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The Chemical Tanker Market

Does free competition cause for optimal use of vessels and the lowest possible environmental footprint?

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Abstract

In this thesis, I have assessed the impact free competition has on the productivity, costs and environmental footprint of the chemical tanker freight market. My impression is, after an extensive dialogue with participants of this market, that there is a general belief that a consolidation between operators in the market, would allow for a more sensible allocation of cargo, and therefore a more productive use of vessels, as well as a reduced environmental footprint. By comparing the current market situation under free competition with a simulated regulated market under a central planner, using the same input data in the two scenarios, I was able to complete a comparative study examining productivity measures (utilization of vessels and port congestion), changes in cost, and changes in CO2 emissions. Thus, I could ascribe the observed differences to the incorporation of market regulation, as this was the single factor differentiating the two. The simulation of a central planner and the following observations were that utilization of vessels increased, and port congestion, voyage costs and overall environmental footprint decreased under market regulation. In other words, free competition did in fact, based on this assessment, contribute to neither optimal use of vessels nor the lowest possible environmental footprint. However, when that is said, I also shortly evaluated who the beneficiaries of market regulation would be, and examined crucial challenges of implementing a central planner. Though the challenges are many and certainly cause for further research, the most predominant and vital challenge is that of setting the correct freight rate in a non-competitive setting. Assuming that it is possible in an efficient manner to achieve a correct price under market regulation, both ship operator and customers would reap benefits, as free competition in this case, does not cause for the optimal use of vessels and the lowest environmental footprint.

Preface

Working on this master thesis during this past spring has been both challenging and rewarding. When starting out this process my goal was to use this opportunity to further develop my knowledge and understanding of shipping economics. After completing the course INB426 Shipping Economics at NHH the fall of 2012 I developed a special interest in this field. Due to connections in the chemicals shipping market it was natural to grasp the opportunity to immerse myself into this specialized industry. When this writing process now is coming to an end, I believe I have increased my competence in the field of shipping economics as well as gained an in depth insight to the world of chemical shipping.

I would like to take this opportunity to thank both Odfjell Tankers and Marintek for crucial guidance throughout this process. A special thanks to Klaus Walderhaug, senior analyst at Odfjell for providing me with the necessary market and vessel data, and Victoria Gribkovskaia and Lars Noonås at Marintek, for guidance in methodology and model development. Finally I would like to thank my supervisor, Roar Os Ådland for helpful comments along the way.

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1. Introduction

After a continuing dialogue with members of the chemical tanker market as a part of the process of determining a research question for this thesis, I gained an impression that there is a general belief in the market that a consolidation between operators will allow for a more sensible distribution of cargo, and therefore a more productive use of vessels, in addition to reducing the industries environmental footprint. To determine whether there is truth to this idea, I have in this paper assessed the impact free competition has on the productivity, costs and the environmental footprint of the chemical tanker freight market. More specifically, the idea amongst operators is that using a central authority to consolidate in terms of cargo allocation will increase efficiency. As indicated by Triton Partners, a fairly new market player, there are advantages in operating larger fleets. Operating large fleets makes it is easier to minimize the number of vessel voyages carrying little to no cargo (Wright 2012), in other words increasing utilization. Further he indicates that being able to control more ships, you have the capability to co-ordinate the logistics part of operations more efficiently (ibid.).

Inefficiencies are also indicated to be a result of port congestion, due to the large number of vessels berthing at the same ports. Carriers in short sea shipping spends about 40% of their time either servicing cargos or waiting at anchorage (Jetlund and Karimi 2003). Odfjell vessels are indicating to be spending 44% of their available time in port (Walderhaug, 2013). By comparing the current market situation under free competition with a simulated regulated market under a central planner with the ability to redistribute cargo, I will attempt to determine whether *free competition in the global chemical tanker market causes for the optimal use of vessels and the lowest environmental footprint.*

In order to underpin this assessment I begin by introducing the chemical tanker market´s different fragments, actors and mechanisms in chapter 2 and 3. Following this, in chapter 4 I give an overview of some of the theoretical frameworks of shipping economics that will be useful for my assessment, as well as a presentation of the model I use in order to solve the scheduling problem of a simulated central planner. In chapter 5 I present the method by which I attempt to compare the two scenarios in addition to the parameters of which the comparison is based. Finally in chapter 6, I introduce the comparable estimates of the parameters for both scenarios. I then attempt to compare and analyze these estimates in order to draw some final conclusions in chapter 7.

2. The Chemical Tanker Market

Shipping in general is a broad industry defined as the transportation of commodities by sea. It is said that ocean going ships are the blood vessels of international trade and facilitate the expansion of the global economy, in other words shipping plays a crucial part of the global society (Christiansen, Fagerholt and Nygreen, et al. 2007). Due to the very different nature of commodities traded, one may divide shipping into different sub-industries or niches like for instance container shipping, liner shipping, bulk shipping, LNG shipping, chemicals shipping and so on. Each of these segments is characterized by many similarities as well as several crucial differences. The chemical tanker market is defined as the market for transportation of bulk liquid chemicals by sea (Østensjø 1992). A market is defined in the Oxford Dictionary (2010) as a regular gathering of people for the purchase and sale of provisions, livestock, and other commodities. In my case the market is a gathering of suppliers and buyers of the commodity "chemical shipping transport". In order to address my research question, it is crucial to have an underlying understanding of what the chemical tanker market consist of and further how it operates. In this section I identify the different market players and their role in the market.

2.1 Demand

2.1.1 The Buyers

In a market, the buyer is the player that requests a certain commodity (Pindyck and Rubinfeld 2009). In other words, they represent the demand side of the market. Simply put, the buyer is anyone requiring the transport of liquid chemicals from one specific port to another.

Customers of chemical transport are most commonly divided into four main categories, *manufacturers*, *receivers*, *trading companies* and *distributors* (Walderhaug and Hammer 2007). Manufacturing companies produce a specific commodity and sell it under their own name. If the manufacturing company pays for the transportation of the good, the manufacturer is the demander of chemical shipping. In the same situation, if the receiver of the specific commodity pays for the transportation, the receiver is the demander of chemical shipping. Chemical transportation is also often requested by trading companies who speculate in chemical prices therefore buying and re-selling commodities before, after and often while in transportation. In contrast to trading companies, distributers often buy large volumes of chemicals and redistribute it to many smaller buyers through shipping. In addition to transportation, distributers often require storage of their products at terminals (ibid.).

As one can see there is a large variation in the types and size of companies demanding chemical transportation. Buyers can be anyone from large companies like Shell Chemicals and Exxon Chemicals to independent market speculators buying and selling liquid chemicals wishing to make a margin off a product. On a global basis there are several hundred companies involved in buying chemical transportation, thus representing the demand side of the market (Walderhaug and Hammer 2007).

2.1.2 The Cargo

In order to understand the niche of chemicals shipping one must understand the nature of the commodities that are in demand of transportation. This is of importance because they affect, understandably the design of vessel that is used in transportation, but also the way the market interaction works, which I return to when describing market mechanisms in section 3.1. Liquid chemicals transported by freight are most commonly divided into four main product groups: o*rganic chemicals*, *inorganic chemicals*, *vegetable/animal oils and fats*, and *molasses* (Østensjø 1992). Organic chemicals are the largest segment, representing chemicals such as methanol, xylene and ethylene glycol. In 2008, 48% of chemical seaborne trade consisted of organic chemicals (Drewery Shipping Consultants 2009). Inorganic chemicals include among others, sulfuric acid, caustic soda and phosphoric acid, and stood for 17.5% of the trade in 2008. Vegetable and animal oils and fats counted for 26.8% of the trade in the market and involve transport of for example palm oil, soybean oil and rapeseed oil. Molasses is the smallest segment of chemical transport and involve the transport of molasses cane, base oils and molasses beet sugar (ibid.). In addition to these segments chemical tankers are also used for transport of special products such as lube oil, lube oil additives, alcohols as well as clean petroleum products like for instance jet fuel, paraffin, gasoline or naphtha (Walderhaug and Hammer 2007).

Chemical commodities such as these, all have different characteristics. Some may be reactive towards other commodities, causing a risk of spoiling the product or worse, safety hazards if not handled correctly. Also some of these products might need to be handled at a certain temperatures in order for it to maintain its liquid state necessary for shipment. In addition to the general security regulations put forth by the International Maritime Organization (IMO), the customer might also have additional handling requirements of its products, in order to maintain quality and quantity (Walderhaug and Hammer 2007). For example they might not allow the product to be moved from one tank to another more than twice (loading and discharge), making for instance transshipment difficult. Also the global focus on environmental issues in later years has increased the demand for stricter regulations with regards to the operation of chemical tankers. All these considerations make up a very complex and specialized transportation market specific for chemical tankers (ibid.).

2.2 Supply

Now that we have an idea of what makes up the demand side of the market I shift our focus to introducing the supply side. In order to supply transportation of a commodity by sea one must be in possession of a ship or a vessel. In shipping, vessels come in many shapes and sizes depending on the intended use (Stopford 1988). Dry bulkers, container vessels, tankers and specialized carriers are all examples of different ship categories, where each category has different variations of sizes as well as functionality areas. In the transportation of liquid chemicals, various sizes and types of tankers make up the supply (ibid.).

2.2.1 Chemical Tanker Vessels

Historically the first chemical tankers were introduced in the late 1950´s when there was a growth in chemical demand together with an expansion of the petrochemical industry (Østensjø 1992). Tankers for petroleum products built during the Second World War were converted into the first chemical tankers. The first ship owners were already in the oil trade and offered primarily short sea transport from the oil nations in the Middle East by the Suez Canal. The cost of converting of vessels was quite low and there were therefore many ship owners willing to invest. When refineries were set up closer to the consumer, the demand for transport increased creating a global market. During the 1960´s the first specially designed chemical tankers were developed opening up for a wider range of cargos to be carried at the same time (ibid.).

A tanker is defined as a sea going vessel fitted with tanks for carrying oil or other liquids in bulk (Encyclopædia Britannica Inc. 2013). Common tankers descending according to size are: *Ultra large crude carriers (ULCCs)* with a capacity of 320 000 to more than 550 000 dwt., *Very large crude carriers (VLCCs)* with capacities between 200 000 and 320 000 dwt., *Suezmax* with the capacity of 120 000 to 200 000 dwt., *Aframax* with capacities of 80 000 to 120 000 dwt., *Panamax* with capacities of 50 000 to 80 000 dwt., and *Handymax, Handysize, Coastal*, and other classes. These final vessels have capacities of less than 50 000 dwt., however some can be as small as a few thousand dwt., with lengths up to approximately 200 meters. These vessels represent the size of vessels operating in the chemical tanker market carrying liquid chemicals (ibid).

Today there are several types of chemical tankers dependent on their size as well as their ability to carry specific chemicals or for instance several chemicals simultaneously. Chemical tankers generally can be divided into five categories; parcel tankers, chemical carriers, solvents carriers, specialized chemical tankers and molten sulphur carriers (Stopford 1988). Most chemical tankers are parcel tankers. A parcel tanker is a vessel designed to carry different liquids in separate piping and tanks as illustrated in figure 2.1 below.

