_{t \to \infty} e^{\lambda_2 t} = \infty$$

From (22), it then follows that a solution converges if and only if

$$C_2 = 0$$

This condition implies that there is only certain initial point that gives a stabile solution. When $C_2 = 0$ it follows from (21) that

$$C_1 v_1 + C_2 u_1 = C_1 v_1 = x_0 - x_\infty$$
$$C_1 v_2 + C_2 u_2 = C_1 v_2 = P_0 - P_\infty$$
$$\begin{bmatrix} x_0 \\ P_0 \end{bmatrix} = \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix} + C_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

The equation

$$(23) \quad \begin{bmatrix} x_0 \\ P_0 \end{bmatrix} = \begin{bmatrix} x_\infty \\ P_\infty \end{bmatrix} + C_1 \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

The equation is for points on the straight line through the stationary point and with the direction along the characteristic vector for the negative spectral value λ_1.
This condition for convergence tells that the system is stabile for starting points on this critical line. If the system starts on this line the solution will converge to the stationary point. If the initial point does not lay on the critical line, then the solution diverges and the system is unstable. Hence, the conclusion is that the relatively high freight rates are unstable. The pattern of instability/stability discussed above, are also illustrated in the figure below.
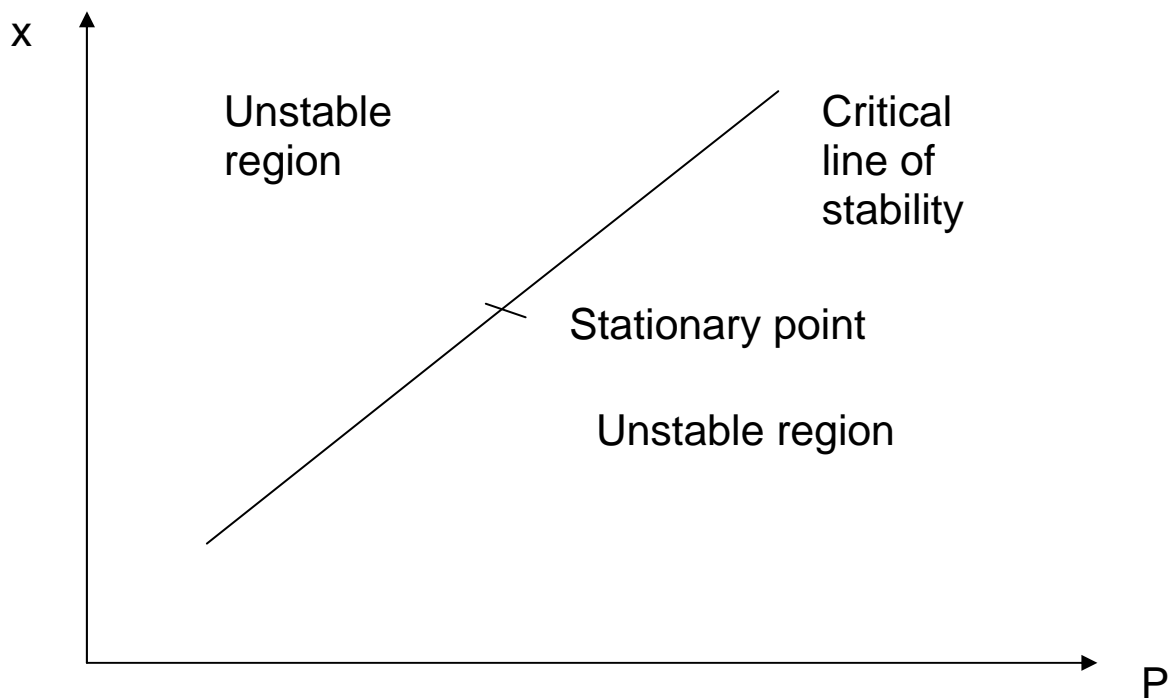
3. Playing the game

In this chapter I investigate how the different participants of the game play, given the market setting of the oil shipping industry outlined and analyzed in the previous chapter. In addition, in 3.2, 3.3 and 3.5, I examine some other important issues within shipping finance and the ship-building industry.

3.1 The shipping companies[130]

The cycles of freight rates investigated in the previous chapter are something the shipping companies have to take as given, since each individual company's operations have no effects on the freight rates due to the nearly perfect competition characteristic of the market. Rather than a competition between each other in market power by price or capacity, it is a competition where all depends on one's own timing of positions of the assets, the ships.

As outlined in the previous chapter, the shipping companies generally want to increase their capacity in the spot market during booms to capture the relative high profits. Then, the value of owning ships increases and thereby, the second-hand prices. The second-hand prices may even increase to higher levels than the new-building prices, but then, if the shipping companies expect the freight rates to remain high, they may find it relatively cheaper to buy new ships instead of purchasing used ships, and the activity and prices in new-building increase as well. During booms, the activity in scrapping falls to a minimum and the percent of lay-up decreases, since more inefficient ships become profitable to operate as the freight rates increase. All this increases the total supply of ships and also, the new delivered ships cause this to be a permanently boost of supply.

