UNIVERSITY OF AGDER

Eco-design ships

-An industry game-changer or just hype?

Ole André Skuland Olsen

Supervisors
Steen Koekebakker
René Taudal Poulsen

This master's thesis is carried out as a part of the education at the University of Agder and is therefore approved as a part of this education. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.

University of Agder, 2014
School of Business and Law

Abstract

This thesis examines the on going discussion whether new Eco-design vessels are an industry game-changer or just hype. The empirical results show that the new Eco-design vessel gains the highest net present value (NPV) if both the Eco- and the Standard vessel steam equally and both vessels are priced at market levels. The Standard vessel is however the favourable vessel if its greater speed range is taken into account. Thus, higher vessel revenue by conducting more voyages when good markets exist.

Medium Range (MR) Eco- newbuildings were in 2012/2013 reported booked at-/or lower than shipyards break-even. Pricing the Eco-vessel as reported, whereas the Standard vessel still is priced at current market level, results in highest NPV to the Eco-design even if the Standard vessel steams as historical.

New Eco-design vessels are therefore not industry game-changers where investment should be determined by the price of the vessel, not the design of it.

Acknowledgement

This master thesis is written as a concluding part of the MSc Business Administration program at the University of Agder, School of Business and Law. The thesis constitutes 30 credits.

The subject for the thesis is based on my deep interest for the shipping industry, which led me to conduct a minor in Maritime Business at Copenhagen Business School as a freemover student. The minor program was a part of my final year of the MSc program. The writing process has been both intense and educational, and I have gained much knowledge and understanding about the shipping industry that I hope to benefit in future time.

I would like to express my gratitude to my external advisor, Ass. Prof. at CBS René Taudal Poulsen, for insightful comments throughout the writing process. I would also like to thank my internal advisor, Prof. Steen Koekebakker for guidance during the calculation process. Lastly, a thank to Jan William Denstad for planting the seeds of what proved to be a very interesting topic for my thesis.

Table of contents

List of figure

List of tables

1. Introduction

The purpose of this thesis is to provide further evidence on the on going Eco-design discussion that has started as an increased focus on cost reduction due to the high cost of bunkers. In general, costs of running vessels are often associated with operating costs, periodic maintenance, voyage costs, cargo-handling costs, and capital costs. Capital costs and crew costs used to be the shipowners main concern, but fuel costs is now "the only thing that matters"[1]. The cost of fuel is even more important than the value of time. One way to reduce fuel costs is by going slow. This term is called "slow steaming" and it has reduced vessel service speed. Vessel design has changed accordingly and new design includes various features that are speed-reduction oriented, in order to reduce costs.

New vessels are today referred to as Eco-design ships and there are various points of view on these new vessels. Some shipowners claim Eco-design vessels to be industry game-changers while others say they are not worth investing in and are just marketing gimmick by shipyards[2]. New Eco-design vessels are by yards claimed to consume up to 30%[3] less than existing design. These comparisons are often between the worst performing vessels in the world fleet and the new Eco-vessels. Furthermore, the speed-reduction set question on Eco-design's performance in rough weather conditions.

Like in all industries, shipowners are acting to generate returns on their investments whether it will be with new Eco-design vessels or older existing tonnage. Herbjørn Hansson, CEO of Nordic American Tankers, clearly states their view of the Eco-design discussion; "*We are in the business of generating returns – not acting like the neighbour who every year has to buy the flashiest new car".*

This thesis will conduct a net present value comparison of a new Eco-design MR[4] tanker and an existing 10-year old, "Standard" MR tanker. The vessel with highest net present value is the favourable one in terms of investments aspects. The empirical study covers historical spot rates and bunker costs from December 2013 and back to January 1989, and from January 1989 to December 2013. First, this study examines whether it is the new Eco-design MR

[1] *The only thing that matters is cost of fuel* – (DNV and PwC, 2011).
[2] *Shipyard's eco design are a marketing gimmick, say owners* – (Lloyd's List, June 05 2012).
[3] *Euronav "eco" – euronav.com* – (Patrick Rodgers, CEO of Euronav).
[4] MR – Medium Range tanker.

tanker or the Standard MR tanker that gain the highest net present value, when both vessels steam equally. Next, this study examines whether the Standard vessel return a higher net present value if steaming is based on average historical knots. Subsequently, this study examines the net present value when retrofitting the Standard vessel. The retrofit fuel savings are however uncertain and results should therefore only be seen as an example. Lastly, the thesis investigates whether vessel's profitability depends on vessel prices or the technology applied to the ship.

The presentation of this study is organized as follows: Section 2 presents a brief overview of the shipping industry and it discusses the revenue received from chartering/operating a vessel and the cost of running a vessel. Section 3 elaborates new features of design and today's Eco discussion, and it reviews relevant literature to evaluate the various criteria to evaluate investments in ships. Section 4 describes the data set and explains the methodology employed to compute the two MR tanker's net present value. In section 5 the results and the analysis of the empirical research are presented. Section 6 concludes the thesis.

2. Theory

In this section, a basic insight in the specifics of the shipping industry will be presented. Then, a theoretical framework will be set up to investigating the revenue received from chartering/operating ships and the cost of running ships.

2.1 The shipping industry

The shipping industry is a complex industry, which can be divided into different markets and different segments. In general, there are four markets within the shipping industry; the newbuilding market, the sale and purchase market, the freight market, and the demolition market. The newbuilding market trades in new ships, the sale and purchase market trades in second-hand ships, the freight market is known as the core product of the maritime industry and trades in sea transport, and the demolition market trades in ships for scrapping (Stopford, 2009).

2.1.1 The Newbuilding Market

The newbulding market and the sales and purchase market are closely related to each other since both markets trades in ships. The newbuilding market trades however in ships, which do not exist. There are two parts in this market; the buyer and the seller. The buyer (or the purchaser) may need a vessel of a certain size and specifications that differs from vessels available on the second-hand market. Such example can be new Eco-design ships with lower fuel consumptions than already existing vessels, or with a different design (hull, bow, etc.).

Prices of newbuildings are determined by supply and demand where shipyards are suppliers and shipowners are the buyers. In booms, when yards have built up long orderbooks and many owners are competing for the few berths available, prices rise sharply. On the other hand, prices of new ships drops in recessions. Key factors for demands are freight rates, the prices of standard second-hand ships, financial liquidity of buyers, the availability of credit and, most important, expectations.

2.1.2 The Sale- and Purchase Market

The sale and purchase market differs from the newbuilding market by trading with existing second-hand ships. Vessels will typically be sold with prompt delivery, for cash, free for any charters, mortgages or maritime liens. Most sale and purchase transactions are carried out through shipbrokers that find a buyer or a seller. Full details of the ship are drawn up, including the specification of the hull, machinery, equipment, class, survey status and general equipment.

Ship prices in the sale and purchase market are like in the newbulding market, determined by supply and demand. Factors such as freight rates, age, inflation (in the long run) and shipowners expectations for the future influence prices. Peaks and troughs in the freight market are transmitted through into the sale and purchase market and many shipowners are willing to add more vessels into their fleet, if they expect a boom. Thus, higher demand of second-hand ships will increase second-hand prices. Second-hand prices may even be greater than prices of newbuildings. Older vessels are more depreciated than newer vessels and will therefore be less valuable compared to newer vessels.

2.1.3 The Freight Market

The freight market is a market were sea transports are bought and sold with two different types of transaction, often by a freight rate. The first type of transaction is the freight contracts in which the shipper buys transport from the shipowner at a fixed price per ton of cargo (the shipper pays an agreed sum and leaves the management of the transport to the shipowner). The second type of transaction is the time charter under which the ship is hired by the day (the shipper will manage the transport him- or herself).

The freight rate is determined by supply and demand for sea transport. According to Danish Ship Finance, the five most important factors generally affecting demand in the shipping market are the global economy, raw materials available, average haul, random shocks and transport costs. Furthermore, the five most important factors generally affecting supply in the shipping market are the world fleet, fleet productivity, shipyard production, scrapping, and freight earnings. Section 2.2 gives a closer presentation of the revenue received from chartering/operating ships.

The freight market can be divided into three categories; bulk shipping, liner shipping, and specialized shipping.

Bulk shipping

The bulk shipping segment is characterized by transporting homogenous goods, often raw materials and in large quantities. Bulk shipping can be subcategorized into two categories:

- Dry-bulk: iron-ore, coal, grain, phosphates and bauxite as its main commodities.
- Liquid-bulk: crude oil, oil products, liquid chemicals such as caustic soda, vegetable oils, and wine as its main commodities. It requires tanker transportation.

Bulk tonnage accounts for about three-quarters of the world merchant fleet.

Liner shipping

Liner shipping is very different compared to bulk shipping. Liner shipping is characterized, as opposite to bulk shipping, by smaller and less homogenous goods, which would not justify setting up a bulk shipping operation. The goods transported are often high value and cannot easily be stowed. It requires therefore a special shipping service because shippers prefer a fixed tariff rather than to depend on volatile spot rates. Liner shipping contains goods such as containerized cargo, loose cargo, palletized cargo, pre-slung cargo, liquid cargo, refrigerated cargo, and heavy and awkward cargo.

Specialized shipping

Specialized shipping contains characteristics from both bulk and liner shipping. It is traded as a separate segment since it requires specialized ships designed to carry a specific cargo type.
The best example of specialized cargo is motor vehicles. Cars are high value and fragile units, and require therefore specialized ships. Other specialized sectors are forest products, refrigerated foods, liquid gas, and chemical parcels.

2.1.4 The Demolition Market

The demolition market is often referred to as the recycling industry. Ships, which cannot sell for continuing trading (mainly due to its age), are offered on the demolition market. A broker will usually find a buyer (often demolition yards), and prices are determinate by negotiation and depend on the availability of ships for scrap and the demand for scrap metal.

2.2 The revenue received from chartering/operating vessels

In basic, a shipowner has a ship where he or she will sell available space to transport different types of cargo from port A to port B. The customer pays a freight rate per units (tons, ton miles, cubic metres, etc.) of cargo transported. Therefore, the freight rate times unit transported, equals the revenue. In other words, the revenue per deadweight of shipping capacity can, according to Stopford (2009), be viewed as the product of the ship's productivity, measured in ton miles of cargo transported per annum, and the freight rate per ton mile, divided by the ship's deadweight:

$$R_{tm} = \frac{P_{tm} \cdot FR_{tm}}{DWT_{tm}}$$

Where;

R revenue per dwt annum

P productivity in ton miles of cargo per annum

FR freight rate per ton mile of cargo transported

t time period

m ship type

Revenue in the shipping industry is earned by; voyage charter, contract of affreightment (COA), time charter and by bare boat charter. A closer presentation of the various contracts follows.

2.2.1 Voyage charter

A voyage charter, known as a "spot contract", is a contract to transport cargo between ports. The freight rate is paid per unit of cargo transported and all costs are generally paid by the shipowner except possible cargo handling costs. Both operational and shipping market risks lies at the shipowner.

2.2.2 Contract of Affreightment (COA)

Contract of Affreightment is when shipowners agree to transport a series of cargoes at a fixed price per ton within a specified period of time. These contracts differ from the others by not binding a specified ship to the cargo transported.

2.2.3 Time charter

The time charter is when the vessel is hired by a fixed daily or monthly payment. The shipowner pays all operating costs while the charterer pays all voyage costs such as fuel, port charges, stevedoring and other cargo-related costs. The operational risk is carried by the shipowner and the market risk (unless the charter rate is linked to the market in some way) is carried by the charterer.

2.2.4 Bare boat charter

The bare boat charter is when the charterer is given full control of the vessel. The charterer pays all operating costs, voyage costs, and cargo-related costs while the shipowner finance the vessel (the charter hire only covers the financing cost of the ship). The charterer carries both the operational- and the shipping market risk.

2.3 The cost of running a vessel

The cost of running ships is often associated with operating costs, periodic maintenance, voyage costs, cargo-handling costs and capital costs. A closer presentation of the various cost elements will be described below.

2.3.1 Operating costs

Operating costs consist of daily running costs such as manning costs, stores and lubricants, repairs and maintenance (not major dry dockings), insurance, and general costs.

$$OC_{tm} = M_{tm} + ST_{tm} + MN_{tm} + I_{tm} + AD_{tm}$$

Where;

OC	operating costs
M	manning cost
ST	stores and lubricants
MN	repairs and maintenance
I	insurance
AD	general costs
t	time period
m	ship type

Stopford (2009, Figure 6.4) states that crew costs may account for up to half of the operating costs. There are however different factors that influences crew costs, such as ship size, minimum regulations of the flag state, automation and reliable monitoring systems, and commercial factors[5]. Expenditure on consumable supplies accounts for about 15% of operating costs. These are cabin stores and lubricating oil. Routine maintenance accounts for 14% of operating costs, and cover also breakdowns and spares. Routine repairs are needed to maintain the vessel to the standard required by company policy, its classification society, and the charterers of the vessel who choose to inspect it. Insurance accounts for 14% of operating

[5] Commercial factors: the degree of automation of mechanical operations, catering and cargo handling, the skill of the crew and the amount of on-board maintenance undertaken – (Stopford, 2009, p.227).

costs and varies between the different ship types. General costs include registration costs paid to the flag state, management fees and sundries.

2.3.2 Periodic maintenance

Periodic maintenance is required to maintain a ship in class for insurance purpose. A ship must undergo regular surveys with a dry-docking every 2nd year and a special survey every 5th year to determine its seaworthiness. All machinery is inspected and the thickness of the steel in certain areas of the hull is measured and compared with acceptable standards. As the ship ages, each special surveys will become more stringent[6].

2.3.3 Voyage costs

Voyage costs consist of fuel costs, port dues, tugs and pilotage, and canal dues. These are variable costs and vary depending on the particular voyage.

$$VC_{tm} = FC_{tm} + PD_{tm} + TP_{tm} + CD_{tm}$$

Where;

VC	voyage costs
FC	fuel cost
PD	port dues
TP	tugs and pilotage
CD	canal dues
t	time period
m	ship type

The cost of fuel is today ships main running cost and it is due to the high cost of bunker. An article from DNV and PwC, *The only thing that matters is cost of fuel* (2011) elaborates that fuel cost accounts for 58% of total running costs for product tankers, 63% for VLCCs, 65% for bulk and 78% for container ships.

Port-related charges represents a major component in voyages costs and includes various fees levied against the vessel and/or cargo for the use of the facilities and services provided by the

[6] *What is a "Special" Survey?* – (BIMCO, 2010).

port. These fall into two components, port dues (general use of port facilities, including docking and wharfage charges) and service charges (covers various services that vessels uses in port, including pilotage, towage and cargo handling). The cost related to port depends on the various port authorities pricing policy.

Canal dues payable are for transiting canals such as the Panama- and the Suez Canal. The Panama Canal charges a flat rate per Panama Canal net ton used, while the toll structure of the Suez Canal is slightly more complicated. It is based on two little-known units of measurement; the Suez Canal net ton and Special Drawing Rights (SDRs).

