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Investment Analysis of the Framo Cargo Pumping System

Erling Hekland Teigland

Supervisor: Siri Pettersen Strandenes

Master in International Business

NORWEGIAN SCHOOL OF ECONOMICS

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Abstract

This paper looks into whether or not it can be profitable for a shipping company operating in the product tanker segment, to change from a steam driven cargo pumping system to a hydraulic cargo pumping system by Frank Mohn AS. By looking at two triangulation scenarios, one between the U.S. and Europe transporting dirty products and the other between the U.S. and Asia transporting both dirty and clean products, I have been able to show that there are both market factors such as economical, political and technological, as well as the vessel speed and bunker price influencing the profitability for the different route alternatives. In order to make the results as realistic as possible, I have used three different variables; vessel speed, bunkers price, and investment cost. The methods used to estimate whether the investment is sound or not, is the discounted cash flow (DCF) model and the adjusted present value (APV) model. In addition to the main scenarios, I have also looked at the profitability of the first route, without the use of triangulation, in order to find out whether the use of triangulation is an important factor for the profitability of the pumping system. I have also looked into which factors that might impede on the trade for the two triangulation routes in the future, by use of the PESTLE analysis.

The two analyses show that the new cargo pumping system will be profitable with the use of triangulation and the competitive advantage of quite easily switching from dirty to clean cargo. There are however some market conditions one have to keep in mind; for the first route, it is important to not forget that the U.S. are getting less dependent on foreign oil, as a result of their own increasing production. For the second route, one have to keep in mind the changing economical and political situations in the concerned countries. With these conditions in mind, one would be hard pressed to not see the potential profit from the new cargo pumping system.

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Background

I got the first idea for this paper, during a summer job working for Kristian Gerhard Jebsens Skipsrederi AS. They are the last company in the world still using the once very popular Oil-Bulk-Ore carriers, a vessel designed for triangulation. My initial idea was to look into whether these vessels might become popular again, however after some research, I realized that this would be difficult, due to the lack of data available. But the triangulation concept still intrigued me, and after discussing the data challenge with Alf Utvær at Frank Mohn AS, I developed the idea for a new research question that would let me write about triangulation, and at the same time far more relevant for a larger part of the shipping industry. Thus my main research question became: Is substitution to a new hydraulic cargo pump system economic viable for the shipowners of Long Range 2 product tankers? Are there other factors beside the new technology, which play an important role in the profitability of the system? And finally, do the use of triangulation play an important role in the profitability of the investment?

Structure

The structure of this paper is as follows. First I conduct a presentation of the shipping markets, the technology of the hydraulic cargo pump system and triangulation. This will hopefully give the reader a basic understanding of the shipping industry and important elements of this research. Then I will describe the different methods used, before I start looking into the markets in the scenarios, starting off with the route between the U.S. and Europe, and then end with the route between the U.S. and Asia.

Next up I will talk about how I came up with the different inputs used in the investment analysis and show some of the results the analysis of the different routes gave me.

I will round up with a conclusion and a summary of my most important findings.

1. Presentation of the Markets, the technology and triangulation

1.1 The shipping markets

The shipping industry comprises four different but closely linked markets. Sea transport services are dealt in the spot freight market and the time charter market, new ships are ordered and built in the new building market, used ships are traded in the second-hand market, and old or obsolete ships are scrapped in the demolition market. The interactions of buyers and sellers of these four markets determine the prices. We can further categorize these markets in real and auxiliary markets. The spot freight market and the new building and scrapping market are real markets as their activities affect the market clearing prices for transport services and transport capacity respectively. While the time charter market and the second-hand market are auxiliary markets, as their transactions do not change existing shipping capacity.

The spot freight market is a place where buyers and sellers are brought together to trade sea transport services. As previously mentioned, the interaction between the supply and demand of shipping services determines the freight rate. Due to the derived demand, demand for sea tanker shipping services depends on seaborne trade volume. On the other hand, supply of shipping service is inelastic in the short run. Excessive supply of shipping capacity not only causes reduction in freight rate but also extra costs to lay up ships. On the other hand, shortage in ships leads to an increase in freight rate to motivate shipping firms for adjusting their shipping capacity.

The new building market and the freight market are positively correlated, however usually with a time lag, due to the time it takes to build a ship. Shipping firms order new ships to expand their fleet sizes during a freight boom. In the tanker shipping industry, the demand for new vessels reflects the need for shipping capacity. An increase in orders of new builds, indicate that ship owners expects the freight rates to increase in the near future, as there is a 2-4 years delay between ordering a new vessel and delivery.
From the perspective of business operations, prices of new building ships have a stabilizing effect in tanker shipping. When the demand for shipping services increase the freight rate increases, and thus shipping firms orders new ships in order to increase their capacity. The increase in orders of new builds will in turn increase the prices in the shipbuilding market, and hence the capital costs of shipping firms' increase. Such rise in the prices of new ships could be seen as a "stabilizer" to set a barrier for shipping firms for excessive profit.

The second-hand market can, as mentioned, be categorized as an auxiliary market, as the buying and selling of used ships are unlikely to alter the existing number of ships and the carrying capability in the tanker shipping market. The sales and purchase market facilitates the entry of shipping firms to the shipping market as shipping firms may acquire ships to a lower capital cost than in the new-build market. Further more the second-hand market allows for easier exit and restructuring of the fleet in response to the changing demand. As the demand for second-hand ships increase during a freight boom, the second-hand market is also closely linked with the freight market. At the time of high freight rate, demand for second-hand ships are high as shipping firms can deploy these ships to earn higher than normal profit. And as such the price of second-hand vessels increases with the increase of the freight rate, and decreases with the decrease of the freight rate.

The demolition market is the last of the four closely linked markets, and as the new buildings market, its activity determine the tanker shipping capacity. With exception of old ships that are unable to meet the safety requirements and regulations, the scrapping decision made by ship owners depends on expected financial return from scrapping the shipping and the future freight rate. The activity in the scrapping market is as such linked to the second-hand market. If the freight rate is high, during a boom, a ship owner might keep the vessel to increase profits or sell the vessel in the second-hand market, and if the prices in the second-hand market are low, he might choose to scrap it instead, especially if the scrapping prices are high, due to increased demand for steel. (Lun, et al. 2013)

1.2 The tanker market

The oil trade accounted for about 27.5% of the total world seaborne trade in 2013. We can mainly divide the vessels transporting oil, into two categories, crude tankers and product tankers, where the crude tankers accounts for 18% of the world trade and the product tankers accounts for 9.5%. (Clarksons Research Services 2014)The crude tankers are mainly used for the deep-sea transportation of unrefined oil from extraction locations to the refineries, and range in size from 55,000 dwt to 550,000 dwt. The main trading routes are from the production areas in the Arabian Gulf and West Africa, to Asia, USA and Europe. While the product tankers transport refined oil products such as gasoline, kerosene, diesel, jet or fuel oil to consuming markets. They range in size from around 10,000 dwt to around 160,000 dwt, and one of the traditional trading routes are between North America and Europe, carrying gasoline to the US and diesel fuel back to Europe. We can categorize the tankers after size, General Purpose (10,000-25,000 dwt), Medium Range, MR (25,000-45,000 dwt), Long Range 1, LR1 (45,000-80,000 dwt), Long Range 2, LR2 (80,000-160,000 dwt), Very Large Crude Carriers or VLCC (160,000-320,000 dwt) and Ultra Large Crude Carriers or ULCC (320,000-550,000 dwt). (Hamilton 2014)

Tanker shipping provides an economical and convenient way to transport wet bulk for international seaborne trade. It is the belief of many maritime economists that the supply of tanker shipping operates under perfect competition, characterized by several conditions. The first is the number of shipping service providers, there are a number of ship owners that own tankers that provide identical shipping services. The second characteristic is the availability of information, due to institutions such as the Baltic Index, shipping service providers are unable to manipulate the freight rate and as such the price. There are some entry and exit barriers, but these are mainly due to the cost of buying vessels in either the new building market or the second-hand market and losses due to sale of vessels in the second-hand market, and not due to marketing condition, as it does not exist in the tanker market. As for governmental restrictions, there are no restrictions on entry, but there is however some restrictions on quality, i.e. restriction on the use of heavy fuel oil (HFO) while in port in emission control areas (ECA). (IMO 2014)

The price level (i.e., freight rate) in tanker shipping is influenced by the supply of shipping service and the demand for shipping service. The supply of shipping service is determined by the fleet size in terms of dwt, and the demand for shipping service depends on consumption levels of refined oil products. (Lun, et al. 2013)

1.3 Vessel type

Product tankers are built to transport refined oil products from the oil refinery to another refinery or the end user. The product tanker can carry both clean and dirty products, giving them a trading flexibility across both clean and dirty petroleum markets. However due to strict regulations switching from dirty to clean, the cargo tanks needs a thorough cleaning before switching to clean products. They are characterized by having coated tanks to prevent corrosion and to facilitate the cleaning of the tanks. The product tankers are classified in segments according to vessel size, most commonly divided into the Long Range 2 (LR2), Long Range 1 (LR1) and Medium Range (MR).

The MR ranges in size from 25,000 to 45,000 dwt, while the LR1 ranges in size from 45,000 to 80,000 dwt. The (LR2), often referred to as a “coated Aframax”, due to its abilities to carry

an array of refined crude products which require special handling, ranges in size from 80,000 to 160,000 dwt and is as such the largest specialized petroleum product tanker. (Hamilton 2014)
The LR2 tankers usually transport clean products on the long distances from the Middle East to countries in Asia or Northern Europe, and dirty products on the long or intermediate distances out of the Black Sea to the Mediterranean or to the USA, or from the Baltic or the North Sea to Northern Europe or the USA.
(Taurus Tankers Ltd. 2011) (Danish Ship Finance A/S 2012)

1.4 Pump technology

The new pump technology from Framo AS, hydraulically driven submerged cargo pumps, provide a safe, efficient and flexible cargo handling of any type of wet cargo. This new and improved cargo handling performance gives a quicker turnaround time, which results in more ton-miles. With the new technology one can transport a petroleum product on one voyage, and then transport an acid on the next, making it possible to obtain triangulation opportunities for a product tanker, and as such reduce time in ballast.
The Framo cargo pump is a vertical single stage centrifugal pump powered by a hydraulic motor for safe and efficient operation. The pump design allows operation with a minimum of liquid in the tank, which saves time spent for drainage and tank cleaning, reducing port-time.

Further more, by combining the cargo pumps in each cargo tank with submerged ballast pumps inside the ballast tanks, the pump room becomes redundant. The arrangement provides a safer ship design and increases space available for cargo, as there is no need for a pump room anymore. In addition to this, it also consumes less fuel per discharge than its steam turbine driven counterpart. (Frank Mohn AS 2014)

1.5 Triangulation

Triangulation is a way for shipowners to reduce the time in ballast, for example by transporting gasoline from the U.S. gulf to Brazil, and after unloading it can sail up to Venezuela, to load road fuel bound for the U.S. Atlantic Coast. Then after unloading sail back to the U.S. gulf, to load diesel for Europe, returning to the U.S. Atlantic Coast with gasoline. By using triangulation, one can increase a ship's utilization rate and boost earnings.
(Overseas Shipholding Group, Inc. 2009)
According to Pareto's shipping outlook from 2013, we now see a change in the tanker market. In the past, the oil refineries were often situated quite far away from the oil reserves, creating

a market for the crude oil tankers, and the refineries were closer to the end users, creating a good market for the MR product carriers. However in the last couple of years we have seen a trend, that the refineries are built closer to the oil reserves, thus reducing the need for crude oil tankers, while creating a market for the larger product carriers like LR2. There has also been a change in the transport pattern, as the U.S. oil production increases, lessening the demand for imports of oil products from Europe. Further more it is expected that the product trade from the Middle East to Asia will grow rapidly going forward, despite increasing refinery capacity in India and China, as the expected demand of products to be used as power sources for domestic households will increase with more than what the local refineries are able to produce, due to an increased urban population. (EIA 2014) (Pareto Shipping AS 2013) (BIMCO 2013)

2. Methodology

2.1 PESTLE

The market changes everyday, and in a matter of seconds the scenario before us may have changed. Some of these changes are controllable, however there is also some we cannot control, these are called systematic factors. Systematic things happen in the environment that surrounds us, and very often they influence our agenda. It is as a result of this, that we need to constantly check and analyse the environment in which we operate. A detailed analysis of the macro-environment is called PESTLE analysis. The analysis consists of factors, Political, Economic, Social, Technical, Legal and Environmental, which directly or indirectly affect the business environment. The PESTLE analysis is used as a tool for the managers and strategists to ascertain the current market situation and what the future might look like.

Political

Political factors take into account the political situation of a country and the world in relation to the country. All of the policies, tax laws, and every tariff that a government levies over a trade fall under this category of factors.

Economic

These factors include all the determinants of an economy and its condition. The inflation rate, the interest rates, monetary or fiscal policies, the foreign exchange rates that affect imports and exports, all these determine the direction in which an economy might move.

Social

As every country differs, and the importance of cultural understanding becomes more and more important in this global world, it is important to look at the social aspect as well. Especially since the social factors like social lifestyle, domestic structures and connected demographics influences the market.