However, while the relatively high freight rates are unstable equilibriums, as found in the previous chapter, the freight rates may suddenly drop to a stable equilibrium of low rates for a relatively long period. Then, the companies with relatively large capacity and exposure to the spot freight market may come into critical financial positions. This is especially the situation if they have purchased second-hand ships at high prices, expecting the freight rates and second-hand prices to remain high, and additionally have orders in new-building. This was for example the case for some shipping companies/ship owners on the 1973s boom and crash respectively. One such example is Reksten, a ship owner that increased his fleet considerably through second-hand trade at sky high prices, but became bankrupt with the following crash.[131] But of course, it is the opposite for those who manage to sell at high prices and buy relatively cheaply. Examples on such ones are some Greek ship owners on the 1970s.[132] This

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[130] This discussion is based on that outlined and analyzed in chapter two and
Thanopoulou, Helen (2002): Investing in ships: an essay on constraints, risk and attitudes, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 623-637
Lorange, Peter (2007): Shipping company strategies, first edition, Emerald Group Publishing Limited, page 42-47
[131] Thanopoulou, Helen (2002): Investing in ships: an essay on constraints, risk and attitudes, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 634-636, 641; reference 51
[132] Ibid, page 635

is shown in the figure below; the Greeks' net second-hand trading between 1980 and 1984 was profitable, while the net Scandinavian was the contrary, and this was according to Thanopoulou (2002)[133] due to their converse attitude of trading in booms and periods of low freight rates respectively.

Figure 2: Net* purchases of tonnage from the second-hand market, 1980–1984

* Purchases minus sales.
Note: Graph calculated from data in Tables 2 and 3 in Thanopoulou, H. (1996), *op.cit.* Original data Lambert Brothers, *Trade Review and Outlook*, various issues.
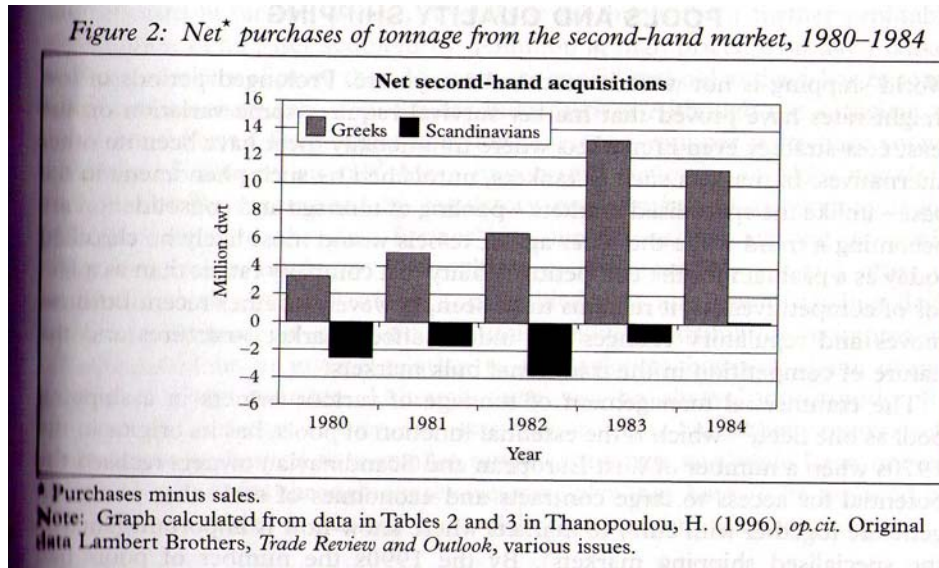
Hence, investment strategies which follow the cycles may not be the optimal ones, but rather the ones that are anti-cyclical investment strategies[134]; investments against the tide by purchasing to low prices and selling at high prices. And this does not only yield during booms, but also during the following recessions/depressions, because as some shipping companies are forced to sell to lower prices, and also since of the relatively low prices in new-building, this create opportunities for those which have invested cleverly previously and have relatively strong financial positions. Moreover, going into longer-term contracts may be better than being in the spot freight market at the top of the freight rate booms. This is however something I will investigate in more detail in the following sections.