2.3.4 Cargo-handling costs

Cargo-handling costs are the costs of loading and discharging cargo plus the cost of any claims that may rise.

$$CHC_{tm} = L_{tm} + DIS_{tm} + CL_{tm}$$

Where;
CHC = cargo-handling costs
L = cargo loading charges
DIS = cargo discharge costs
CL = cargo claims
t = time period
m = ship type

2.3.5 Capital costs

Capital costs are costs related to how the ship is financed (interests, dividend and debt repayments), depreciation and taxation[7]. If a ship is financed by a loan, the size of the loan, the source of the loan, interest rate and terms of the loan are factors that reflects the capital cost.

[7] Shipping companies may avoid taxation by registering under one of the many open registry flags.

DNB[8], world's largest shipping bank, use what they call the 4 Cs when determining shipowners credit risk. The 4 Cs are client, cash flow, covenants and collateral. Client is financial strength, track record and standing, and investment horizon. Cash flow is cash flow projections, historical performance and volatility. Covenants are a set of financial and minimum value covenants, they act as early warning signals and they are used actively in client discussions. Collateral is 1st priority mortgages, acceptable jurisdictions, and modern and standard tonnage. These 4 Cs are important for determining the credit risk related to the different shipowners (debtors) and thus influence the terms of the loan and especially the interest rate.

The cost of loan:

Final price = Cash price + Interests = Cash price + n x Instalment

Instalment = CRF x Loan

Loan = Cash price – Down payment

Capital recovery factor (CRF) = $\frac{r \times (1+r)^n}{(1+r)^n - 1}$

Where;

r interest rate (for adequate period of time)

n number of instalments

Depreciation refers to two very different but related concepts; decline in value of vessel and allocation of the cost of tangible vessel to periods in which the vessel is used. Cost related to depreciation depends on the cost of the vessel, expected salvage value of the vessel, estimated useful life of the vessel and a method of apportioning the cost over such life.

[8] DNB is Norway's largest financial services group and one of the largest in the Nordic region in terms of market capitalisation.

3. Literature Review

Section 3 presents and discusses literature that is relevant for understanding today's Eco discussion. Firstly, new features of design and today's discussion will be presented. Secondly, relevant literature is presented and discussed.

3.1 New features of design and today's discussion

Vessels are today designed mainly to achieve lower fuel consumption while carrying the same amount of cargo. They are often referred to as Eco-design ships but what is "Eco"? Economical or Ecological? "*For the shipowner, the markets and the environment, the answer should be both*", says Atlantic Bulk Carriers Management Ltd[9].

BIMCO's article "*What is an "Eco" Ship?* (2013)*"* elaborates that new vessel design includes features such as a more efficient underwater form, new bow design that will make the vessel less liable to speed loss in head seas, it might employ ducts or other devices[10], and a smaller and less powerful engine fitted aboard the ship. The article elaborates further that the new engine will be designed and maintained to make the best use of the fuel by using sophisticated fuel injection systems and a range of measures to use the exhaust heat productively, rather than merely sending it up the funnel. This may include the use of an exhaust gas generator which can satisfy the ship's electrical requirements while the main engine is running and only one requiring the use of an auxiliary generator when the ship is manoeuvring, or alongside in port. However, the new design does not anticipate fuel regulatory changes[11] expected to impact in the coming years, according to Patrick Rodgers - CEO of Euronav[12].

New features on vessel design are speed-reduction oriented. The less powerful engines are designed in order to accomplish higher energy efficiency. However, these new engines could

[9] *The basics of Eco design* – (Atlantic Bulk Carriers Management LTD).
[10] Ducts or other devices will reduce the amount of propulsive power that is often wasted as the propeller pushes a vessel along.
[11] *Smoking Ban: Shipping Shifts to Cleaner Fuel* – (spiegel.de, 2013).
[12] *Euronav "eco" – euronav.com* – (Patrick Rodgers, CEO of Euronav).

have adverse effects on the vessel's performance in rough weather conditions, leading to higher fuel consumption. Furthermore, Eco-design vessels might slow down more easily leading to charter party disputes and speed claims. The question is therefore if these vessels are able to encounter the perils of the sea with a "weaker" engine, when heavy seas occurs.

Eco-design vessels are claimed to be game-changers for the shipping industry but the concept is far from new. When oil prices were low, like in early 1970s, less attention was paid to fuel costs in ship design, according to Stopford (2009). Many large vessels were fitted with turbines in order to steam fast (the first large 3000 TEU[13] containerships in 1972 were designed to steam 30 knots[14]). The higher power output and the lower maintenance costs outweighed their high fuel consumption. Then, oil prices increased and resources were poured into designing more fuel-efficient ships, with steam turbines disappearing after 1980[15]. The Journal of Det Norske Veritas no.107-Oslo-1982-III[16] discussed optimizing energy savings in ship design with features such as better market adaption, improved hull performance, improved propulsion machinery, and improved auxiliary system. Features we also see in today's new design.

Currently, we are facing high oil prices and it has therefore been a renewed emphasis on fuel conservation in order to reduce costs. As a result, vessel service speed has been reduced. This term is called slow steaming and is effectively regarding fuel reduction when in a market where reduced fuel cost is more important than the value of time. And even more effectively is the term "super slow steaming" -*"Super slow steaming has proved to be so effective that the world tanker fleet has today uniformly changed operating speeds from 15 knots when laden to 13 knots and from 15 knots in ballast (unladen) to 10 knots"*, says Rodgers. Vessel design has changed accordingly and new vessels are by yards claimed to reduce fuel consumption by up to 30%[17]. Rodgers elaborates further that comparisons are often between the worst performing vessels in the world fleet and the new Eco-design vessel. Resulting in a wide variation of consumption. Therefore, vessels are best measured on the basis of the same

[13] TEU – Twenty-foot Equivalent unit.
[14] *The Logical Illusion of Eco-Ships* – (Danaos, 2012).
[15] *The Logical Illusion of Eco-Ships* – (Danaos, 2012).
[16] *The eco-ship debate: will it make or break the shipping industry* – (Teriakidis, 2013).
[17] *Euronav "eco" – euronav.com* – (Patrick Rodgers, CEO of Euronav).

speed and in the same sea condition with the same laden- and ballast condition[18].

The present debate set question whether new Eco-design vessels are set to change the future of the shipping industry. BW Gas, Scorpio Tanker[19], Frontline 2012, DS Norden and Western Bulk have all ordered new Eco-vessels with delivery in 2013-2015 to possibly gain market advantages by a "greener" vessel. The main reason is however to gain highest possible return on their investments. Commercial Director at Maersk Tankers, Klaus Rud Sejling, pointed out that a daily rate level of USD 14,000 is not even close to the level needed to recoup a USD 35-50 million investment in a new eco ship, according to ShippingWatch[20]. Herbjørn Hansson, CEO of Nordic American Tankers, clearly states their view of the Eco-discussion; "*We are in the business of generating returns – not acting like the neighbour who every year has to buy the flashiest new car".*

[18] However, every ship engine is optimised to a particular range and will therefore have various optimal sailing speeds.
[19] Scorpio Tanker illustrated TCE premium for a 2012 built Eco-design MR tanker on their Q1 2013 Conference Call.
[20] *This is how much shipowners earn on product tank* – (ShippingWatch, 2013).

3.2 Relevant literature

Shipping economics is a broad area which covering a vast array of topics, such as the economics of shipping markets and shipping cycles, the various shipping segments, port economics and management, shipping company economics, and ship finance and taxation, to name just a few. The main maritime economic books *Maritime Economics* by Stopford (2009), *Shipping Derivatives and Risk Management* by Alizadeh and Nomikos (2009), *The Handbook of Maritime Economics and Business* edited by Grammenos (2010), and *The Blackwell Companion of Maritime Economics* by Talley (2012), do not discuss the Eco-design discussion in any broad sense. Stopford (2009) do however mention the leaps after every past energy shock while Talley (2012) discusses how speed, and a smaller and less powerful engine aboard the ship could reduce fuel costs in future time. In addition, Talley (2012) elaborates how to evaluate investments in ships by various criteria[21]. The first and the traditional one, is the net present value (NPV) criterion, which is defined as:

$$NPV = \sum_{t=0}^{N} \frac{I(t) - C(t)}{(1+i)^t}$$

Where;

N = lifetime of vessel (years)

I(t) = Income generated by ship in year t

C(t) = Expenditure spent on ship in year t

i = shipowner's cost of capital (rate of return)

I(t) and C(t) are according to Talley (2012), supposed to include everything that will go into or out of the shipowner's pocket during the entire ship construction, operating and scrapping cycle. I(t) – C(t) equals vessel cash flow and are divided by the rate of return, in order to calculate the net present value.

Talley (2012) elaborates further that a closely related criterion to the NPV is the required freight rate (RFR). It is defined as:

$$I(t) = FX(t)$$

[21] *The Blackwell Companion of Maritime Economics* – (Talley, 2012, chapter 19.2).

Where X(t) is the cargo carried by the ship in year t and F is constant freight rate. Then, the RFR of a ship is defined as the freight rate F for which the NPV associated with the ship throughout its lifetime is zero. The vessel with lowest RFR is favourable over the others. RFR is often used when comparing alternative design or alternative investments choices but the constant F is seldom experienced and the X(t) is no less difficult to predict than the market throughout a vessel's lifetime. As a result, the NPV is a more sound criterion than the RFR, as a shipowner is more interested in what money he or she will make through a vessel's lifetime than what value a particular ratio will take on, Talley (2012).

The last criterion Talley (2012) elaborates is the internal rate of return (IRR). It is defined as the interest rate *i* in an equation that produces an NPV of zero[22]. The vessel with highest IRR is the best alternative. The IRR should however not be used to rate two "equally" projects.

When estimating a vessel's net present value the various charter contracts should be taking into account[23]. If the vessel operates under a voyage charter, the fuel is paid by the shipowner whereas it is being paid for by the charterer if the vessel sails under time charter. BIMCO calculated in 2012[24] the net present value for a new Eco-design MR tanker and a new "Standard" MR tanker. They based their calculations on time charter contracts where the Eco-design MR tanker gained an added fuel premium on top of the regular time charter rate. Both vessels were scrapped after 20 years in service and results showed that a premium of 25% on new-building prices was commercially viable for Eco-ships. However, vessels being built today are most likely all fitted with Eco-design features and comparison made in this thesis is therefore between a new- and an existing vessel. Furthermore, the NPV analysis in this thesis is in opposite to the BIMCO study, based on the time charter equivalent (TCE) under voyage charter contracts[25]. It will therefore emphasis on voyage revenues and voyage expenses, and exclude other costs[26] based on the assumption of no relevance when comparing an Eco-design

[22] NPV(i) = 0
[23] Please see chapter 2.2 and 2.3 for explanations.
[24] *"A premium of 25% on new-buildings prices is commercially viable for Eco ships"* – (BIMCO, 2012).
[25] Time charter rates may better be used when looking at vessels only as an asset investment. Furthermore, the added Eco-premium might not be prevailing in 20 years time – *"It is important not to permanently handicap a ship's speed to improve economy in a poor market because, in a good market, the value of time will become paramount (not the cost of the voyage) for the returns on investment"* – (Patrick Rodgers, CEO of Euronav).
[26] Operating costs, periodic maintenance and cargo-handling costs. Please see chapter 2.3 and chapter 5 for further explanation. NB! Capital costs are excluded due to the Modigliani-Miller theorem – see section 5.1 for further explanation.

MR tanker and a "Standard" MR tanker. According to the NPV criterion, the vessel with highest NPV is the best alternative for the shipowner[27].

[27] Talley, 2012, p. 374.

4. Presentation of methodology and the source of data

In this part, the methodology and the data sample for the study will be presented. First, the methodology and the computation of variables will be presented. Then, the dataset and its practical limitations will be outlined.

4.1 Methodology

The calculation used in this study is based on the Baltic Exchange[28] MR product tanker TCE for the TC2_37 route, and the net present value equation presented in section 3.2. The time charter equivalent (TCE) is first calculated as presented in section 4.1.1. Then, the TCE is multiplied by average operative days per month[29] in order to estimate monthly (each period) vessel revenue[30]. Monthly vessel revenue, or the cash flow from the period, is then discounted by the rate of return, as presented in section 4.1.2.

4.1.1 Time charter equivalent

The time charter equivalent (TCE) calculates the average daily revenue performance of a vessel. Taking voyage revenues, subtracting voyage expense and then dividing the entire total by the round-trip voyage duration in days, calculates the TCE.

4.1.1.1 Revenues

To calculate the Gross Freight of the voyage, initially, the cargo quantity (37,000 Mts) is multiplied by the Worldscale[31] Flat Rate and the Worldscale Multiplier for the TC2_37 route divided by 100 as market levels of freight as a percentage of the nominal freight rate. As per Worldscale guidance, there is a premium added[32]. Adding this to the calculation described above produces the Gross Freight.

[28] The Baltic Exchange is now publishing daily Time Charter Equivalent (TCE) assessments alongside its Worldscale assessments for 12 of its 25 tanker routes.
[29] Stopford (2009, Table 6.14) operate a vessel for 340 days/year. 340/12 = 28,33. Therefore, 28 days per month.
[30] Monthly vessel revenue equals the cash flow in the net present value equation i section 3.2.
[31] Worldscale – A unified system to establish freight rates for oil tankers, consisting of a Worldscale Flat Rate and a Worldscale Multiplier (spot rate).
[32] Please see 4.2.4 Fixed Differentials.

4.1.1.2 Expenses

Initially laden and ballast days are calculated. The laden days are calculated by dividing the laden miles (including a weather factor) by the daily speed (knots per hour multiplied by 24 hours). The ballast days are calculated in the same manner, with the ballast miles being used instead of the laden ones.

The next step is establishing the bunker costs. For the trip's IFO[33] consumption while loading, the loading days are multiplied by the daily IFO loading consumption. For the trip's IFO laden consumption, the laden days are multiplied by the daily IFO laden consumption. For the trip's IFO ballast consumption, the ballast days are multiplied by the daily IFO ballast consumption. For the trip's IFO consumption while discharging, the discharging days are multiplied by the daily IFO discharging consumption. Finally for the trip's IFO consumption while waiting, the waiting days are multiplied by the daily IFO waiting consumption. Adding the results from the calculations described above generates the trip's total IFO consumption. These figures are then multiplied by the IFO market price per MT, which produces the total IFO cost for the trip.

Total Expenses are calculated as the sum of the total IFO cost, the load port charges, the discharge port charges, and the broker commissions.

Deducting the total expenses from the Gross Freight produces the Voyage Earnings.

4.1.1.3 Duration

The total voyage days are the sum of loading, laden, ballast, discharging, and waiting day(s).

4.1.2 Net present value (NPV)

The monthly vessel revenue[34] is discounted by the rate of return in order to estimate monthly present value. Sum of vessel investment, all monthly present values, and the discounted scrap price, estimates the vessel's net present value. The vessel with highest net present value is the favourable vessel. A more supplementary description of the net present value calculation is presented in section 3.2.

[33] IFO: Intermediate Fuel Oil
[34] The monthly vessel revenue equals the cash flow in the net present value equation.

4.2 The Data sample

The TC2_37 route is considered a benchmark voyage for a MR tanker and covers the route between Rotterdam – New York laden and New York – Rotterdam in ballast with a 47,000 dwt MR tanker (37,000 mt cargo of clean product transported[35]). A weather margin of 5% must be added to the sea miles. Furthermore, calculations do not include the Fixed Rate Differential for Emissions Control Areas (ECA)[36]. Excluding the Fixed Rate Differential for ECA will be in disfavour for the Eco-design vessel based on its lower fuel consumptions and hence consume less of the more expensive low sulphur fuel, compared to the Standard vessel.