Technological

Technology has always and will always influence the business world, take for example the assembly line technique and how it revolutionised the manufacturing industry at the beginning of the 20th century. This is also why technology is one of the factors in the Pestle analysis. If one is not up-to-date on new relevant technology, one might end up losing income compared to competitors with the new technology. Another reason of analysing the technological factor is to understand how consumers react to technological trends and how to utilize them for their benefit.

Legal

Legislative changes occur from time to time and many of them affect the business-environment. For example in 1992 MARPOL was amended to make it mandatory for tankers of 5,000 dwt and more ordered after 6th of July 1993 to be fitted with double hulls, or an alternative design approved by IMO (regulation 19 in Annex 1 of MARPOL). (International Maritime Organisation 2014) The law had an impact on most of the businesses in the tank industry, and regulations in other industries have a similar impact, making it important for businesses to analyse the legal development happening in their environment.

Environmental

Environmental factors also have a tendency to influence the business, and especially how we do things in an industry. For example, due to the climate changes happening, there have been an increased focus on clean energy, which have a potential to reduce the demand of coal, which will lead to reduced coal prices and a slow down in the coal industry. The environmental factors include geographical location, the climate, weather and other such factors that are not just limited to climatic conditions like the wildlife and other factors. (Constantinides 2011)

2.2 Discounted Cash Flow (DCF)

The Discounted Cash Flow (DCF) Analysis is a method used to value an asset using the time value of money to determine expected cash flows in the future. Based on these future cash flows, given in their present value, one is able to determine the value of the asset in question. The DCF Analysis is widely used to value companies, real estate development, and internal corporate projects. In the analysis, the present value of a company is the sum of the present value of all future cash flows plus the terminal value of assets.

The advantage of the DCF Analysis is that it is often the soundest method of valuations, due to its usage of a number of intrinsic and external factors to determine the value of an asset. Because of the focus on future cash flow generation, it is less affected by accounting practices and assumptions, as well as historical financial results. And last but not least, it allows for greater flexibility, as the DCF analysis allows different components of a business to be valued separately, therefore factors impacting isolated parts of a business can be assessed independently.

The disadvantage of the DCF analysis that the accuracy of the method varies with the factors and assumptions used. For example the accuracy of the estimates for the cash flow forecasts, choice of discount rates and the growth rates will all have a significant impact on the accuracy of the DCF analysis. Further more due to the market fluctuations, the assumptions will also vary, leading fluctuations in Net Present Value of future cash flows as the assumptions changes.

The mathematic formula of the DCF model:

$$DCF = \sum_{Y=0}^{N} \frac{FCF_Y}{(1+R)^Y} = \frac{FCF_1}{(1+R)^1} + \frac{FCF_2}{(1+R)^2} + \cdots + \frac{FCF_Y}{(1+R)^Y}$$

Where:

DCF = Net Present Value (NPV) of all future cash flows

FCF_Y = Future cash flows in year Y

R = The current discount rate, often based on Weighted Average Cost of Capital (WACC), reflects the cost of tying up capital and may also allow for the risk or the payment not being received in full

N = Number of years

Since we cannot estimate cash flows forever, we generally impose closure in discounted cash flow valuation by stopping the estimation of cash flows sometime in the future and then computing a terminal value that reflects the value of the firm at that point. Thus we can use this formula to find the value of the firm:

$$\sum_{Y=0}^{N} \frac{FCF_Y}{(1+R)^Y} + \frac{Terminal\ Value_Y}{(1+R)^Y}$$

Where:

The formula for terminal value is:

$$\frac{FCF_{Y+1}}{(R-g)}$$

Where:

FCF_{Y+1}= Future cash flow in year Y+1

R = The current discount rate (often based on WACC)

g = The growth rate

Since we already have assumed that the cash flows will grow at a constant rate, we can use the formula of compounded annual growth rate to find the expected growth rate needed in the terminal value formula:

$$g = CAGR = \sqrt[N]{\left(\frac{Ending\ Value}{Beginning\ Value}\right)} - 1$$

Where:

N = Number of years

WACC

The weighted average cost of capital (WACC) represents the opportunity cost that investors face for investing their funds in one particular business instead of others with similar risk. The most important principle underlying successful implementation of the cost of capital is consistency between the components of the WACC and free cash flow. In its simplest form the weighted average cost of capital equals the weighted average of the after-tax cost of debt and cost of equity:

$$WACC = \frac{E}{V}k_e + \frac{D}{V}k_d(1 - T_m)$$

Where:

E/V = Target level of equity (E) to enterprise value (V) using market-based values

D/V = Target level of debt (D) to enterprise value (V) using market-based values
k_e = Cost of equity
k_d = Cost of debt
T_m = Company's marginal income tax rate

In order to determine the WACC for a particular project or enterprise, one need to estimate the three components of WACC; the cost of equity, the after-tax cost of debt, and the project's/company's target capital structure.
The cost of equity is again determined by three components; the risk-free rate of return, the market-wide risk premium (the expected return of the market portfolio less the return of risk-free bonds), and a risk adjustment that reflects each company's riskiness relative to the average company. We can use the capital asset pricing model (CAPM) to estimate the cost of equity.

The capital asset pricing model (CAPM) says that the expected return on a portfolio should exceed the risk-free rate of return by an amount that is proportional to the portfolio beta. That is, the relationship between return and risk should be linear. (Modigliani and Pogue 1974)

$$E(R_i) = r_f + \beta_i\left[E(R_m) - r_f\right]$$

Where:
$E(R_i)$ = Expected return of security i
r_f = Risk-free rate
β_i = Stock's sensitivity to the market
$E(R_m)$ = Expected return of the market

In the CAPM, the risk-free rate and market premium, defined as the difference between $E(R_m)$ and r_f, are common to all companies; only beta varies across companies. The beta represents a stock's incremental risk to a diversified investor, where risk is defined as the extent to which the stock covaries with the aggregate stock market.
In order to estimate the beta, we can use the theories of Modigliani and Miller, according to them; the weighted average risk of a company's financial claims equals the weighted average risk of a company's economic assets. Using the beta to represent risk and rearrange the equation to solve for the beta of equity (β_e), we get:

$$\beta_e = \beta_u + \frac{D}{E}(\beta_u - \beta_d) - \frac{V_{txa}}{E}(\beta_u - \beta_{txa})$$

Where:

β_u = The beta of the unlevered company

β_d = The beta of debt

V_{txa} = The value of the company's interest tax shields

β_{txa} = The beta of the tax shields

In order to simplify this even further, we can use two additional restrictions; (1) due to the fact that debt claims have priority, the beta of debt tends to be low, and thus we can for simplicity assume it is 0. (2) If the company maintains a constant capital structure, the value of the tax shields will fluctuate with the value of operating assets, and the beta of the tax shields will equal the beta of the unlevered company. By setting these two components equal to each other, we eliminate the final part of the formula and end up with:

$$\beta_e = \beta_u + \left(1 + \frac{D}{E}\right)$$

As a result we get that the company's equity beta equals the company's unlevered beta times a leverage factor.

In order to estimate the cost of debt we can use the yield to maturity of the company's long term, option-free bonds. This method is however only useful if the company's debt rating is not lower than BBB. The use of a debt rating lower than BBB or so called junk bonds, will overstate the true cost of capital and as such paint a wrong picture of the company. Thus if the debt rating is lower than BBB, one should not use the WACC at all, but rather the adjusted present value (APV) based on the unlevered cost of equity rather than the WACC to value the company. (Koller, Goedhart and Wessels, Valuation Measuring and Managing the Value of Companies 2010)

2.3 Adjusted Present Value (APV)

When doing a DCF analysis, we assume that the company manages its capital structure to a target debt-to-value ratio. However, suppose the company we are analysing have a high proportion of debt, and pays it down as cash flow improves, lowering their future debt-to-value ratios. In this case the use of WACC would overstate the value of the tax shields, unless one adjust the WACC yearly in order to handle the changing capital structure. This is

however a complex process, which is why we use an alternative model, the adjusted present value (APV).
The adjusted present value separates the value of operations into three components: the value of operations as if the company were all-equity financed, the value of tax shields that arise from debt financing and the value of distress costs. (Koller, Goedhart and Wessels 2010)

The first step is the estimation of the value of the unlevered firm. In this step we value the firm as if it was all-equity financed, by discounting the expected free cash flow to the firm at the unlevered cost of equity. If we assume the cash flow to grow at a constant rate, the value of the firm is easily computed.
Value of Unlevered Firm:

$$\frac{FCFF_0 \times (1+g)}{k_u - g}$$

Where:
$FCFF_0$ = The current after-tax operating cash flow to the firm
k_u = The unlevered cost of equity
g = The expected growth rate (see CAGR in 2.2.)
In order to find the unlevered cost of equity, we first need to find the unlevered beta of equity. We can find the unlevered beta of equity, by reformulating the formula we used in the DCF analysis to compute the beta of equity:

$$\beta_u = \beta_e / \left(1 + \frac{D}{E}\right)$$

Where:
β_u = The unlevered beta of equity
β_e = The beta of equity
D/E = The debt/equity ratio
We can then use the CAPM to estimate the unlevered cost of equity, the same way we did in the DCF analysis, just using the unlevered beta of equity instead of the beta of equity.

If we assume that the tax rate will be constant over time, we can find the value of the tax shield by multiplying the marginal tax rate with the value of the debt.
Value of the tax shield:

$$t_c \times D$$

Where:

t_c = The marginal tax rate
D = The value of the debt

The third and last part of the APV, the distress costs, poses the most significant estimation problem, since neither the probability of bankruptcy nor the cost of bankruptcy can be estimated directly. We can divide the distress costs into two parts the probability of bankruptcy and the costs of bankruptcy. One-way of estimating the probability of bankruptcy is to estimate a bond rating, at each level of debt and use the empirical estimates of bankruptcy probabilities for each rating. For instance, the table underneath, extracted from a study by Altman and Ramayanam, summarizes the probability of bankruptcy over ten years by bond rating class in 2007 (Appendix XX). (Altman 2007)

The cost of bankruptcy can be estimated, according to Andrade and Kaplan (1998), by the use of this relationship:

$$EV_0 - L_V = B_D + B_I$$

Where EV_0 is the value of the firm before onset of financial distress, L_V the value of the liquidated assets, B_D is the direct costs of bankruptcy (such as court-related fees) and B_I is the indirect costs of bankruptcy (such as the loss of customers and suppliers). In this case, we do not need to split the cost of bankruptcy into the indirect and direct costs of bankruptcy, which make the estimation a bit easier. By rearranging the formula above, we get

$$B = EV_0 - L_V$$

Thus, we have an expression for the costs of bankruptcy that can be used for estimation purposes. Values of the liquidated assets can be found by looking at the net asset value in the bankruptcy files. The enterprise value can be found by calculating the market capitalization and then add the book value of net debt. We can further find the cost of bankruptcy ratio by dividing the cost of bankruptcy on the enterprise value. (Andrade and Kaplan 1998)

Once we have calculated the cost of bankruptcy ratio and the probability of default, we can find the expected bankruptcy costs, by multiplying the two factors with the unlevered firm value.

The adjusted present value can now be calculated by taking the unlevered firm value, adding the present value of tax shields and subtracting the expected bankruptcy costs. (Damodaran 2005)

3. Analysis of the macro-environment

In the following, I will look at two scenarios of triangulation in the tanker market.
The first scenario uses a route that has been used quite frequently for several years and goes between the United States and Europe. The second scenario looks at a route between the U.S. South America and East Asia, an area that will become even more important as the refineries are moved closer to the oil wells, and due to the expected economic growth in this area.

I will first use the previously introduced PESTLE theory to analyse the industry factors in the product tanker market for each of the two scenarios, starting with the triangulation opportunity between the US and Europe. Following the strategic analysis, I will do an Investment Analysis for both scenarios using the new pump technology, to see whether the new technology makes the LR2 product tanker even more profitable than without the new technology.

3.1 Triangulation scenario 1

The first triangulation route goes from the U.S. Gulf to Europe with diesel, then from Europe to New Haven with gasoline, and the last leg, sail in ballast from New Haven to the U.S. Gulf. As previously mentioned and described, the PESTLE analysis are made up by six different factors: Political, Economical, Social, Technological, Legal and Environmental. This is also the same way I will structure my analysis, starting with the Political factor.