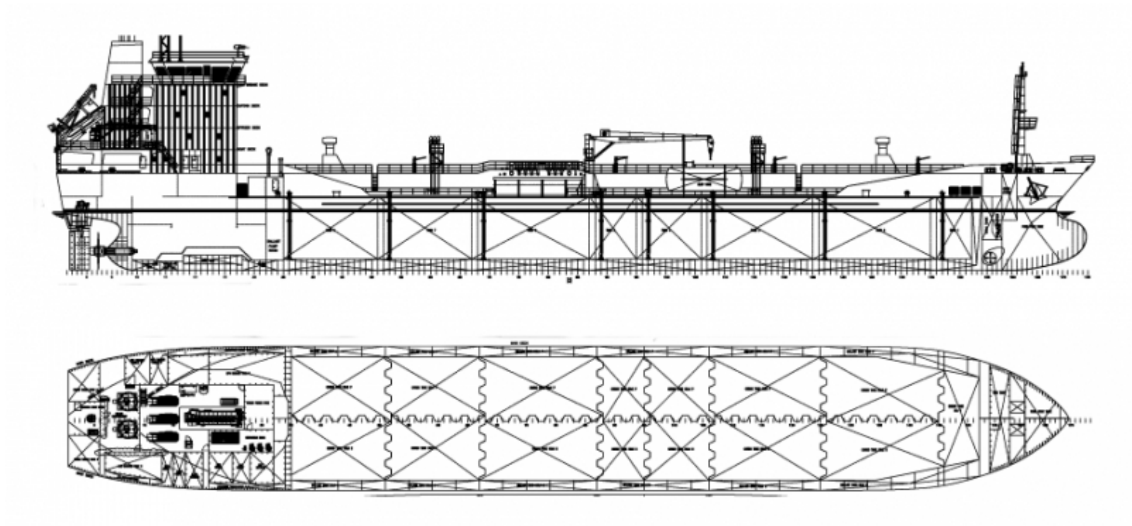

Figure 2.1: Chemical Parcel Tanker (Frydenbø Marine 2008)

One might also distinguish between deep-sea tankers and short-sea tankers, where deep-sea tankers are larger and are used for the longer distance trade lanes, while the short-sea tankers are smaller and service mostly coastal areas (Stopford 1988). A chemical tanker overall is often defined as IMO I and IMO II tankers, with stainless steel, zinc, epoxy, or marineline coated tanks. If one does not distinguish between parcel and chemical tankers, the chemical global fleet consists of 2 700 vessels of totally 47 million dwt. (Rex, et al. 2012).

As mentioned above the commodities carried by these vessels have many different characteristics and are therefore subject to many restrictions and regulations with respect to how they can be transported. A restriction mandatory for all chemical tankers is to have a double hull. In 1992 MARPOL was amended to make it mandatory for tankers of 5 000 dwt or more, ordered after July 6th 1993, to be fitted with double hulls (IMO 2013). The hull of a vessel is the body or shell. Requiring a double hull implies that the vessel must have two shells separating the commodities from the water. In 1995 a program was started to also include ships built before 1993. The program implied that all tankers would have to be converted or taken out of service when they reached up to 30 years of age. This measure was phased in over a number of years in order to avoid causing a disruption in world trade and industry. However due to the Erika catastrophe off the coast of France in December 1999, IMO Member States eventually decided to speed up the out-phasing of single hull vessels, and as a result most tankers today have a double hull (ibid.).

There are many different restrictions as to how one can carry chemicals, implemented by the IMO that effect vessel design and system complexity. Tankers as a result of this are some of the most technologically complex vessels in global shipping (Walderhaug and Hammer 2007). Products to be carried in bulk must be carefully considered with regards to their compatibility with other cargoes being carried and with the various tank coatings. Other necessary considerations are the method of containment, their heating requirements, pumping arrangements, tank cleaning procedures, etc. Chemical cargo tankers are constructed from either mild steel or stainless steel where the mild steel tankers are further coated with a protective covering. There are many different coatings offered in the market due to the large amount of mild steel tankers in the global fleet (ibid.). Examples of coatings are phenolic epoxy or zinc paint. Some cargoes require stainless steel due to their extreme corroding nature. Stainless steel containers have high initial costs and are therefore not offered by all operators (Østensjø 1992).

A vessels cargo system includes the tank compartments, pumping system, piping, venting system, cargo monitoring systems, environmental control systems and tank cleaning systems. The IBC code provides four types of cargo tanks: independent, integral, gravity and pressure tanks (Escola Superior Náutica Infante D. Henrique 2011). An independent tank´s boundaries are not part of the hull structure and therefore do not contribute to the structural strength of the vessel. These tanks are designed to eliminate the transfer of stress from the vessels structure to the tank structure and typically are deck tanks. An integral tank is formed by the hull structure by dividing the hull into several compartments creating the individual integral tanks. Integral tanks are the most common type of tank used on chemical tankers. Gravity tanks are either independent or integral tanks designed for a maximum pressure of 0.7 bar gauge at the top of the tank. Pressure tanks are designed for pressure greater than 0.7 bar gauge and are uncommon in chemical tankers (ibid).

The piping system that allows for the tanks to be loaded and discharges can be shared, however on modern chemical tankers it is more common to have completely segregated piping to each tank (Escola Superior Náutica Infante D. Henrique 2011). This makes it possible to service a larger range of commodities simultaneously. In a segregated system each tank is equipped with a deep-well pump and its own pipe system, completely segregating commodities. The tanks are also equipped with a tank cleaning system. After discharging a commodity, the tank must be prepared for the next cargo. The system by which this is done varies greatly according to the size, shape and material of the tank. Although not officially defined, there are two main washing standards, the "Water White" standard and the "High Purity" standard. The "Water White" standard leaves the tank clean, dry and odor free. The "High Purity" however is required when contamination of the cargo may lead to spoliation of the product or large safety risks. The customer might then also require the tank to be tested and approved before loading (ibid.).

2.2.2 New Building and Scrapping

Ship owners acquire chemical tankers either through the contracting of one or a series of new buildings or by the purchase of one or several vessels in the second hand market (Stopford 1988). When new buildings are delivered, the global fleet or supply increases, likewise when a tanker is scrapped, the global fleet or supply decreases. The growth rate of supply in the chemical tanker market can therefore be determined by the balance between deliveries and scrapping of chemical tankers in the market (ibid.).

In a shipping market review delivered by Danish Skibskredit in October (2012), the chemical tanker fleet was expected to grow only 3% in 2012. Deliveries were at the lowest level in ten years, as a result of cancelations, only 49% of the expected deliveries actually were delivered. About 40% of the vessels delivered were highly specialized chemical tankers with either stainless steel or marineline coated tanks. The remaining 60% were vessels with less sophisticated tanks, coated either with zinc or epoxy. Scrapping activity remained fairly high compared to previous years. During the first eight months of 2012 scrapping amounted to 0.5 million dwt. with an average scrapping age of 27 years (Rex, et al. 2012).

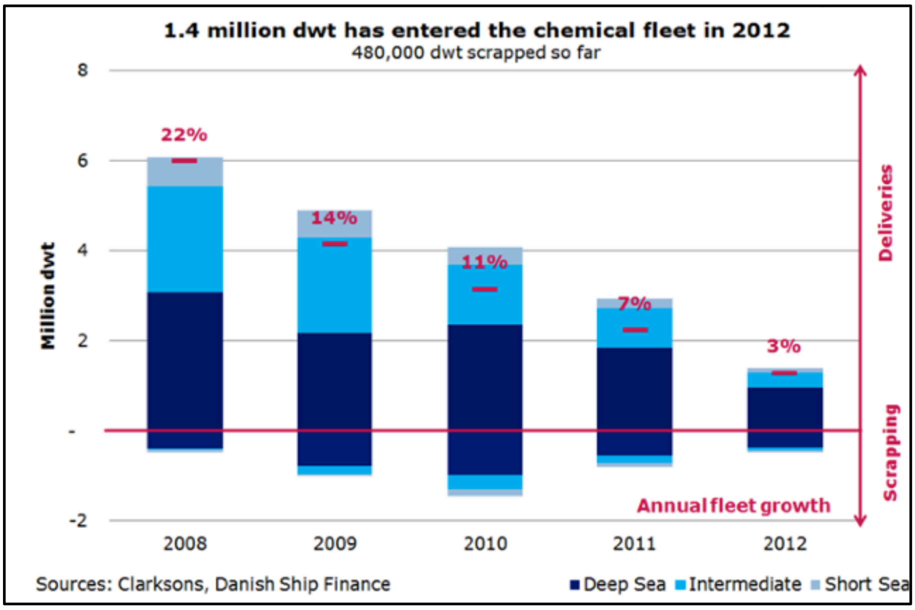

Figure 2.2 Annual Fleet Growths 2008-2012 (Rex, et al. 2012).

As shown in figure 2.2 above, there is a clear reduction of fleet growth over the last couple years. This reduction can possibly be ascribed to the downfall of the global trade following the financial crisis, thus the fall in chemicals shipping demand and as a result thereof reduced fleet expansion (Rex, et al. 2012).

2.2.3 Vessel Emissions

Today's global society has an increased focus on environmental issues due to the fear of global warming and the predictions of its consequences (Psaraftis and Kontovas 2009). Dreading these consequences of increasing greenhouse gas (GHG) emissions, the global community is constantly driving to address the problem in a more formal manner. According to the Kyoto protocol to the United Nations Framework Convention on Climate Change – UNFCCC (1997), reduction of carbon dioxide (CO2) emissions are necessary in order to curb the projected growth of GHG worldwide. CO2 is the most prevalent of the GHGs and it is obvious therefore, that any set of measures to reduce GHG primarily should focus on CO2 emissions reductions. Shipping has so far not been included in the Kyoto global emissions reduction target for CO2 and other GHG emissions. The seemingly recent high sense of urgency on this matter on the other hand will probably lead to an incorporation of global shipping in the near future (ibid.).

Today, international shipping stands for approximately 2.7% of global CO2 emissions (figure 2.3) according to a study presented by Øyvind Buhaug at the "Seas at Risk Annual Conference" in Brussels in 2008.

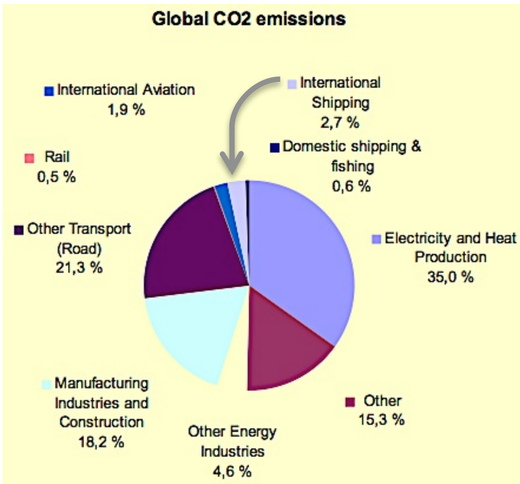

Figure 2.3 Global CO2 Emissions (Buhaug 2008)

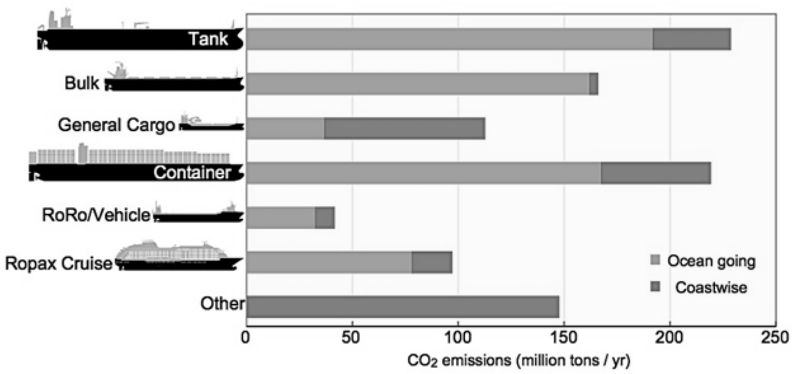

Figure 2.4: CO2 Emission from Global Commercial Shipping (Buhaug 2008)

Further it is determined that tanker vessels account for a significant share of this portion, see figure 2.4 above. One might further discuss whether port congestion for chemical tankers due to the large number of berth calls per vessel, might be contributing to this relatively large share of international shipping emissions. Psaraftis and Kontovas (2009) discover in their analysis that by changing the capacity utilization of a tanker, the CO2 emissions uniformly responded, telling us that an increase in utilization leads to a decrease in emissions. Their estimated utilization of tankers was approximately 50% compared to 70% for container vessels. Based on their findings one might assume that an increase in productivity will reduce the environmental footprint of the chemical tankers.

2.2.4 The Ship Operator

Going back to the initial definition of a market, which is a gathering of people for the purchase and sale of commodities, we can ask: who are the suppliers of chemical transport by sea? Behind each chemical tanker there is an owner or ship operator who make their vessels available to the market or in other words, offer the market the "product", chemical transport by sea.