4.2.1 Vessel descriptions

2014 built Eco-design MR product tanker:

Vessel price - $36.5m in January 2014. Scrap price after 25 years in service[37] - $355 x ldt.

47,000 mt dwt, double hull.

Steaming 13.5 knots, Rotterdam to NYC in laden (Consuming 19.5 MT/Day – 380 CST[38])

Steaming 12.0 knots, NYC to Rotterdam in ballast (Consuming 12.7 MT/Day – 380 CST)

Consuming while: Loading 5 MT/Day – 380 CST
Discharging 6 MT/Day – 380 CST
Waiting/anchor 5 MT/Day – 380 CST

2004 built "Standard" MR product tanker:

Vessel price - $18.0m in January 2014. Scrap price after 15 years in service[39] - $355 x ldt.

47,000 mt dwt, double hull.

Steaming 13.5 knots, Rotterdam to NYC in laden (Consuming 28.8 MT/Day – 380 CST)

Steaming 12.0 knots, NYC to Rotterdam in ballast (Consuming 18.2 MT/Day – 380 CST)

Consuming while: Loading 5 MT/Day – 380 CST
Discharging 12 MT/Day – 380 CST
Waiting/anchor 5 MT/Day – 380 CST

[35] The cargo size was quoted as 28k tonnes until 2002; and 33k tonnes between 2002 and Jun-08 – (Clarkson SIW Sourches and Methods).
[36] Lower sulphur fuel (max 1% sulphur. 0,1% after January 1, 2015) within restricted ereas/ECA – (IMO.org)
[37] Medium sized tankers are, according to Herman Billung, CEO of Golden Ocean (HegnarTV – May 23, 2014), on average in service until vessel age of 26/27 years. The vessels are however in this thesis scrapped just before the 25-year special survey.
[38] CST - Centistoke
[39] See footnote above regarding the lifetime of the Eco-design MR tanker.

Consumptions of a 2004 built MR product tanker when historical speed[40] used:

2004 – 2008	14.0 knots laden (Consuming 36.4 MT/Day – 380 CST)
	14.0 knots in ballast (Consuming 25.5 MT/Day – 380 CST)
1997 – 2003	13,5 knots laden (Consuming 28.8 MT/Day – 380 CST)
	14.5 knots in ballast (Consuming 25.5 MT/Day – 380 CST)
Pre – 1997	14.0 knots laden (Consuming 36.4 MT/Day – 380 CST)
	13.5 knots in ballast (Consuming 21.7 MT/Day – 380 CST)

Vessel consumptions are for both tankers based on average measurement provided by two world-leading shipbroker firms, RS Platou ASA and Poten & Partners Inc. Fuel consumptions used in this thesis, and recent voyage reports, do not differ substantially with each other[41]. It is however important to have in mind that other vessels than used, could consume different than in this analysis. Main reasons for different consumptions are equipment aboard the ship, crew performance, where the vessel is built (shipyard), and hull conditions (hull and propeller fouling). Vessels are also considered to consume more fuel by aging but the two vessels in this thesis are set to have a constant consumption for the entire lifespan, to simplify calculations.

Vessel- and demolition prices are provided by Pareto JGO Shipbrokers AS and the daily tanker report made by ICAP Shipping Ltd. Current ppt/resale price of an Eco-design MR tanker is $36.5m while a 10-year old MR tanker is priced at $18.0m. Demolition prices in 15- or 25 year into the future is an unknown quantity, so best estimates from current values should be used (Talley, 2012, section 19.2.6). Any change in demolition prices will affect the net present value but not substantially.

4.2.2 Broker Commissions

Broker commissions are set to a standard measurement made by the Baltic Exchange broker and are assumed to be equal regardless of ship type. They may vary each year but are set to be constant for the entire investment horizon to simplify calculations.

[40] Historical speeds are based on annex 2 from Clarkson SIW Sources and Methods.
[41] Recent voyage reports are kept confidentially due to competitive significance.

4.2.3 Port costs

Port costs in Rotterdam and New York are sourced from Cory Brothers Shipping Ltd and are based on a MR product tanker of 47,000 dwt, loa: 183.88m and cargo quantity of 37,000mt Clean Petroleum Products (CPP). Port costs in Rotterdam are measured in Euros and are therefore converted into US Dollars[42]. Costs in both ports have been unchanged for the last three months and are set to be constant for the entire time horizon to simplify calculations. They are however expected to a minor change over time. The Port of Rotterdam offer 6% discount for vessels holding a Green Award Certificate[43] but this is mainly issued to ocean-going LNG tankers.

4.2.4 Fixed Differentials

As per Worldscale guidance[44], there should be a premium added for coverage of Oil Pollution Liability Insurance on vessels carrying persistent oil to and from the USA. This premium will be added per voyage and are equally for both the tankers. Hence, conducting more voyages will result in more Fixed Differentials. The added premium will however complicate calculations and are therefore excluded[45]. Excluding the premium may be in disfavour for the Standard vessel when its speed flexibility is taken into account (hence its possibility to conduct more voyages).

4.2.5 Worldscale Flat Rate

Future Flat Rates are hard to predict. The Worldscale Flat Rate for the route between Rotterdam and New York with a MR product tanker is therefore set based on the 2014 Flat Rate. Furthermore, the Flat Rate is set constant throughout the entire investment horizon. Figure 1 in the appendix illustrates that historical earnings for the route made by Clarkson Research and earnings using a constant 2014 Flat Rate, and historical -spot rates and bunker cost, fluctuates with each other. The gap will however increase over time. All variables used in this analysis are in January 2014 values, hence the use of the 2014 flat rate. The Worldscale Flat Rate is sourced from Worldscale subscriptions.

[42] Foreign exchange rates are sourced from dnb.no as of January 2014.
[43] *Rotterdam rewards Green Award LNG tankers too* – (portofrotterdam.com, 2013)
[44] Intertanko – WMU 4th April, 2011.
[45] The premium varies from year to year and depends on the product transported.

4.2.6 Worldscale Multipliers (spot rate) and bunker costs

Spot rates and bunker costs are based on monthly historical numbers to best quantify the different cycles in the shipping market, dated from December 2013 – January 1989 (1st period is December 2013) and from January 1989 – December 2013 (1st period is January 1989). Historical bunker costs are adjusted to January 2014 values whereas the Worldscale Multiplier is a percentage of the flat rate. The multiplier increases when the market gets hot and decreases when the market goes cold. It is however important to have in mind that future spot rates and future bunker costs could differ from what used in this analysis. Hence, another net present value for the two MR tankers. Bunkers are based on Rotterdam IFO380[46] and both the historical Worldscale Multiplier and historical bunker costs are sourced from Clarkson SIN.

4.2.7 Deflator

The consumer price index (CPI) is used to calculate historical bunker costs to January 2014 values. The CPI indicates the prices of a representative basket of commodities procured by consumers and it compares prices of the current period to a base period, which is set to be January 2014. The US CPI is used in this thesis since bunkers are priced in US Dollars.

4.2.8 Rate of return

The rate of return consists of a risk-free rate and an equity risk premium. Stopford (2009) used a rate of return of 12% in his DCF analysis[47] but current risk-free rate and risk premium differs from one used in 2009. Duff & Phelps[48] U.S. Equity Risk Premium (ERP) is currently 5% and the normalized risk-free rate is 4%. They recommend therefore a rate of return of 9%. This thesis uses a rate of return of 10%. The added 1% is to cover the extra volatility in shipping (thus a higher risk). A higher rate of return will lower the net present value, while a lower rate of return will lead to a greater net present value. The rate of return will normally vary in size among shipowners. It all depends on their risk perspective on the various investments projects.

[46] IFO380 – A blend and gasoil and heavy fuel oil with a maximum viscosity of 380 Centistokes (<3,5% sulphur).
[47] Stopford, 2009, p. 261-262.
[48] Global valuation- and corporate finance advisory firm.

5. Results and analysis

This section presents the results and the analysis of the conducted study. First, a net present value comparison between an Eco-design MR product tanker and a Standard MR product tanker will be presented and analysed. Then, a net present value comparison between an Eco-design MR product tanker and a Retrofitted MR product tanker will be presented and analysed. It is however important to have in mind that the Retrofitted MR product tanker is based on fuel savings and capital expenditure illustrated in an article in Lloyd's List[49].

5.1 Eco-design MR product tanker compared to Standard MR product tanker ("December 2013 – January 1989" figures)

In order to compare the net present value of an Eco-design MR product tanker with the net present value of a Standard MR product tanker, the cash flow from operating the ship was first calculated by multiplying the TCE with expected operative days for the vessel. Then, the cash flow was discounted by the rate of return. Both vessels are assumed to a lifetime of 25 years before scrapping. The 2014 built Eco-design operate therefore for 25 years while the 2004 built Standard operate for its remaining 15 years lifetime. Table 3, Colum 3 and 4, show that the Eco-design's net present value is estimated to $54 990 860 while the Standard's net present value is estimated to $52 910 230. Calculations are based on historical spot rates and bunker costs dated from December 2013 and backwards, with speed set to 13,5 knots laden and 12,0 knots in ballast for both tankers. The Eco-design gain therefore a premium in net present value over the Standard of $2 080 630.

Due to the fact that the vessel speed has changed in present years it is certainly to assume that vessel speed will change in future time as well. The Standard vessel's net present value is therefore best estimated when adjusting for the vessel's greater speed range. Colum 5 in Table 3 is calculated in the same matter as for the two other columns, but the Standard vessel is in

[49] *Keeping up with the efficiency pack: How to pimp a ship to remain competitive* – (Lloyd's List, 2013).

Colum 5 set to steam based on historical knots for the Rotterdam – New York route[50]. Standard's net present value when adding the speed flexibility, is estimated to be $56 049 058. Resulting in a premium in net present value of $1 058 198 to the Standard vessel over the Eco-design. The speed flexibility will in other words overcome the higher fuel consumption due to higher vessel revenue if more voyages are conducted when good markets exist[51]. The Eco-design vessel could on the other hand favour over the Standard vessel if the cost of bunker is assumed to be high in indefinitely years. The Standard vessel is however expected to do slow steaming[52] if bunker prices remain high.

MR Eco- newbuildings were in 2012/2013 reported booked at-/or lower than shipyards break-even[53]. Will the result favour the Eco-design vessel if the vessel price is set to $31.0m? Table 3, Colum 6, shows that the Eco-design vessel is estimated to a net present value of $60 490 860 if the vessel is priced as reported. Results are a premium in net present value by $4 441 802 to the Eco-design over the Standard vessel. Pricing the Eco-vessel to $35.4m will give an equal net present value for both vessels (break-even).

In addition to vessel price, any change in the rate of return will impact the net present value. A higher rate of return will lower the net present value, while a lower rate of return will lead to a greater net present value. A lower rate of return could be set for Eco-design ships on the basis of a newer vessel, newer equipment/technology aboard the ship and its lower fuel consumption. The Standard vessel's speed flexibility could on the other hand lower the Standard vessel's rate of return by the possibility of higher vessel revenue by conducting more voyages when good markets exist. Furthermore, any new possibly IMO emissions regulations[54] may favour the Standard vessel over the new Eco-design vessel on the basis of the possibility to still have an operative "Eco" vessel (where the Standard vessel has been scrapped due to aging) while the industry has switched to using LNG[55] as fuel.

The net present value made in this thesis is calculated based on the TCE for the Rotterdam – New York route. The TCE does not include operating costs, periodic maintenance and capital

[50] Please see 4.1.1 Vessel description for more details.
[51] Greater gap between freight rates and bunker costs. The speed flexibility is set based on historical speeds – (Clarkson SIN).
[52] Slow steaming refers to the deliberate reduction of vessel cruising speed in order to cut fuel costs.
[53] *Mipo rides strong demand for eco products tankers* – (tradewinds.com, November 29, 2013).
[54] *Smoking Ban: Shipping Shifts to Cleaner Fuel* – (spiegel.de, 2013)
[55] LNG – Liquefied natural gas (a cleaner fuel).

costs. These costs run even if the vessel is operative or not. As mentioned in section 2.3.1, operating costs consist of daily running costs such as manning cost, stores and lubricants, repairs and maintenance, insurance, and general costs. Manning costs may vary between the two vessels. More advanced technology in the Eco-design vessel could for instance require higher educated crew aboard the ship. Crew costs are however expected to increase in pace with ship age[56]. Other operating costs such as stores and lubricants, repairs and maintenance, and insurance, are like crew costs expected to increase in pace with ship age. General costs are on the other hand expected to stay constant for the vessel's entire lifespan. Periodic maintenance is expected to increase up to the vessel age of 15, before declining until scrapping[57]. Operating costs and periodic maintenance is therefore assumed to not differ significantly between the two vessels. Hence, no relevance when "rating" the Standard vessel and the Eco- vessel. Capital costs are excluded when calculating the net present value due to the Modigliani-Miller theorem, which states that it makes no difference how a firm is financed (debt or equity), when perfect capital markets exist[58].

[56] Stopford, 2009, Table 6.2 – (estimated from various sources)
[57] Clarkson Research, Capesize Quality survey (1993)
[58] Modigliani, F.; Miller, M. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *America Economic Review* 48 (3): p. 261-297.

5.2 Eco-design MR product tanker compared to Retrofitted MR product tanker ("December 2013 – January 1989" figures)

There are various but uncertain[59] opportunities to upgrade an existing vessel to remain competitive. An article in Lloyd's List[60] illustrated some for MR tankers. Changing the propeller will reduce consumptions approximately by 10%, hull coating improvements[61] will reduce consumptions by 6%, appendixes by 5%, voyage optimisation by 5%, and bulbous bow by 2%. Total saving will be 23%[62] while estimated investment will be about $4.0m if bulbous bow considered (excludes drydock and annual running costs). It is important to have in mind that these retrofit upgrades are based on approximately figures and upcoming results on fuel savings is uncertain and should only be seen as an example. The Retrofitted vessel is therefore excluded from the conclusion in section 6 and from the Tables in the appendix.

If consumptions of the Standard vessel is set to be reduced by 23% and other calculations are done in the same matter as previous, net present value of the Retrofitted MR product tanker is estimated to be $53 690 294 if steaming equal the Eco-vessel. The Eco-design is in such case the favourable vessel.

The Retrofitted vessel has like the Standard vessel a greater speed flexibility than the Eco-design vessel. The Retrofitted vessel with speed flexibility will therefore gain a net present value of $57 259 230, which are greater than the Eco-design vessel. The Eco-design vessel will however be the favourable one if it is priced to $31.0m.

[59] Uncertainties related to actual fuel savings achieved by retrofits.
[60] *Keeping up with the efficiency pack: How to pimp a ship to remain competitive* – (Lloyd's List).
[61] International Paint notes that if the vessels are de-rated and then sail at lower optimal speeds it will lenghten payback times.
[62] Savings are calculated assuming the methods selected offer the savings given. The probability is that operational expences suggestmuch lower accumulative savings that suggested here.