What is certainly most optimal for the shipping companies to do are to buy ships cheaply, whether it is new orders or second-hand trading, and then sell to high prices. As outlined in chapter two, the prices in both new-building and second-hand trading peak during booms, and fall during the following recessions/depressions and remain relatively low until a new boom hit the market. At the beginning of a boom, second-hand prices may still be attractive, and the time of deliveries from new-building may be shorter than the remaining time of the boom. But as more shipping companies want to buy ships in those two markets and prices raise, this trading may actually not be optimal for the shipping companies, because of the increasing prices relatively to average freight rates and the limited remaining time of the boom. Still some optimistically ones do so, but those are also commonly forced to sell at low prices after coming in liquidity squeezes during the following pitfall in freight rates. Then, the companies

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[133] ibid
[134] This denotation is commonly used in the literature, see for example HO,
Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge
Lorange, Peter (2007): Shipping company strategies, first edition, Emerald Group Publishing Limited

with good financial positions might take this opportunity to buy. The ships are then used either as capacity in spot market or chartered within longer term contracts, since the pitfalls in freight rates most often are followed by longer periods with low freight rates. But it is not the earnings within those periods that actually matter for those shipping companies; it is the opportunities during the next booms. They may use their increased additional capacity in spot freight market at first, but then, as others still want to buy and the prices in second-hand trading continue to increase, they sell to high prices. In fact, those which buy cheap and sell at high prices like this, may have an average return of as much as 150-300%.[135] Therefore, buying and selling in the new-building and second-hand market are by some companies not done for the purpose to capture the profits of high freight rates, but for earning the possible high profits of asset play.[136]

As outlined previously, trading in second-hand market is, however, based on expectations among the shipping companies, and while some buy cheap and sell at high prices, there have to be someone who do the opposite. That is, the successors require that there are losers too, ones that have not learned from the past and buy ships to sky level prices. This is a peculiarity of the freight market where it is the sum of all companies' supply that matters, not only the expectations of individual companies, and where it therefore can be successors without the same numbers of losers.

Furthermore, successful anti-cyclical investments are often self-sustaining in the future, while the successors from the past have strengthened their cash reserves and thereby are able to invest when such opportunities rise. Losers from the past with disadvantaged financial positions may have enough with the business to run, but if they want to change to an anti-cyclical investment strategy, they have to rely more on banks to be able to finance those opportunities. However, banks are likely more restrictive with lending to such firms and generally more restrictive in times with depressed markets.[137] And to some degree, the banks may be right in being more restrictive in such times, since the cycles do not have identical lengths, and thereby, the anti-cyclical investments may as well fail to be successful and hence, risky. If for example the periods with relatively low freight rates last for a longer time, then the financial positions of the companies, which invest according to an anti-cyclical investment strategy, may also be pressed. And this is especially true if the additional capacity is financed through loans so that the financial costs increase and thereby, the average costs of the fleet. Hence, anti-cyclical investments are risky. However, investing at relatively low prices are anyway less risky and most likely more profitable than investing at high prices during booms which are unstable equilibriums.[138]

Moreover, anti-cyclical strategies are not only regarding investments in ships, but also how the assets, the ships, should be positioned. As previously outlined, shipping companies tend to increase their exposure to the spot market during booms. At the time when the freight rates are increasing, this is optimal, but when the freight rates reach peaking levels, this is unstable

[135] Thanopoulou, Helen (2002): Investing in ships: an essay on constraints, risk and attitudes, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 632
[136] Thanopoulou, Helen (2002): Investing in ships: an essay on constraints, risk and attitudes, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 632-634
[137] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge
[138] Thanopoulou, Helen (2002): Investing in ships: an essay on constraints, risk and attitudes, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 631-636

equilibriums as shown in chapter two, and therefore, the freight rates and the prices will fall at some time. Exactly when is not certain, and thereby, it is likely best for a shipping company to go into longer-term contracts as soon as possible, when the market is still high and it has better chances to get relatively high priced contracts and thereby, also avoid the following pitfall in spot prices. How good a price will be, depends on the expectations and the demand of oil companies.

In reality, it is however not easy to predict exactly when to invest or change positions[139], due to the time-lag in new-building and possible sudden demand changes. But the points outlined above are useful notes though; especially that the price equilibrium of booms is unstable and that doing investments and taking risky positions during those times are most often not a clever thing to do. Furthermore, to reduce the uncertainty about the investments, market indicators and forecasts, though not always accurate, may be useful. Different investment methods are also something that may be constructive for this. Discounted cash flow analysis and net present value with an assumed risk adjust rate are a common method to evaluate if to invest or not[140]; investments are done if the discount value of the expected cash flows are equal to or exceed the capital costs of the investments. Other methods are real option analysis and stochastic investments analysis[141]. This is however not a theme for this thesis, so I will not investigate this any further. And whatever methods, it should also be noted that the shipping companies have different risk policies, which are matters of individual valuations and therefore, some have always less exposure to the spot market, while others vary their exposure more according to the cycles, either by great excellence or failure.

Finally, it should be noted that if an increasing number of shipping companies managed to invest against the tide, then the prices of ships during recessions/depressions would raise and those during booms would increase by less, because less shipping companies would invest to booming prices. Thereby, the price differences *on ships* would generally be lower and the profitability of asset play decrease, as well as it would minimize the largest failures. During the relatively low freight rates, the competitive pressure causes the freight rates to remain at a stable equilibrium anyway, as shown in the previous chapter. The relatively high freight rates would furthermore only be influenced by anti-cyclical investments if the shipping companies met sudden booming demand with accordingly supply in *aggregate*. This is however not very likely, because of the difficulties in forecasting demand shocks a few years ahead when the ships have to be ordered due to the time-lag in new-building.