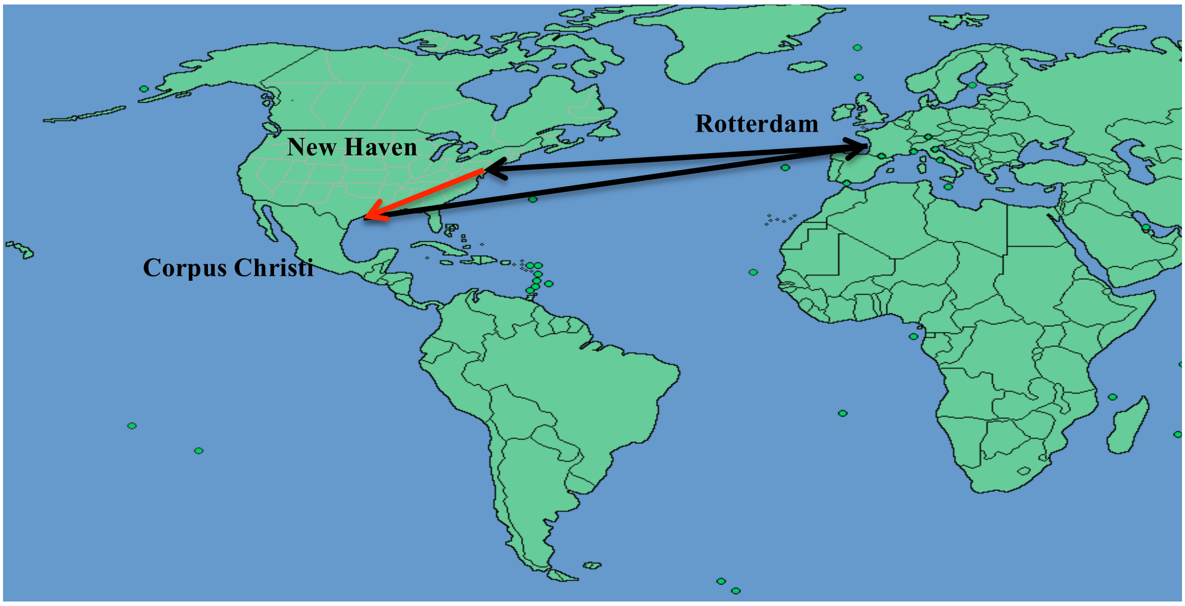

Figure 1: Triangulation Route 1

Political

Since the beginning of the 90's both the EU and the United States have been part of many large conflicts, from the war on Balkan to the war in Iraq. It would be quite logical to assume that these conflicts especially those in the middle east would have some influence on the oil price, and through that the price on diesel and gasoline.

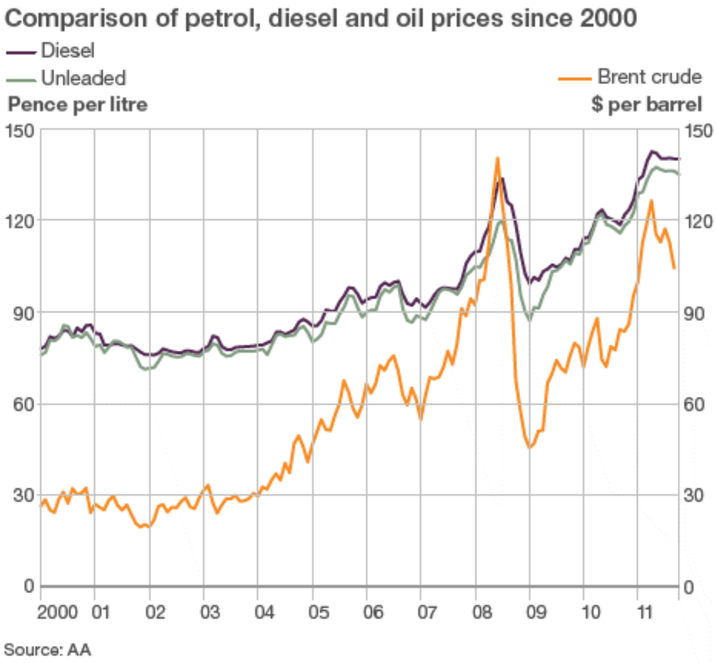

Figure 2: Oil price fluctuation (Anderson and Kahya 2011)

As we can see from the graph, the biggest fluctuation in the prices was not due to the conflicts, but due to the financial crisis in 2008/2009. This and an article, "Recent oil price fluctuations linked to world economy", by Professor Lutz Kilian at the University of Michigan, supports the theory that the economic environment is the most important factor when it comes to oil prices. (Kilian 2011)

Furthermore, the political environment in both the EU and the United States are relatively stable especially if we look at its impact on the diesel and gasoline trade between the two. There are of course some new regulations on the emission standards for diesel and gasoline, but nothing that cannot be handled by the refineries. In fact, as a result of the conflict in Ukraine, it looks like that the European Union are less focused on the environmental impact of how the oil is produced and more focused on being less dependent on Russian oil and gas. (Gallo 2014)

Economical

In the economic aspect of the product tanker trade between the US and the European Union, we can see from the graph above, that the recession did have some impact on the price per barrel. However, as the graph also clearly shows, the drop in price per barrel did not last, and already in 2011, were we back at the same level as before the recession. One reason for this quick recovery is probably the fiscal stimuli brought forward by both the Federal Reserve in the US and the ECB, the European Central Bank. The stimuli have ensured that companies have stayed afloat, investments are recovering and thus also the unemployment rate is reduced compared to the 2009 levels. Which again had a positive impact on the demand for diesel and gasoline as people can afford to drive their cars.

There are however some factors which might reduce the demand for gasoline in the US, and thus reducing the profitability of the triangulation between the US and the EU. Firstly, the increased oil production in the US, making them less dependent on oil product imports. Secondly, due to the recession, we have seen a shift from larger and less fuel-efficient vehicles, to smaller and more economical vehicles. In the future we might also see a reduction in demand for fuel, as the electric cars become more popular, however for the time being the decrease in operational cost for an electric car versus a conventional vehicle does not outweigh the difference in purchase cost. (Todd, Chen and Clogston 2013)

Social

When looking at the social aspect of the analysis there are few factors, if any that might have an impact on the trade between the US and EU. They are quite similar both culturally and when it comes to social lifestyle. The only factor the could have had some impact, would be that the inhabitants of the US used to use large vehicles, however in the last couple of years the carpool have become more and more alike, the one in Europe. Thus there is no need to focus on the social aspect when looking at the triangulation opportunity and product tanker trade between the US and the European Union.

Technological

Technologically there are some aspects that might have an impact on the trade. Firstly, the new tare sand technology, which already have increased and will further increase the oil production in the US, making them less dependent on oil and oil products from other countries. Secondly, as mentioned before, we have seen a shift to more fuel-efficient vehicles

in the US. This shift and the new hybrid and electric engine technology, will further lessen the demand for fuel. However, due to the power of the car industry in the US, it might take some time before we see the full effect of this change. According to an article written in Dagens Næringsliv, the governor of Michigan signed a bill that prohibits the worlds leading electric car manufacturer, Tesla, from selling their cars directly to the consumer, lessening their competition power against GM, Chrysler and Ford. (Hartwig 2014)
And last but not least, the new technology for product tankers, like for instance the new pump technology. The new technology have the potential to reduces port costs, and increase the amount of cargo carried, making it possible to transfer more to a lower cost. Which will have a positive effect in the long run, making the trade more profitable. But in the short run, it might have a negative impact, as reduced travel time and the ability to carry more, will increase the number of vessels available, leading to lower charter prices.

Legal

The legal aspect is an important one, but have a relatively small impact on the trade, at least in the long run. As we get new technology and more knowledge, there will probably occur new legislative changes, like the change in MARPOL of 1992, making it mandatory for new vessels above 5,000 dwt to be fitted with a double hull. However most of these changes will be mandatory for all vessels, and in the case of the EU and the US, both follow the legislative changes made by the IMO, the International Maritime Organisation. Which means that any new changes will not impede on the trade, at least not in the long run. It might have some effect in the short run, due to the fact that the market supply of vessels might decrease for some time, resulting in increased chartering prices, but it is not likely as most changes have incorporated an outfacing time for the vessels in question. (International Maritime Organisation 2014)
There is however one legislative factor that could impede a big impact on the trade, the Jones Act. The Jones Act is a US freight cabotage law saying that only American built and registered ships, with American crew can transport cargo between ports in the US. However since the product tanker in this scenario goes in ballast between USNH and the US gulf, it is not affected by the Act. (Maritime Law Center n.d.)

Environmental

The last aspect in the PESTLE analysis is the environmental aspect. In the last couple of decades, we have seen an increased focus on the environment in the shipping industry, mainly due to the Marine Environmental Protection Committee (MEPC), a subsidiary of the IMO. The MEPC is empowered to consider any matter within the scope of the organisation concerned with prevention and control of pollution from ships. (IMO 2014) The regulations made by the MEPC, closely links the environmental aspect to the legal aspect as well as the technological, due to the fact that new regulations may enforce shipowners to either improve their vessels or scrap them. Which again will have an impact on the trade, at least for the shipping companies who are registered or do business with member states of the IMO. Both of the countries in this scenario are members of the IMO, thus any shipping company transporting oil products between these two, will have to follow the regulations set down by the MEPC.

Conclusion

In the analysis we have seen that the main factors that might influence the profitability for this triangulation route is mainly the economical and technological factors, as the U.S. becomes less dependent on the import of oil products, as a result of the switch to more fuel efficient cars and its increased oil production.

3.2 Triangulation scenario 2

The triangulation route in this scenario is both longer, and more complex than the one in scenario 1. In this scenario, it goes from Texas to Chile with diesel, then in ballast to Argentina, then from Argentina to China with soybean oil, again in ballast from China to Malaysia, with palm oil from Malaysia and back to the U.S.

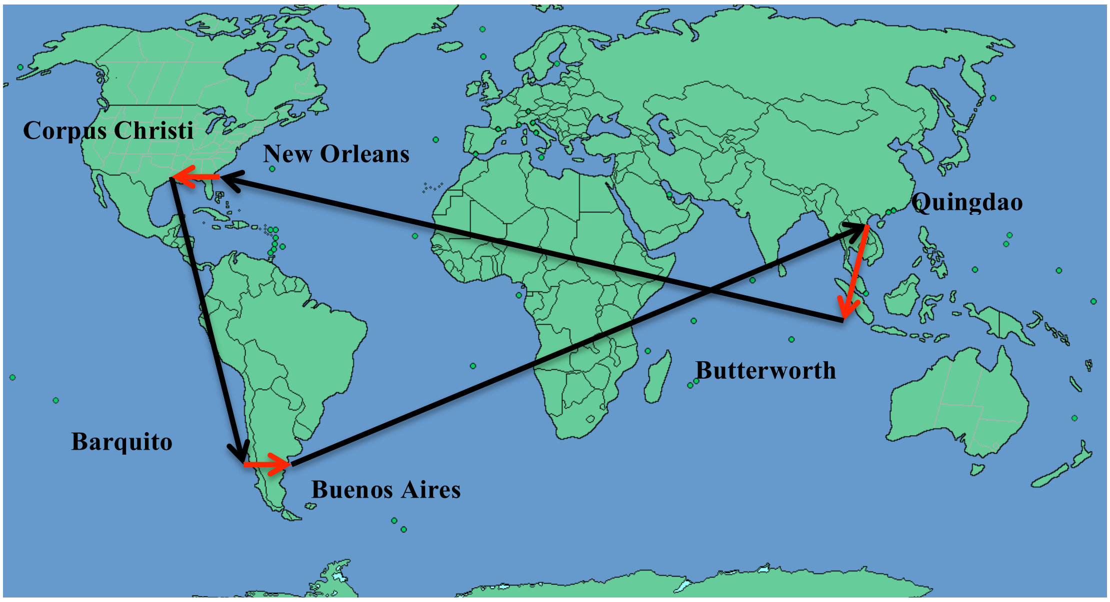

Figure 3: Triangulation route 2

Political

The political aspect is more important in scenario 2 than in scenario 1, as some of the countries involved are more volatile. Since I already looked at the United States in the PESTLE analysis in scenario one, I will not use much time on it in this analysis. Shortly summarized, the political situation in the U.S. is quite stable, also in relation to the countries they are trading with in this scenario. According to the Office of the United States Trade Representative, Chile was, in 2013, the 21st largest goods export market, exporting mineral fuel (oil) for $6.0 billion, and Malaysia was the 17th largest supplier of goods to the US, exporting palm oil for $1.1 billion (USTR 2014). In the case of the export of palm oil to the US, this number might decrease in the coming years, due to the increasing environmental concerns of the production of palm oil, making the future trade of this product more uncertain.

According to a research paper, made by the US congressional research service, Chile is a political stable country, and has been so for over 20 years, since Pinochet lost the presidential election in 1989. Since the end of the Pinochet regime, the country has gradually recovered its democracy and new economic, social and political reforms have been implemented, despite political challenges from the Pinochet regime. The political, social and economic reforms implemented have resulted in Chile being one of the fastest growing economies in Latin America, with an average economic growth of 5.38 % from 1987 to 2014. (USTR 2014) (Meyer 2014)

Where as Chile has had political stability and an exceptional economic growth for over two decades, Argentina's story is quite the opposite. In the last 13 years Argentina has defaulted its loans twice, making the political environment quite unstable. Even more so, looking at how it affects international trade. In order to try to solve its economical problems, the Argentinian governments have enforced an increasingly complex strategy of trade protectionism, using relatively high tariffs, import restrictions, export taxes, and limiting foreign exchange transactions. With reference to the triangulation route used in this scenario, there was, according to a trade report made by USTR in 2013, a 32 % export tax on soybean oil. (USTR 2013)This strategy of trade protectionism in addition to other governmental issues, like nationalising the largest oil company in Argentina, Yacimientos Petrolifero Fiscales (YPF), have brought retaliation from countries around the world, as well as denouncement at the WTO. (Hornbeck 2013)

China on the other hand, has a relatively stable political environment, however different from Argentina in the sense that Argentina is a democracy, while China is a one-party state. However whereas there have been little change in the governing of Argentina, we have seen quite big change in China, economic and trade reforms begun in 1979 have helped transform China into one of the world's fastest-growing economies. The economic growth and trade liberalisation, including comprehensive trade commitments made upon entering the World Trade Organisation (WTO) in 2001, have led to a sharp expansion in China's commercial ties around the world. (Morrison 2014)
Even though China has become more liberal when it comes to trade, there is still a long way to go. According to an annual report by Global Trade Alert, Argentina and China, are the only two countries in the world that are in the top 10 list of offenders for all major categories of discriminatory harm it measures by the number of (1) discriminatory measures, (2) tariff lines, (3) sectors affected, and (4) trading partners involved. China tops the list in terms of trading partners harmed; in part due to its extensive export management policies through selective VAT rebates for exporters (Evenett 2012).