5.3 Eco-design MR product tanker compared to Standard MR product tanker ("January 1989 – December 2013" figures)

Table 4 is calculated in the same matter as Table 3. The only difference is the Worldscale Multiplier and bunker costs dated from January 1989 – December 2013, instead of December 2013 – January 1989 (as in Table 3). Hence, another net present value for the vessels. The net present value for the Eco-design is in Table 4, Colum 3, estimated to be $64 288 586 while the net present value for the Standard vessel is estimated to $64 222 002[63], when both vessels steam 13,5 knots laden and 12,0 knots in ballast. The premium to the Eco-design is therefore estimated to be "only" $66 584 if both vessels steam equally.

The Standard's vessel should however be set with the speed flexibility as in section 5.2 whereas the Eco-design vessel still steam 13,5 knots laden and 12,0 knots in ballast. The Standard vessel with speed flexibility[64] is therefore estimated to a NPV of $68 915 140[65]. Standard's speed flexibility will in other words gain a premium over Eco-design's net present value by $4 626 554.

The Eco-design vessel is priced at current market price. Will the net present value favour the Eco-design if the vessel is priced as reported in section 5.1? Calculations in Table 4, Colum 6, estimates Eco's net present value to be $69 788 586 if vessel price is set to $31.0m. The Eco-vessel will in such case favour Standard's speed flexibility by a small premium in net present value of $873 446. Pricing the Eco-vessel to $31.9m will give an equal net present value for both vessels (break-even).

[63] Table 4, Colum 4.
[64] Set based on historical knots for the Rotterdam – New York route for an MR product tanker.
[65] Table 4, Colum 5.

5.4 Eco-design MR product tanker compared to Retrofitted MR product tanker ("January 1989 – December 2013" figures)

If the Standard vessel is retrofitted in the same matter as in section 5.2, net present value of the Retrofitted vessel assumed to "operate from" January 1989 – December 2003 is estimated to $61 876 509. The Eco-design premium is therefore $2 412 077 when both steam equally. The net present value of the Retrofitted vessel with speed flexibility is estimated to $66 910 161, which will give a net present value premium to the Retrofitted vessel over the Eco-design vessel by $2 621 575. The Eco-design vessel will however be the favourable one if it is priced as reported.

6. Conclusion

This thesis examines whether new Eco-design vessels are industry game-changers or just hype. The empirical results show that vessels profitability depends on vessel prices, not the technology applied to the ship.

The new Eco-design MR tanker gain the highest NPV if both the Eco- and the Standard vessel are set to steam equally and both vessels are priced at current market levels. Speed should however not permanently handicap a vessel's productivity and the Standard vessel is therefore assumed to steam faster when good markets exist. Results when historical speed is used show that the Standard vessel gain the highest NPV and are therefore the favourable vessel. In other words, Standard's speed flexibility outperforms Eco's lower fuel consumption.

MR Eco newbuildings were in 2012/2013 reported booked at-/or lower than shipyards break-even. Pricing the Eco-vessel as reported, whereas the Standard vessel still is priced at current market level, results in the highest NPV to the Eco-design even if the Standard vessel steams using historical knots. The lower investment in the new Eco-vessel outperforms Standard's speed flexibility and thus the possibility of higher vessel revenue by conducting more voyages. All results are independent regardless of using historical Worldscale Multipliers and bunker costs dated from December 2013 and back to January 1989, or starting from January 1989 till December 2013.

New Eco-design vessels are therefore not industry game-changers where investment should be determined by the price of the vessel, not the design of it.

Reference

Books

Alizadeh, A.H. and Nomikos, N.K. (2009). *Shipping Derivatives and Risk Management.* Basingstoke: Palgrave Macmillan.

Grammenos, C.Th. (2010). *The Handbook of Maritime Economics and Business.* London: Lloyd's List, 2 Ed.

Stopford, M. (2009). *Maritime Economics*. London: Rutledge, 3 Ed.

Talley, W.K. (2012). *The Blackwell Companion of Maritime Economics.* Chichester: Blackwell Publishing Ltd.

Articles

Andersen, O. (2013). *This is how much shipowners earn on product tank.* http://shippingwatch.com/carriers/article6155179.ece

Ang, I. (2013). *Mipo rides strong demand for eco products tankers.* http://www.tradewindsnews.com/weekly/328245/mipo-rides-strong-demand-for-eco-products-tankers

Atlantic Bulk Carriers Management LTD. *The basics of Eco design.* http://www.newsfront.gr/conference4/images/stories/Presentations/Panos_Zachariadis.pdf

BIMCO. (2010). *What is a "Special" Survey?* https://www.bimco.org/Education/Seascapes/Questions_of_shipping/2010_04_13_What_is_a_Special_Survey.aspx

Bimco. (2012). *A premium of 25% on new-buildings prices is commercially viable for Eco ships.*
https://www.bimco.org/Reports/Market_Analysis/2012/0912_ECOshipsFinancing.aspx

BIMCO. (2013). *What is an "Eco" ship?*
https://www.bimco.org/Education/Seascapes/Questions_of_shipping/2013_09_19_What_is_an_ECO_ship.aspx

Blikom, L.P. (2011). *The only thing that matters is cost of fuel.*
http://blogs.dnvgl.com/lng/2011/11/the-only-thing-that-matters-is-cost-of-fuel/

Danaos. (2012). *The Logical Illusion of ECO-Ships (Marine Money Conference).*
http://www.marinemoney.com/sites/all/themes/marinemoney/forums/GR12/postprogram/Dr%20John%20Coustas.pdf

Duff & Phelps. (2013). *Duff & Phelps Decreases U.S Equity Risk Premium Recommendation to 5%.*
http://www.duffandphelps.com/SiteCollectionDocuments/Articles/DP%20Client%20Alert%20-%20ERP%20and%20RFR%20Recommendation%2003%2020%2013%20FINAL4.pdf

Fuglesang, K. R. (2011). *Worldscale – Intertanko, WMU.*
www.intertanko.com/upload/**Worldscale**KRF.ppt

IMO.org (2012). *North American emission control area comes into effect on 1 August 2012*
http://www.imo.org/MediaCentre/PressBriefings/Pages/28-eca.aspx#.U4g8m17n7GA

IMO.org. *Special Areas under MARPOL*
http://www.imo.org/OurWork/Environment/PollutionPrevention/SpecialAreasUnderMARPOL/Pages/Default.aspx

IMO.org. *Sulphur oxides (SOx) – Regulation 14*
http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-–-Regulation-14.aspx

Lloyd's List. (2012). *Shipyard's eco design are a marketing gimmick, say owners* http://www.lloydslist.com/ll/sector/ship-operations/article400038.ece

Lloyd's List. (2013). *Keeping up with the efficiency pack: How to pimp a ship to remain competitive.* http://www.revs-online.net/ip_pr/jun2013/ezine-pdfs/Lloyds%20List%20Article%20combined.pdf

Port of Rotterdam (2013). *Rotterdam rewards Green Award LNG tankers too* http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/rotterdam-rewards-green-award-lng-tankers.aspx

Rodgers, P. (2013). *Euronav "eco" – euronav.com.* http://www.euronav.com/Documents/IR/Presentations/131009%20Eco-ships%20not%20worth%20investing.pdf

Scorpio Tanker, Inc. (2013). *Q1 Conference Call* http://www.scorpiotankers.com/sites/default/files/Scorpio%20Tankers%20Inc.%20Fuel%20Efficiency%20Presentation.pdf

Teriakidis, G. (2013). *The eco-ship debate: will it make or break the shipping industry* http://www.marinemoney.com/sites/all/themes/marinemoney/forums/IST13/presentations/Georgios%20M.%20Teriakidis.pdf

Wüst, C. (2013). *Smoking Ban: Shipping Shifts to Cleaner Fuel.* http://www.spiegel.de/international/business/new-imo-regulations-push-shipping-industry-toward-cleaner-fuel-and-lng-a-916811.html

Others

Clarkson SIN

Clarkson Research. (1993). *Capesize Quality survey.*

Modigliani, F.; Miller, M. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *America Economic Review* 48 (3): p. 261-297.

US CPI, Bureau of Labour Statistics.
http://data.bls.gov/timeseries/CUSR0000SA0?output_view=pct_1mth

Freight Rates, Supply and Demand. – (Danish Ship Finance).
http://www.shipfinance.dk/en/SHIPPING-RESEARCH/Introduktion/Fragtrater-udbud-og-efterspoergsel

http://www.balticexchange.com/media/pdf/tce/tc2_37-tce_calculation.pdf

https://www.dnb.no/bedrift/markets/valuta-renter/kalkulator/valutakalkulator.html

http://www.dedola.com/2012/03/what-is-slow-steaming/

http://gcaptain.com/eco-ships-sense/

http://www.investopedia.com/terms/t/time-charter-equivalent-tce.asp

http://www.poten.com/Document.aspx?id=24873&filename=Adding%20Fuel%20to%20the%20Eco%20Ship%20Fire.pdf

https://www.worldscale.co.uk

Appendix

Figure 1: Historical Earnings and Estimated Earnings

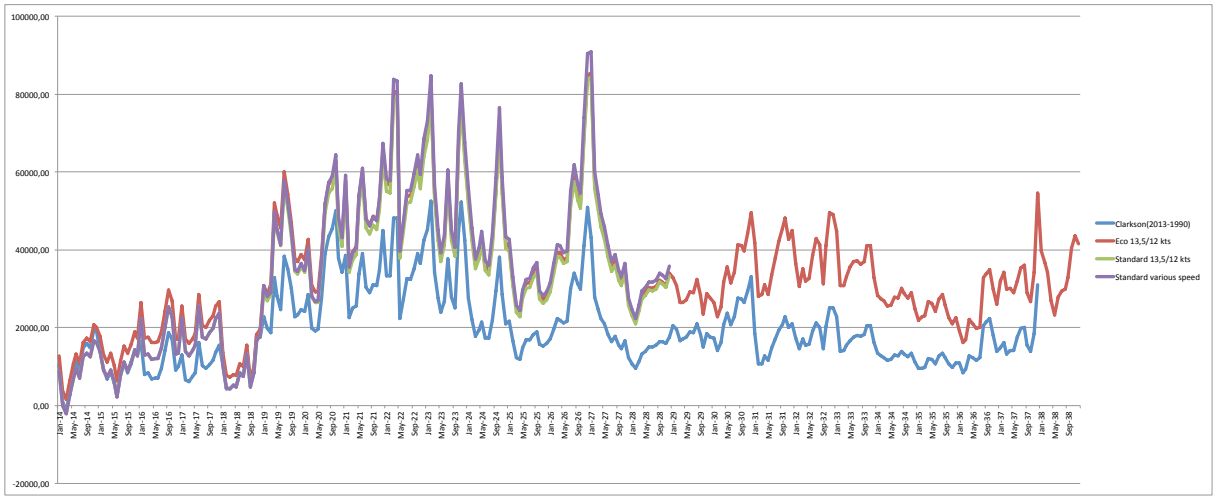

Figure 1 illustrates that historical earnings for the TC2_37 route made by Clarkson Research and earnings using a constant 2014 Flat Rate, and historical -spot rates and bunker cost, fluctuates with each other. Figures dated from 2013 backwards to 1989. The gap between historical earnings and earnings estimated in this thesis will however increase over time.

The red line represent the Eco-vessel, the blue represent historical earnings made by Clarkson Research, the green represent the Standard vessel steaming 13.5 laden and 12.0 knots in ballast, and the purple represent the Standard vessel with various speed.

Table 1: TCE Inputs for one period ("January 1989")

Gross Freight		
World Scale		*2,4125*
Flat Rate in USD		*15,48*
Metric Tons (mt)		37000
Fixed Differentials	$	-
Gross Freight	**$**	**1 381 783,50**

Port Expenses	
Port	**Cost**
Rotterdam	$ 69 659,00
New York	$ 37 900,00
Total Port Exp.	**$107 559,00**

Broker Commisions	
Total	3,75 %

Cost of Bunkers	
Specifications	**$/MT**
IFO 380	*$ 138,25*

Eco-design 2014			
Durations	**Speed**	**Days**	**MT/Day**
Load	-	2	5
Laden	13,5	*11*	19,5
Anchor	-	1	5
Discharge	-	2	6
Ballast	12	*12*	12,7

Standard 2004			
Durations	**Speed**	**Days**	**MT/Day**
Load	-	2	5
Laden	14	*10*	36,4
Anchor	-	1	5
Discharge	-	2	12
Ballast	13,5	*11*	21,7

Table 1 shows input variables for the "January 1989 period." A Worldscale Multiplier of 2.4125, a Flat Rate of $15.48, and 37.000 Metric Tons of goods transported estimate the Gross Freight. Port Expenses are constant for the entire investment horizon and equal $107 559 per voyage. Broker Commissions are set to be constant and equal 3,75%. Cost of Bunker is based on historical figures dated January 1989. The January 1989 Cost of Bunker is however calculated into January 2014 values using the US CPI as deflator.

The two last tables show duration days for the voyage and each vessel's fuel consumption. The Standard vessel is set to steam faster and has therefore less laden and ballast days.

Table 2: TCE Outputs for one period ("January 1989")

Eco-design MR:			*Knots*	*Days*	*MT/Day*		*Bunker Price*	*Bunker Cost*
Leg	**Durations**	**Miles+Sea Marg.**	**Speed**	**Duration**	**Eco-design**	**Leg**	**$/MT**	**Eco-design**
Rot	Load		-	2	5	*Rot*	$ 138,25	$ 1 382,50
Rot-NYC	Laden	3514	13,5	11	19,5	*Rot-NYC*	$ 138,25	$ 29 241,51
NYC	Anchor		-	1	5	*NYC*	$ 138,25	$ 691,25
NYC	Discharge		-	2	6	*NYC*	$ 138,25	$ 1 659,00
NYC-Rot	Ballast	3514	12	12	12,7	*NYC-Rot*	$ 138,25	$ 21 425,03
	Total			**28**				**$ 54 399,28**

Standard MR:			*Knots*	*Days*	*MT/Day*		*Bunker Price*	*Bunker Cost*
Leg	**Durations**	**Miles+Sea Marg.**	**Speed**	**Duration**	**Standard**	**Leg**	**$/MT**	**Standard**
Rot	Load		-	2	5	*Rot*	$ 138,25	$ 1 382,50
Rot-NYC	Laden	3514	14	10	36,4	*Rot-NYC*	$ 138,25	$ 52 634,71
NYC	Anchor		-	1	5	*NYC*	$ 138,25	$ 691,25
NYC	Discharge		-	2	12	*NYC*	$ 138,25	$ 3 318,00
NYC-Rot	Ballast	3514	13,5	11	21,7	*NYC-Rot*	$ 138,25	$ 32 540,55
	Total			**26**				**$ 90 567,01**

	Eco-design MR	**Standard MR**	**Premium $**	**Premium %**
Gross Freight	$ 1 381 783,50	$1 381 783,50		
Less:				
Commissions	$ 51 816,88	$ 51 816,88		
Port Expenses	$ 107 559,00	$ 107 559,00		
Bunker Expenses	$ 54 399,28	$ 90 567,01	$ -36 167,73	40 %
Voyage Earnings	$ 1 168 008,33	$1 131 840,61	$ 36 167,73	3 %
TCE ($/Day)	$ 41 641,17	$ 43 025,73	$ -1 384,56	-3 %

Table 2 shows output variables for the "January 1989" period. The two first tables estimate Eco- and Standard voyage bunker costs. We can further see that Eco's voyage duration is estimated to 28 days while Standard's voyage duration is estimated to 26 days due to its higher steaming. The last table illustrates the TCE calculation for the "January 1989 period" and the Standard vessel gains the highest TCE.