In addition, the shipping companies may take decisions about laying up ships. Those decisions are quite simple and predictable, since lay-up decisions are based only on calculations of differences between incomes with current rates and the costs of operations. For example, when freight rates are relatively low, the shipping companies frequently lay up ships. Those are typically the older ships; the ones that are more inefficient and costly to operate, so that the incomes of operations during lower freight rates are less than the costs.[142] It costs to lay-up though, because reactivating later cost and if there are loans on the ships to

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[139] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge,
[140] Bendal, Helen (2002): Valuing maritime investments using real options analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 642
[141] See Bendal, Helen (2002): Valuing maritime investments using real options analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 642-658 and
Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 319-342
[142] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 165-166, 222-223

repay; the capital costs are not covered by any income.[143] Since the costs of fuel comprise major savings, an alternative to lay-up may be to operate the more inefficient ships at a slower speed, as this reduces the fuel consumption.[144] Scrapping is another choice. During recessions/depressions after booms, when more shipping companies are in need of capital and increase their deliveries for scrapping, the income which the shipping companies receive is less. Therefore, this may not be the optimal timing of scrapping; at least not if a shipping company have sufficient funds. However, decisions about scrapping are commonly adjusted according to the other considerations about cash-flows and expectations of the future pattern of the freight rates and operations costs anyway, and not when they possible receive the highest income from scrapping.[145]

3.2 Banks and finance houses

The shipping industry, oil shipping included, is very capital intensive today. For example, tankers commonly cost up to hundreds of millions of dollars each[146], and as a result, capital may count for up to 80%[147] of the costs of running an oil shipping company with its fleet. Thereby, the financial decisions are crucial for the shipping companies. On the other hand, for the banks and finance houses which operate in shipping, this has become an important business, especially during booms in freight markets.[148] But oil shipping, and shipping in general, has distinctive characteristics from most other capital-intensive industries. The unique characteristics of shipping with volatilities in the freight market do not create predictable earnings, but instead fluctuating profitability for shipping lenders as well as shipping companies over the years.[149] The early 1970s, late 1980s, late 1990s and from 2003 to 2007, were highly profitable years for banks in shipping, while in 1973, late 1970s, early and mid 1980s during the shipping recessions and depressions, heavy losses were frequent.[150] Another distinctive characteristic of the shipping industry is the highly global performance of the shipping industry, which may cause less well-defined and formal corporate structures and ownerships, lower levels of disclosure and frequently shifts of which legal jurisdiction the companies are beyond. This creates challenges for lenders to identify the shipping companies and origin to possible principal-agent problems, which I will discuss in further sections.

According to Stopford (2009)[151], there are actually a range of critical risks for lenders which deal with the shipping business. The volatilities in the freight market are one major risk

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[143] ibid

[144] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 243-244

[145] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 160

[146] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 269

[147] Ibid
Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 744

[148] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 286

[149] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 744

[150] Ibid
Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 311

[151] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 313

affecting the cash-flows and the abilities of the shipping companies to pay their lenders. There are also operation risks of for example technical problems with ships. This may cause reduced earnings of the shipping companies as well and thereby, their abilities to pay their capital costs to lenders. Due to the possibility of overinvestment in capacity for the freight market or bad timing in asset play trading, the lenders have to find out both if the shipping companies purchase insurance against possible losses and the risk policies of a particular shipping company. Higher exposure to the spot freight market relatively to contract and aggressive investments increase the risks. Also, if shipping companies operate only in oil shipping, not in other shipping or maritime segments, they increase their relative exposure to volatilities in this market and the risks of failures increase. Furthermore, there are risks linked to the status of the shipping companies' fleets: If they have a relatively high share of new ships, they are most likely also subjected to relatively high capital costs and changes in interest rates might affect their abilities to pay. On the other hand, if they have a relatively high share of old ships, then the shipping companies have most likely less capital costs, but higher operating, repair and governmental regularly costs, and this may create payment problems as well. Another risk is that of counterparties, for example if the charterers are creditworthy. If they are not creditworthy, this may also cause problems with payments to lenders. However, this is not a frequent problem among oil companies, which most often are the counterparties.

The numerous risks for lenders to deal with shipping indicate that their need of financial controls of the shipping companies must be strong. However, in some booming periods, this has not been the case. For example, within the peak in oil shipping in 1973, the shipping industry was viewed as a core business among the shipping lenders, since the returns on capital were high.[152] But with this, it came to that point that loans were frequently arranged by telephone with little documentation and control[153], and the loans contributed to finance new-building orders on 105 million tonnes deadweight of tankers, or additional 55% of the fleet.[154] Then, as the demand fell while supply had more than doubled, the pitfall in freight rates was unavoidable and more shipping companies/owners, and lenders, as well went bankrupt.