In the 1960´s Norwegian ship owners dominated the market with vessels primarily under US, British and Norwegian flags (Østensjø 1992). The main players were from strong and historically grounded ship owning families like Stolt Nielsen, led by Jacob Stolt Nielsen, Odfjell who had been engaged in international shipping since 1914 and Anco Tanker Service, a coalition between Norwegians and the British after WW2. During the 70´s and early 80´s the growth was less rapid than expected due to the excess supply creating poor returns. Regulations of the vessels with regard to how chemicals were to be handled also caused an increase in new building during this period. There was a tendency towards building larger chemical tankers. Due to these conditions several of the ship owners struggled. Stolt-Nielsen experienced financial problems early in this period and was granted a loan by the American BP injecting capital to become 50% owner, thus causing the company to move from Oslo to the US. The Odfjell family restructured the company dividing into JO Odfjell/Johnsen and Odfjell. The latter continued the joint venture with Westfal Larsen, also a Bergen based company. Newer actors like Mowinckels and PanOcean-Anco left the market during this period leaving their fleets to be handed over to other competitors like for instance Stolt-Nielsen. In the late 80´s early 90´s there was a new increase of the fleet size, with an increase in capacity in tonnage of 85%. This growth eliminated to some extent the effect of the expansion of trade in the same period, causing worsened freight rates and employment. Due to these difficult times the market again saw that there was a tendency for concentration by which the strongest actors acquired smaller companies (ibid.).

As of today the main ship operators in the deep-sea chemical freight market are still the Odfjell and Stolt-families with a total market share of approximately 30%. Other operators are Tokyo Marine, Navig8 Chemicals, MISC and so on, with fairly small market shares. These estimates are based on the global fleet of suppliers operating mainly in chemical freight, deep-sea shipping comprised of vessels with IMO II capacity for the entire vessel, or at least the center tanks. In addition the vessels must have minimum 6 tanks with an average tank size of maximum 3000 cbm or minimum 50% stainless steel tank capacity.

Table 2.1 Overview of Ship operators in the Chemical Tanker Market as of March 2013 (Walderhaug 2013)

	Current fleet		
	#	**'000 Dwt**	**%**
Odfjell	79	2,574	16.4
Stolt-Nielsen	60	2,024	12.9
Total big two	**139**	**4,599**	**29.4**
Fairfield/Iino	50	1,311	8.4
Tokyo Marine	39	1,016	6.5
Navig8 Chemicals	45	840	5.4
MISC	26	831	5.3
Eitzen	26	688	4.4
Nordic Tankers	36	653	4.2
IMC/Aurora	16	617	3.9
BLT/Chembulk	21	523	3.3
Westchart	10	450	2.9
Dorval/Sinochem	23	400	2.6
Others	196	3,730	23.8
Total fleet	**627**	**15,656**	

Looking briefly at this overview of chemical tanker suppliers and their corresponding market shares (table 2.1), one can see that close to one third of the market is supplied by smaller operators categorized as “others”. This indicates that the chemical tanker market today is characterized by having a large number of small suppliers in addition to the historically grounded larger market players. This is in contrast to the high market concentration with only a few suppliers seen in the past.

2.3 Ports

The ports play a crucial role for any shipping segment, also for chemical shipping as they represent an important element of an extended supply chain (Stopford 1988). Primarily the role can include the facilitation of loading and unloading vessels, storage, freight handling, and transportation to or from the hinterland. Port activities are in other words seemingly heterogeneous products involving different actors (ibid.). Depending on the shipping segment in which one operates, for instance liner service or tramp shipping, the role of the port as well as the activities provided differ. In liner shipping, which I return to in section 3.2, the ship owner operates within a schedule and has fixed port rotations, while in tramp shipping the vessel has no fixed route and can theoretically therefore give notice of readiness and proceed to berth at any port in order to pick up a charter (Jetlund and Karimi 2003). In chemicals shipping, the ship owner operates his or her vessels with contracts as well as spot charters, cf. section 3.1. The contracts specify certain ports that must be called, however additional capacity is chartered in the spot market making port rotation unique and often unpredictable (ibid.).

The main activity at port is of course the loading and/or discharging of cargos to/from the chemical tanker (Stopford 1988). The procedure associated hereto varies from port to port. When a chemical tanker is approaching a port, the vessel first typically sends a notice of arrival to the port master. The port master or harbormaster is an officer with responsibility to execute the regulation of a port or harbor (Oxford Dictionary of English 2010). The authorities at the port in Singapore for example, require notifications latest 12 hours before a vessel´s arrival, and if the vessel is carrying hazardous cargo, they require the notification of arrival 24 hours in advance (Maritime and Port Authority of Singapore 2008). When the vessel is within the port operational area a second notification is reported to the port master called the conformation of arrival. The vessel then typically gives a specific notice to berth according to an intended rotation plan. However due to port congestion the berth might not always be available, the vessel is then typically ordered to wait or change the rotation plan. According to Jetlund and Karimi (2003) port delays are significant, as carriers in short-sea operation spend about 40% of their time in ports, either handling cargos or waiting at anchorage. The method of which a port handle port operations and costs varies, some might operate with contracts where one pays for a specific slot in advance, however most commonly ports facilitate vessels at a first come first serve basis. This is considered an inefficient method due to the fact that it disregards the differences in waiting costs. After a vessel has given notice of arrival there is normally a six-hour free waiting period before the vessels agreed laytime begins to run, regardless as to whether or not the vessel still is waiting for anchorage. The laytime is the amount of time the vessel uses to load and/or discharge the cargo required at berth (Oxford Dictionary of English 2010). All time used in addition to the pre-negotiated laytime, is charged the customer by the ship owner, and however is possible to negotiate. The extra charge is called demurrage and is defined as the amount payable to the owner of a chartered ship on failure to load or discharge the ship within the time agreed (Oxford Dictionary of English 2010). Odfjell alone collected approximately 60 million USD in demurrage in the coarse of 2012 indicating that chemical tankers spend a considerable amount of time waiting in ports (Walderhaug 2013). They have estimated that their vessels spend approximately 44% of their service time in port, 25% of this, presentably 10% of total available time, represents waiting for berths (ibid.).

When a chemical tanker has berthed, the applicable cargo is to be loaded or discharged. As mentioned above, chemical tankers are equipped with a complex piping system that makes it possible to discharge or load essentially all tanks simultaneously. This is done simply by connecting the ports pipe system (normally a hose) to the specific outlet of the tank one wishes to load or discharge followed by starting the pumps. Cargo is then transferred through this piping system, typically to storage tanks where the customer can further distribute the commodity to the hinterland. The possibility of storage is typical for chemicals transport and is therefore why one might refer to these complete port facilities as terminals. Other port activities may include vessel maintenance, classification inspections, and so on.

The pricing of port activities is done differently from port to port. No two ports are similar. Typically port pricing differentiates according to vessel type and destination, location of operations in the port territory, processing time and season. The fact that these points of differentiation do not reflect actual cost incurred under port operations causes severe inefficiency at port. In an article by Strandenes (2004) alternative pricing methods are researched as a method to reduce port congestion. Traditional port pricing is typically characterized by lack of transparency, favoring regional and coastal shipping, favoring exports and differentiated cargo charges (ibid.). In addition to this, the lack of expansion of ports compared to the increase in port demand from an expanding Asian economy is considered to cause additional port congestion (CEMT/ITF 2007).

3. Market Mechanisms

Now that I have established the elements involved in the chemical tanker market it might be appropriate to further introduce how the market works, the market mechanisms, which essentially means the interactions between supply, demand and price that determine the reallocation of resources and again quantity of transport supplied (Pindyck and Rubinfeld 2009).

3.1 Chartering

When buyers and sellers meet in the market, they negotiate price and terms for transportation of a specific commodity. The purchase of transportation of liquid chemicals by sea is negotiated and purchased predominately through spot chartering, entering into contracts of affreightment or by time chartering one or several ships (Stopford 1988).

3.1.1 Spot market

The spot market is comprised of single voyage charters for the transportation of one or a combination of cargos (Walderhaug and Hammer 2007). The price of transportation of a specific cargo from one point to another is called the spot freight rate. The freight rate is determined based on the interaction between the supplier's marginal cost and the demander's willingness to pay. The buyer expresses a demand for a specific charter and the ship owner then follows by tendering an offer. The best offer normally wins the charter. According to Norman (1980) the tanker market is a highly efficient. The spot market is often used in order to reap the benefits of short-term arbitrage possibilities, to secure competitive freight rates in booming markets or to postpone the locking of contract freight rates in low markets (Walderhaug and Hammer 2007).

3.1.2 Contract of Affreightment

A contract of affreightment (COA) is an agreement between a charterer and a ship owner for the transportation of one or several commodities over a period of time (Østensjø 1992). COAs are typically entered into for 12 or 24 months at a time and account for about 50% of all bulk liquid chemical transport worldwide. Like in the spot market, COAs are negotiated and tendered between the buyer and ship owner. In many ways one can consider COAs as a series of spot charters with built in flexible terms (ibid.).

A COA often guaranties the quantity of cargo to be transported during a specific period of time between certain ports (Walderhaug and Hammer 2007). There are however limitations as to minimum and maximum quantity as well as the number of parcels per lifting. In chemical shipping these contracts binds the ship owner for having to make vessels available for a customer in cycles. Most commonly the contracts involve having a vessel available once a month due to the customers wish to adapt according to changes in chemical prices. COAs in which the volume is not guaranteed are called requirement contracts. The COA is beneficial for the charterer as it secures the transportation of his or her commodity from a known and perhaps trusted source. In a longer production chain the contract, contrary to the spot market, might provide savings in time as well as overall costs. The ship owner secures employment of his or her vessel over a period of time through these contracts and is therefore able to reduce market exposure (ibid.).

3.1.3 Time Charter

It is also possible for a customer to charter a vessel on a time charter basis (Stopford 1988). Under a time charter the owner still manages the vessel, but the charterer selects the ports and directs the vessel where to go. The charterer covers all voyage specific costs and pays a daily hire to the owner of the vessel. A charterer may wish to do this because they can justify the need for the entire capacity of a vessel, or in order to keep a closer quality control due to special product requirements or for example to reduce the risk of untimely delivery. However there are disadvantages in the fact that the vessels voyage costs in this case would not be split on several charterers as well as limiting flexibility with regards to reaping the benefits in periods where there otherwise are low freight rates (ibid.).

3.1.4 Bill of lading

When traders buy and sell commodities in the market the ownership of the commodity changes frequently, also when under shipment. The owner of the commodity while under shipment is the person holding the bill of lading. The bill of lading is a receipt for goods delivered to and received by a ship, signed by the person who contracts to carry them, or his agent, and evidencing the terms of contracted of carriage under which the goods have been delivered and received (Burden, Barlow and Barlow 1992). During the period of transit and voyage, the bill of lading is recognized as the symbol of the goods described in it, and the endorsement and delivery of the bill of lading operates as a symbolic delivery of the goods. This allows for market speculators to buy or sell cargo while in transit by handing over the bill of lading. Hence s.1 of the Bills of Lading Act 1855 provides that an endorsee or consignee of such a bill of lading "... shall have transferred to and vested in him all rights of suit, and be subject to the same liabilities in respect of such goods as if the contract contained in the bill of lading had been made with himself". A bill of lading is in other words a combination of a receipt for the goods, evidence of the terms of the contract of carriage, and a document of title (ibid.).

The method of which a customer wishes to charter its cargo is therefore based on the “type” of customer and his or her specific needs. Generally speaking, the spot market is typical for customers demanding single voyage transportation; the COAs are typical for customers with continuing needs for transportation over time, often to and from the same ports, while the time charter is common for larger customers with the need for closer quality control. Finally, the bill of lading, as part of all charter agreements is considered a tool often used by market speculators in order to buy and sell commodities while still in transit.

3.2 Ship owner’s operational motivation (Supply)

The shipping industry is often categorized into three main segments based on their mode of operation, *liner*, *industrial* or *tramp* shipping (Stopford 1988). Liner shipping involves vessels following a fixed route according to a public schedule. A liner operator, like an operator of container ships, wishes to operate its vessels so to maximize the earnings. Liner shipping can be compared to a bus service in the sense that it follows a given route according to a given schedule, at a speed and with a vessel that maximizes profit (Jetlund and Karimi 2003). Like there are frequent departures at busy bus stations, there are frequent departures from busy liner terminals (ibid.).

Industrial shipping is when the ship operator owns the vessel, as well as the cargo and operates with an intention to minimize costs within their extended supply chain. The quantity supplied, in other words the number of vessels, therefore reflects the exact amount necessary in order to meet their own demand (Stopford 1988).