The TCE calculation illustrated above differs by $4 from data used in this thesis due to minor adjustments (approximately 0.05 days) in voyage days.

Table 3: Net Present Values ("December 2013 – January 1989")

Net Present Value (December 2013 - January 1989 figures)					
Period	Using historical figures from	Present Value Eco $36.5m	Present Value Standard	Present Value Standard w/speed flex	Present Value Eco $31.0m
0	Jan-14	$ -36 500 000,00	$ -18 000 000,00	$ -18 000 000,00	$ -31 000 000,00
1	Dec-13	$ 354 016,09	$ 249 564,14	$ 249 564,14	$ 354 016,09
2	Nov-13	$ 101 349,02	$ -710,54	$ -710,54	$ 101 349,02
3	Oct-13	$ 45 156,27	$ -58 022,71	$ -58 022,71	$ 45 156,27
4	Sep-13	$ 174 819,72	$ 71 236,28	$ 71 236,28	$ 174 819,72
5	Aug-13	$ 287 435,91	$ 183 923,91	$ 183 923,91	$ 287 435,91
6	Jul-13	$ 354 402,41	$ 252 490,65	$ 252 490,65	$ 354 402,41
7	Jun-13	$ 286 241,94	$ 188 008,54	$ 188 008,54	$ 286 241,94
8	May-13	$ 425 650,33	$ 327 999,29	$ 327 999,29	$ 425 650,33
9	Apr-13	$ 447 585,93	$ 349 972,56	$ 349 972,56	$ 447 585,93
10	Mar-13	$ 424 108,48	$ 323 864,44	$ 323 864,44	$ 424 108,48
11	Feb-13	$ 530 774,35	$ 426 383,06	$ 426 383,06	$ 530 774,35
12	Jan-13	$ 508 793,56	$ 408 692,12	$ 408 692,12	$ 508 793,56
13	Dec-12	$ 442 403,58	$ 347 125,26	$ 347 125,26	$ 442 403,58
14	Nov-12	$ 320 904,13	$ 225 855,71	$ 225 855,71	$ 320 904,13
15	Oct-12	$ 276 470,30	$ 178 105,37	$ 178 105,37	$ 276 470,30
16	Sep-12	$ 325 994,33	$ 224 843,53	$ 224 843,53	$ 325 994,33
17	Aug-12	$ 247 245,26	$ 146 443,40	$ 146 443,40	$ 247 245,26
18	Jul-12	$ 150 512,89	$ 56 832,69	$ 56 832,69	$ 150 512,89
19	Jun-12	$ 272 252,30	$ 183 372,37	$ 183 372,37	$ 272 252,30
20	May-12	$ 361 555,09	$ 261 414,78	$ 261 414,78	$ 361 555,09
21	Apr-12	$ 314 882,28	$ 208 799,74	$ 208 799,74	$ 314 882,28
22	Mar-12	$ 364 264,78	$ 256 421,47	$ 256 421,47	$ 364 264,78
23	Feb-12	$ 431 754,30	$ 326 749,86	$ 326 749,86	$ 431 754,30
24	Jan-12	$ 391 952,73	$ 289 240,76	$ 289 240,76	$ 391 952,73
25	Dec-11	$ 595 012,04	$ 501 520,29	$ 501 520,29	$ 595 012,04
26	Nov-11	$ 385 872,08	$ 290 257,61	$ 290 257,61	$ 385 872,08
27	Oct-11	$ 386 599,21	$ 293 671,37	$ 293 671,37	$ 386 599,21
28	Sep-11	$ 353 240,15	$ 260 216,68	$ 260 216,68	$ 353 240,15
29	Aug-11	$ 352 877,13	$ 261 400,90	$ 261 400,90	$ 352 877,13
30	Jul-11	$ 352 587,81	$ 259 772,18	$ 259 772,18	$ 352 587,81
31	Jun-11	$ 404 861,19	$ 315 078,07	$ 315 078,07	$ 404 861,19
32	May-11	$ 513 895,53	$ 426 322,48	$ 426 322,48	$ 513 895,53
33	Apr-11	$ 621 254,96	$ 531 246,28	$ 531 246,28	$ 621 254,96
34	Mar-11	$ 561 423,94	$ 476 549,36	$ 476 549,36	$ 561 423,94
35	Feb-11	$ 353 649,49	$ 273 050,14	$ 273 050,14	$ 353 649,49
36	Jan-11	$ 348 064,26	$ 276 213,24	$ 276 213,24	$ 348 064,26

The Standard vessel with speed flexibility (Colum 5) steams 13.5 knots laden and 12.0 knots in ballast in the period 2009 – 2013.

37	**Dec-10**	$ 519 863,05	$ 451 929,92	$ 451 929,92	$ 519 863,05
38	**Nov-10**	$ 345 325,53	$ 279 604,16	$ 279 604,16	$ 345 325,53
39	**Oct-10**	$ 319 563,76	$ 256 766,11	$ 256 766,11	$ 319 563,76
40	**Sep-10**	$ 340 233,63	$ 281 584,97	$ 281 584,97	$ 340 233,63
41	**Aug-10**	$ 363 730,19	$ 304 460,34	$ 304 460,34	$ 363 730,19
42	**Jul-10**	$ 554 200,03	$ 497 492,64	$ 497 492,64	$ 554 200,03
43	**Jun-10**	$ 394 826,87	$ 338 507,74	$ 338 507,74	$ 394 826,87
44	**May-10**	$ 385 429,50	$ 327 943,43	$ 327 943,43	$ 385 429,50
45	**Apr-10**	$ 415 918,56	$ 355 023,37	$ 355 023,37	$ 415 918,56
46	**Mar-10**	$ 431 667,81	$ 372 974,93	$ 372 974,93	$ 431 667,81
47	**Feb-10**	$ 475 326,27	$ 417 901,18	$ 417 901,18	$ 475 326,27
48	**Jan-10**	$ 494 208,79	$ 435 770,88	$ 435 770,88	$ 494 208,79
49	**Dec-09**	$ 248 339,96	$ 192 555,37	$ 192 555,37	$ 248 339,96
50	**Nov-09**	$ 141 989,36	$ 83 859,34	$ 83 859,34	$ 141 989,36
51	**Oct-09**	$ 131 852,67	$ 79 040,34	$ 79 040,34	$ 131 852,67
52	**Sep-09**	$ 144 013,66	$ 92 935,65	$ 92 935,65	$ 144 013,66
53	**Aug-09**	$ 138 132,38	$ 85 375,85	$ 85 375,85	$ 138 132,38
54	**Jul-09**	$ 188 702,15	$ 141 970,97	$ 141 970,97	$ 188 702,15
55	**Jun-09**	$ 175 312,04	$ 128 883,39	$ 128 883,39	$ 175 312,04
56	**May-09**	$ 268 712,90	$ 229 146,53	$ 229 146,53	$ 268 712,90
57	**Apr-09**	$ 113 573,27	$ 80 391,72	$ 80 391,72	$ 113 573,27
58	**Mar-09**	$ 170 572,55	$ 141 386,08	$ 141 386,08	$ 170 572,55
59	**Feb-09**	$ 306 309,39	$ 277 943,29	$ 277 943,29	$ 306 309,39
60	**Jan-09**	$ 325 610,78	$ 298 936,24	$ 298 936,24	$ 325 610,78
61	**Dec-08**	$ 506 310,68	$ 483 423,24	$ 507 616,76	$ 506 310,68
62	**Nov-08**	$ 464 493,95	$ 439 369,98	$ 458 423,22	$ 464 493,95
63	**Oct-08**	$ 505 598,01	$ 460 919,33	$ 468 462,69	$ 505 598,01
64	**Sep-08**	$ 837 068,40	$ 777 126,45	$ 800 296,07	$ 837 068,40
65	**Aug-08**	$ 776 125,75	$ 706 807,82	$ 717 829,09	$ 776 125,75
66	**Jul-08**	$ 721 680,31	$ 648 509,09	$ 652 120,98	$ 721 680,31
67	**Jun-08**	$ 938 434,18	$ 874 716,13	$ 903 343,15	$ 938 434,18
68	**May-08**	$ 843 325,40	$ 784 987,12	$ 809 892,08	$ 843 325,40
69	**Apr-08**	$ 723 853,35	$ 670 691,30	$ 689 716,56	$ 723 853,35
70	**Mar-08**	$ 574 945,43	$ 523 798,62	$ 532 117,73	$ 574 945,43
71	**Feb-08**	$ 558 444,99	$ 511 637,91	$ 521 904,87	$ 558 444,99
72	**Jan-08**	$ 581 706,95	$ 534 014,19	$ 545 518,98	$ 581 706,95
73	**Dec-07**	$ 554 328,52	$ 506 839,88	$ 516 249,52	$ 554 328,52
74	**Nov-07**	$ 629 834,28	$ 579 781,40	$ 593 445,39	$ 629 834,28
75	**Oct-07**	$ 448 282,30	$ 405 035,45	$ 408 957,52	$ 448 282,30
76	**Sep-07**	$ 420 979,32	$ 382 024,88	$ 386 970,78	$ 420 979,32
77	**Aug-07**	$ 417 471,40	$ 380 849,40	$ 387 282,84	$ 417 471,40
78	**Jul-07**	$ 549 559,92	$ 512 688,05	$ 529 789,17	$ 549 559,92
79	**Jun-07**	$ 729 681,02	$ 696 587,89	$ 731 372,40	$ 729 681,02
80	**May-07**	$ 794 643,84	$ 761 775,38	$ 802 071,03	$ 794 643,84
81	**Apr-07**	$ 804 001,07	$ 772 614,26	$ 814 807,21	$ 804 001,07
82	**Mar-07**	$ 861 911,61	$ 834 539,03	$ 884 548,72	$ 861 911,61
83	**Feb-07**	$ 648 513,91	$ 623 259,79	$ 657 340,74	$ 648 513,91
84	**Jan-07**	$ 574 557,64	$ 551 627,72	$ 581 398,93	$ 574 557,64

The Standard vessel with speed flexibility (Colum 5) steams 13.5 knots laden / 12.0 knots in ballast in the period 2009 – 2013, and 14.0 knots laden / 14.0 knots in ballast in the period 2004 – 2008.

85	**Dec-06**	$ 771 360,95	$ 745 894,85	$ 789 912,68	$ 771 360,95
86	**Nov-06**	$ 479 041,18	$ 453 117,50	$ 472 757,67	$ 479 041,18
87	**Oct-06**	$ 519 418,76	$ 493 396,13	$ 516 280,07	$ 519 418,76
88	**Sep-06**	$ 531 416,52	$ 504 372,62	$ 527 465,21	$ 531 416,52
89	**Aug-06**	$ 692 211,89	$ 662 632,75	$ 697 012,73	$ 692 211,89
90	**Jul-06**	$ 769 932,63	$ 740 027,15	$ 780 547,46	$ 769 932,63
91	**Jun-06**	$ 608 297,51	$ 579 981,54	$ 608 425,37	$ 608 297,51
92	**May-06**	$ 584 555,61	$ 554 257,18	$ 579 239,96	$ 584 555,61
93	**Apr-06**	$ 607 685,62	$ 577 918,43	$ 605 207,01	$ 607 685,62
94	**Mar-06**	$ 587 079,88	$ 559 170,66	$ 586 180,05	$ 587 079,88
95	**Feb-06**	$ 643 656,06	$ 616 344,48	$ 648 459,59	$ 643 656,06
96	**Jan-06**	$ 798 689,92	$ 772 648,09	$ 818 474,05	$ 798 689,92
97	**Dec-05**	$ 686 616,90	$ 663 093,52	$ 701 624,38	$ 686 616,90
98	**Nov-05**	$ 675 501,04	$ 652 230,92	$ 690 040,86	$ 675 501,04
99	**Oct-05**	$ 955 461,41	$ 931 313,80	$ 991 468,93	$ 955 461,41
100	**Sep-05**	$ 947 073,80	$ 921 495,24	$ 979 871,39	$ 947 073,80
101	**Aug-05**	$ 465 097,30	$ 441 801,48	$ 462 296,25	$ 465 097,30
102	**Jul-05**	$ 538 172,64	$ 516 099,53	$ 543 532,18	$ 538 172,64
103	**Jun-05**	$ 616 921,50	$ 596 412,00	$ 631 508,49	$ 616 921,50
104	**May-05**	$ 611 977,28	$ 591 824,75	$ 626 786,61	$ 611 977,28
105	**Apr-05**	$ 651 141,93	$ 631 026,46	$ 669 235,95	$ 651 141,93
106	**Mar-05**	$ 691 221,98	$ 673 648,11	$ 717 087,39	$ 691 221,98
107	**Feb-05**	$ 631 211,44	$ 616 399,31	$ 657 008,37	$ 631 211,44
108	**Jan-05**	$ 714 295,58	$ 700 712,57	$ 749 087,14	$ 714 295,58
109	**Dec-04**	$ 753 377,64	$ 741 085,40	$ 793 655,36	$ 753 377,64
110	**Nov-04**	$ 862 802,23	$ 850 407,22	$ 911 893,86	$ 862 802,23
111	**Oct-04**	$ 581 748,96	$ 567 155,33	$ 603 864,83	$ 581 748,96
112	**Sep-04**	$ 462 807,05	$ 449 274,75	$ 477 015,08	$ 462 807,05
113	**Aug-04**	$ 402 389,81	$ 388 512,30	$ 411 023,38	$ 402 389,81
114	**Jul-04**	$ 439 746,52	$ 426 324,46	$ 452 253,10	$ 439 746,52
115	**Jun-04**	$ 598 188,10	$ 585 175,91	$ 624 440,84	$ 598 188,10
116	**May-04**	$ 447 821,19	$ 433 978,38	$ 460 250,42	$ 447 821,19
117	**Apr-04**	$ 400 163,84	$ 387 820,40	$ 411 316,51	$ 400 163,84
118	**Mar-04**	$ 671 477,78	$ 659 855,56	$ 706 203,34	$ 671 477,78
119	**Feb-04**	$ 779 008,30	$ 767 853,64	$ 823 396,65	$ 779 008,30
120	**Jan-04**	$ 633 962,59	$ 622 652,68	$ 666 154,43	$ 633 962,59
121	**Dec-03**	$ 519 749,03	$ 508 511,97	$ 547 354,73	$ 519 749,03
122	**Nov-03**	$ 424 717,11	$ 412 504,20	$ 443 354,25	$ 424 717,11
123	**Oct-03**	$ 349 301,02	$ 337 451,04	$ 362 292,44	$ 349 301,02
124	**Sep-03**	$ 369 486,55	$ 358 068,26	$ 384 673,33	$ 369 486,55
125	**Aug-03**	$ 405 077,07	$ 392 804,43	$ 422 044,36	$ 405 077,07
126	**Jul-03**	$ 337 269,83	$ 324 231,06	$ 347 747,50	$ 337 269,83
127	**Jun-03**	$ 323 316,92	$ 312 124,47	$ 335 052,12	$ 323 316,92
128	**May-03**	$ 387 228,26	$ 376 841,57	$ 405 188,45	$ 387 228,26
129	**Apr-03**	$ 505 109,73	$ 495 686,79	$ 533 875,64	$ 505 109,73
130	**Mar-03**	$ 652 905,50	$ 641 973,37	$ 691 703,08	$ 652 905,50
131	**Feb-03**	$ 501 723,84	$ 488 844,96	$ 525 743,59	$ 501 723,84
132	**Jan-03**	$ 371 557,72	$ 358 808,42	$ 385 190,26	$ 371 557,72

The Standard vessel with speed flexibility (Colum 5) steams 14.0 knots laden / 14.0 knots in ballast in the period 2004 – 2008, and 13.5 knots laden / 14.5 knots in ballast in the period 1997 – 2003.