Today, the situation seems to be better within shipping finance[155], though perhaps not within many other divisions of the financing sector. The improvements within shipping finance may be due to lenders within shipping have learned from the past of risks and failures, and numerous unknowingly lenders have left the business. In fact, shipping finance has developed to be a business of highly specialist divisions of some commercial banks, some investment banks and finance houses.[156] But proficiency and experience may also come to short, as the future in this business are always somehow unknown and since problems with asymmetric information and moral hazard between finance institutions and shipping companies, and problems with adverse selection among shipping companies, perhaps are unavoidable.

Asymmetric information within oil shipping and shipping in general, happen if the shipping companies have inside and more accurate information than the bankers about such as financial accounts, the conditions of own fleet of tankers and expectation of future freight rates.[157] A main tool for the lenders to avoid this is to identify the shipping companies with their

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[152] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, 273-274

[153] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 274

[154] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 274

[155] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, 275-276, 317

[156] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page

[157] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 733

financial and fleet status and their risk exposure.[158] But while the shipping companies have global and less well-defined and formal corporate structures as stated earlier, identifying possible and currently borrowers may be problematic.[159] Therefore, although the problem of asymmetric information is reduced as lenders have become more specialised, it is perhaps inevitable to completely avoid problem.

Moral hazard arises when the shipping companies are trying to improve their chances of getting loans by misinforming the lenders,[160] or when the shipping companies change their behaviour without informing the lenders about this.[161] Common cases are according to Grammenos (2002)[162] false items in the running expenses of vessels, untrue statements regarding overall net worth and liquidity of the shipping group, transfer of income from mortgaged ships to other companies, clauses in longer-term contracts unknown to the banker or change in risk policy and/or asset play investment policy. Grammenos (2002)[163] discuss also which tools may be useful for lenders to reduce those risks, and once again the conclusion is to identify the individual shipping companies and continually update on this, and also to learn from experiences from the past and knowing the companies' reputations.

The problems of adverse selection arise since shipping companies have different policies and abilities of optimising their operations and while at the same time, lenders are not able to identify those different types of shipping companies. This becomes even more challenging due to the global company structures and the possible changing performance of their policies and operations during the time.[164] Previous experiences of individual shipping companies, knowing the companies' reputation and management may be useful information to at least reduce the problems of adverse selection according to Grammenos (2002)[165]. Stopford (2009)[166] also outline that early signals may be detected through continually observations of individual shipping companies.

The risks and the problems outlined above can possibly cause both increased risks for defaults of payments on loans and increased challenges for the lenders to detect this. The lenders may therefore set special conventions within the loan contracts to secure against losses in advance. One such convention may be the guarantee of ownership of ships and hence, in cases of defaults, the lenders have the right to possess ships and operate them or sell them.[167] Another may be that lenders secure the loans against revenues or/and insurances, so that when defaults of payments occur, the lenders have the right to receive all the income from chartering and all

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[158] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 733-739
[159] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 269
[160] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 733-734
[161] ibid
[162] ibid
[163] ibid
[164] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 269, HO page 736
[165] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 735-739
[166] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 313-315
[167] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 735, 739-740

the insurance coverage of losses.[168] However, to receive any income at all, lenders usually allow the shipping companies to withdraw necessary cash to ensure that the ships remain to their standards to operate those in order.[169] Lenders sometimes diversify the risks by spreading the loans and the risks among a syndication of several banks.[170] Then, the risks of each individual lender are reduced and the information about the borrower most likely improved while more lenders have to investigate the borrowers' performance.

Conclusively, oil shipping finance as well as shipping finance in general may be very profitable, but the characteristics of the market of volatilities in earnings and the continually uncertainty of the future, cause considerably risks of providing loans. And as outlined above, there are not only risks from market volatilities, but also problems for lenders to identify the individual companies, which become especially considerable because of the sizes of the loans within oil shipping/shipping in general. This has caused gigantic defaults of banks as well as shipping companies during the past. Today however, shipping finance seems to have learned from the vulnerable stories and it has become a business of specialists. By the specialists' knowledge and analysis of the market and companies, the risks and problems are reduced, but as argued above, they cannot be completely avoided. Therefore, the lenders usually secure themselves against defaults through guarantees of for example ownership of ships and rights of capturing the incomes and insurances.

The advantages of anti-cyclical investment strategy, which I discussed in the previous chapter, are not only something shipping companies should be aware of, but also lenders. According to Stopford (2009)[171], the lenders tend to increase their exposure in shipping in good times, but moderate it during the following periods of low freight rates. But the lenders that follow this strategy actually increase their risks of providing loans to defaults when the recessions and depressions set in afterwards. These lenders inhibit themselves from taking part of the feast of the most profitable asset play of relatively cheap investments in recessions/depressions and the selling to relatively high prices during booms. However, also as discussed in the previous chapter, as more shipping companies and lenders discover this possibility; the profitability and advantage of anti-cyclical investments would decrease. Hence, for lenders that provide loans to an increasing number of shipping companies for anti-cyclical investments, this may actually have opposite effect for the profitability in aggregate.