The last of the five countries of the triangulation route is Malaysia. Since its independence in 1957, there has been a high degree of political stability. Political coalitions led by the dominant political party, United Malays National Organisation (UMNO), have been in power without interruption since the Malaysian independence. Still the outlook for the future, may not be that stable as there is a growing resentment with corruption and discriminatory pro-Malay affirmative action policies. In relation to the trade between the U.S. and Malaysia, Malaysia was in 2013 the 17th largest supplier of goods to the U.S. and the 25th largest importer of U.S. goods (USTR 2014). They are also part of the on-going negotiations to create a new trade agreement, know as the Trans-Pacific Partnership (TPP). There are however some issues that hamper the negotiations, like the Malaysia's government procurement policies, which give preferential treatment for certain types of Malaysian-owned companies, provisions for intellectual property rights (IPR) protection, and market access for key commodities and services (Rinehart 2014).

Economical

In this scenario the economical aspect for the United States, are less important for the trade, than in scenario 1, at least for the trade to Chile. The recession in 2008/2009 did have some effect on trade, but as the United States are considered to be back on track, and since they are the exporter of fuel oil, the other aspect mentioned, are not that problematic. For instance the fact that they have changed to smaller and more fuel efficient cars and that they are becoming more self supplied with fuel, are actually more positive for the trade with Chile, as they can export more, than before. There is however one problem that might put a dent in the trade between the U.S. and Chile, and that's the falling oil prices. According to an article in the Guardian, there are a rising number of factors pointing in the direction of an even further reduction in oil prices, as economic growth in China and the U.S. have weakened, and the supply of oil have increased, due to increased production in the U.S., Russia and OPEC. (Farrell 2014)

As mentioned earlier, Chile has had an average growth of 5.38 % from 1987 to 2014, making Chile the most competitive and fundamentally sound country in Latin America. The economic success stems from policies implemented since the fall of Pinochet, opening the country to investment, secured access to foreign markets and mitigated the effects of external shocks, like the financial crisis. The strong economic growth paired with targeted social

assistance programs, has also contributed to a significant decline in the poverty rate. There are however still high levels of inequality, contributing to some discontent among the population. In relation to the trade, the economic growth and especially the free trade agreement with the U.S., entering in to force in 2004, have increased trade between the two countries, as we can see from the figure above.
According to the U.S. Department of Commerce, the export of goods from the U.S. to Chile, were valued at 18.9 billion USD in 2012, with refined oil products, heavy machinery and motor vehicles accounting for the majority. Whereas the export of goods from Chile to the U.S. were valued at 9.4 billion USD, with top products including copper, edible fruit and seafood, leaving the U.S. with a substantial trade surplus. (Meyer 2014)

Whereas Chile is doing quite well economically, the same cannot be said for Argentina. As previously mentioned, they have defaulted twice on their loans in the last 13 years, and have an inflation rate, second only to Venezuela in the world. The default in 2002 left the government unavailable to access the international bond markets, making it harder to finance their debt, without harming the population even further through taxes or printing more money. In the end they have managed to reduce their debt, mainly due to restructuring and increased taxes on financial transactions and on export. So far these taxes have improved the Argentinian situation to some extent, as we can see from the table above, the growth in GDP has been quite high in the last couple of years.

Table 1. Argentina: Selected Economic Data, 2000-2012

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GDP Growth (%)	-0.8	-4.4	-10.9	8.8	9.0	9.2	8.5	8.7	6.8	0.9	9.2	8.9	2.2
Overall Fiscal Balance (% of GDP)	-3.6	-6.8	-2.0	0.9	3.7	2.1	1.9	0.6	0.7	-0.8	-0.1	-2.3	-1.6
Primary Fiscal Balance (% of GDP)	0.4	-1.3	0.7	2.8	5.3	4.4	4.0	2.7	2.8	1.4	1.5	-0.1	0.5
Public Debt (% GDP)	45.7	53.7	166.3	138.2	126.4	72.8	63.6	55.7	48.5	48.5	45.1	41.2	39.9
Inflation Rate INDEC (%)[a]	-0.7	-1.5	41.0	3.7	6.1	12.3	9.8	8.5	7.2	7.7	10.9	9.5	10.2
Inflation Rate (adjusted) (%)[a]									25.0	18.1	22.4	25.1	25.4
Real Avg. Wages (index)			76.0	85.2	93.1	100.0	108.9	118.8	129.2	144.3	163.0	196.1	231.8
Current Acct Balance (% GDP)	-3.1	-1.4	8.5	6.3	2.1	2.9	3.6	2.8	1.5	2.1	0.8	-0.3	0.2
Terms of Trade (index)				91.0	95.3	100.0	106.8	109.6	113.0	103.3	113.4	120.3	119.6
Real Effective Exchange Rate Index[b]			106.9	97.5	100.2	100.0	102.0	101.2	97.2	99.3	98.5	96.0	93.6
International Reserves ($ bn)	32.5	15.3	10.4	13.8	19.3	27.3	31.2	45.7	46.2	48.0	52.2	46.4	45.3
International Bond Issues ($ mn)[c]	13,468	2,711	0	100	200	540	1,896	3,256	65	500	3,146	2,193	663

Table 1: Argentina: Selected economic data, 2000-2012 (Hornbeck 2013)

However, the taxes do also have a negative effect, as it raises costs, which can reduce the incentive to produce and invest, ultimately leading to reduced revenue and economic growth. Furthermore, the taxes on export makes the goods exported from Argentina less competitive in the global markets, which might suggest that these financial schemes might jeopardise the future growth and development and as such does not really fix the problem, only postponing it, leaving the future Argentina in even bigger problems than they have today. In relation to trade, this is not yet a big problem for Argentina, as they are still the biggest producer of soybean and soybean oil. However, should for instance China or other major importers go into a recession, they might go looking for cheaper sources of soybean and soybean oil, leaving Argentina bare. (Hornbeck 2013)

The latest figures from the IMF, adjusted for purchasing power, shows that China has surpassed the U.S. as the largest economy in the world, with a PPP adjusted GDP of 17.632 trillion USD. (Bird 2014) Since the first initiations of market reforms in 1978, China has seen an unprecedented economic growth with an average of 10 percent GDP growth. Even the financial crisis of 2008/2009 did not put a dent in the growth, at least not compared to the west, with a growth of 9.635 and 9.214 percent respectively. The market reforms have also given them one of the most diverse spread of industry production in the world, and made them the world's second largest trading nation behind the U.S., being the largest exporter, and the second biggest importer in the world. Since its accession into the WTO in 2001, the country's share in the global trade has doubled, accounting for about 10 percent of both the worlds merchandise trade exports and imports. Even though it looks like China are doing pretty good for them and being an engine of the world, there are some growing concerns about the big trade imbalances between China and the rest of the world. Further more there have also been a growing number of trade disputes, mainly for dumbing, unfair subsidies by the Chinese government, intellectual property rights (IPR) and the valuation of the Yuan. (EW World Economy Team 2013)

In relation to trade, the big question is whether the growth we have seen in China, will still continue or if it will slow down, causing waves that might affect the world trade. According to an article by Pritchett and Summers, there are a consensus by forecasters that China will continue to grow strongly, both over the medium and long term. However, according to arguments by Pritchett and Summers, there are many reasons to a more pessimistic outcome. Firstly, they argue that the past growth performance is of very little value for forecasting future growth. Secondly, abnormally rapid growth is rarely persistent and "regression to the mean" is an empirically robust feature of economic growth. Further more, they argue, that rapidly growing countries are substantially more likely to suffer a sharp downward change in growth than gradual and small and even more so for countries with high levels of state control and limited respect for the rule of law. (Pritchett and Summers 2013) Taking into consideration the latest numbers from the Chinese economy, and the arguments made by Pritchett and Summers, it seem wisely to start preparing for a downturn in the Chinese economy, specially due to the effects it might have on the world economy and through that, the world trade.

China and Malaysia have some common traits, looking at economic performance, both have been among the fastest growing economies over the last 30 years, and recovered rather quickly from the financial crisis in 2008/2009. Numbers from the World Bank, show that the Malaysian economy was back on track at its pre-crisis levels earlier this year.

There are however some concerns with the Malaysian economy. First and foremost, the diversification within the country, Most of the nation's GDP contribution comes from four of the nine Malaysian regions; the State of Selangor, which surrounds the capital Kuala Lumpur, Kuala Lumpur, the State of Johor, located next to Singapore, and the state of Sarawak, on the

island of Borneo. These four regions are the most prosperous and form the core of Malaysia's manufacturing and service sectors. The five other states, mainly concentrated along the border of Thailand, except for the state of Sabah on the northern tip of Borneo, are relatively poor regions with less manufacturing and service activity.
In addition to the regional diversity, there is also large economic differences between urban and rural areas, as well as ethnicities, where the Chinese Malaysians are those with the most power and wealth, whereas the majority of the population, the Malays and other indigenous people have traditionally been considered economically disadvantaged. In relation to trade, and especially with the U.S., there are raised some concerns about Malaysia's IPR protection and limited market access, as a result of tariffs and other restrictions on imports, like automobiles, and agricultural goods. (Rinehart 2014)

Social

The social aspect of this analysis is, as in the first analysis, not especially relevant for this scenario, even though there are bigger social and cultural differences in this scenario, there are still few social factors that might have an impact on the trade. The most realistic factor would be increasing differences between the rich minority and a growing middle class, resulting in an uprising limiting trade for some time.

Technological

Technically there are also few factors that could impact the trade in this scenario. The main one is the new hydraulic pump technology, which has the potential of shortening port time, increase the amount of cargo carried, and make it possible to be able to switch between clean and dirty products, a lot more efficient than product tankers without the technology. However as soon as this becomes know within the industry, this advantage will disappear.

Legal

The legal aspect in relation to the shipping industry in this scenario is not much different from the first scenario, as all the countries are members of the IMO, and as such have to abide the same regulations like the MARPOL. The only aspect that is different in relation to the first scenario is the Emission Control Areas (ECA), which prohibits vessels from using Heavy Fuel Oil (HFO) in coastal areas. As of yet, these areas have not been created outside Europe and the U.S. As a result one can reduce some port costs when loading and discharging outside

Europe and the U.S., as the price of the HFO is cheaper than the Marine Diesel Oil, allowed in the ECA.

Environmental

In regard to the last aspect of the PESTLE analysis, the environmental aspect, there are no big differences from this scenario to the first scenario. Due to the fact that all of the countries described in this scenario, are members of the IMO, and as such have to abide by the same regulations mentioned in the first scenario, like the MEPC.

Conclusion

In the analysis we have seen that the main factors that might influence the profitability for this triangulation route is mainly the political and economical factors, and especially the economical situation in China and Argentina. The Argentinian government are trying to solve their economic problems with increased tax on trade, and as for China, many analysts are just waiting for an economic crisis that might create ripples affecting the whole region or the whole world.

4. The Profitability of the hydraulic pump technology

For both of the two scenarios, I have used the discounted cash flow model as my primary valuation model, in order to find out the profitability of the hydraulic pump technology. I have also used the adjusted present value (APV) model, as a sort of fail-safe, due to the fact that the average shipping company, do not have a bond rating of BBB and above. Furthermore, both of these models need inputs that are relatively hard to find or get access to, resulting in the need to both assume some of these values, and estimate others. However, in order to find a relevant approximation, I have used the average of five listed companies within the product tanker industry; Scorpio Tankers Inc., Teekay Tankers, Capital Product Partners LP, Tsakos Energy Navigation Ltd, and DHT Holdings Inc.

Economical Inputs

In the DCF analysis, as mentioned under 2.2, we need to calculate the weighted average cost of capital, and in order to find the cost of capital, we need the cost of equity, cost of debt, equity to value, debt to value, and the marginal tax rate.
In order to estimate these values, I have had to make some assumptions:

Cost of equity: From 2.2 we know that we can estimate the cost of equity, using the capital asset pricing model (CAPM) and Modigliani & Miller's theories on risk. In the CAPM, I have assumed an equity risk premium of 5.00%, and used the 10-year U.S. government bond yield as the risk free rate (2,32%). The beta of equity, the last of the values needed, I found using the betas listed at Reuters, then I unlevered and relevered them and calculated the industry average of the relevered beta's of the five previously mentioned companies (Appendix 1).

Cost of debt: As mentioned under 2.2, we can use the yield to maturity (YTM) to find the cost of debt, if the company has a bond rating equal or above BBB. However since most shipping companies have a bond rating below BBB, I used the 12 months U.S. dollar LIBOR rate (03.12.2014), and applied "the rule of thumb" adding 4.00 % to the rate, leading to a cost of debt of 4.57%.