133	**Dec-02**	$ 360 618,69	$ 350 787,92	$ 377 140,47	$ 360 618,69
134	**Nov-02**	$ 278 172,45	$ 269 076,37	$ 288 959,46	$ 278 172,45
135	**Oct-02**	$ 219 385,96	$ 208 340,43	$ 222 883,74	$ 219 385,96
136	**Sep-02**	$ 207 847,94	$ 196 349,93	$ 209 824,67	$ 207 847,94
137	**Aug-02**	$ 246 063,68	$ 235 741,37	$ 252 660,46	$ 246 063,68
138	**Jul-02**	$ 265 090,83	$ 255 047,20	$ 273 591,07	$ 265 090,83
139	**Jun-02**	$ 263 956,46	$ 254 529,79	$ 273 162,99	$ 263 956,46
140	**May-02**	$ 282 794,71	$ 273 040,85	$ 293 105,44	$ 282 794,71
141	**Apr-02**	$ 290 560,68	$ 281 214,33	$ 302 028,41	$ 290 560,68
142	**Mar-02**	$ 231 161,55	$ 222 911,81	$ 239 231,63	$ 231 161,55
143	**Feb-02**	$ 219 724,83	$ 212 680,38	$ 228 427,05	$ 219 724,83
144	**Jan-02**	$ 225 453,36	$ 218 357,33	$ 234 553,36	$ 225 453,36
145	**Dec-01**	$ 239 187,33	$ 232 184,69	$ 249 521,82	$ 239 187,33
146	**Nov-01**	$ 273 823,91	$ 267 032,58	$ 287 240,41	$ 273 823,91
147	**Oct-01**	$ 307 051,42	$ 299 755,07	$ 322 508,82	$ 307 051,42
148	**Sep-01**	$ 303 572,01	$ 295 092,39	$ 317 216,25	$ 303 572,01
149	**Aug-01**	$ 287 589,39	$ 279 454,54	$ 300 383,73	$ 287 589,39
150	**Jul-01**	$ 288 752,04	$ 281 160,61	$ 302 343,78	$ 288 752,04
151	**Jun-01**	$ 394 371,40	$ 386 640,76	$ 416 347,44	$ 394 371,40
152	**May-01**	$ 437 520,16	$ 429 815,29	$ 463 028,38	$ 437 520,16
153	**Apr-01**	$ 397 969,91	$ 390 628,66	$ 420 741,58	$ 397 969,91
154	**Mar-01**	$ 379 973,97	$ 372 479,23	$ 401 087,79	$ 379 973,97
155	**Feb-01**	$ 506 681,83	$ 499 127,89	$ 537 993,49	$ 506 681,83
156	**Jan-01**	$ 612 698,30	$ 605 401,11	$ 652 938,79	$ 612 698,30
157	**Dec-00**	$ 611 030,71	$ 603 205,98	$ 650 453,40	$ 611 030,71
158	**Nov-00**	$ 404 284,05	$ 395 122,83	$ 425 212,87	$ 404 284,05
159	**Oct-00**	$ 363 138,20	$ 353 436,29	$ 380 031,00	$ 363 138,20
160	**Sep-00**	$ 328 459,19	$ 319 148,77	$ 343 046,51	$ 328 459,19
161	**Aug-00**	$ 302 583,90	$ 294 627,03	$ 316 824,39	$ 302 583,90
162	**Jul-00**	$ 269 605,42	$ 261 693,22	$ 281 229,57	$ 269 605,42
163	**Jun-00**	$ 242 394,32	$ 233 859,97	$ 251 006,98	$ 242 394,32
164	**May-00**	$ 250 761,38	$ 243 302,61	$ 261 444,20	$ 250 761,38
165	**Apr-00**	$ 222 459,97	$ 215 118,47	$ 230 999,62	$ 222 459,97
166	**Mar-00**	$ 212 227,86	$ 203 678,97	$ 218 375,59	$ 212 227,86
167	**Feb-00**	$ 230 323,37	$ 222 558,48	$ 238 952,83	$ 230 323,37
168	**Jan-00**	$ 175 505,68	$ 168 132,76	$ 180 197,27	$ 175 505,68
169	**Dec-99**	$ 156 365,16	$ 149 042,87	$ 159 570,20	$ 156 365,16
170	**Nov-99**	$ 141 481,81	$ 134 068,91	$ 143 362,75	$ 141 481,81
171	**Oct-99**	$ 161 712,99	$ 154 491,36	$ 165 481,92	$ 161 712,99
172	**Sep-99**	$ 179 102,70	$ 172 488,23	$ 185 067,32	$ 179 102,70
173	**Aug-99**	$ 182 676,80	$ 176 363,14	$ 189 320,44	$ 182 676,80
174	**Jul-99**	$ 187 998,88	$ 182 676,50	$ 196 356,69	$ 187 998,88
175	**Jun-99**	$ 184 840,42	$ 180 376,71	$ 194 053,15	$ 184 840,42
176	**May-99**	$ 185 791,56	$ 181 850,96	$ 195 758,26	$ 185 791,56
177	**Apr-99**	$ 194 127,50	$ 190 171,78	$ 204 750,58	$ 194 127,50
178	**Mar-99**	$ 189 581,29	$ 186 225,09	$ 200 611,44	$ 189 581,29
179	**Feb-99**	$ 182 595,76	$ 179 481,21	$ 193 372,13	$ 182 595,76
180	**Jan-99**	$ 198 938,31	$ 938 577,92	$ 953 694,64	$ 198 938,31

The Standard vessel with speed flexibility (Colum 5) steams 13.5 knots laden / 14.5 knots in ballast in the period 1997 – 2003. The Standard vessel with or without the speed flex is scrapped at end of period 180 ("January 1999").

181	**Dec-98**	$ 190 500,71			$ 190 500,71
182	**Nov-98**	$ 177 559,42			$ 177 559,42
183	**Oct-98**	$ 150 864,11			$ 150 864,11
184	**Sep-98**	$ 150 186,93			$ 150 186,93
185	**Aug-98**	$ 152 046,70			$ 152 046,70
186	**Jul-98**	$ 162 565,37			$ 162 565,37
187	**Jun-98**	$ 159 719,43			$ 159 719,43
188	**May-98**	$ 177 301,41			$ 177 301,41
189	**Apr-98**	$ 153 600,81			$ 153 600,81
190	**Mar-98**	$ 126 544,16			$ 126 544,16
191	**Feb-98**	$ 152 731,17			$ 152 731,17
192	**Jan-98**	$ 145 208,10			$ 145 208,10
193	**Dec-97**	$ 138 973,95			$ 138 973,95
194	**Nov-97**	$ 117 950,96			$ 117 950,96
195	**Oct-97**	$ 130 131,68			$ 130 131,68
196	**Sep-97**	$ 162 049,03			$ 162 049,03
197	**Aug-97**	$ 180 085,26			$ 180 085,26
198	**Jul-97**	$ 157 579,13			$ 157 579,13
199	**Jun-97**	$ 169 917,05			$ 169 917,05
200	**May-97**	$ 203 013,52			$ 203 013,52
201	**Apr-97**	$ 200 627,05			$ 200 627,05
202	**Mar-97**	$ 192 576,57			$ 192 576,57
203	**Feb-97**	$ 212 640,86			$ 212 640,86
204	**Jan-97**	$ 235 601,22			$ 235 601,22
205	**Dec-96**	$ 197 301,27			$ 197 301,27
206	**Nov-96**	$ 131 634,27			$ 131 634,27
207	**Oct-96**	$ 132 175,51			$ 132 175,51
208	**Sep-96**	$ 143 052,63			$ 143 052,63
209	**Aug-96**	$ 129 972,21			$ 129 972,21
210	**Jul-96**	$ 151 902,22			$ 151 902,22
211	**Jun-96**	$ 169 225,71			$ 169 225,71
212	**May-96**	$ 187 451,06			$ 187 451,06
213	**Apr-96**	$ 199 490,98			$ 199 490,98
214	**Mar-96**	$ 210 108,22			$ 210 108,22
215	**Feb-96**	$ 185 035,29			$ 185 035,29
216	**Jan-96**	$ 193 195,45			$ 193 195,45
217	**Dec-95**	$ 154 792,10			$ 154 792,10
218	**Nov-95**	$ 128 722,50			$ 128 722,50
219	**Oct-95**	$ 146 664,82			$ 146 664,82
220	**Sep-95**	$ 132 616,72			$ 132 616,72
221	**Aug-95**	$ 134 247,45			$ 134 247,45
222	**Jul-95**	$ 157 227,91			$ 157 227,91
223	**Jun-95**	$ 173 038,47			$ 173 038,47
224	**May-95**	$ 164 988,50			$ 164 988,50
225	**Apr-95**	$ 123 840,22			$ 123 840,22
226	**Mar-95**	$ 161 277,48			$ 161 277,48
227	**Feb-95**	$ 192 638,02			$ 192 638,02
228	**Jan-95**	$ 189 558,15			$ 189 558,15

229	**Dec-94**	$ 171 422,61			$ 171 422,61
230	**Nov-94**	$ 116 779,45			$ 116 779,45
231	**Oct-94**	$ 115 969,42			$ 115 969,42
232	**Sep-94**	$ 123 264,23			$ 123 264,23
233	**Aug-94**	$ 131 454,00			$ 131 454,00
234	**Jul-94**	$ 135 929,34			$ 135 929,34
235	**Jun-94**	$ 135 271,27			$ 135 271,27
236	**May-94**	$ 131 139,01			$ 131 139,01
237	**Apr-94**	$ 132 000,20			$ 132 000,20
238	**Mar-94**	$ 145 535,83			$ 145 535,83
239	**Feb-94**	$ 144 232,89			$ 144 232,89
240	**Jan-94**	$ 114 259,17			$ 114 259,17
241	**Dec-93**	$ 97 760,41			$ 97 760,41
242	**Nov-93**	$ 93 813,90			$ 93 813,90
243	**Oct-93**	$ 91 296,59			$ 91 296,59
244	**Sep-93**	$ 85 691,21			$ 85 691,21
245	**Aug-93**	$ 85 637,07			$ 85 637,07
246	**Jul-93**	$ 91 958,40			$ 91 958,40
247	**Jun-93**	$ 90 740,78			$ 90 740,78
248	**May-93**	$ 97 810,85			$ 97 810,85
249	**Apr-93**	$ 92 495,08			$ 92 495,08
250	**Mar-93**	$ 87 835,14			$ 87 835,14
251	**Feb-93**	$ 91 531,69			$ 91 531,69
252	**Jan-93**	$ 78 056,85			$ 78 056,85
253	**Dec-92**	$ 68 036,26			$ 68 036,26
254	**Nov-92**	$ 70 085,69			$ 70 085,69
255	**Oct-92**	$ 70 460,18			$ 70 460,18
256	**Sep-92**	$ 80 882,12			$ 80 882,12
257	**Aug-92**	$ 78 828,86			$ 78 828,86
258	**Jul-92**	$ 71 832,24			$ 71 832,24
259	**Jun-92**	$ 80 926,42			$ 80 926,42
260	**May-92**	$ 83 219,38			$ 83 219,38
261	**Apr-92**	$ 74 954,43			$ 74 954,43
262	**Mar-92**	$ 65 172,42			$ 65 172,42
263	**Feb-92**	$ 59 534,67			$ 59 534,67
264	**Jan-92**	$ 64 120,85			$ 64 120,85
265	**Dec-91**	$ 53 807,38			$ 53 807,38
266	**Nov-91**	$ 44 652,79			$ 44 652,79
267	**Oct-91**	$ 46 730,08			$ 46 730,08
268	**Sep-91**	$ 60 105,05			$ 60 105,05
269	**Aug-91**	$ 56 626,52			$ 56 626,52
270	**Jul-91**	$ 52 949,47			$ 52 949,47
271	**Jun-91**	$ 53 143,16			$ 53 143,16
272	**May-91**	$ 86 345,81			$ 86 345,81
273	**Apr-91**	$ 88 173,94			$ 88 173,94
274	**Mar-91**	$ 90 502,06			$ 90 502,06
275	**Feb-91**	$ 76 928,37			$ 76 928,37
276	**Jan-91**	$ 66 451,82			$ 66 451,82

277	**Dec-90**	$ 80 631,19			$ 80 631,19
278	**Nov-90**	$ 85 639,63			$ 85 639,63
279	**Oct-90**	$ 74 409,26			$ 74 409,26
280	**Sep-90**	$ 74 258,52			$ 74 258,52
281	**Aug-90**	$ 70 452,36			$ 70 452,36
282	**Jul-90**	$ 77 255,52			$ 77 255,52
283	**Jun-90**	$ 84 622,74			$ 84 622,74
284	**May-90**	$ 85 521,30			$ 85 521,30
285	**Apr-90**	$ 68 121,24			$ 68 121,24
286	**Mar-90**	$ 62 173,28			$ 62 173,28
287	**Feb-90**	$ 79 031,53			$ 79 031,53
288	**Jan-90**	$ 124 889,83			$ 124 889,83
289	**Dec-89**	$ 90 284,09			$ 90 284,09
290	**Nov-89**	$ 82 617,48			$ 82 617,48
291	**Oct-89**	$ 76 296,83			$ 76 296,83
292	**Sep-89**	$ 59 645,73			$ 59 645,73
293	**Aug-89**	$ 50 855,34			$ 50 855,34
294	**Jul-89**	$ 60 413,53			$ 60 413,53
295	**Jun-89**	$ 63 592,00			$ 63 592,00
296	**May-89**	$ 64 007,66			$ 64 007,66
297	**Apr-89**	$ 69 502,72			$ 69 502,72
298	**Mar-89**	$ 85 112,49			$ 85 112,49
299	**Feb-89**	$ 91 002,69			$ 91 002,69
300	**Jan-89**	$ 348 018,85			$ 348 018,85
Net Present Value		**$ 54 990 859,99**	**$ 52 910 230,29**	**$ 56 049 058,26**	**$ 60 490 859,99**

Table 3 shows the various present values (PV) when using historical spot rates and historical bunker costs dated from December 2013 – January 1989, where December 2013 is the first period (month). Sum of all PVs equals the various net present values.