3.3 Insurance companies

Due to the volatile market settings, there are risks of heavy income reductions and possible payments failures during some periods, and shipping companies commonly insure themselves against such risks.[172] But there are also risks for accidents, and especially because of the

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[168] Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 741

[169] ibid

[170] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge,

[171] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 278

[172] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230-231

evolvement of stricter governmental regulations during the recent years, accidents may count for considerably costs for the shipping companies when they happen.[173] Therefore, insurance is an important way to secure against this. Other insurances are purchased by the shipping companies to protect against technical defaults of ships and thereby income losses, to cover third parties defaults such as injury or death of crew members, passengers or others, to protect against cargo damage, against possible strikes and wars.[174] In fact, insurances typically count for about 15%[175] of the operating costs of individual shipping companies.

The companies that provide insurances are special marine insurance companies. Such companies set the conditions for insurance agreements through the shipping companies' claim record and that of particularly tankers/ships.[176] Conditions for insurance against income losses may be determined according to the market conditions, future expectations and individual companies' risk and operation policies. The accident and environmental insurances are furthermore based on the fleet standards and knowledge of the crews.[177] But as for lenders within shipping, principal-agent problems are also frequent within shipping insurance.

The insurance companies face mainly the same challenges as lenders when insurance contracts about protection against income losses for the shipping companies are set.[178] However, by the fleet, the third party and accident insurance, insurance companies have to deal with additional challenges; to identify the status of the fleet, the competence of the crew and individual governmental and international regulations in the case of accidents.[179] Those challenges may cause asymmetric information between the well informed shipping companies and the principals, the insurance companies. Therefore, it is important for the insurance companies to provide themselves with detailed information from the shipping companies and also to have competent human resources on those issues within the insurance companies.[180] However, the shipping companies may provide the insurance companies with false information to improve their insurance conditions, similar to the case of loan contracts, and thereby, moral hazard problems arise. Identifying each shipping company, through previous experience in the business and perhaps also through previous experience with each individual companies, are important.[181] Setting special conventions in the contracts similar like the lenders might be another way of dealing with this, and possibly also strict punishments in the case of false or imperfect information.

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[173] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230-231
Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 265
[174] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230
[175] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230
[176] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230-231
[177] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230
[178] Ibid
Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 734-739
[179] ibid
[180] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230-231
HO, page 736-737
[181] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 730-731
Grammenos, Costas Th. (2002): Credit risk, analysis and policy in bank shipping finance, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 734-737

Furthermore, the challenges with adverse selection arise because of different cost function of fleets and different operation policy among the shipping companies, and in the case of income insurance, also different risk management.[182] Once again, identifying the shipping companies is crucial, and this might be through detailed company and fleet information and through previous experience of each shipping company.[183]

3.4 Oil companies

As outlined in previous chapters, oil shipping is not a significant part of the oil companies' business anymore and today, the costs of oil shipping count for only a relatively small part of the oil companies' total costs and thereby, for no more than a few percent of the total retail price. The relatively inelastic demand for oil shipping and demand for oil in the short run entice oil companies to follow short run production policies without actually modifying them to, because of volatilities in oil shipping prices.[184] Hence, chartering is not of major consideration to the oil companies either, but surely, if possible, they want to avoid additional costs. How they might do so, I will discuss in the following section.

Longer-term contracts create less risks and increased predictability and stability for the shipping companies, as previously noted, but they also do the same for the charterers, the oil companies. While shipping companies avoid losses of recessions in the freight market through the longer-term contracts, oil companies avoid booming freight rates if they have covered their chartering demand by such contracts.[185] On the other hand, by chartering in the spot market, the oil companies can order shipping services exactly when and to what volume they need. It is generally optimal for the oil companies to increase the chartering to spot freight rates when there are recessions or depressions in the market, and to increase the share of long-term contracts when spot freight rates are still relatively low and soon peaking upwards.[186] However, other factors may be of greater importance for the oil companies, since that shipping capture only a small fraction of their costs. And for the oil companies as for the shipping companies, the future in oil shipping is uncertain and not possible to forecast accurate. Hence, the decisions about when to increase the chartering to spot freight rates or to prices set in advance in long-term contracts may be a matter of risk policy.