Tramp shipping on the other hand, is when the ship owner or operator offers them vessels with available cargo capacity in order to maximize the earnings (Stopford 1988). Tramp shipping is often compared to a taxi service by the fact that nobody operates with a fixed schedule or route, but elects the passengers to be serviced based on their contribution to the marginal profit, which often is determined based on how a particular passengers requested route fits in with the place where the taxi is going or coming from (Jetlund and Karimi 2003). The chemical tanker market is as mentioned a form of tramp shipping. The ship owner in tramp shipping considers taking cargos like the taxi driver considers passengers. How will serving this customer increase the marginal profit? However unlike taxies, chemical tankers can carry several cargoes from different customers simultaneously. In chemical shipping the cargo sizes are small and a combination of several customers cargoes are often necessary to fill a single vessel. The market therefore rests on the concept that you can combine customer's cargo on the same vessel and the same voyage. This is also in contrast to the general tanker and bulk market where one often fills the entire vessel with a single cargo. In chemical shipping the ship owner first commits a vessel to the customers with existing COAs. The remaining capacity is filled using the spot market. The ship owner therefore has a set of commitments by which the vessel must call, and evaluates all additional cargos with consideration to these limitations. Each new cargo added in addition to the COAs, is a marginal consideration. For instance if a ship owner has nominated vessel A to commit to a set of contracts that give him the obligation to call certain berths in Houston, Freeport and Corpus Christy before proceeding, his additional cargo capacity can then be filled by spot cargos for charterers from this area with the motivation of increasing vessel A´s marginal profit. In many ways one can compare this type of operations to selling Christmas trees, where all spaces or capacity has to be sold before a given date. All Christmas trees must be sold before Christmas Eve, like all tank capacity must be chartered before the vessels sets sail for its final destination (Walderhaug and Hammer 2007).

3.2.1 Drivers of supply

Market supply is the number of vessels available and their aggregated capacity to transport cargo. The number of vessels owned or controlled by the various operators is given by the costs connected to operating the vessel as well as the level of demand for capacity in the market. Contracting of new buildings for the first eight months of 2012 was historically low with only five contracts signed during this period (Rex, et al. 2012). Ship owners decide to adjust their fleet size when they are confident that additional unit of capacity can be utilized to increase revenue from the freight market, as lay up of vessels are costly (Lun, et al. 2013). One might therefore conclude that the factor market and freight market are heavily interlinked where seaborne trade and freight rates affect the number of ships provided.

An updated table of the historical development of the chemical tanker fleet is presented in table 3.1 below. As can be seen, the global chemical fleet in total grew 4.4% in 2012. This represents a contrast to the high growth rates in the years 2004-2010 of around 14%. This might be explained by high demand in the market prior to the financial crisis (see figure 3.1). Ship owners expectations to continuing high freight rates might explain the high number of new buildings that were delivered in the following years causing a considerably increase in the global fleet in the period 2004-2010. A drop in demand as a result of the financial crisis in 2008/09 (see figure 3.1) lead to the more recent low growth rates as new buildings were rarely contracted during the crisis, cf. the 2012 growth rate of 4.4%.

Table 3.1: Historical Development of Chemical Tanker Fleet *(No. and '000 dwt)*

Start of	Small		Handysize						Handymax				Total >1,000 dwt		Growth
Year	1,000 - 9,999		10,000 - 19,999		20,000 - 29,999		30,000 - 39,999		40,000 - 49,999		50,000 +				p.a.
	No.	000 Dwt	No.	000 Dwt	No.	000 Dwt	No.	000 Dwt	No.	000 Dwt	No.	000 Dwt	No.	000 Dwt	%
2002	1 136	5 202	320	4 622	112	2 881	208	7 430	116	5 202	5	313	**1 897**	**25 650**	6,0%
2003	1 166	5 392	340	4 938	117	3 006	217	7 824	145	6 480	5	313	**1 990**	**27 953**	9,0%
2004	1 210	5 654	367	5 402	121	3 099	250	9 038	179	8 013	5	313	**2 132**	**31 519**	12,8%
2005	1 246	5 845	394	5 832	125	3 181	282	10 213	221	9 904	6	407	**2 274**	**35 383**	12,3%
2006	1 305	6 161	435	6 486	134	3 428	305	11 051	260	11 652	22	1 341	**2 461**	**40 120**	13,4%
2007	1 366	6 407	510	7 599	137	3 494	332	12 058	301	13 478	42	2 365	**2 688**	**45 403**	13,2%
2008	1 428	6 742	614	9 138	139	3 525	368	13 417	352	15 815	64	3 560	**2 965**	**52 198**	15,0%
2009	1 535	7 391	771	11 491	145	3 666	400	14 597	406	18 277	127	6 889	**3 384**	**62 310**	19,4%
2010	1 636	7 994	898	13 441	148	3 731	415	15 156	456	20 559	181	9 706	**3 734**	**70 587**	13,3%
2011	1 673	8 206	972	14 612	148	3 719	427	15 596	486	21 938	226	12 099	**3 932**	**76 171**	7,9%
2012	1 708	8 451	1 019	15 373	156	3 913	427	15 586	501	22 630	255	13 576	**4 066**	**79 530**	4,4%
2013	1 735	8 636	1 037	15 703	160	3 995	419	15 304	518	23 415	278	14 754	**4 147**	**81 806**	2,9%
march-13*	1 735	8 637	1 039	15 735	160	3 995	420	15 341	523	23 651	289	15 312	**4 056**	**82 671**	

*~ Indicates highest IMO grade on vessel. *Data as at start month.*

Note : The Historical Fleet data show the position as at 1st January each year, and take into account subsequent changes to the database. Totals include chemical tankers of unknown chemical grading. The Clarkson Fleet Changes database is compiled under procedures accredited to ISO9002 Quality Standards.

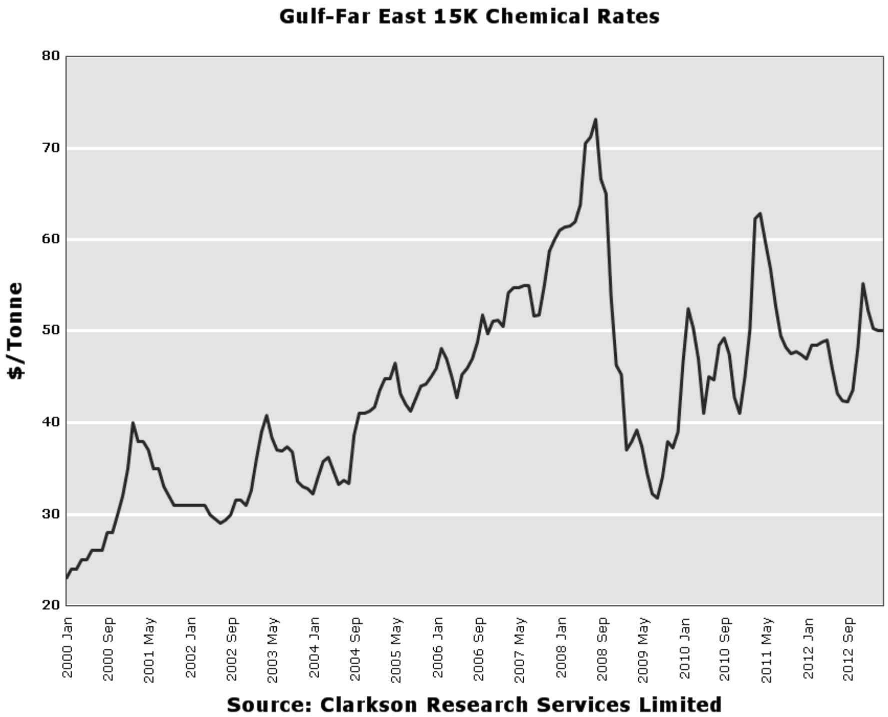

Figure 3.1Freight Rate Development on the US Gulf-Asia Trade Lane (Clarkson Reasearch Service 2010)

In addition to supply being affected by freight rates and global demand, it is also indirectly affected by the price of tanker fuel. Being that fuel costs are the most significant voyage specific cost, the bunker price also affects the tanker market in determining the speed at which a vessel is set to go. When fuel prices are high, the voyage costs increase resulting in a reduction of the earnings. Thus if freight rates in a period are low, a ship owner might choose to slow steam in order to minimize the costs thereby reducing the total supply in the freight market (Strandenes, Is there potential for a two-tier tanker market ? 1999). Empirical evidence from the dry bulk capsize sector however, shows that speed as an adjustment factor is in fact not used to the same extent as predicted through theory (Ådland 2013). One could consider whether the same is expected from the chemical tanker market.

3.3 Customer motivation (Demand)

When a customer wishes to transport cargo from one specific berth on the US coast to one specific berth in Asia they normally tender a request in the market. The suppliers then respond with a set of price and terms for the specific voyage, a spot, or a COA price if the tender is for a set of voyages within a time period. The supplier with the best offer normally wins the tender. The customer wishes to minimize its cost of transportation. With a large number of suppliers and assuming them all to deliver identical service the price or in this case the freight rate the customers must pay, will at the lowest be equal to the marginal cost of service (Walderhaug and Hammer 2007). The marginal cost of service differs with regards to the time horizon of which it is evaluated (Pindyck and Rubinfeld 2009). In the long run a ship operator is more flexible and has the possibility to adjust capacity through new buildings or acquisitions through the secondhand market, thus including capital costs. In the short run however the ship operator is unable to adjust the capacity causing the marginal cost to include only voyage specific and operating costs (Evans and Marlow 1990). Capacity may however to some extent be adjusted by speeding up or slowing down the vessels, cf. section 4.1.1.

Other additional considerations for the customer are timeliness, regularity and quality control, which might cause them to choose a more costly provider (Walderhaug and Hammer 2007). If the customer has high costs for tardiness in their further production and are dependent on the product being delivered at the specific point in time, they might be willing to pay more in order for this to be secured. Also customers might be willing to pay more in order to reduce the risk of cargo contamination or loss. This also might affect with whom a customer wishes to charter their cargo (ibid.).

3.3.1 Drivers of demand

The demand for chemical tankers is influenced mainly by the trends in the world economy, the restructuring of production facilities, feed stock prices, tariffs, quotas, protectionism and exchange rates (Stopford 1988). As mentioned in the introduction to chapter 2, shipping is considered the blood vessels of the global economy. The relationship between the global economy and sea trade is however is not obvious. Generally there are three main aspects of the world economy that may bring change in the demand for sea transport: the occurrence of business cycles, the long term trend relationship between the growth of seaborne trade and the growth of the world economy, and the occurrence of economic shocks (ibid.).

The demand for sea transport also depends on the distance over which a cargo is to be shipped (Stopford 1988). Cargo shipped from Ulsan to Houston therefore generates far more demand for sea transport then the same cargo shipped from Ulsan to Shanghai.

3.4 The Rules and Regulations of The Market

When operating in a global market one is accountable to several jurisdictions. As mentioned earlier chemical tankers are subject to security requirements determined by IMO, MARPOL and the IBC code. In addition to these environmental and safety regulations, governments also monitor market transactions in order to maintain free competition and therefore efficient trade.

Ship operators are subject to trade regulations in terms of “game rules” to safeguard the market competition. The Norwegian Competition Law 1993 (not applicable for business only outside of Norway) provides restrictions enforcing competition, like other regulators such as the EU and the US. The EEA treaty article 53 states that “the following shall be prohibited as incompatible with the functioning of this agreement: all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Contracting Parties and which have as their object or effect the prevention, restriction or distortion of competition within the territory covered by this Agreement, and in particular those which:

a) directly or indirectly fix purchase or selling prices or any other trading conditions;
b) limit or control production, markets, technical development, or investment;
c) share markets or sources of supply;
d) apply dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage;
e) make the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts”

(EU Commission 1994)

In other words, any participants in the market who limits competition from flowing freely in the form of fixing prices, controlling production or in any way defer from operating independently, will be sanctioned. Similarly the Us Sherman Act §1 states that “Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States, or with foreign nations, is declared to be illegal." (Encyclopædia Britannica Inc. 2013).