Colum 1 presents the period. Colum 2 presents historical month used. Colum 3 presents the Eco-design vessel priced at $36.5m. Colum 4 presents the Standard vessel steaming 13,5 knots laden and 12,0 knots in ballast. Colum 5 presents the Standard vessel steaming based on historical knots for the TC2_37 route. Colum 6 presents the Eco-design vessel priced at reported “booking” price, $31.0m

Table 4: Net Present Values ("January 1989 – December 2013")

Net Present Value (January 1989 - December 2013 figures)					
Period	Using historical figures from	Present Value Eco $36.5m	Present Value Standard	Present Value Standard w/speed flex	Present Value Eco $31.0m
0	Jan-14	$ -36 500 000,00	$ -18 000 000,00	$ -18 000 000,00	$ -31 000 000,00
1	Jan-89	$ 1 155 966,69	$ 1 131 342,36	$ 1 194 405,04	$ 1 155 966,69
2	Feb-89	$ 1 201 463,15	$ 1 177 696,20	$ 1 244 245,13	$ 1 201 463,15
3	Mar-89	$ 1 104 340,45	$ 1 074 831,57	$ 1 131 787,70	$ 1 104 340,45
4	Apr-89	$ 886 267,92	$ 855 852,25	$ 897 859,10	$ 886 267,92
5	May-89	$ 802 137,22	$ 773 164,84	$ 810 390,22	$ 802 137,22
6	Jun-89	$ 783 200,04	$ 753 171,82	$ 788 561,80	$ 783 200,04
7	Jul-89	$ 731 236,54	$ 703 302,56	$ 736 400,55	$ 731 236,54
8	Aug-89	$ 604 942,02	$ 578 148,16	$ 603 503,98	$ 604 942,02
9	Sep-89	$ 697 284,56	$ 670 539,80	$ 702 041,76	$ 697 284,56
10	Oct-89	$ 876 578,17	$ 846 557,22	$ 888 138,98	$ 876 578,17
11	Nov-89	$ 932 845,20	$ 903 690,38	$ 949 476,91	$ 932 845,20
12	Dec-89	$ 1 001 849,20	$ 969 075,26	$ 1 017 444,62	$ 1 001 849,20
13	Jan-90	$ 1 361 983,13	$ 1 334 605,85	$ 1 409 806,82	$ 1 361 983,13
14	Feb-90	$ 847 029,46	$ 820 999,49	$ 862 817,41	$ 847 029,46
15	Mar-90	$ 654 870,50	$ 630 703,69	$ 660 812,39	$ 654 870,50
16	Apr-90	$ 705 160,02	$ 682 961,96	$ 717 485,55	$ 705 160,02
17	May-90	$ 870 027,38	$ 848 866,82	$ 894 885,89	$ 870 027,38
18	Jun-90	$ 846 056,12	$ 829 397,78	$ 876 303,67	$ 846 056,12
19	Jul-90	$ 759 093,25	$ 739 764,39	$ 779 439,38	$ 759 093,25
20	Aug-90	$ 680 322,25	$ 649 820,71	$ 678 133,19	$ 680 322,25
21	Sep-90	$ 704 723,69	$ 669 461,36	$ 696 773,37	$ 704 723,69
22	Oct-90	$ 693 989,78	$ 656 911,14	$ 682 513,26	$ 693 989,78
23	Nov-90	$ 784 972,39	$ 749 287,27	$ 781 684,57	$ 784 972,39
24	Dec-90	$ 726 333,57	$ 689 720,54	$ 717 721,93	$ 726 333,57
25	Jan-91	$ 588 292,64	$ 552 506,09	$ 571 814,50	$ 588 292,64
26	Feb-91	$ 669 308,87	$ 650 623,59	$ 684 702,79	$ 669 308,87
27	Mar-91	$ 773 841,50	$ 756 503,22	$ 798 249,92	$ 773 841,50
28	Apr-91	$ 740 947,24	$ 723 617,45	$ 763 189,06	$ 740 947,24
29	May-91	$ 713 085,82	$ 695 877,20	$ 733 669,17	$ 713 085,82
30	Jun-91	$ 431 321,79	$ 409 437,93	$ 425 988,17	$ 431 321,79
31	Jul-91	$ 422 346,70	$ 405 464,92	$ 424 170,53	$ 422 346,70
32	Aug-91	$ 443 895,66	$ 427 726,23	$ 448 251,45	$ 443 895,66
33	Sep-91	$ 463 047,44	$ 447 140,25	$ 469 078,76	$ 463 047,44
34	Oct-91	$ 353 805,49	$ 335 576,19	$ 348 999,00	$ 353 805,49
35	Nov-91	$ 332 253,93	$ 312 447,81	$ 323 575,57	$ 332 253,93
36	Dec-91	$ 393 474,69	$ 376 919,88	$ 393 892,03	$ 393 474,69

The Standard vessel with speed flexibility (Colum 5) steams 14.0 knots laden / 13.5 knots in ballast in the period Pre – 1997.

37	**Jan-92**	$ 460 816,20	$ 446 190,13	$ 468 685,14	$ 460 816,20
38	**Feb-92**	$ 420 486,35	$ 406 101,09	$ 426 055,99	$ 420 486,35
39	**Mar-92**	$ 452 375,73	$ 436 426,42	$ 457 634,59	$ 452 375,73
40	**Apr-92**	$ 511 312,34	$ 495 350,84	$ 520 457,80	$ 511 312,34
41	**May-92**	$ 557 913,61	$ 540 747,58	$ 568 280,36	$ 557 913,61
42	**Jun-92**	$ 533 195,26	$ 514 069,74	$ 538 887,21	$ 533 195,26
43	**Jul-92**	$ 465 124,12	$ 446 591,71	$ 467 224,49	$ 465 124,12
44	**Aug-92**	$ 501 635,39	$ 483 339,97	$ 506 522,49	$ 501 635,39
45	**Sep-92**	$ 505 835,09	$ 487 346,93	$ 510 701,78	$ 505 835,09
46	**Oct-92**	$ 433 065,60	$ 412 571,83	$ 430 001,89	$ 433 065,60
47	**Nov-92**	$ 423 343,41	$ 404 895,46	$ 422 806,06	$ 423 343,41
48	**Dec-92**	$ 403 884,63	$ 388 739,29	$ 407 176,18	$ 403 884,63
49	**Jan-93**	$ 455 387,82	$ 441 683,02	$ 464 324,82	$ 455 387,82
50	**Feb-93**	$ 524 801,88	$ 511 345,59	$ 538 723,79	$ 524 801,88
51	**Mar-93**	$ 494 932,15	$ 480 107,78	$ 504 754,47	$ 494 932,15
52	**Apr-93**	$ 512 211,74	$ 497 363,55	$ 523 142,19	$ 512 211,74
53	**May-93**	$ 532 318,31	$ 518 894,63	$ 546 788,84	$ 532 318,31
54	**Jun-93**	$ 485 333,61	$ 474 293,09	$ 500 384,07	$ 485 333,61
55	**Jul-93**	$ 483 373,44	$ 472 671,70	$ 498 819,06	$ 483 373,44
56	**Aug-93**	$ 442 391,38	$ 431 198,63	$ 454 360,32	$ 442 391,38
57	**Sep-93**	$ 435 045,48	$ 424 257,67	$ 447 155,21	$ 435 045,48
58	**Oct-93**	$ 455 518,91	$ 444 123,59	$ 468 043,82	$ 455 518,91
59	**Nov-93**	$ 460 015,57	$ 449 185,66	$ 473 714,72	$ 460 015,57
60	**Dec-93**	$ 471 109,50	$ 461 662,89	$ 487 687,62	$ 471 109,50
61	**Jan-94**	$ 541 132,24	$ 530 468,46	$ 560 464,10	$ 541 132,24
62	**Feb-94**	$ 671 320,82	$ 658 173,26	$ 695 430,39	$ 671 320,82
63	**Mar-94**	$ 665 716,39	$ 652 775,38	$ 689 774,69	$ 665 716,39
64	**Apr-94**	$ 593 399,82	$ 581 165,04	$ 613 760,52	$ 593 399,82
65	**May-94**	$ 579 372,93	$ 566 396,05	$ 597 654,01	$ 579 372,93
66	**Jun-94**	$ 587 334,29	$ 573 309,84	$ 604 519,43	$ 587 334,29
67	**Jul-94**	$ 580 024,71	$ 564 750,45	$ 594 788,52	$ 580 024,71
68	**Aug-94**	$ 551 265,21	$ 537 812,39	$ 566 946,10	$ 551 265,21
69	**Sep-94**	$ 508 015,97	$ 496 430,10	$ 523 724,31	$ 508 015,97
70	**Oct-94**	$ 469 718,07	$ 456 085,29	$ 479 716,29	$ 469 718,07
71	**Nov-94**	$ 464 850,93	$ 449 270,28	$ 471 507,82	$ 464 850,93
72	**Dec-94**	$ 670 608,21	$ 656 173,82	$ 692 676,23	$ 670 608,21
73	**Jan-95**	$ 728 780,44	$ 712 692,70	$ 752 140,93	$ 728 780,44
74	**Feb-95**	$ 727 863,17	$ 712 724,34	$ 752 633,50	$ 727 863,17
75	**Mar-95**	$ 598 873,33	$ 583 507,07	$ 614 743,58	$ 598 873,33
76	**Apr-95**	$ 451 935,48	$ 436 896,76	$ 458 576,41	$ 451 935,48
77	**May-95**	$ 591 727,70	$ 576 464,66	$ 607 284,40	$ 591 727,70
78	**Jun-95**	$ 609 908,08	$ 596 805,82	$ 630 018,30	$ 609 908,08
79	**Jul-95**	$ 544 634,12	$ 533 348,39	$ 563 234,16	$ 544 634,12
80	**Aug-95**	$ 457 019,52	$ 445 599,33	$ 469 605,31	$ 457 019,52
81	**Sep-95**	$ 443 690,87	$ 431 817,42	$ 454 690,98	$ 443 690,87
82	**Oct-95**	$ 482 238,23	$ 470 718,05	$ 496 340,21	$ 482 238,23
83	**Nov-95**	$ 415 952,42	$ 404 577,49	$ 425 887,02	$ 415 952,42
84	**Dec-95**	$ 491 576,89	$ 478 012,78	$ 503 130,02	$ 491 576,89

The Standard vessel with speed flexibility (Colum 5) steams 14.0 knots laden / 13.5 knots in ballast in the period Pre – 1997.

85	**Jan-96**	$ 602 966,34	$ 589 488,50	$ 622 034,48	$ 602 966,34
86	**Feb-96**	$ 567 550,15	$ 555 281,03	$ 586 144,68	$ 567 550,15
87	**Mar-96**	$ 633 353,55	$ 619 843,79	$ 654 385,86	$ 633 353,55
88	**Apr-96**	$ 590 989,71	$ 576 546,37	$ 607 767,87	$ 590 989,71
89	**May-96**	$ 545 755,41	$ 533 416,35	$ 562 797,30	$ 545 755,41
90	**Jun-96**	$ 484 205,80	$ 473 333,58	$ 499 442,35	$ 484 205,80
91	**Jul-96**	$ 427 150,82	$ 416 453,97	$ 438 878,37	$ 427 150,82
92	**Aug-96**	$ 359 187,43	$ 347 483,78	$ 364 851,00	$ 359 187,43
93	**Sep-96**	$ 388 525,90	$ 374 932,68	$ 393 205,16	$ 388 525,90
94	**Oct-96**	$ 352 800,03	$ 338 425,45	$ 353 900,94	$ 352 800,03
95	**Nov-96**	$ 345 302,78	$ 331 776,20	$ 347 221,10	$ 345 302,78
96	**Dec-96**	$ 508 644,67	$ 494 788,49	$ 520 876,17	$ 508 644,67
97	**Jan-97**	$ 596 919,31	$ 584 389,46	$ 617 055,93	$ 596 919,31
98	**Feb-97**	$ 529 466,30	$ 518 636,67	$ 547 768,09	$ 529 466,30
99	**Mar-97**	$ 471 246,92	$ 461 272,45	$ 487 016,07	$ 471 246,92
100	**Apr-97**	$ 482 489,72	$ 473 009,38	$ 499 769,69	$ 482 489,72
101	**May-97**	$ 479 818,56	$ 470 584,18	$ 497 302,71	$ 479 818,56
102	**Jun-97**	$ 394 677,65	$ 385 316,28	$ 406 323,07	$ 394 677,65
103	**Jul-97**	$ 359 714,34	$ 350 148,22	$ 368 725,56	$ 359 714,34
104	**Aug-97**	$ 404 008,70	$ 392 498,05	$ 412 941,51	$ 404 008,70
105	**Sep-97**	$ 357 283,11	$ 347 076,52	$ 365 140,63	$ 357 283,11
106	**Oct-97**	$ 281 969,79	$ 271 139,33	$ 283 869,75	$ 281 969,79
107	**Nov-97**	$ 251 173,91	$ 240 134,91	$ 250 709,96	$ 251 173,91
108	**Dec-97**	$ 290 843,88	$ 281 802,16	$ 296 104,05	$ 290 843,88
109	**Jan-98**	$ 298 655,74	$ 291 242,76	$ 313 281,45	$ 298 655,74
110	**Feb-98**	$ 308 717,47	$ 301 828,50	$ 324 837,07	$ 308 717,47
111	**Mar-98**	$ 251 379,06	$ 244 735,23	$ 263 166,40	$ 251 379,06
112	**Apr-98**	$ 299 870,68	$ 292 076,14	$ 314 101,20	$ 299 870,68
113	**May-98**	$ 340 177,97	$ 333 098,58	$ 358 602,25	$ 340 177,97
114	**Jun-98**	$ 301 165,52	$ 294 711,99	$ 317 236,16	$ 301 165,52
115	**Jul-98**	$ 301 251,37	$ 294 926,01	$ 317 494,80	$ 301 251,37
116	**Aug-98**	$ 276 905,42	$ 271 027,97	$ 291 754,25	$ 276 905,42
117	**Sep-98**	$ 268 806,71	$ 262 648,62	$ 282 635,72	$ 268 806,71
118	**Oct-98**	$ 265 367,29	$ 258 978,64	$ 278 619,08	$ 265 367,29
119	**Nov-98**	$ 306 943,67	$ 301 430,44	$ 324 699,49	$ 306 943,67
120	**Dec-98**	$ 323 642,12	$ 318 598,10	$ 343 359,09	$ 323 642,12
121	**Jan-99**	$ 332 154,67	$ 326 389,91	$ 351 629,34	$ 332 154,67
122	**Feb-99**	$ 299 616,78	$ 294 506,19	$ 317 299,45	$ 299 616,78
123	**Mar-99**	$ 305 720,39	$ 300 308,16	$ 323 507,70	$ 305 720,39
124	**Apr-99**	$ 307 658,91	$ 301 389,77	$ 324 494,66	$ 307 658,91
125	**May-99**	$ 289 375,60	$ 283 238,00	$ 304 899,00	$ 289 375,60
126	**Jun-99**	$ 282 934,80	$ 276 102,21	$ 297 036,69	$ 282 934,80
127	**Jul-99**	$ 282 812,22	$ 274 805,60	$ 295 385,11	$ 282 812,22
128	**Aug-99**	$ 270 072,15	$ 260 737,93	$ 279 894,21	$ 270 072,15
129	**Sep-99**	$ 260 226,80	$ 250 616,33	$ 268 893,08	$ 260 226,80
130	**Oct-99**	$ 230 912,95	$ 220 601,05	$ 236 294,67	$ 230 912,95
131	**Nov-99**	$ 198 544,33	$ 188 141,65	$ 201 183,89	$ 198 544,33
132	**Dec-99**	$ 215 650,45	$ 205 551,94	$ 220 070,67	$ 215 650,45

The Standard vessel with speed flexibility (Colum 5) steams 14.0 knots laden / 13.5 knots in ballast in the period Pre – 1997, and 13.5 knots laden / 14.5 knots in ballast in the period 1997 – 2003.