Equity to value and debt to value: As with most of the other values related to the five companies, I used their balance sheet and then calculated the average of both the equity to value and the debt to value, leading to an E/V ratio of 53.91% and a D/V of 46.09%.

Marginal tax rate: Due to the fact that the shipping industry in most countries only pay a freight tax, or a tonnage tax, I have assumed for simplicity that the marginal tax rate equals

zero. This is mainly due to the fact that the tonnage tax might differ from country to country, and from contract to contract, making it quite complex to estimate.
Using these numbers and a marginal tax rate of 0%, I arrive at WACC=8.17%

In addition to find the future free cash flow, we also need to calculate the terminal value, as mentioned under 2.2. In order to do this we need a growth rate, but due to the fluctuations within the shipping industry, it is quite difficult to estimate a realistic growth rate. However as mentioned in the presentation of the shipping industry, the growth varies as a result of supply and demand, when there are few vessels available, the growth increases, and when there are too many, the growth dwindles. Assuming that the fleet growth paints a picture of the growth of the industry, I have used the CAGR formula to estimate a growth rate of 3.9%, using annual average dwt in the Aframax tanker market from 1987 to 2014 (Appendix 3)

I have also had to make some assumptions regarding the APV model, as with the DCF model, I have assumed a marginal tax rate of 0% and a growth rate of 3.9%. In addition I have had to make some assumptions regarding the probability of bankruptcy and the cost of bankruptcy. As mentioned earlier, most shipping companies have a bond rating below BBB, due to the fluctuations of the shipping industry, centralising around B, thus I have assumed a bond rating of B, which give a probability of bankruptcy of 37.06% (Appendix 2). The cost of bankruptcy on the other hand was much harder to calculate, as I could not find any relevant data. Further more, according to studies on the cost of bankruptcy, it varies between 10% and 90% of the firm value. As a result, I have assumed an average cost of bankruptcy of 45%. (Prakt and Larsson 2014)

Technical Inputs

In addition to the DCF and APV inputs, we also need some technical inputs to be able to calculate the cash flow. As mentioned in the description of the pump technology, the pumps will reduce the time needed in port, as well as reduce the amount of fuel needed while being in port. According to FRAMO, the hydraulic pumps will use about 50 ton less fuel while discharging, and according to the calculation beneath, 4.5 hours less at each discharge compared to an Aframax product tanker using steam turbine driven pumps. The technical inputs used in this analysis, are derived from a collaboration paper between Framo and the National Technical University of Athens, and a presentation on the hydraulic pumps from

Framo.

Discharge time						
	Framo system		Steam turbine		Difference	
cargo capacity (m^3)	130 000	m^3	130 000	m^3		
Pumping capacity (m^3/h)	9 000	m^3/h	9 000	m^3/h		
Pumping time (h)	14,4	h	14,4	h		
Stripping time (h)	0,5	h	5	h	4,5	h
Total dischare time (h)	14,9	h	19,4	h	4,5	h

Table 2 Calculation of total discharge time for each of the two cargo pumping systems (FRAMO 2014) (Plessas, Chroni and Papanikolaou 2014)

We also need to calculate the total length of the route, as well as the time a vessel with hydraulic pumps and with steam turbine driven pumps will use at different speed for one voyage. The total distance of the triangulation voyages in scenario 1 and scenario 2, are 10,519 nm in the first and 38,580 nm in the latter. (Sea-Distances.org 2014)

Once we have the total distance, we need to calculate the total traveling time, including the time needed at port. In this calculation I have assumed loading time of 24 hours, and an average speed, depending on the market situation, of 10.5 knots (nm/h) during a trough, 14.5 knots in a normal market, and 16.5 knots during a peak. See appendix 4, for tables showing the number of voyages that can be done in one year, and the total time used for discharging in one year, with the two pump technologies, and for each speed.

The next input needed to be able to start calculating the cash flow using the hydraulic pump technology, is the total fuel consumption per discharge and per year, at each of the three different speeds, see appendix 5.

In relation to this input, we also need one final input, and that is the bunker price. For most part of the voyage, the vessels will use heavy fuel oil (HFO), however while in port, they have to use marine diesel oil (MDO), which have a lower sulphur grade than HFO. This means that I will only look at the price of the MDO, as the hydraulic pumps only have an effect on the profit while discharging. In order to take into account the fluctuations in the oil price, I have decided to use the highest value, the lowest value, and the median value of the MDO prices, from the 1991 until 2013, see appendix 6 for more details on the movement of the MDO price.

Using the technical and financial data, I have calculated the net present value of the investment using both the discounted cash flow model and the adjusted present value model for three different sailing speeds (10.5, 14.5, and 16.5 knots), which in turn becomes three yearly number of discharges depending on the chosen route, at three different bunker oil prices (MDO) ($119.03/MT, $612.92/MT, and $1106.82/MT), and with three different investment costs ($6m (low), $7m (medium), and $8m (high)). The reason for why I have done this is the cyclicality of the shipping market. As mentioned in the presentation of the shipping markets, the shipping market moves in cycles, from a trough to a peak and down again to a trough, following the supply and demand of vessels. This means that when the market is in a trough, the shipping companies often chooses to travel at a lower speed than normal, and the shipyards have often few orders, meaning they would lower their prices to prevent closing down part of their operations. During a peak, however, the shipping companies will try to increase the number of discharges to increase their profits, thus increasing the speed of the vessel, and the same goes for the shipyards, with a full order book, their prices will increase. The bunker price, on the other hand, does not follow this cyclicality, as it is more closely linked to political situation in the world, and especially the situation of the OPEC. For instance, the wars in the Middle East have had a tendency to make the oil price skyrocket, and the main reason for the recent reduction in the oil price, is mainly due to the OPEC wanting to show the world, that they still are a major player in the oil export.

Following the reasoning above, it is important to take these variables into consideration, when trying to paint a full picture of the profitability of the investment. Thus I will first look at the result of the net present value, DCF method when the investment cost is medium, and then I will compare the DCF and the APV methods. I will not look at the graphs of the low investment cost and the high, as these are the same as the one with a medium investment cost, with the exception of an increase or a decrease in NPV equal the difference in investment cost.

4.1 Scenario 1

The triangulation route used in this scenario goes between the U.S. and Europe with diesel and gasoline. For more information on the ports and distances between them, see the table underneath. The calculations and structure used are the ones described above, and I will also follow the same structure as presented earlier.

Loading port	Discharge port	Distance
Port of Corpus Christi, TX	Rotterdam, NL	5111 nm
Port of Rotterdam, NL	New Haven, CT	3331 nm
New Haven, CT	Port of Corpus Christi, TX	2077 nm

Table 3 Scenario 1 ports and distances (Sea-Distances.org 2014)

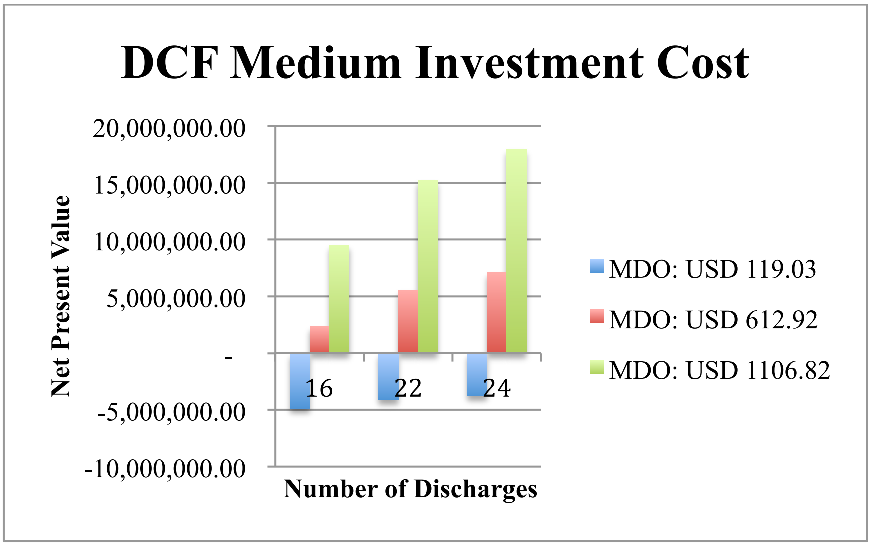

Figure 4: Profitability of the investment in Scenario 1 with a medium investment cost using the DCF method

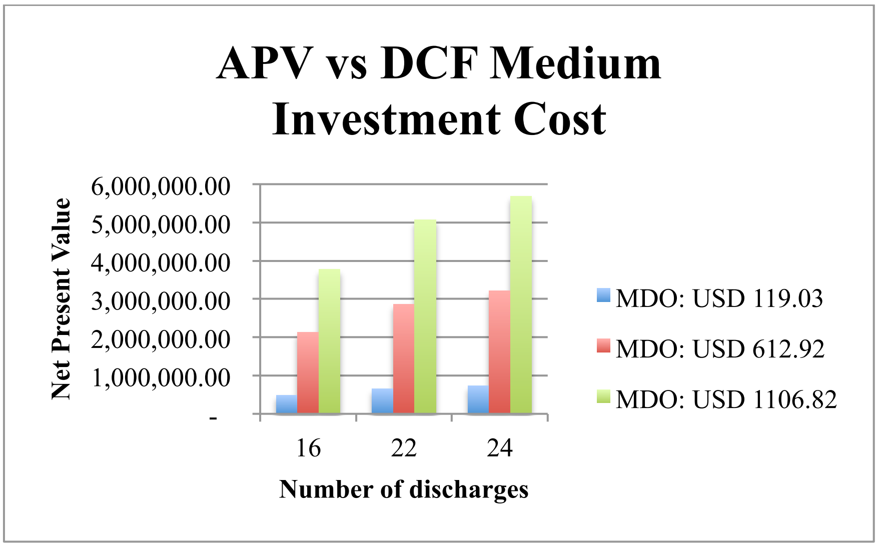

Figure 5: Difference between the APV method and the DCF method with a medium investment cost

As we can see from the first graph, the most important variable is the bunker price. This is mostly a result of the lower fuel consumption when discharging the cargo compared to the steam turbine pumps. The speed or the number of discharges is also an important variable, as we can see from the first graph, the NPV increases with the number of discharges. Comparing the two graphs, we see some difference between the two, however not enough to suggest that, in the case of shipping companies, the bond rating playes an important role.

4.2 Scenario 1 without the use of triangulation

The route in this scenario is similar to the route in the scenario above, with the exception that the LR2 product tanker only travels from the U.S. to Europe with diesel and then travels in ballast back to the U.S. By doing this we will be able to find out whether or not triangulation improves the profitability of the cargo pumping system and as such whether it has the potential to improve profitability whether one chooses to invest or not.

The calculations used are the same as in the scenario above, with the exception of a reduction in the number of loadings and discharges, as well as a reduction in travel distance due to the fact that the vessel only travels back and forth between Corpus Christi, TX and Rotterdam, NL. Following the same structure and reasoning as in the scenario above, I will start with the DCF analysis, and compare the DCF and the APV method while looking at the medium investment cost.

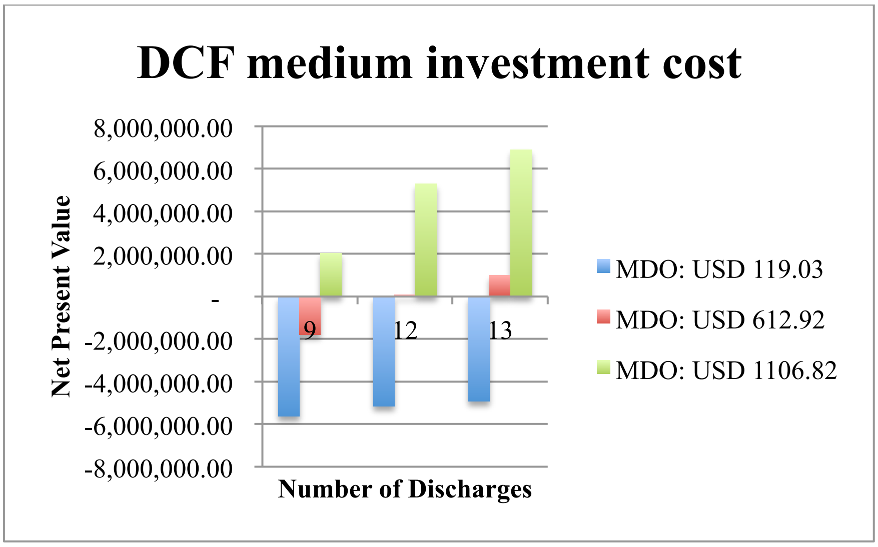

Figure 6: Profitability of the investment in Scenario 1 without triangulation with a medium investment cost using the DCF method

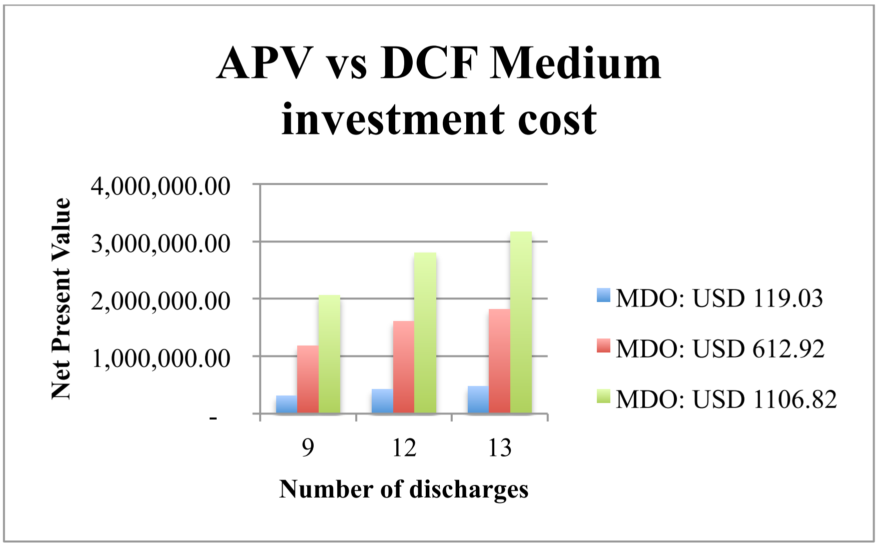

Figure 7: Difference between the APV method and the DCF method with a Medium investment cost

Looking at the graph above, we see, as we saw in the first scenario, that the APV method provides us with a higher profit than the DCF method, which in this case would have made the investment profitable during a trough.