To sum up, it is illegal to fix prices among competitors, share the market or customers, to co-operate with competitors in relation to tenders (bid rigging) or agree with competitors to restrict supply or boycott customers, or act in any way that contributes to reducing free competition in the market. These rules are set with the clear motivation to maintain an efficient market driven by free competition. In late 2003 The EU and US government opened an investigation of Stolt Nielsen and Odfjell SE based on suspicion of an anti competition cartel had been formed (Daly 2008). In April 2007, the European commission sent out statements of objections to the companies, accusing them of bid-rigging, price-fixing and exchanging confidential market information regarding the transportation of bulk liquids by sea, this way restricting competition in the EU market violating the EEA Treaty, they were however exempted based on the treaty's article 81. The US government as a result of these competition-distorting activities invoked sanctions on them in US jurisdiction (ibid.).

4. Theory

Now having presented a basic description of the chemical tanker market, its participants and mechanisms, I in this chapter give an overview of theoretical frameworks and concepts of shipping economics. These concepts will compose the basis of my analysis, as well as provide a general understanding of the economics of shipping.

4.1 The Chemical Tanker Market

The chemical tanker market, as described in chapter 2 is made up of supply and demand. Supply can be defined as the amount of a product available for a customer, while demand is considered the amount of product asked for by the customer (Oxford Dictionary of English 2010). We can, using economic theory, portray and analyze how these two factors interact with each other when for instance environmental factors or base assumptions change.

4.1.1 Supply Curve

The supply curve in shipping economics is a function of the capacity of the vessel and number of vessels, as well as the speed at which each vessel sails (Strandenes 1999). The supply function of a perfectly homogenous fleet is typically expressed as follows: $S = l * dwt * \bar{m}(12 - o)r(s)$, where *l* is the load factor, *dwt* is the capacity, $\bar{m}$ is the mean distance travelled by the vessels and *r(s)* is the number of trips travelled per month, corrected by the number of months off hire (*o*). The supply curve is illustrated in the figure below and is commonly referred to as the “hockey stick” based on its form. It consists of four parts; the part above maximum speed, the elastic part or curve, the part below minimum speed (p*) and the lay up rate (*pu*) (ibid.). The shape of the supply curve does however change at different marginal cost levels based on the technological specification of the vessel. Looking at the mathematical supply function above, one can determine that for instance, vessels with different load factors, or speed range would cause the supply function to take a different form, possibly increasing the steepness of the curve. Further more the global fleet most often does not consist of perfectly homogenous vessels, but vessels of many different sizes as well as technological specifications. However this theoretical framework provides us with insights in the composition and behavior of supply in the market.

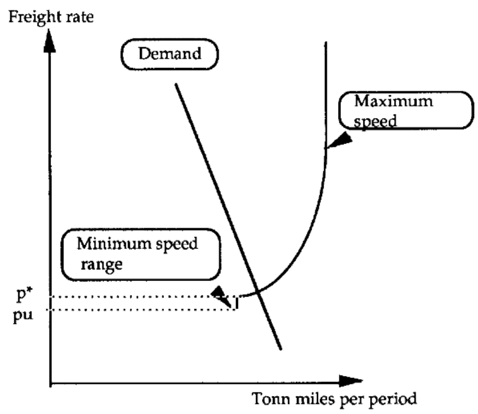

Figure 3.1: Supply and demand curve for the tanker market (Strandenes, Is there potential for a two-tier tanker market ? 1999).

In figure 3.1, the tanker market is inactive at freight rates below *pu*, the vessels in the fleet lay up. It is more costly to operate the vessels than what is earned through freight rates. When the freight rate reaches p^* the vessels operate at minimum speed and with freight rates passing p^* the ship operator will increase speed, causing the hockey stick shape of the curve. When all vessels are operating at full speed we have reached the vertical part of the supply curve limiting capacity (Strandenes 1999). Supply can only expand by contracting a new building of an additional vessel pushing the supply curve to the right like in figure 4.2 (Stopford 1988).

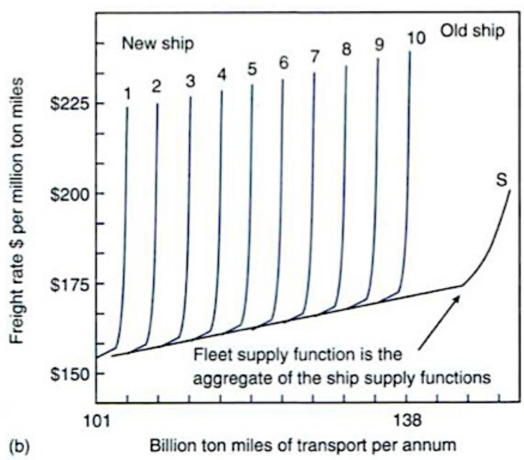

Figure 4.2: Aggregate Supply Curve (Stopford 1988)

4.1.2 Demand Curve

The demand curve shows how much of goods or services consumers are willing to buy as the price per unit changes (Pindyck and Rubinfeld 2009). The demand curve is an exogenous measure of the total demand for chemical transportation in the market. It is an expression of the charterers' willingness to pay in terms of freight rate per ton-miles transportation. Figure

3.3 shows a highly inelastic demand curve, indicating that the charterer's willingness to pay is high, for the same amount of transportation. The demand curve is downward sloping from the left to the right based on the law of demand that states that buyers will increase their number of purchases of a product when its price falls, and will decrease their number of purchases when its price rises (Y.H.V. Lun 2010).

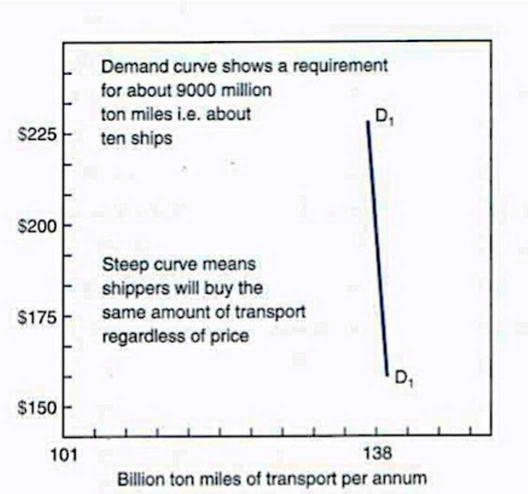

Figure 3.3 Demand Curve (Stopford 1988)

The inelasticity of the curve might be a result of few alternative options for transportation (Stopford 1988). Given that the chemical tanker market supplies the transportation of liquid bulk chemicals, a commodity with many special requirements in transportation, one would assume that the demand curve would be somewhat inelastic, similar to figure 3.3 above. If alternative transportation methods become available as possible substitutes for chemical tankers, like for instance chemical containers, the demand curve would possibly become more elastic. This given that the customer would be able to transport the same amount of transportation to a lower price causing their willingness to pay to be reduced (Pindyck and Rubinfeld 2009). Demand elasticity is also affected by the cost of the good transported. The lower the cost of sea transport as a proportion of the total cost of the final good, the more inelastic the demand for sea transport will be (Y.H.V. Lun 2010). One should think that the high value of the chemical commodity contra the low value of for instance coal would cause the demand curve in the chemical tanker market to be more inelastic than for instance the dry bulk market. In addition to this the demand for sea transport tends to be price-inelastic in the short run (ibid.).

The demand curve is also directly affected by the demand for the commodities transported, liquid bulk chemicals cf. section 2.1.2 (Stopford 1988). This affects the positioning of the curve; a fall in demand for liquid chemicals results in a shift to the left, while an increase in demand causes a shift to the right. In the wake of the financial and economic crisis, when spending is and was restricted, the chemical tanker market expected the demand for almost all chemical commodities to suffer (Drewery Shipping Consultants 2009), shifting the demand curve to the left. In subsequent years however, an increase in chemical tanker demand is predicted (ibid.), possibly shifting the demand curve to the right.

4.1.3 Freight Rates

The market price or freight rates are determined in the intersection of the supply and demand curve (Stopford 1988). This is the rate at which the market is cleared. The "hockey stick" curve in the supply function causes for two separate regimes of the tanker market, a high rate and low rate regime. Under high rates one is situated to the right on the supply curve above the elastic bend, where small changes in demand lead to large changes in freight rates. Under low rates the left side of the supply curve, the elastic part, changes in demand cause for minimal changes in freight rates (ibid.).

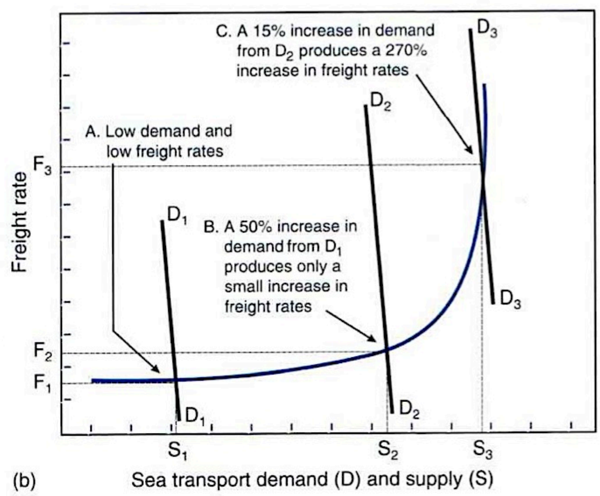

Figure 3.4 Changes in demands effect on freight rates (Stopford 1988)

4.1.4 Market Interactions

There are four interlinked markets in the tanker shipping industry, the freight market, new building market, second hand market and the scrapping market (Lun, et al. 2013). Sea transport services like assessed herein are dealt with in the freight market. However, a ship owner is exposed to the other three markets as new vessels are ordered and built in the new building market, used vessels are traded in the second hand market, and old or obsolete vessels are scrapped in the demolition market. These markets can be considered as a factor market. Being that vessels supplied in the freight market are provided and recalled through the factor market, we can consider these two as interlinked. The demand in the freight market reflects the prices and activity in the other markets. When there are future expectations of increasing freight rates, ship owners then wish to expand fleet capacity therefore causing an increase of demand for new buildings or for purchases in the second hand market driving up the value of a vessel (ibid.).

4.2 An Efficient Market (Free Competition)

A market as mentioned is defined by the Oxford Dictionary (2010) as a regular gathering of people for the purchase and sale of provisions, livestock, and other commodities. The chemical freight market is a gathering of suppliers and buyers of the provision of transport by tankers. The price of the provision is determined based on the interaction between the supplier's marginal cost (supply) and the buyer's willingness to pay (demand) (Stopford 1988). In a perfectly competitive market the supplier services at the level at which these two aspects are equivalent. Changes in supply or demand effect the price of the provisions, for example if the cost of input increases, the marginal cost for the suppliers would increase and therefor shift up causing an increase in price (Pindyck and Rubinfeld 2009).

What is an efficient market with perfect free competition? The model of perfect competition rest on three basic assumptions; 1) price taking, 2) product homogeneity and 3) free entry and exit (Pindyck and Rubinfeld 2009). Assuming that there are many suppliers, each individual firm sells a sufficiently small proportion of total market output, thus their decisions have no impact on market price. Therefore each competitor takes the market price as a given, assumption 1. Secondly in order for the players in the market to be in competition with each other, they will have to produce identical products that are perfectly substitutable with one another, product homogeneity; assumption 2. Finally, there must be no entry or exit barriers so that suppliers can easily enter or exit according to their ability to make a profit; this way a buyer can easily switch from one supplier to the next. In order for a market to be in perfect competition all of the three assumptions above must be held. In most markets these assumptions are unlikely to hold (Pindyck and Rubinfeld 2009).

4.3 Simulating The Central Planner – Regulated Market.

A central planner can be defined as a person, government, or organization that controls the development of a given subject (Oxford Dictionary of English 2010). The most well known central planners are probably the Soviet government enforcing a planned economy in former Eastern Europe. Here the Soviet government determined production, investment, prices, and incomes (Encyclopædia Britannica Inc. 2013). In contrast to central planning of the Soviet who acted in self-interest, the central planner in a global chemical tanker market should aim to improve productivity of the market as a whole, thus seeking to improve the interests of all market players. The central planner should attempt to do this by taking advantage of better information achieved through the consolidation of economic resources when making decisions regarding for instance, the composition of routes and distribution of cargoes.