Moreover, if an oil company is in need of more oil shipping service during booms, the most cost effective method would usually be to go into contracts, but only for a restricted period, because the spot freight rates would surely fall again within short time, and therefore, spot freight rates would be attractively priced within the longer perspective relatively to longer-term contracts which are set when the spot freight rates are peaking.[187] But for the oil companies as for the shipping companies, the future is challenging to forecast accurate, if at

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[182] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 230
[183] ibid
[184] McConville, James (1999): Economics of Maritime Transport, first edition, Witherby & Co LTD, page 308
[185] See for example Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 180-198
[186] Lorange, Peter (2007): Shipping company strategies, first edition, Emerald Group Publishing Limited, page 44; but opposite for oil companies
[187] ibid

all possible, and therefore, the decisions about oil shipping of the oil companies as well, are based on expectations.[188]

It should also be noted that the oil companies may increase their own tanker fleet instead of employing independent shipping companies if this is cheaper in the long run, like the situation was for up to about fifty years ago. However, the industry would most likely become less competitive then, as in the past. And this would also have considerable effects on the market settings, while for example market power would instead impact the freight rates.

3.5 Ship yards

As outlined in the previous chapters, the volatilities in the freight market affect the activity and prices in shipbuilding considerably. The recessions/depressions in the freight market cause sudden falls in tanker ship building as well. And since cycles are prevalent in all shipping segments, and that the major cycles happen approximately at the same time, the ship building industry has corresponding cycles.[189] Those are shown in the figure below.[190] As indicated in the figure, during the downswing of a cycle, after a boom and throughout recessions/depressions, the activity in shipbuilding may fall between 40% and 60% annually, and sometimes even more. During the step from a period of low freight rates and low activity in shipbuilding to a boom in freight rates, the activity in shipbuilding may increase by more hundred percent annually.

[188] Glen, David; Brendan, Martin (2002): The tanker market: current structure and economic analysis, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 257
[189] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 625-628
[190] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 626

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Table 15.2 Shipbuilding cycles, 1902–2007

Cycle no	Cyclical peak and downswing			Cyclical trough and upswing			Full cycle years
	Year	Peak '000 grt	Peak to next trough		Year	Trough '000 grt	Trough to next peak	
			years	%			years	%	
1	1901	2,617	3	−24%	1904	1,987	2	47%	5
2	1906	2,919	3	−45%	1909	1,602	4	108%	7
3	1913	3,332	2	−59%	1915	1,358	4	426%	6
4	1919	7,144	4	−77%	1923	1,643	1	37%	5
5	1924	2,247	2	−26%	1926	1,674	4	73%	6
6	1930	2,889	3	−83%	1933	489	5	520%	8
7	1938	3,033	2	−42%	1940	1,754	4	1057%	6
8	1944	20,300	3	−90%	1947	2,092	11	343%	14
9	1958	9,269	3	−14%	1961	7,940	14	352%	17
10	1975	35,897	4	−67%	1979	11,787	3	47%	7
11	1982	17,289	5	−43%	1987	9,770	20	534%	25
12	2007	61,900	Based on the orderbook output likely to double by 2010						
Analysis of cycles									
Average length			3.1	−52%			6.5	322%	9.6
Standard deviation			0.9	25%			5.9	313%	6.4

Source: Compiled by Martin Stopford from Lloyd's Register and other sources

The relatively large variations create difficulties for the shipyards. The ship yards solve this in different ways. Some of them are divisions of conglomerates and thereby, they can take advantage of corporate reserves from other market areas to meet short-term cash difficulties.[191] Resources from other divisions may also be used to modernise the production facilities to improve a shipyard's competitive position in times when independent shipyards instead have to rationalize.[192] But a perhaps more important contributing factor for surviving through though times is the governmental interests in the shipbuilding industry. Those interests arise because of the ship yards' strong national connections and from the impacts of the downturns on labour. According to Soo Jon (2002)[193], the governments try to help the shipyards and to stimulate the activity in shipbuilding during low-activity periods mainly in two ways; financial assistance and/or increasing orders for war ships. By financial assistance, governments act as credit guarantors in the process of constructing ships and they provide with favourable financing so the shipyards may cut prices during downturn periods.

Today, the largest shipyards are found in South Korea, Japan and China[194], and it is also the governments of those countries that play the major role in contributions to the shipbuilding industry.[195] But the governments' subsidies to the shipbuilding industry are controversial.[196]

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[191] Jon, Soo Joon (2002): Government policies and the shipbuilding industry, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 531

[192] Jon, Soo Joon (2002): Government policies and the shipbuilding industry, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 531

[193] Jon, Soo Joon (2002): Government policies and the shipbuilding industry, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 532

[195] Jon, Soo Joon (2002): Government policies and the shipbuilding industry, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 532-534, 537

The subsidies may lead to a competition between governments rather than the survival of the most competitive companies. But on the other hand, due to the market settings of the shipping industry overall, it is perhaps the only way to make any shipyard surviving during though times. And if only a few or none shipyards survived, this would considerably affect the rest of the shipping industry negatively, especially the shipping companies.[197] However, since this is not the main theme for this thesis, I leave the additional discussion of this to further studies.

4. Summary and conclusions

This paper examines the market settings of oil shipping and how the participants of this business play their game, according to existing literature of various authors. I have also shown some empirics graphically to visualize the theory. An important characteristic of the oil shipping market is the nearly perfect competition and hence, the price settles at equilibrium of demand and supply.