Looking at the DCF graph we see that the bunker price have a huge impact on the profitability of the cargo pumping system, and if the bunker price stays low during a trough, it will not be profitable no matter whether the investment cost is high or low. Further more, if we look at the graph above, we see that during a trough two out of three bunker prices will result in losses.

Comparing the two DCF medium investment graphs in 4.1 and 4.2, we see that the triangulation plays an important role in the profitability of the cargo pumping system for this route. Both have a deficit when the MDO price is around USD 120/MT, however at the two higher prices the graph with triangulation has a substantially higher NPV, compared to the one without triangulation. Suggesting that triangulation is smart way to increase the profit of a route.

4.3 Scenario 2

The triangulation route in this scenario is both longer, and more complex than the one in scenario 1. In this scenario, it goes from Texas to Chile with diesel, then in ballast to Argentina, then from Argentina to China with soybean oil, again in ballast from China to Malaysia, with palm oil from Malaysia and back to the U.S. In the table beneath you can see the ports used and the distance between them.

Loading port	Discharge port	Distance
Port of Corpus Christi, TX	Barquito, CL	9368 nm
Barquito, CL	Buenos Aires, AR	3220 nm
Buenos Aires, AR	Qingdao, CN	11385 nm
Quingdao, CN	Butterworth, MY	2839 nm
Butterworth, MY	New Orleans, LA	11209 nm
New Orleans, LA	Port of Corpus Christi, TX	559 nm

Table 4: Scenario 2 ports and the distance between them (Sea-Distances.org 2014)

The calculations of this scenario are more or less the same as in scenario 1, with the exception of the time used while in port. In this scenario, I have also added the time to clean the tanks, making them ready to transport clean products. According to Michael Sangolt, Bunker Manager at SKS Tankers, the LR2 product tankers with the hydraulic pumps, use between 3 and 5 days to clean the tanks, as such I have used 4 days. As for the LR2 with steam driven pumps, there is a problem with dirty product residue in the pipes, which can ruin the clean products. Thus it normally takes one or more trips carrying gas condensate, in order to switch from dirty to clean products, according to Alf M. Utvær, Area Manager at Frank Mohn AS. I could not find any export of gas condensate from Chile to Argentina, instead I assume that it will take 30 days to make the vessel ready to transport clean products.

With the exception of the time used to switch from dirty to clean products, I follow the same reasoning as in scenario 1, thus I will also follow the same structure as well.

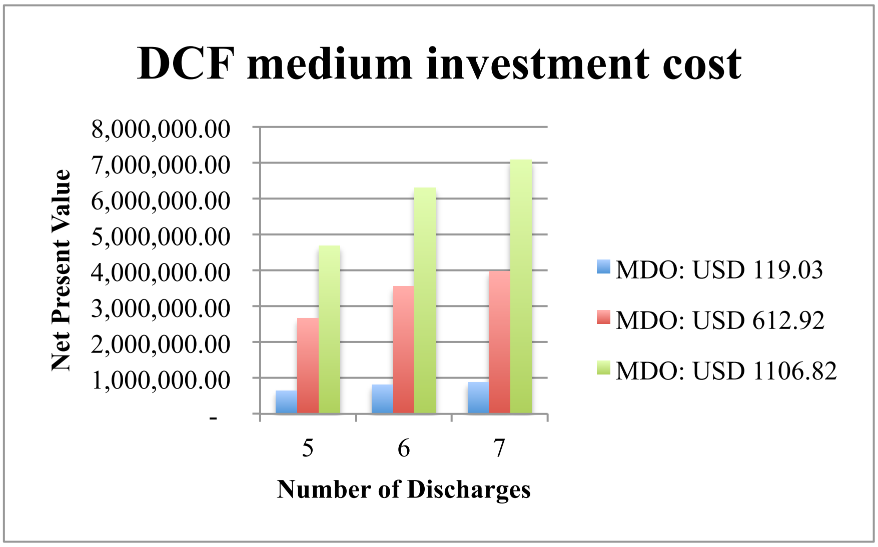

Figure 8: Profitability of the investment in Scenario 2 with a medium investment cost using the DCF method

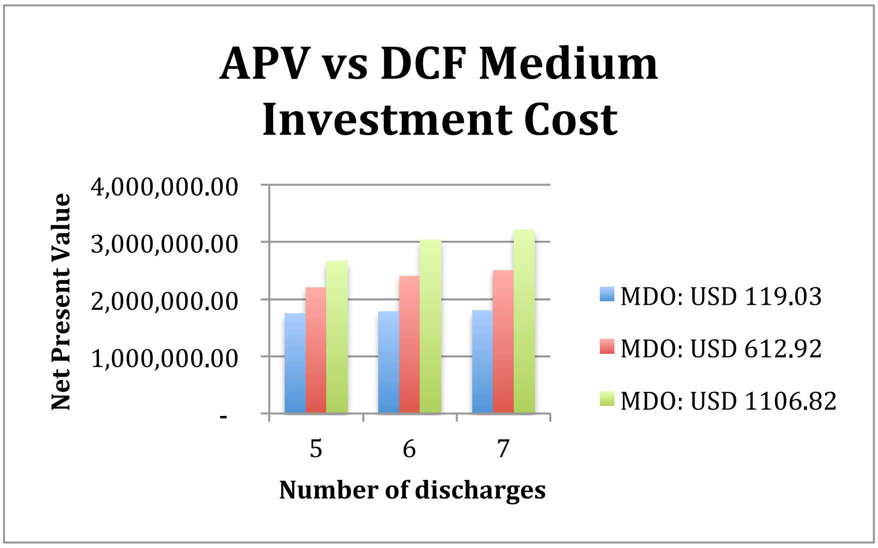

Figure 9: Difference between the APV method and the DCF method with a medium investment cost

As we can see from the graph above, there is not much difference between the two methods, with the exception that the APV method has a bit higher net present value. From the first graph we can see that the bunker price has quite a big impact on the net present value, however this can be explained by the big difference between the MDO prices, especially if we compare them to the difference between the numbers of discharge. This might suggest that there might be another factor influencing the analysis. This becomes even more apparent if we look at the graph beneath where we assume that they use the same switching time.

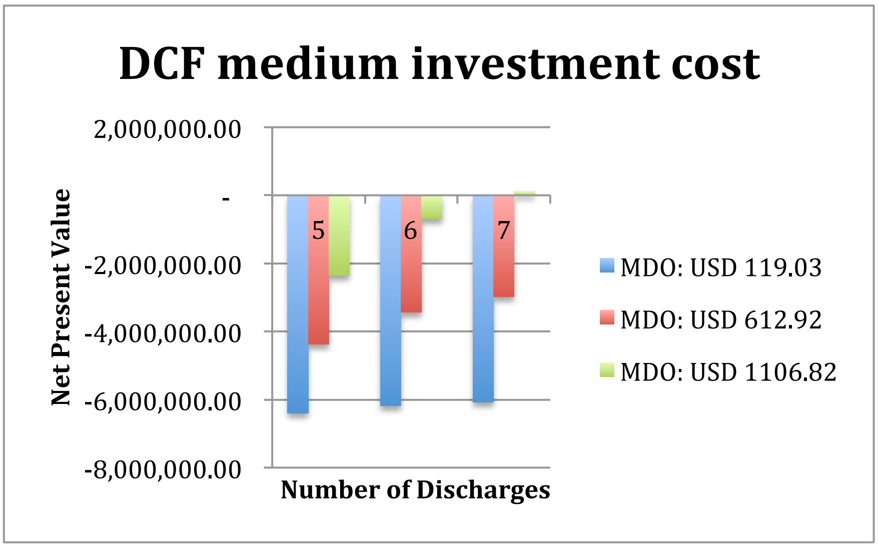

Figure 10: Profitability of the investment in Scenario 2 with a medium investment cost, no switching time difference, using the DCF method

As we can see from the graph, only with the lowest investment cost, and the highest MDO price, would it be profitable to switch from steam driven pumps to the new pumping system if the time to switch from dirty to clean cargo were the same for the two pump systems. This suggests that reduction in travelling time is quite important when sailing longer distances.

4.4 Comparing the result of the scenarios

If we compare the result of the scenarios it becomes quite apparent that it is a good investment to change from steam driven pumps to hydraulic pumps. However there is a but, if one chooses not to take advantage of the triangulation opportunity, the profitability of the investment becomes more dependent on the market situation, as we saw looking at scenario 1 without the use of triangulation. Further more, the fact that it is easier to switch between clean and dirty products, gives the company a competitive advantage compared to companies with vessels utilizing steam driven pumps, as one can transport a larger spectre of tradable goods. And as such increase the laden-to-ballast ratio, which again will result in increased profits. However if one choose to contract the vessel on long voyages suitable for the LR2 product tanker, like the one in scenario 2, with few discharges and only transporting either dirty or clean products, it is not profitable to take on the investment. Further more, due to the fact that the distances in scenario 1 is more suitable for a smaller vessel, such as the MR2 or the LR1, it might be more profitable to equip those with the hydraulic pumps instead, at least if one have long-term contracts, and do not operate in the spot market. As a last comment to the graphs, it might seem strange that one should need to slow steam during a period with high investment cost. However as a result of the two to four years time lag between the cycles of the shipping market and the shipbuilding market, which is the time it normally takes from the order of a new vessel is placed and until the vessel is delivered, such a situation might occur.

5. Conclusion

In the strategic analysis of the two different triangulation routes, we saw that there are some factors that might influence the profitability of the routes. In scenario 1, it is mainly the economic and technological factors, as the United States are becoming less dependent on oil and as such can produce more of the gasoline they need by them selves and in addition there has also been a switch to more fuel efficient cars, reducing this need even further. This development might result in a scenario similar to the one without the use of triangulation, where one transports diesel to Europe and travels empty back to the U.S. And as we saw, in the investment analysis, one will be more dependent on the fluctuation of the market, reducing the profitability of the investment. However, it will still take some time until we will see any effect of this development in the product tanker trade, and if we take into account both the increased profit one will gain from the use of triangulation and switching to the hydraulic pumping system, it is quite apparent, that this is a sound investment. Especially due to the larger spectre of products one can transport with the new pumps.

In scenario 2, it is mainly the political and the economical factors from the pestle analysis that might impede on the trade, and especially the economical situation in Argentina and China. Argentina has been and is still in deep economical problems, which might lead to increased taxes, which will make importers look for other suppliers to buy their supplies. China on the other hand seems to be in a good economical situation, at least if we believe the governmental officials. However, many analysts are just waiting for an economic crisis that might create ripples affecting the whole region, if not the whole world, which will most definitely have an impact on the proposed trading route, being a large importer of soybean oil. In the case that this would result in only transporting dirty products over similar long distances, it would not be profitable to invest in the new pumps, as the last graph in scenario 2 suggests. However such a crisis would not last the entire lifetime of the pumps, take for instance the financial crisis, we are already seeing improved rates with forecasts of higher rates in the coming years. And with this in mind, it would be profitable to invest in the hydraulic pumps, as one have the possibility to switch between different cargoes, dirty and clean, and also have the opportunity to choose shorter hauls, and as such reduce the cost of discharging, increasing the profit.