Nagurney (2007) defines transportation networks as complex large-scale systems that come in a variety of forms, such as road, rail, air, and waterway networks. Further she describes that from an economic perspective, the supply in such network systems is represented by the underlying network topology and the cost characteristics. This could for example be the time charter equivalent for a specific vessel. The users of the transportation system represent the demand, so for chemical tankers that would typically be the charterer wishing to transport chemicals from port A to B. An economic equilibrium in the transportation network occurs when the number of trips between an origin and destination equals the travel demand given by the market price (Nagurney 2007). In other words a transport network in equilibrium occurs when all cargoes demanded are served.

The aim of the central planner will be to attempt to improve productivity by taking advantage of better information when making decisions regarding route scheduling and vessel assignment, while at the same time serving all requested cargo transportation keeping the transport network in equilibrium. The object of the scheduling problem is to minimize the sum of the costs for all the ships in the fleet. By doing this the central planner can find an optimal solution preserving the interest of all market players as well as the interests of society as a whole. The cargoes that are lifted from loading ports must also be unloaded at the corresponding unloading ports. The chemical tanker vessel, as described in section 2.2.1, is able to carry several cargoes simultaneously. In order to solve the scheduling problem of assigning vessels to routes so as to minimize the total cost, one can use a mathematical model like the one presented in the article "Ship routing and scheduling, status and trends" by Christiansen et al (2002).

The mathematical formulation of the model for a given planning period is presented in the article using the following notation: Denote the set of ships (fleet) to be scheduled as V, indexed by v, and let N be the set of cargoes, indexed by i. They then make the assumption that for each ship v, a set of candidate schedules (or routes) is available, denoted R_v, and a specific schedule is indexed by r. Further they let c_{vr} be the transportation cost for sailing schedule r by ship v, and constant a_{ivr} is equal to one if schedule r for ship v services cargo i and zero otherwise. Let x_{vr} be a binary variable that is equal to one if ship v sails schedule r and zero otherwise. The set partitioning formulation of the scheduling problem can then be given as follows:

(1) $$min \sum_{v \in V} \sum_{r \in R_v} c_{vr} x_{vr}$$

(2) $$\sum_{v \in V} \sum_{r \in R_v} a_{ivr} x_{vr} = 1 \qquad \forall i \in N$$

(3) $$\sum_{r \in R_v} x_{vr} = 1, \qquad \forall v \in V,$$

(4) $$x_{vr} \in \{0,1\}, \qquad \forall v \in V, r \in R_v$$

The objective function (1) minimizes the transportation costs, which also is the motivation of the simulated central planner. Constraints (2) ensure that all cargoes are serviced so the transportation network is at equilibrium. Constraints (3) ensure that each ship in the fleet sails one of its candidate schedules. The "=" in (3) may be replaced by "$\leq$", thus allowing some ships to be unused, which will be the case in my simulation. This because we wish to increase productivity, reducing the number of vessels on this trade lane should thus be an option. Constraint (4) imposes binary requirements on the variables. Often, ship-scheduling problems are well restricted; this means that it is possible to enumerate all feasible candidate schedules in a set partitioning approach. Because of the long duration of each ship voyage and the high uncertainty, it is hardly possible for a ship schedule planner to make plans for more than a few voyages ahead for each ship. It is therefore sensible to set the ship scheduling to a limited time horizon (ibid.).

4.4 Productivity measure

The productivity of a market can be defined as the effectiveness of productive effort often measured in the rate of output per unit of input (Stopford 1988). When increasing productivity one is able to increase output without increasing the input. In other words you are able to transport a larger amount of chemicals within the same time period using the same number of vessels. The productivity can in this case be measured as the utilization rate of the vessels, as an increase of utilization would lead to an increased output using the exact same number of vessels, the input remains unchanged. A typical productivity measure of a fleet can be calculated by dividing the total ton-miles of cargo shipments by the total tonnage actively employed in carrying the cargo.

$$U = \frac{total\ cargo}{total\ vessel\ capacity}, \qquad \bar{U} = \frac{\sum total\ cargo}{\sum total\ vessel\ capactiy}$$

Productivity in shipping often depends on three main factors, the mean operating speed as this determines the time a vessel spends on a journey, the deadweight utilization, and the number of loaded days at sea in contrast to unproductive days waiting in port, travelling empty or in ballast or periods in off hire (ibid.). Observing these parameters over time or across sectors can provide an insight in the productivity level of an industry.

4.5 Shipping Costs

When optimizing the utilization of a vessel, ship owners' use the cost structure of the voyage in order to determine what result the voyage will bring. The costs are divided in to three main groups, capital costs, running costs and voyage specific costs. (Evans and Marlow 1990)

Capital costs are the actual costs of the ship (Evans and Marlow 1990). Shipping is a highly capital intensive business, since even a small chemical tanker requires a substantial capital investment. However the vessels have a long life span and are “easily” tradable in the second hand market making the capital invested in the long run considered liquid. In the short run when making chartering decisions it is considered a fixed cost and can be regarded as sunk (ibid.).

Running costs are the costs that must be incurred, when the vessel is in service. These costs do not vary with the specific voyage and are time related. Examples of running costs may be crew salaries, insurance, protection and indemnity, maintenance, virtual, lubricating oil and so on. The level of costs is influenced by the efficiency with which the owner manages the operation of the ship, including the administrative overhead (Stopford 1988, 100). Crew costs account for up to half of the running cost and comprise of all direct and indirect charges incurred by the crewing of the vessel (Evans og Marlow 1990). Mainly two things determine the crew costs, the size of the crew and the direct and indirect cost of hiring them. Another significant cost of operating a vessel is expenditure on consumable supplies such as spare parts, deck and engine room equipment, and lubrication oil, which may account for about one-quarter of running costs. Repairs and maintenance costs are the costs associated with maintaining the vessel at a standard required by company policy or classification societies. Routine maintenance includes maintaining the main engine and auxiliary equipment, painting superstructure and so on. To maintain class for insurance purposes, all merchant ships must undergo regular surveys. Running costs also include the cost of insuring the vessel and for instance the administrative costs of managing the ships (ibid.).

Voyage specific costs are the costs related to the specific voyage being undertaken and include fuel costs, port charges, cargo handling and so on (Evans and Marlow 1990). In order to estimate the specific voyage costs the ship owner must have information on the following: vessel capacity, vessels speed and fuel consumption, list of bunkering ports and fuel prices, maritime atlas (to determine different possible routes and the location of cargo and bunkering ports), a map of the load line zones, ports disbursements, canal dues, rates of loading and discharging, and the exchange rates (often in US dollars) (ibid.).

4.5.1 Fuel Costs and Speed Optimization

Fuel costs are the single most important item of voyage costs (Stopford 1988). Fuel costs are determined by the vessels fuel consumption and the bunker fuel price at the time of the voyage. Although the ship owner cannot influence fuel prices, since this is determined by oil prices, he has considerable control over the level of fuel consumption. The amount of fuel burned is dependent on the way the vessel and its main engine are designed and of course the way it is operated. The fuel consumption can be expressed as follows, where F is the actual fuel consumption, v is the speed of the vessel, k is a fuel constant and a is the admiralty consumption, $F(v) = k(v)^a$ (Strandenes 2012).

When a vessel is earning unit freight revenue the mean operating speed of a ship is important because it determines the amount of cargo that can be delivered during a fixed period and hence the revenue earned. In a market with high freight rates and low bunker prices the ship operator will have an incentive to steam at full speed. In a market with a given freight rate as shown in figure 5.1 below, the change in bunker prices may cause for a change in speed (and therefore supply) because the fuel cost savings may be greater than the loss of revenue (Devanney 2010).

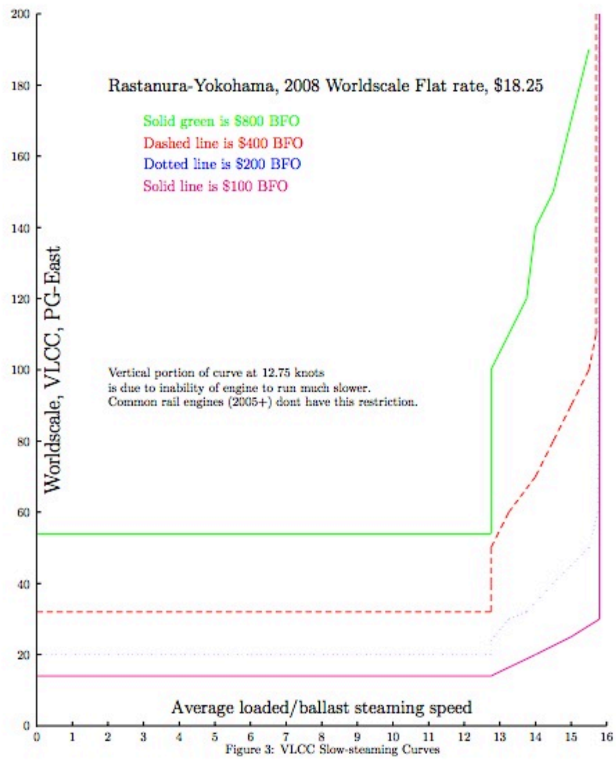

Figure 5.1: Slow Steaming (Devanney 2010).

In order to determine the optimal speed of a vessel we must maximize the gross profit of a voyage per day with regards to the vessels speed.

GS = gross surplus per day
C = cargo tons carried
RC = running costs
V = speed in nautical miles per day
s = freight rate per cargo ton
D = distance
p = fuel price per ton
k = vessels fuel constant
α = exponent in fuel consumption function

$$MAX\left[GS=\frac{sC}{\frac{D}{V}}-(RC-pkV^{\propto})\right]\ w.r.t.\ V\ (assuming\ \ \propto=3)$$

$$\frac{\partial GS}{\partial V}=\frac{sC}{D}-3pkV^2=0$$

$$V^2=\frac{sC}{3pkD}\rightarrow V_{opt}=\sqrt{\frac{sC}{3pkD}}$$

(Strandenes 2012)

The optimal speed of a vessel is in other words a function of the fuel price and freight rates obtainable in the market (ibid.).

4.5.2 Port Costs

Port-related costs make up a major component of the voyage costs. According to Meersman et al (2010) current port pricing methods differentiate according to a set of criteria's. Among others they pinpoint the vessel type and destination, location of operations in port territory, total time of service use (processing time) and the season. Mentioned in section 2.3, this is considered an inefficient method due to the fact that these criteria's do not reflect the waiting cost connected to the different vessels. As a result of increased port congestion the chemical tanker operator might in addition be subject to higher port costs due to the necessity of shifting berths within the port in order to serve a large number of customers simultaneously. The complex pricing systems that are in use today make it increasingly difficult to compare costs of alternative ports (ibid.).

4.5.3 Additional Costs

Other voyage costs include canal dues and cargo handling costs (Evans and Marlow 1990). The main canal dues payable are for transiting the Suez and Panama canals (Stopford 1988). The toll structure of the Suez Canal are calculated in terms of Suez Canal Net Ton (SCNT)/ Special Drawing Rights (SDRs). This method is used to determine the revenue-earning capacity of a vessel, which is the basis for what is charged. The Panama Canal however operates with a flat rate charge per Panama Canal Net Ton (PCNT). Cargo handling is also a significant cost of the voyage involving the loading and discharging of cargo. Investing in improved ship design to facilitate rapid cargo handling, along with advanced shipboard cargo handling gear may reduce the level of these costs (ibid.).

4.6 Voyage Optimization

When the cost structure of the voyage is determined, the ship owner is able to set up a voyage calculation determining the result of a specific voyage (Stopford 1988). A ship owners desire is to maximize this result. In order to compare one voyage from another, it is common to use the time charter equivalent. The time charter is the charter hire of the vessel per day. Under a time charter the owner is managing the running costs and operating costs, and the charterer covers the voyage specific costs. The time charter equivalent is the average daily revenue provided by this vessel and is calculated: $TCE = \frac{VR}{days}$ when on a specific voyage. The voyage result (VR) is the gross revenue of the voyage, minus the voyage specific costs (ibid.).