The demand for oil shipping is a derived demand from the demand of oil and both demands are relatively price inelastic in the shorter run. However, within a longer time frame, oil demand is less inelastic to price. This is because the possible substitutability of oil with other energy resources as for example coal and gas, at least to some degree, and also since that the technology may be improved so the fuel drivers become more efficient within the longer time aspect. And thus, the demand for oil shipping decreases if the price of oil increase and hence, the demand for oil decreases, in the relatively long run.

Because of this relative price inelasticity, both demand for oil and oil shipping has shown to be relatively sensitive to the state and the growth rate of the world economy. Generally, the larger the growth rate of the world economy, the more the demand for oil shipping increases. For example, while there was a booming growth in the world economy from the post-war period onwards and until the early 1970s, and from the beginning of current century up until 2007, there was also a booming demand for oil and for oil shipping.

The supply of tankers are increased by new-building, and decreased by scrapping, and in short-run, supply is also decreased by lay-up. The shipping companies lay-up when the possible incomes from operations are lower than the operation costs of the ships. It is usually the older and more inefficient ships that are first laid up. In the longer perspective, the shipping companies may also increase their supply through orders in new-building, and this tend to be the situation during booms in freight rates, and conversely during the pitfalls in the freight rates after the booms. Furthermore, the activity in new-building is affected by the second-hand trading. When the second-hand trading and prices increases relatively to the activity and prices in new-building, the orders for and prices in new-building commonly increases also, at least if the shipping companies expect remaining high freight rates in the further. Thereby, even though second-hand trading does not increase ship supply directly, it does indirectly through its impact on new-building. Also, during booms in freight rates, the

[196] Jon, Soo Joon (2002): Government policies and the shipbuilding industry, in Grammenos, Costas Th. (2002): The Handbook of Maritime Economics and Business, first edition, Informa Proffesional, page 536
[197] Stopford, Martin (2009): Maritime Economics, Third Edition, Routledge, page 630-638

activity in scrapping decreases while it may be profitable to operate even the least efficiency ships. During recessions in freight rates, more ships are sent to scrapping due to squeezes in more shipping companies' financial positions and due to the unprofitable operations of the more inefficient ships then.

Moreover, the shipping companies can contract the ships into contracts or in the spot market. The contracts are either voyage contracts, where the shipping companies contract to carry cargo for an agreed price per ton, or forward freight agreements, which are contracts settled against the value of a base index on the date specified in the agreement. Generally, the shipping companies want to increase their spot freight rate exposure during booms and reduce it by some during the low freight rates, but this is also a matter of risk policy of individual companies.

Due to the time-lag in supply and the sudden chocks in demand, cycles are an important characteristic of the shipping industry. In this thesis, I have shown that the relatively low freight rates are stable equilibriums and the relatively high freight rates are unstable equilibriums. The last point indicates that the booms in freight rates do not last forever and those booms may suddenly drop to relatively low freight rates. This is also important for the shipping companies to be aware when making their investment decisions.

The shipping companies tend to follow the cycles by their investments, but as I outlined in chapter three, this might actually not be the optimal. The optimal and perhaps least risky ones are rather the investments/operations which go against the tide within second-hand trading, new-building and contract/spot market. However, if all the shipping companies managed to do so, the price differences on ships would be less, and the profitability in asset play would decrease at the same time as the sizes of the failures would also be less.

The anti-cyclical investment strategies seem also to be self-sustaining in the future, while those with success in the past may use their strengthen financial positions to increase their investments in recessions/depressions, while failures from the past have weakened financial positions and must rely still more on the banks to be able to take part of those opportunities at all. However, the banks seem to be more restrictive towards those shipping companies and generally during the periods with low freight rates also. This may be reasonable, but the banks should also be aware of the possible profitability of anti-cyclical investments, and that it is usually more risky to deal with investments within bubbles that soon or later will crash.

Finally in this thesis, I investigated the challenges of asymmetric information, moral hazard and adverse selection within shipping finance. This is an interesting issue for more specific studies about shipping finance, and perhaps this could be extended to an investigation of optimal sizes of loans and insurance contracts, empirical examinations of different shipping companies' actual payment patterns due to cycles etc., and also of the banks' and insurance companies' actions.

At the end of this thesis, I also mentioned the possibility of studying the effects of governmental subsidies in ship-building. Though a bit outside of this thesis, perhaps still more interesting would be to investigate the shipping economics from an international trade perspective: For example, what are the actual impacts of opening up for trade on the growth in shipping, and what are the factors which contribute to this? And specifically by regions; what have been the effects of China's and other East Asian countries' integration into the world economy on both oil shipping and shipping industry in general? And does this impact the

shipping companies' structure and operations? The list could certainly also have been extended still further due to the wide range of subjects and issues within the field of shipping economics.

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