Glossary

Aframax:	A tanker size ranging between 80,000 and 120,000 dwt
Ballast voyage:	A voyage with no cargo on board to get a ship in position for the next loading port or docking. On voyage the ship is said to be in ballast.
Bulk Cargo:	Unpackaged cargoes such as coal, ore and grain
Bunkers:	The ship's fuel
Capesize:	Bulk ship size ranged as 100,000 dwt or larger
Combination Carrier:	Ship capable of carrying oil or dry bulk cargoes, thereby increasing the productivity of the vessel. Typically termed OBO or Ore/Oiler.
Dwt:	Deadweight ton. A measure expressed in metric tons (1000 kg) or long tons (1,016 kg) of a ship's carrying capacity, including bunker oil, fresh water, crew and provisions. This is the most important commercial measure of capacity.
ECA:	Emission Control Areas
FFA:	A Forward Freight Agreement is a cash contract for differences requiring no physical delivery based on freight rates on standardised trade routes.
Freight rate:	The Agreed charge for the carriage of cargo expressed per ton(ne) of cargo (also Worldscale in the tanker market) or as a lump sum.
Handysize/ Handymax:	Bulk ships size ranges of ships defined as 10-40,000 dwt and 40-60,000 dwt.
IMO:	International Maritime Organisation: A United Nations agency devoted to shipping
IPR:	Intellectual Property Rights.
ISM code:	International Safety Management code for the safe operation of ships and for pollution prevention as adopted by the IMO.
LR1	Long Range 2 product tanker, size ranging from 45-80,000 dwt.
LR2:	Long Range 2 product tanker, size ranging from 80-160,000 dwt.
MARPOL:	The International Convention for the Prevention of Pollution from Ships.
MEPC:	Marine Environment Protection Committee.
MR:	Medium Range product tanker, size ranging from 25-40,000 dwt.
Oil Tanker:	Tanker Carrying crude oil or Refined oil products.

Panamax:	Bulk ship size ranging from 60-100,000 dwt. Strictly speaking the largest ship capable of navigating in the Panama Canal.
Product Tanker:	Tanker that carries refined oil products.
GP:	General Purpose product tanker, size ranging from 10-25,000 dwt
Spot market:	Short-term contracts for voyage, trip or short term time charters, normally no longer than three months in duration.
Suezmax:	A tanker size ranging from 120-200,000 dwt.
Time charter (t/c):	An arrangement whereby a shipowner places a crewed ship at a charterer's disposal for a certain period. Freight is customarily paid periodically in advance. The charterer also pays for bunker, port and canal charges.
Time Charter Equivalent (TCE):	Gross freight income less voyage costs (bunker, port and canal charges), usually expressed in US$ per day.
ULCC:	Ultra Large Crude Carrier. Tanker of more than 320,000 dwt.
VLCC:	Very Large Crude Carrier. Tanker between 200,000 and 320,000 dwt.
USNH:	United States North of (Cape) Hatteras (northern range).
USTR:	Office of the United States Trade Representative
Voyage Charter:	The transportation of cargo from port(s) of loading to port(s) of discharge. Payment is normally per tonne of cargo, and the shipowner pays for bunker, port, and canal charges
Voyage costs:	Costs directly related to a specific voyage (e.g. Bunker, port and canal charges).
Worldscale (WS):	An international index of freight for tankers. Worldscale is a schedule of freight rates for a standard ship in US dollars per tonne of oil for an array of oil routes. The rates listed in the table are designated as Worldscale flat of WS100 and are revised annually.

Bibliography

Altman, Edward I. "About Corporate Default Rates." *NYU STERN.* 2007. http://people.stern.nyu.edu/ealtman/AboutCorporateDefaultRates.pdf (accessed November 12, 2014).

Anderson, Richard, and Damian Kahya. "The cost of petrol and oil: How it breaks down." *BBC News.* 8 November 2011. http://www.bbc.com/news/business-15462923 (accessed September 25, 2014).

Andrade, G, and S. N. Kaplan. "How Costly is Financial (Not Economic) Distress? Evidence from Highly Leveraged Transactions That Became Distressed." *Journal of Finance*, October 1998: 1443-1493.

BIMCO. *Market Analysis 2013: Tanker Shipping - Improving Asset Prices for Product Tankers.* 19 August 2013. https://www.bimco.org/Reports/Market_Analysis/2013/0819_TankerSMOO2013-4.aspx (accessed September 18, 2014).

Bird, Mike. "China Just Overtook The US As The World's Largest Economy." *Business Insider.* 8 October 2014. http://www.businessinsider.com/china-overtakes-us-as-worlds-largest-economy-2014-10 (accessed November 1, 2014).

Clarksons Research Services. *World Seaborne Trade Tables November 2014.* Report, EC3R 6HE: Clarcksons Research Services, 2014.

Clarksons SIN. "Clarksons Shipping Intelligence Network 2010." *Published Tables.* 2014. http://www.clarksons.net/sin2010/search/Default.aspx?q=historical+fleet+growth+tankers (accessed November 10, 2014).

Constantinides, Dimitries. *Pestle Analysis: Business Environmental Analysis.* 15 December 2011. http://pestleanalysis.com/pestle-analysis-business-environmental-analysis/ (accessed September 15, 2014).

Damodaran, Aswath. "Adjusted Present Value Approach." *NYU STERN.* 2 February 2005. http://pages.stern.nyu.edu/~adamodar/New_Home_Page/valquestions/apv.htm (accessed November 12, 2014).

Danish Ship Finance A/S. *Product Tankers: Segments.* 2012. http://www.shipfinance.dk/en/SHIPPING-RESEARCH/Tankskibe/Produkttankskibe/Segmenter (accessed September 12, 2014).

EIA. *China.* 4 February 2014. http://www.eia.gov/countries/analysisbriefs/China/china.pdf (accessed December 4, 2014).

—. *India.* 26 June 2014. http://www.eia.gov/countries/analysisbriefs/India/india.pdf (accessed December 4, 2014).

Evenett, Simon J. "Excecutive Summary." *Débâcle: The 11th GTA report on protectionism*, June 2012: 6.

EW World Economy Team. "China Economy." *Economy Watch.* 4 June 2013. http://www.economywatch.com/world_economy/china (accessed November 3, 2014).

Farrell, Sean. "Brent crude oil price drops below $86 in face of rising global supply." *The Guardian.* 27 October 2014. http://www.theguardian.com/business/2014/oct/27/brent-crude-oil-price-drops-goldman-sachs-forecast (accessed October 31, 2014).

FRAMO. "FRAMO LR2 Presentation." Presentation, 2014.

Frank Mohn AS. "Cargo Pumping System." Bergen, Hordaland, 2014.

Gallo, Claudio. "Europe sticking its head in the sand over environmental issues." *RT Op-Edge.* 9 June 2014. http://rt.com/op-edge/164800-ecology-europe-russian-oil/ (accessed September 25, 2014).

Hamilton, T. Mason. *Today in Energy.* 16 September 2014. http://www.eia.gov/todayinenergy/detail.cfm?id=17991 (accessed October 12, 2014).

Hartwig, Kathinka. "Amerikansk stat forbyr salg av Tesla." *Dagens Næringsliv.* 23 October 2014. http://www.dn.no/nyheter/2014/10/23/1150/Tesla/amerikansk-stat-forbyr-salg-av-tesla (accessed October 23, 2014).

Hornbeck, J. F. *Argentina's Post-Crisis Economic Reform: Challenges for U.S. Policy.* Report, Washington, D.C.: Congressional Research Service, 2013.
IMO. "Structure of IMO." *IMO.* 2014. http://www.imo.org/About/Pages/Structure.aspx#4 (accessed October 25, 2014).

—. *Sulphur oxides (SOx) – Regulation 14.* 2014. http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-–-Regulation-14.aspx (accessed October 15, 2014).

International Maritime Organisation. *Construction Requriements for Oil Tankers.* 1 Januar 2014. http://www.imo.org/OurWork/Environment/PollutionPrevention/OilPollution/Pages/constructionrequirements.aspx (accessed September 12, 2014).

Kilian, Lutz. *Recent Oil Price Fluctuations Linked to World Economy.* Faculty Research, Economics, University of Michigan, University of Michigan, 2011.

Koller, Tim, Marc Goedhart, and David Wessels. *Valuation Measuring and Managing the Value of Companies.* Vol. 5. 5 vols. New Jersey: John Wiley & Sons, Inc., 2010.

—. *Valuation Measuring and Managing the Value of Companies.* Hoboken, New Jersey: John Wiley & Sons, Inc., 2010.
Lun, Venus Y.H., Olli-Pekka Hilmola, Alexandros Goulielmos, Kee-hung Lai, and T.C. Edwin Cheng. Vol. VIII, in *Oil Transport Management*, 13-25. Springer, 2013.

Maritime Law Center. "The Jones Act." *Maritime Law Center.* http://www.maritimelawcenter.com/html/the_jones_act.html (accessed October 23, 2014).

Meyer, Peter J. *Chile: Political and Economic Conditions and U.S. Relations.* Report, Washington, D.C.: Congressional Research Service, 2014.

Modigliani, Franco, and Gerald A. Pogue. "An Introduction to Risk and Return: Concepts and Evidence." *Financial Analysts Journal*, 1 June 1974: 69-86.

Morrison, Wayne M. *China-U.S. Trade Issues.* Report, Washington, D.C.: Congressional Research Service, 2014.

Overseas Shipholding Group, Inc. *Newsletter Article: The Advantages of Commercial Shipping Pools.* 20 February 2009. http://www2.osg.com/index.cfm?pageid=74&itemid=13 (accessed September 16, 2014).

Pareto Shipping AS. *Shipping Market Outlook 2013-'16.* Oslo: Pareto Research, 2013.

Plessas, T., D. Chroni, and A. Papanikolaou. "The Potential Use of FRAMO Cargo Handling Arrangement as a Retrofit Solution for an Aframax Tanker." Thesis, National Technical University of Athens, 2014.

Prakt, Marcus Johansson, and Oscar Larsson. "Indirect Bankruptcy Costs." Master Thesis, Centre for Finance, University of Gothenburg, Gothenburg, 2014.

Pritchett, Lant, and Lawrence Summers. "Asiaphoria Meets Regression to the Mean." *Asia Economic Policy Conference*, 5 November 2013: 33-71.

Reuters. *Reuters.* 1 November 2014. http://www.reuters.com/finance/stocks/ (accessed November 1, 2014).

Rinehart, Ian E. *Malaysia: Background and U.S. Relations.* Report, Washington, D.C.: Congressional Research Service, 2014.

Sea-Distances.org. "Sea-Distances.org." *Sea-Distances.org.* 2014. http://www.sea-distances.org (accessed September 20, 2014).

Taurus Tankers Ltd. *About the LR2.* 2011. http://www.taurustankers.com/company/long_range_2/ (accessed September 12, 2014).

Todd, Jennifer, Jess Chen, and Frankie Clogston. *Creating the Clean Energy Economy: Analysis of the Electric Vehicle Industry.* Analysis, International Economic Development Council, 2013.

USTR. "Argentina." *Office of the United States Trade Representative.* 2013. https://www.ustr.gov/sites/default/files/2013%20NTE%20Argentina%20Final.pdf (accessed October 29, 2014).

—. “Chile.” *Office of the United States Trade Representative.* 4 April 2014. http://www.ustr.gov/countries-regions/americas/chile (accessed October 27, 2014).

—. “Malaysia.” *Office of the United States Trade Representative.* 30 April 2014. http://www.ustr.gov/countries-regions/southeast-asia-pacific/malaysia (accessed October 27, 2014).

Appendix

Appendix 1

Tanker firm	*Beta*	*D/E Ratio*	LT D/E Ratio	Unlevered beta	Relevered Beta
Scorpio Tankers Inc	1,81	60,61 %	55,26 %	1,17	1,45
Teekay Tankers	2,36	194,89 %	178,27 %	0,85	2,66
Capital Product Partners LP	1,43	77,37 %	76,65 %	0,81	1,60
Tsakos Energy Navigation Ltd	1,33	116,06 %	116,06 %	0,62	1,95
DHT Holdings Inc	1,50	41,46 %	40,14 %	1,07	1,28
Industry Average				0,90	1,79

(Reuters 2014)

Appendix 2

Bond Rating	Default Rate
AAA	0.09 %
AA	0.54 %
A	0.71 %
BBB	8.00 %
BB	19.88 %
B	37.06 %
CCC	59.36%

(Altman 2007)

Appendix 3

Historical Fleet Growth - Tankers (,000 Dwt)