133	**Jan-00**	$ 237 878,42	$ 227 885,25	$ 244 237,34	$ 237 878,42
134	**Feb-00**	$ 306 800,01	$ 296 456,86	$ 318 294,79	$ 306 800,01
135	**Mar-00**	$ 277 826,23	$ 266 634,93	$ 285 874,19	$ 277 826,23
136	**Apr-00**	$ 286 204,35	$ 276 759,18	$ 297 190,97	$ 286 204,35
137	**May-00**	$ 317 057,83	$ 307 627,11	$ 330 564,99	$ 317 057,83
138	**Jun-00**	$ 301 199,17	$ 290 594,38	$ 311 901,26	$ 301 199,17
139	**Jul-00**	$ 329 240,64	$ 319 578,31	$ 343 435,99	$ 329 240,64
140	**Aug-00**	$ 363 148,40	$ 353 598,89	$ 380 239,23	$ 363 148,40
141	**Sep-00**	$ 387 412,14	$ 376 430,66	$ 404 617,64	$ 387 412,14
142	**Oct-00**	$ 420 937,13	$ 409 691,01	$ 440 518,69	$ 420 937,13
143	**Nov-00**	$ 460 559,14	$ 450 122,71	$ 484 401,19	$ 460 559,14
144	**Dec-00**	$ 684 093,29	$ 675 332,93	$ 728 229,86	$ 684 093,29
145	**Jan-01**	$ 674 143,67	$ 666 114,67	$ 718 419,74	$ 674 143,67
146	**Feb-01**	$ 547 891,56	$ 539 723,24	$ 581 749,88	$ 547 891,56
147	**Mar-01**	$ 403 800,29	$ 395 835,58	$ 426 238,05	$ 403 800,29
148	**Apr-01**	$ 415 639,20	$ 407 972,01	$ 439 421,90	$ 415 639,20
149	**May-01**	$ 449 073,92	$ 441 165,58	$ 475 255,74	$ 449 073,92
150	**Jun-01**	$ 397 812,72	$ 390 014,62	$ 419 980,53	$ 397 812,72
151	**Jul-01**	$ 286 254,16	$ 278 728,40	$ 299 728,32	$ 286 254,16
152	**Aug-01**	$ 280 190,30	$ 272 264,75	$ 292 655,47	$ 280 190,30
153	**Sep-01**	$ 290 666,82	$ 282 547,68	$ 303 731,02	$ 290 666,82
154	**Oct-01**	$ 288 933,79	$ 282 067,96	$ 303 479,12	$ 288 933,79
155	**Nov-01**	$ 253 228,21	$ 246 947,70	$ 265 635,59	$ 253 228,21
156	**Dec-01**	$ 217 386,40	$ 211 022,03	$ 226 778,95	$ 217 386,40
157	**Jan-02**	$ 201 374,48	$ 195 036,32	$ 209 502,57	$ 201 374,48
158	**Feb-02**	$ 192 876,95	$ 186 693,26	$ 200 515,86	$ 192 876,95
159	**Mar-02**	$ 199 420,73	$ 192 303,76	$ 206 382,70	$ 199 420,73
160	**Apr-02**	$ 246 345,72	$ 238 421,62	$ 256 068,40	$ 246 345,72
161	**May-02**	$ 235 631,29	$ 227 504,14	$ 244 222,44	$ 235 631,29
162	**Jun-02**	$ 216 146,14	$ 208 426,92	$ 223 685,09	$ 216 146,14
163	**Jul-02**	$ 213 335,62	$ 205 252,87	$ 220 176,31	$ 213 335,62
164	**Aug-02**	$ 194 612,02	$ 186 448,10	$ 199 829,43	$ 194 612,02
165	**Sep-02**	$ 161 555,36	$ 152 618,23	$ 163 091,83	$ 161 555,36
166	**Oct-02**	$ 167 586,10	$ 159 148,56	$ 170 258,00	$ 167 586,10
167	**Nov-02**	$ 208 831,86	$ 202 003,18	$ 216 929,97	$ 208 831,86
168	**Dec-02**	$ 266 062,93	$ 258 809,83	$ 278 252,63	$ 266 062,93
169	**Jan-03**	$ 269 411,37	$ 260 167,03	$ 279 296,14	$ 269 411,37
170	**Feb-03**	$ 357 526,19	$ 348 348,76	$ 374 642,56	$ 357 526,19
171	**Mar-03**	$ 457 242,87	$ 449 586,88	$ 484 413,60	$ 457 242,87
172	**Apr-03**	$ 347 644,88	$ 341 159,49	$ 367 443,20	$ 347 644,88
173	**May-03**	$ 261 921,20	$ 254 895,64	$ 274 069,47	$ 261 921,20
174	**Jun-03**	$ 214 924,31	$ 207 484,14	$ 222 725,26	$ 214 924,31
175	**Jul-03**	$ 220 337,33	$ 211 819,14	$ 227 182,36	$ 220 337,33
176	**Aug-03**	$ 260 076,88	$ 252 197,32	$ 270 970,61	$ 260 076,88
177	**Sep-03**	$ 233 139,69	$ 225 934,94	$ 242 722,28	$ 233 139,69
178	**Oct-03**	$ 216 606,22	$ 209 257,89	$ 224 662,37	$ 216 606,22
179	**Nov-03**	$ 258 835,79	$ 251 392,86	$ 270 193,84	$ 258 835,79
180	**Dec-03**	$ 311 294,71	$ 1 047 656,78	$ 1 070 920,98	$ 311 294,71

The Standard vessel with speed flexibility (Colum 5) steams 13.5 knots laden / 14.5 knots in ballast in the period 1997 – 2003. The Standard vessel with or without the speed flex is scrapped at end of period 180 ("December 2013").

181	**Jan-04**	$ 373 160,09			$ 373 160,09
182	**Feb-04**	$ 450 637,29			$ 450 637,29
183	**Mar-04**	$ 381 742,21			$ 381 742,21
184	**Apr-04**	$ 223 578,41			$ 223 578,41
185	**May-04**	$ 245 895,26			$ 245 895,26
186	**Jun-04**	$ 322 802,42			$ 322 802,42
187	**Jul-04**	$ 233 214,17			$ 233 214,17
188	**Aug-04**	$ 209 726,34			$ 209 726,34
189	**Sep-04**	$ 237 060,65			$ 237 060,65
190	**Oct-04**	$ 292 852,28			$ 292 852,28
191	**Nov-04**	$ 426 852,42			$ 426 852,42
192	**Dec-04**	$ 366 296,45			$ 366 296,45
193	**Jan-05**	$ 341 311,90			$ 341 311,90
194	**Feb-05**	$ 296 416,13			$ 296 416,13
195	**Mar-05**	$ 319 005,38			$ 319 005,38
196	**Apr-05**	$ 295 331,39			$ 295 331,39
197	**May-05**	$ 272 786,42			$ 272 786,42
198	**Jun-05**	$ 270 253,20			$ 270 253,20
199	**Jul-05**	$ 231 694,67			$ 231 694,67
200	**Aug-05**	$ 196 784,89			$ 196 784,89
201	**Sep-05**	$ 393 808,64			$ 393 808,64
202	**Oct-05**	$ 390 452,37			$ 390 452,37
203	**Nov-05**	$ 271 290,40			$ 271 290,40
204	**Dec-05**	$ 271 004,43			$ 271 004,43
205	**Jan-06**	$ 309 808,69			$ 309 808,69
206	**Feb-06**	$ 245 370,73			$ 245 370,73
207	**Mar-06**	$ 219 947,78			$ 219 947,78
208	**Apr-06**	$ 223 745,77			$ 223 745,77
209	**May-06**	$ 211 521,83			$ 211 521,83
210	**Jun-06**	$ 216 321,11			$ 216 321,11
211	**Jul-06**	$ 269 084,75			$ 269 084,75
212	**Aug-06**	$ 237 754,59			$ 237 754,59
213	**Sep-06**	$ 179 381,81			$ 179 381,81
214	**Oct-06**	$ 172 311,58			$ 172 311,58
215	**Nov-06**	$ 156 179,20			$ 156 179,20
216	**Dec-06**	$ 247 150,49			$ 247 150,49
217	**Jan-07**	$ 180 921,81			$ 180 921,81
218	**Feb-07**	$ 200 692,02			$ 200 692,02
219	**Mar-07**	$ 262 136,22			$ 262 136,22
220	**Apr-07**	$ 240 311,43			$ 240 311,43
221	**May-07**	$ 233 423,09			$ 233 423,09
222	**Jun-07**	$ 210 648,24			$ 210 648,24
223	**Jul-07**	$ 155 916,95			$ 155 916,95
224	**Aug-07**	$ 116 401,48			$ 116 401,48
225	**Sep-07**	$ 115 357,55			$ 115 357,55
226	**Oct-07**	$ 120 723,09			$ 120 723,09
227	**Nov-07**	$ 166 693,45			$ 166 693,45
228	**Dec-07**	$ 144 182,64			$ 144 182,64

229	**Jan-08**	$ 148 697,44			$ 148 697,44
230	**Feb-08**	$ 140 292,07			$ 140 292,07
231	**Mar-08**	$ 141 949,17			$ 141 949,17
232	**Apr-08**	$ 175 634,69			$ 175 634,69
233	**May-08**	$ 201 098,30			$ 201 098,30
234	**Jun-08**	$ 219 922,94			$ 219 922,94
235	**Jul-08**	$ 166 213,03			$ 166 213,03
236	**Aug-08**	$ 175 673,31			$ 175 673,31
237	**Sep-08**	$ 186 203,63			$ 186 203,63
238	**Oct-08**	$ 110 531,49			$ 110 531,49
239	**Nov-08**	$ 99 796,25			$ 99 796,25
240	**Dec-08**	$ 106 906,66			$ 106 906,66
241	**Jan-09**	$ 67 567,82			$ 67 567,82
242	**Feb-09**	$ 62 467,62			$ 62 467,62
243	**Mar-09**	$ 34 186,71			$ 34 186,71
244	**Apr-09**	$ 22 370,61			$ 22 370,61
245	**May-09**	$ 52 016,80			$ 52 016,80
246	**Jun-09**	$ 33 351,88			$ 33 351,88
247	**Jul-09**	$ 35 280,85			$ 35 280,85
248	**Aug-09**	$ 25 381,14			$ 25 381,14
249	**Sep-09**	$ 26 005,95			$ 26 005,95
250	**Oct-09**	$ 23 399,77			$ 23 399,77
251	**Nov-09**	$ 24 764,63			$ 24 764,63
252	**Dec-09**	$ 42 567,31			$ 42 567,31
253	**Jan-10**	$ 83 251,78			$ 83 251,78
254	**Feb-10**	$ 78 691,60			$ 78 691,60
255	**Mar-10**	$ 70 232,76			$ 70 232,76
256	**Apr-10**	$ 66 504,63			$ 66 504,63
257	**May-10**	$ 60 567,83			$ 60 567,83
258	**Jun-10**	$ 60 975,76			$ 60 975,76
259	**Jul-10**	$ 84 114,45			$ 84 114,45
260	**Aug-10**	$ 54 254,64			$ 54 254,64
261	**Sep-10**	$ 49 875,62			$ 49 875,62
262	**Oct-10**	$ 46 038,59			$ 46 038,59
263	**Nov-10**	$ 48 893,00			$ 48 893,00
264	**Dec-10**	$ 72 336,99			$ 72 336,99
265	**Jan-11**	$ 47 597,53			$ 47 597,53
266	**Feb-11**	$ 47 528,22			$ 47 528,22
267	**Mar-11**	$ 74 152,01			$ 74 152,01
268	**Apr-11**	$ 80 640,90			$ 80 640,90
269	**May-11**	$ 65 556,21			$ 65 556,21
270	**Jun-11**	$ 50 757,31			$ 50 757,31
271	**Jul-11**	$ 43 442,35			$ 43 442,35
272	**Aug-11**	$ 42 729,02			$ 42 729,02
273	**Sep-11**	$ 42 036,16			$ 42 036,16
274	**Oct-11**	$ 45 213,43			$ 45 213,43
275	**Nov-11**	$ 44 350,99			$ 44 350,99
276	**Dec-11**	$ 67 210,82			$ 67 210,82

277	**Jan-12**	$ 43 511,16			$ 43 511,16
278	**Feb-12**	$ 47 103,92			$ 47 103,92
279	**Mar-12**	$ 39 056,30			$ 39 056,30
280	**Apr-12**	$ 33 179,94			$ 33 179,94
281	**May-12**	$ 37 441,68			$ 37 441,68
282	**Jun-12**	$ 27 708,05			$ 27 708,05
283	**Jul-12**	$ 15 054,33			$ 15 054,33
284	**Aug-12**	$ 24 303,53			$ 24 303,53
285	**Sep-12**	$ 31 492,34			$ 31 492,34
286	**Oct-12**	$ 26 248,04			$ 26 248,04
287	**Nov-12**	$ 29 941,75			$ 29 941,75
288	**Dec-12**	$ 40 567,10			$ 40 567,10
289	**Jan-13**	$ 45 851,17			$ 45 851,17
290	**Feb-13**	$ 47 008,05			$ 47 008,05
291	**Mar-13**	$ 36 914,14			$ 36 914,14
292	**Apr-13**	$ 38 286,51			$ 38 286,51
293	**May-13**	$ 35 782,92			$ 35 782,92
294	**Jun-13**	$ 23 648,83			$ 23 648,83
295	**Jul-13**	$ 28 775,74			$ 28 775,74
296	**Aug-13**	$ 22 936,35			$ 22 936,35
297	**Sep-13**	$ 13 709,68			$ 13 709,68
298	**Oct-13**	$ 3 480,23			$ 3 480,23
299	**Nov-13**	$ 7 676,50			$ 7 676,50
300	**Dec-13**	$ 288 322,90			$ 288 322,90
Net Present Value		**$ 64 288 586,07**	**$ 64 222 001,78**	**$ 68 915 140,37**	**$ 69 788 586,07**

Table 4 shows the various present values when using historical spot rates and historical bunker costs dated from January 1989 – December 2013, where January 1989 is the first period (month). Sum of all PVs equals the various net present values.

Colum 1 presents the period. Colum 2 presents historical month used. Colum 3 presents the Eco-design vessel priced at $36.5m. Colum 4 presents the Standard vessel steaming 13,5 knots laden and 12,0 knots in ballast. Colum 5 presents the Standard vessel steaming based on historical knots for the TC2_37 route. Colum 6 presents the Eco-design vessel priced at reported “booking” price, $31.0m

Please contact the author on ole@skulandolsen.no for requests of all calculations.