The Voyage Cash Flow Analysis (VCF) is concerned with computing the cash flow on a particular vessel voyage or combination of voyages, with the specific objective of assisting the ship owner in deciding whether the voyage is worth undertaking, or in deciding which vessel to use on a particular voyage where there are several operations (Stopford 1988, 128). The cash flow analysis typical includes five main sections. First of all information about the ship type with regards to capacity and fuel consumption is provided. Secondly information of the specifics of the voyage such as cargo, distances and freight rates are presented. Then the time needed to complete the voyage is calculated, including estimated port time and so on. In the fourth section the voyage cash flow is estimated using the information in the sections above. This amount represents the actual amount the voyage provides to cover the running costs of the vessel. Finally running costs are deducted to give the net cash flow of the voyage. The running costs of the vessel are calculated in section five.

Example of a Voyage Cash Flow Analysis

1. Ship Type:	Size	15 000 d.w.t.
	Fuel Consumption	25 tons/day
	Average Speed	15 knots
2. Voyage Information:	Route	Houston-Ulsan
	Distance	9000 miles
	Cargo	10 000 tons
	Freight Rate	$50/ton
	Fuel Price	$ 100/ton

3. Days On Voyage Calculation:

Average Speed	15 knots
Voyage Distance	9000 miles
Sea Time	25 days
Port Time	5 days
Total Days on Voyage	30 days

4. Voyage Cash Flow Calculation:

Freight Earnings	$ 500 000
Fuel Costs	$ 62 500
Port Costs	$ 35 000
Canal Dues (here disregarded)	
Cargo Handling	$ 20 000
Contribution to Running Costs	$ 382 500
Running Costs (from section 5)	$ 126 650
Net Voyage Cash Flow	$ 255 850

5. Running Costs:

Crew Costs	$ 1 068 000
Repairs and Maintenance	$ 270 000
Insurance	$ 220 000
Administration	$ 215 000
Total Annual Cost (350 days)	$ 1 773 000

Cost per Day	$ 5 066

(ibid.)

4.7 Estimating CO2 Emissions and the Environmental Footprint

In Psaraftis and Kontovas (2009) study of *CO2 Emission Statistics for the World Commercial Fleet* the fuel consumption of the vessel was used as an input measure of emissions. The measurement of CO2 emissions using the fuel consumption is independent of the type of fuel. By multiplying the total bunker consumption in tons per day (port and transit) by a factor of 3.17 you compute CO2 emissions, also in tons per day.

The CO2 factor 3.17 is empirically estimated and is the factor most commonly used in CO2 emissions calculations (Psaraftis and Kontovas 2009). In a broad specter of studies the actual value has been estimated to lie between 3.159 and 3.175. More recent studies have also differentiated between bunker qualities like for instance heavy fuel oil (3.021) versus marine diesel oil (3.082). The most common factor to use for simple estimation is 3.17 without differentiating between bunker qualities (ibid.).

5. Method

Having presented the chemical tanker market, how it works, as well as the theoretical framework, I now shift my focus towards the research question of this paper and how to shed some light on the topic at hand. For the sake of clarity I repeat the research question, which is as follows: *Does free competition in the global chemical tanker market cause for optimal use of vessels and the lowest environmental footprint?*

As mentioned in the introduction it is suggested by ship operators in the global market today, that the combination of many suppliers in free competition and limited port capacity creates an unnecessary amount of waiting in port and low utilization of vessels, in other words low productivity. These aspects are assumed to create higher costs and therefore a non-optimal situation for both ship operator and charterers. In addition, these aspects are considered to contribute to an increasing environmental footprint, which again is non-beneficial for the global society as a whole. In order to attempt to give a reasonable test of these assumptions and therefore an answer to the overall research question, I have elected in the following to compare the real situation in free competition with a simulated regulated market under a central planner.

1. What are the potentials for ***productivity*** improvements in the chemical freight market in a regulated market in the form of a central planner, compared to a market with free competition between suppliers?
2. Are there ***costs*** savings under a regulated market for both ship operator and charterers?
3. What are the ***environmental effects*** of a regulated market?

5.1 Data

In my comparative study I have decided to limit my examination to a geographical segment of the chemical freight market. I have chosen to look at the Asia-Pacific trade-lane, as this is the geographical segment of the market with the largest amount of available data, thus giving me the most complete picture of the market. The data gives information of the number of chemical tankers leaving the US gulf heading for Asia within a limited time period, their size, charterer and cargo specifications.

I have selected a time period stretching from the 15th of October to the 15th of December of 2012, as chemical shipping is considered to be seemingly monthly repetitive. The chemical tanker market is considered to have seasonal trends where market activity tends to be slightly higher in spring and fall, contra low activity levels during the summer. My data set is from late fall; therefore I must consider the possibility of a slightly higher activity level then perhaps the yearly average. Taking this into consideration I believe the dataset still provides me with an adequate impression of the market under free competition.

I have been given access to PIERS data (Port Import Export Reporting Serice) (Appendix A) for the chemical cargoes transported from the US Gulf to the Asia/Pacific area in time horizon selected. PIERS data is a standard in trade intelligence for organizations participating in the import/export business. The data includes area of operation (trade lane), operator, load date, IMO number, vessel name, loading port, discharge port, country, commodity, commodity group, cargo in metric tons and charterer. The PIERS dataset lists 532 different charter agreements by 18 different ship operators. There are a total of 53 charterers (customers) requesting a total cargo of 1.125 million metric tons to be transported by 50 different vessels. The data provides me with information on each and every charter agreement being that spot or a COA. However the data does not provide me with information on the exact sailing pattern of each vessel, in other words the order of which the vessel loaded and discharged at the different ports. Using the information from this dataset I have assumed a sailing pattern that roughly minimizes the distance of travel for each vessel, given the date of loading. In order to estimate the sea distances between ports I use an online sea distance calculator (Sea Distances.com 2013). I also assume all voyages to be west bound as they are categorized as an Asia-Pacific voyage set out from the US. This results in every vessel going through the Panama Canal.

I was also provided with vessel specific data both for their own and competing tonnage (Appendix B). This includes the vessels IMO number, operator, name, dead weight tonnage, age, shipyard where it was built, IMO classification, number of segregations and tanks, and finally its epoxy, zinc and stainless steel capacity. This information is necessary in order to successfully understand the capacity limitations in a simulated regulated market situation with a central planner.

Other information provided is among other things estimates of average speed, fuel consumption and port costs. Being since the focus of this paper is a comparative study of the productivity level of the market under free competition, the exact specific cost structure is not considered necessary. An estimate in cost changes will sufficiently enlighten the issue at hand. I will therefore be using, aggregated estimates as well as a constant fuel price and freight rate for all voyages.

5.1.1 Statistical Errors

When dealing with data sets like those provided for this assessment, it is important to be aware of and evaluate the validity of the data and assess their accuracy. When collecting these datasets from Odfjell, it was indicated to me that there often are plotting errors in for instance the PIERS dataset. Due to the fact that a lot of the information is plotted manually, one must consider the possibility of human error. It was also indicated that the data provided through PIERS in some occasions would lack last minute spot charter agreements. This would result in an incomplete picture of vessels utilization and sailing patterns. In addition to plotting errors I have been advised to consider statistical inaccuracy of the estimates provided for average speed, fuel consumption and port costs. Even if these are estimates based on Odfjell's practical experience in the chemical tanker market, they can result in discrepancies and inaccuracies in my results, as they are simplified to fit this assessment. However, in my analysis I assume the data provided to be sufficiently correct, and when assessing my results I take the possibility of errors into account.

5.2 Simulating a Central Planner

To create a situation with reduced free competition I attempt to simulate a regulated market with a single central planner. A central planner is an authority center that attempts to improve productivity and coordination by taking advantage of better information achieved (Encyclopædia Britannica Inc. 2013). I will attempt to improve productivity as the central planner by redistributing cargo to vessels in a seemingly more production efficient manner.

The first step of my simulation is setting up routes that serve all cargo demand, but at the same time, to as far a degree as possible, minimizes the distance travelled and total number of berth calls. In order to do so I categorized 530 cargo requirements (excluding 2 cargo charter with insufficient information) from the given time period according to their discharge port. I chose to group them in this manner due to the large distances between discharge ports in the

Far East contra the distances between the loading ports in the US Gulf, this being the simplest way to roughly minimize the total distance travelled. I then composed routes typically going to approximately two loading ports in the US Gulf and one discharge port in the Far East, however with some variation. I also composed the routes to have a total volume of cargo similar to the capacities of the chemical tanker vessels available. I composed a total of 36 routes (Table 5.1) in order to cover the 530 cargo charter requirements from this period. An overview of the cargoes redistributed to the different routes is found in Appendix C.

When having composed the routes, I then determined which vessels in the fleet had the capacity to be assigned to which routes, and what costs each vessel would have if assigned to that given route. The costs were estimated in the same manner as will be presented in section 5.3.2. Under free competition the vessel manager assembles a set of charters with respect to maximizing the vessels revenue. The vessel manager considers the cargos load and discharge port, distance, time restriction, stowage restrictions and so on, with regards to its profitability and compatibility with existing chartered cargo. This results in not all cargos being able to travel on every vessel. Under the central planner, when redistributing cargoes to different routes, I have disregarded the security regulations considering stowage of different chemicals and assumed all cargo can be stowed adjacent to all other cargo. Also, as indicated in the presentation of the model I am scheduling only for a limited time period, here from the 15th of October 2012 to the 15th of December 2012. Since chemical shipping is considered approximately monthly repetitive this therefore was a suitable time horizon.

Table 5.1 *Composed Routes (Central Planner)*

Route	Cargo (dwt)	Distance (miles)	Days in transit	# of berthings Houston	# of berthings other US ports	# of berthings Far East
1	20797	12300	37	1	2	6
2	31018	10389	31	1	2	1
3	20000	10339	31	1	0	1
4	29002	10230	30	1	1	1
5	11299	11009	33	1	2	4
6	21995	10855	32	1	2	3
7	14523	10874	32	1	3	1
8	15300	10113	30	1	0	1
9	34351	10678	32	1	0	1
10	19139	10689	32	1	4	5
11	31789	10033	30	1	0	1

12	33483	10033	30	1	0	1
13	29244	10510	31	1	3	1
14	48860	10784	32	0	4	1
15	30968	10256	31	0	1	1
16	44168	10556	31	1	3	1
17	26964	10698	32	1	1	1
18	28100	11332	34	0	4	3
19	33648	9217	27	1	0	1
20	21628	9785	29	1	2	6
21	17113	12261	36	0	4	2
22	42830	12261	36	1	2	3
23	47332	9628	29	0	1	1
24	13044	9653	29	0	1	1
25	21694	9601	29	0	1	1
26	52562	9641	29	1	0	1
27	33216	9516	28	0	1	1
28	47748	9641	29	0	1	1
29	15055	11212	33	0	3	1
30	23269	9515	28	0	1	1
31	27911	9774	29	0	1	3
32	12992	9989	30	1	3	4
33	37263	10203	30	0	2	1
34	39112	10498	31	1	2	1
35	41765	11120	33	1	4	2
36	14262	12620	38	1	1	2

When the routes were composed, I as mentioned determined which vessels had the capacity to serve each route, and the cost connected to vessels serving the different routes. I then used linear programing to set up a model that assigns vessels to routes. The model minimized the total costs of the entire regional fleet, simulating the scheduling problem of a central planner. It is an optimization based on the model presented in Christiansen et al. (2002), cf. section 4.3. The central planner wishes to minimize the total cost of the entire fleet as this contributes to minimizing fuel consumption as well as the total number of berths called, thus causing possibly increased productivity.

By examining the results of the schedule optimization I was able to compare the number of berth calls, distance travelled, and utilization laying the grounds to answer whether free competition is optimal with regards to productivity, cost and environmental footprint.

5.3 The Comparative Study

5.3.1 Comparing Productivity

Using the information in the dataset provided, I estimate the utilization rate (U) of each vessel and based on them, estimate an average utilization rate for this segment of the market.
This gives an idea of the potential for productivity improvements of a regulated market, as running with fully loaded vessels is considered more efficient than running with partly loaded vessels.