Dwt Range	*10,000 - 19,999*	*20,000 - 29,999*	*30,000 - 39 999*	*40,000 - 59 999*	*60,000 - 79 999*	*80,000 - 119 999*	*120,000 - 199 999*	*200,000 - 319 999*	*320,000+*	***Total***
	,000's	*,000's*	*,000's*	*,000's*	*,000's*	*,000's*	*,000's*	*,000's*	*,000's*	***,000's***
1987	6 919	12 570	17 025	11 004	13 431	34 347	31 444	90 283	23 238	**240 263**
1988	6 784	12 533	17 276	11 729	13 476	34 936	31 658	87 435	23 238	**239 064**
1989	6 866	12 653	17 629	12 164	13 832	36 299	32 167	88 729	23 238	**243 576**
1990	6 867	12 816	17 835	12 555	13 795	37 888	33 881	92 792	23 238	**251 667**
1991	6 693	12 971	17 404	12 487	13 788	40 304	34 877	96 334	23 238	**258 096**
1992	6 704	13 062	17 538	13 331	13 571	41 918	36 847	99 445	23 238	**265 652**
1993	6 609	13 033	17 455	13 809	13 130	43 178	39 873	100 509	23 238	**270 833**
1994	6 674	12 381	17 543	14 147	13 509	43 731	40 229	104 445	23 238	**275 896**
1995	6 697	11 960	17 784	14 276	13 269	44 621	39 830	101 444	22 506	**272 386**
1996	6 874	11 540	17 932	14 638	13 265	45 215	39 377	101 083	22 506	**272 430**
1997	7 024	11 157	17 989	16 259	13 335	46 097	38 458	103 560	22 113	**275 992**
1998	7 306	10 605	17 960	16 898	13 319	47 115	39 985	103 702	21 433	**278 322**
1999	7 848	10 389	18 468	18 044	13 114	49 993	41 267	102 889	21 433	**283 445**
2000	8 339	10 186	18 761	19 686	13 522	52 459	40 361	104 232	18 926	**286 472**
2001	8 646	9 454	18 414	20 645	14 359	52 947	41 084	110 039	17 460	**293 048**
2002	8 833	9 215	18 745	21 285	14 271	52 767	38 963	109 353	14 827	**288 260**
2003	9 145	8 788	18 292	22 345	14 488	54 758	41 027	114 474	9 605	**292 922**
2004	9 374	8 195	18 727	24 270	14 733	59 361	42 275	119 744	4 931	**301 609**
2005	9 727	7 966	19 539	27 908	16 176	62 268	44 186	126 681	3 498	**317 948**
2006	10 354	8 067	20 129	31 286	18 665	67 377	47 785	134 565	3 090	**341 319**
2007	11 321	7 894	20 577	35 350	21 308	71 237	51 399	138 635	3 050	**360 771**
2008	12 825	7 644	20 843	39 790	23 751	76 442	53 806	143 498	3 692	**382 290**
2009	15 049	7 160	21 666	46 020	25 988	80 987	54 412	147 493	4 212	**402 986**
2010	16 793	6 835	21 749	52 084	27 366	87 814	58 988	155 186	5 055	**431 869**
2011	17 771	6 231	21 368	55 419	28 189	93 073	62 904	157 189	6 659	**448 801**
2012	18 407	6 239	20 960	58 223	29 299	96 737	68 537	166 465	9 872	**474 740**
2013	18 746	6 133	20 625	59 996	29 802	97 637	72 848	175 728	11 477	**492 992**
2014	18 862	5 958	20 371	63 109	29 986	96 846	76 262	175 837	14 681	**501 911**

(Clarksons SIN 2014)

Appendix 4

Average speed 10.5 knots:

	Framo system		Steam turbine		Difference	
Round trip						
Total Distance	10,519	nm	10,519	nm		
Average Speed	10.5	nm/h	10.5	nm/h		
Total traveling time	1001.8	h	1001.8	h		
Number of loading per voyage	2		2			
Number of discharges per voyage	2		2			
Loading time per trip:	24	h	24	h		
Discharge time per trip:	14.9	h	19.4	h		
Total time loading/discharge per voyage:	77.9	h	86.9	h	9.0	h
Total time per voyage	1079.7	h	1088.7	h	9.0	h
Hours a year	8760.0	h	8760.0	h		
Total voyages a year:	8.1		8.0			
Total Discharge time a year:	121.2	h	156.5	h	35.2	h

Average speed 14.5 knots:

	Framo system		Steam turbine		Difference	
Round trip						
Total Distance	10,519	nm	10,519	nm		
Average Speed	14.5	nm/h	14.5	nm/h		
Total traveling time	725.4	h	725.4	h		
Number of loading per voyage	2		2			
Number of discharges per voyage	2		2			
Loading time per trip:	24	h	24	h		
Discharge time per trip:	14.9	h	19.4	h		
Total time loading/discharge per voyage:	77.9	h	86.9	h	9.0	h
Total time per voyage	803.3	h	812.3	h	9.0	h
Hours a year	8760.0	h	8760.0	h		
Total voyages a year:	10.9		10.8			
Total Discharge time a year:	163.0	h	209.7	h	46.7	h

Average speed 16.5 knots:

	Framo system		Steam turbine		Difference	
Round trip						
Total Distance	10,519	nm	10,519	nm		
Average Speed	16.5	nm/h	16.5	nm/h		
Total traveling time	637.5	h	637.5	h		
Number of loading per voyage	2		2			
Number of discharges per voyage	2		2			
Loading time per trip:	24	h	24	h		
Discharge time per trip:	14.9	h	19.4	h		
Total time loading/discharge per voyage:	77.9	h	86.9	h	9.0	h
Total time per voyage	715.4	h	724.4	h	9.0	h
Hours a year	8760.0	h	8760.0	h		
Total voyages a year:	12.2		12.1			
Total Discharge time a year:	183.0	h	235.1	h	52.1	h

Appendix 5

Average speed 10.5 knots:

	Framo system		Steam turbine		Difference	
Discharges per year	16		16			
Total dischare time (h)	14.9	h	19.4	h	4.5	h
Total Power (kW)	3600	kW				
Fuel consumption	0.0002	ton/kWh	3.6	ton/h		
Fuel consumption	10.8	ton	70	ton		
Fuel consumption from inert gas production	10	ton	included			
Total fuel consumption per discharge	20.8	ton	70	ton	49.2	ton
Total fuel consumption per year	336.9		1126.5		789.6	ton

Average speed 14.5 knots

	Framo system		Steam turbine		Difference	
Discharges per year	22		22			
Total dischare time (h)	14.9	h	19.4	h	4.5	h
Total Power (kW)	3600	kW				
Fuel consumption	0.0002	ton/kWh	3.6	ton/h		
Fuel consumption	10.8	ton	70	ton		
Fuel consumption from inert gas production	10	ton	included			
Total fuel consumption per discharge	20.8	ton	70.0	ton	49.2	ton
Total fuel consumption per year	452.8		1509.7		1057.0	ton

Average speed 16.5 knots:

	Framo system		Steam turbine		Difference	
Discharges per year	24		24			
Total dischare time (h)	14.9	h	19.4	h	4.5	h
Total Power (kW)	3600	kW				
Fuel consumption	0.0002	ton/kWh	3.6	ton/h		
Fuel consumption	10.8	ton	70.0	ton		
Fuel consumption from inert gas production	10	ton	included			
Total fuel consumption per discharge	20.8	ton	70.0	ton	49.2	ton
Total fuel consumption per year	508.4		1693.0		1184.6	ton

Appendix 6

MDO prices from 1991 to 2013

Shipping Intelligence Network Timeseries

Date	41586 MDO bunker prices, Houston $/Tonne	41583 MDO bunker prices, Rotterdam $/Tonne	41592 MDO bunker prices, Japan $/Tonne	41587 MDO bunker prices, Singapore $/Tonne	41584 MDO bunker prices, Los Angeles $/Tonne	Average $/Tonne
1991-Q1	204.69	206.50	324.15	265.92	235.54	247.36
1991-Q2	147.62	151.85	253.46	170.00	206.42	185.87
1991-Q3	159.04	147.69	228.50	167.65	198.15	180.21
1991-Q4	171.38	170.96	230.31	179.81	198.62	190.22
1992-Q1	149.81	156.54	230.54	159.12	183.92	175.99
1992-Q2	161.92	166.69	228.19	166.81	192.77	183.28
1992-Q3	173.42	165.31	226.77	164.77	202.96	186.65
1992-Q4	172.46	156.65	230.69	165.62	190.42	183.17
1993-Q1	163.04	152.85	231.58	165.85	186.58	179.98
1993-Q2	161.15	162.04	238.81	166.12	199.65	185.55
1993-Q3	159.19	144.62	233.69	148.54	202.96	177.80
1993-Q4	157.93	143.46	231.89	146.79	206.61	177.34
1994-Q1	151.62	131.50	228.75	138.29	204.17	170.87

1994-Q2	147.35	132.69	233.46	140.54	204.73	171.75
1994-Q3	148.21	134.07	234.32	137.86	203.14	171.52
1994-Q4	147.69	130.77	232.77	148.62	182.15	168.40
1995-Q1	146.35	135.81	236.85	152.00	177.31	169.66
1995-Q2	149.77	147.15	235.42	152.08	181.92	173.27
1995-Q3	147.38	137.42	230.08	150.31	185.00	170.04
1995-Q4	149.04	143.19	237.54	155.58	185.00	174.07
1996-Q1	165.62	167.62	241.38	190.19	188.85	190.73
1996-Q2	178.12	161.69	275.23	188.92	202.31	201.25
1996-Q3	182.19	167.46	288.62	189.62	204.04	206.39
1996-Q4	218.92	203.81	297.73	217.04	215.27	230.55
1997-Q1	198.62	176.00	291.62	198.12	221.92	217.26
1997-Q2	178.23	149.77	285.73	185.73	217.88	203.47
1997-Q3	171.00	145.88	267.92	162.69	210.38	191.57
1997-Q4	173.50	151.62	242.46	165.08	210.62	188.66
1998-Q1	158.62	129.12	210.42	128.54	195.77	164.49
1998-Q2	141.65	120.50	189.58	121.54	175.19	149.69
1998-Q3	126.00	101.42	168.12	107.88	165.81	133.85
1998-Q4	122.31	99.31	169.19	106.08	151.88	129.75
1999-Q1	110.58	93.38	161.69	101.08	128.42	119.03
1999-Q2	123.04	112.46	164.96	126.88	153.35	136.14
1999-Q3	154.92	144.75	180.38	154.62	160.31	159.00
1999-Q4	186.29	179.93	208.07	183.96	189.18	189.49
2000-Q1	234.08	209.73	250.85	230.04	244.19	233.78
2000-Q2	234.73	211.81	276.04	223.50	260.62	241.34
2000-Q3	263.46	247.12	296.42	279.12	278.65	272.95
2000-Q4	293.81	259.85	330.08	263.54	303.96	290.25
2001-Q1	267.31	208.92	314.62	215.46	279.19	257.10
2001-Q2	232.58	197.73	306.65	222.62	265.73	245.06
2001-Q3	223.50	192.62	287.04	217.54	254.00	234.94
2001-Q4	188.85	162.81	273.81	173.81	216.58	203.17
2002-Q1	169.08	155.81	257.92	165.31	203.00	190.22
2002-Q2	191.42	182.46	257.31	208.19	235.31	214.94
2002-Q3	200.27	203.54	257.38	209.38	240.77	222.27
2002-Q4	223.81	210.69	258.46	229.19	255.42	235.51
2003-Q1	295.73	261.42	283.46	271.96	314.08	285.33
2003-Q2	260.19	206.85	273.85	219.77	320.58	256.25
2003-Q3	254.15	215.69	271.35	227.46	297.69	253.27
2003-Q4	248.50	235.88	274.42	247.58	290.27	259.33
2004-Q1	274.12	250.62	295.15	284.92	331.85	287.33
2004-Q2	295.15	278.92	323.54	301.62	393.04	318.45
2004-Q3	328.04	330.88	357.69	354.42	396.58	353.52
2004-Q4	414.18	390.43	414.64	392.86	464.64	415.35
2005-Q1	414.46	392.96	433.12	402.58	453.88	419.40
2005-Q2	477.81	438.08	545.00	473.81	550.38	497.02

2005-Q3	538.21	519.39	520.00	538.21	619.46	547.05
2005-Q4	602.69	482.50	518.08	510.58	669.42	556.65
2006-Q1	547.69	493.92	542.58	519.69	612.42	543.26
2006-Q2	576.27	566.35	612.15	629.81	704.38	617.79
2006-Q3	582.31	553.85	629.04	644.81	674.81	616.96
2006-Q4	541.12	480.81	585.23	528.58	617.38	550.62
2007-Q1	518.31	465.38	570.00	517.54	616.54	537.55
2007-Q2	568.17	531.50	566.04	597.65	696.42	591.96
2007-Q3	617.81	579.85	594.23	635.54	703.65	626.22
2007-Q4	735.23	712.12	694.92	741.50	827.96	742.35
2008-Q1	822.04	791.54	836.15	845.50	893.08	837.66
2008-Q2	1138.46	1060.69	1037.31	1159.50	1138.12	1106.82
2008-Q3	1110.04	1006.08	1162.88	1071.12	1125.38	1095.10
2008-Q4	672.42	555.77	703.27	559.12	661.62	630.44
2009-Q1	457.35	388.54	528.27	419.04	467.88	452.22
2009-Q2	469.73	462.23	521.15	492.08	503.42	489.72
2009-Q3	547.27	531.96	563.46	562.00	608.92	562.72
2009-Q4	624.00	576.58	615.38	596.23	675.85	617.61
2010-Q1	644.42	603.88	678.65	628.62	692.77	649.67
2010-Q2	669.04	665.54	715.38	664.54	713.81	685.66
2010-Q3	665.00	660.77	707.50	641.88	708.92	676.81
2010-Q4	754.82	739.71	758.25	724.11	770.57	749.49
2011-Q1	910.79	887.67	908.75	884.00	917.08	901.66
2011-Q2	1018.19	983.77	1018.15	973.38	1034.96	1005.69
2011-Q3	976.39	946.36	1001.36	938.21	986.54	969.77
2011-Q4	975.69	944.38	1006.54	939.81	992.50	971.78
2012-Q1	1029.62	991.23	1048.96	997.31	1039.85	1021.39
2012-Q2	960.85	931.62	962.96	921.92	1060.85	967.64
2012-Q3	995.27	941.31	936.88	939.15	1027.62	968.05
2012-Q4	995.58	946.77	962.69	936.85	1064.77	981.33
2013-Q1	1019.38	946.62	974.42	944.62	1071.92	991.39

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