In addition to utilization, port congestion can be considered an aspect reducing productivity. Spending time waiting for occupied berths contributes to increasing the time spent per voyage and therefore reducing output without a corresponding reduction of input. Comparing the number of times each vessel calls a berth in the two scenarios I have been able to estimate a change in productivity. Based on the fact that the two scenarios include transport of the same cargoes, having the same capacity available, only redistributed, I assume that a reduction or increase in the number of berth calls will contribute to a reduction or increase in the vessels total waiting time during a voyage and therefore also an increase or reduction in productivity overall.

5.3.2 Comparing Costs

I also present an estimation of the voyage specific costs connected to the sailing routes travelled for this trade-lane in a selected time period, in order to compare them with the same calculated estimates for the voyages under a central planner. I use a theoretical voyage cost analysis. However I disregarded running costs and cargo handling costs as these are considered to be close to identical in a free competition situation and a regulated market situation. One might consider that a change in utilization, therefore a change in the amount of cargo handled per berth call, might cause a change in cargo handling costs. Assuming that the cargo handling cost is the same for all operators and given in $/ton, the cargo handling cost will remain unchanged as the total amount of cargo handled in both scenarios is the same, allowing me to disregard these costs in my calculations. I only include the costs that are specific for a voyage and in addition might change in the two situations being compared. Examples of this might for instance be a reduction in the distance traveled and therefore reduction of fuel costs, or the reduction of port due to a more efficient route and therefore fewer berth calls per vessel. I have however also chosen to disregard any canal dues in my assessment for simplification purposes

$$Voyage\ specific\ costs = fuel\ costs + \ \ port\ costs$$

In order to calculate the voyage specific costs I made certain assumptions with regards to the fuel price, fuel consumption, estimated number of days in port and port dues (Table 5.3). These assumptions are as mentioned above in section 5.1, based on estimates provided to me by Odfjell through their experience in chemical tanker operations as well as market statistics. For example I have noticed in table 5.2 below that the average speed for chemical tankers is approximately 14 knots. As shown in the table, it does vary some according to the vessels level of fuel consumption, however to a very low extent. An overview of the estimates that compose the base for the voyage cost analysis is shown in table 5.3 below. I addition to this, an example of a complete voyage cost calculation can be viewed in Appendix E.

Table 5.2: Average Speed/Fuel Consumption (Clarkson Reasearch Service 2010)

Average Speed (Kts) / Consumption (t/day) - Chemical & Oil Tankers

Size Group Tonnes Dwt	*Age Range of Vessel in Years*										*Total*		*Avg.*
	20 plus		*15-19*		*10-14*		*5-9*		*0-4*		*Average*		*Size*
	Sp	*Cons*	*Sp*	*Cons*	*Sp*	*Cons*	*Sp*	*Cons*	*Sp*	*Cons*	*Sp*	*Cons*	*Dwt*
1 - 4,999	11,7	6,7	12,4	8,7	12,5	8,9	12,5	9,5	12,3	17,2	**12,2**	**8,5**	**2 719**
5 - 9,999	12,7	12,3	13,4	14,0	13,6	13,9	13,6	13,7	12,9	12,7	**13,2**	**13,0**	**7 306**
10 - 19,999	13,5	17,7	13,8	18,3	14,1	20,4	14,1	19,3	13,9	19,8	**14,0**	**19,3**	**15 150**
20 - 29,999	14,4	24,9	13,7	29,3	15,1	29,6	15,0	30,0	14,9	29,6	**14,9**	**28,0**	**24 971**
30 - 39,999	14,9	35,4	15,6	39,0	14,8	33,0	14,7	30,3	14,9	31,9	**14,8**	**33,5**	**36 524**
40,000 +	14,2	32,2	14,2	32,2	14,8	34,0	14,8	33,7	14,8	31,6	**14,7**	**32,5**	**47 946**
Total Avg.	**12,6**	**13,6**	**13,4**	**20,2**	**14,0**	**23,9**	**14,1**	**21,1**	**13,9**	**22,9**	**13,7**	**20,0**	**19 613**

Note: The Average Size in Dwt (m) shown in this Table is derived from the Deadweight of the vessels for which we have speed / consumption data.

Table 5.3: Estimates used in Voyage Cost Calculations

Average speed (nm/h)	14
Estimated days in port	3
Fuel price ($/ton)	100
Port Costs	
Houston	$50 000,00
Other US ports	$35 000,00
Far East ports	$35 000,00

Fuel consumption (in transit)	
Vessels above 40 000 dwt.	35
Vessels between 30 000 and 40 000 dwt.	30
Vessels below 30 000 dwt.	25
Fuel consumption (in port)	
Vessels above 40 000dwt.	25
Vessels between 30 000 and 40 000dwt	20
Vessels below 30 000 dwt.	15

5.3.3 Comparing the Environmental Footprint

In order to estimate the environmental footprint caused by each and every vessel I have elected to use the fuel consumption of the vessel as an input measure of emissions, like done in Psaraftis and Kontovas (2009) study of *CO2 Emission Statistics for the World Commercial Fleet*. The measurement of CO2 emissions using the fuel consumption is independent of the type of fuel; I simply multiply the total bunker consumption in tons per day (port and transit) by a factor of 3.17, to compute CO2 emissions also in tons per day. These estimations are rough, however they give an idea of the environmental footprint caused by the chemical tanker vessels in the two different scenarios. After estimating the amount of real CO2 released by the vessels in the current situation, I estimate the amount of CO2 released in a situation with a central planner where the exact same cargos were transported.

6. Analysis

In order to determine whether a regulated market situation will improve vessel productivity and port congestion, reducing the environmental footprint and leading to optimal use of chemical tankers, I compare a segment of the market under free competition with a simulated regulated market. In order for this to be a reasonable comparison I first have to determine whether we can categorize today's market as an efficient market with a high level of free competition. Then I give a brief introduction of my observations from this scenario before presenting the results from the schedule optimization of a simulated central planner. Now with two separate scenarios at hand, I observe, compare and discuss the differences between the two in terms of productivity levels, costs and environmental impact. Based on these observations and the following discussions I attempt to give an insight into the overall effect of regulation in the form of a central planner, and whether free competition therefore contributes to an optimal situation for both ship owner, charterer and the global society as a whole.

6.1 The Two Scenarios

In order for my comparison to be sensible, I must first determine the nature of the scenarios, where one scenario is an efficient market under high levels of free competition and the other is a simulated regulated market under a central planner. Using the same input data in the two scenarios I will sufficiently be able to compare the scenarios ascribing the observed differences to this difference in regulation.

6.1.1 Free Competition

Is the chemical tanker market as it operates today, an efficient market under high levels of free competition? The chemical freight market can be described as the demand for the transport of liquid chemicals by sea provided by ship operators for a customer. An *efficient* market as presented in section 4.2, is often characterized by; including many buyers and sellers, uniform motives, low barriers for entry and exit, perfect information and homogenous products (Pindyck and Rubinfeld 2009). Essentially consumers and suppliers rule an efficient market without being regulated by externalities like governments and unions driven by external non- market agendas.

The chemical freight market, as presented in chapter 2, is considered to have several buyers and sellers where the actors operate with a uniform motive. The motivation of the ship owners is to maximize their revenue given limitations set by their own production. The buyers on the other end are motivated to purchase a given transport at the lowest possible price. The chemical freight market can therefore be considered to have a significant number of players with seemingly uniform motives on the demand and of the supply side.

The barriers for entry and exiting the chemical freight market are considered to be relatively low. Even though the initial capital investment necessary in order to buy a single vessel and therefore enter the market might be considered high, the vessels are marketable through the secondhand market making it possible to reduce the risk of the initial investment again lowering the barrier for entry (Walderhaug and Hammer 2007). This might also in a way contribute to an increasing number of suppliers in the market.

The chemical freight market is also characterized by large and free information flows. Freight rates, second hand market rates, fuel prices and so on are available and accessible at any given time. This information is available through a number of different information channels like for instance Clarkson's Shipping Intelligence. Market players are considered to have close to perfect information, where perfect information is a situation where all actors have access to complete and identical information (Oxford Dictionary of English 2010). The market is also characterized as supplying close to identical services, the transport of liquid chemicals from port A to port B. There is some differentiation when it comes to specialization and technological aspects of vessels, giving some operators the ability to differentiate supplying transport of chemical products requiring special conditions for transport. This is however a small segment of the market.

How is the price of chemical transport set and is the price affected by new information in the market? In shipping the price of transportation is set as a freight rate either through spot or COAs. In order for the market to be considered as operating efficiently the freight rate must respond to new information in the market. Looking at historical trends in the freight rate one can conclude that the freight rates do indeed respond to new information in the market like for instance a drop in fuel prices (Norman 1980).

Competition is defined as the activity or condition of striving to gain or win something by defeating or establishing superiority over others (Oxford Dictionary of English 2010). In other words one might say that free competition prevails when the rival activity between suppliers to meet the demand of the customer is able to flow freely without regulation. All operators should have the freedom to operate in any segment of the market that they are able to with respect to own financial or operational limitation, which is provided by the rules and regulations in the chemical tanker market, cf. section 3.4. Also, if reducing any of the characteristics of an efficient market discussed above, one may consider the competition in the market to be weakened, again resulting in the freight rate not efficiently responding to the conditions of the market (Pindyck og Rubinfeld 2009).

I can conclude therefore, from the analysis above that the chemical freight market today operates in an efficient market characterized by a high level of free competition with many actors, uniform motives, low barriers for entry and exit, close to perfect flow of information and homogeneous services, thus meeting the characteristics of the free competition scenario of my comparison.

The input data of the two scenarios that I compare consist of a fleet of 50 different vessels subject to serve 530 cargoes as presented above in section 5.2. In figure 6.1 below, the routes of 8 of the 50 vessels are illustrated as they were operated under free competition in order to give an idea of the routes and sailed distances. A summary for all 50 vessels utilization rate (Table 1(F)), the voyage cost analysis (Table 2(F)), and an estimation of total CO_2 emissions (Table 3(F)) under free competition is found in Appendix F. Provided in table 6.1 bellow, is an overview of the estimates for the entire fleet under free competition.

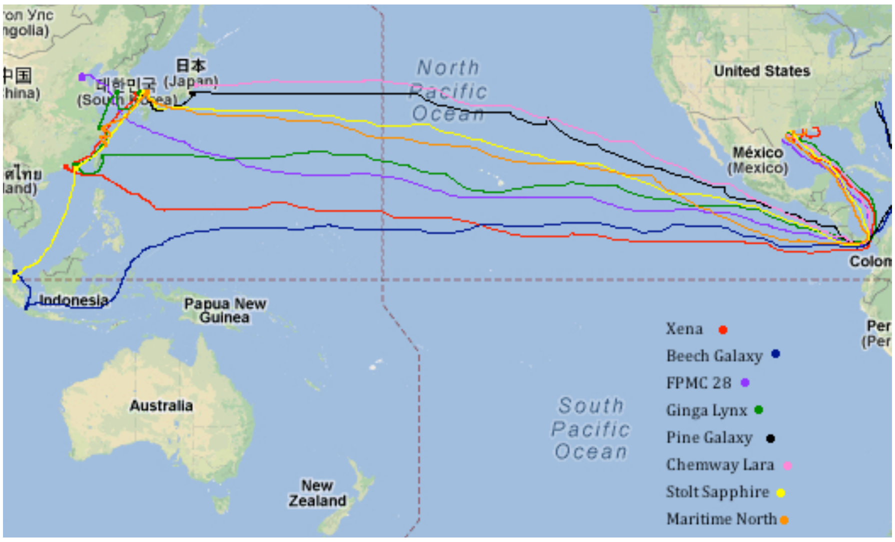

Figure 6.1: The Routes of 8 Out of the 50 Vessels Under Free Competition

Table 6.1 Overall Calculations for Fleet Under Free Competition

Free Competition Scenario		
Average Utilization		61 %
Total Fuel Cost for Fleet	$	6 687 512,75
Total Port Cost for Fleet	$	11 065 000,00
Total Voyage Costs for Fleet	$	17 752 512,75
Total CO2 Emissions (tons)		211 994

6.1.2 Simulated Market Regulation (Central Planner)

A planned market is a market system where decisions regarding production and investment are embodied in a plan formulated by a central authority, usually by a public body such as a government agency or international organization (Encyclopædia Britannica Inc. 2013). There appears to be a general consensus among ship operators in the chemical tanker market today that a central planner would be able to more efficiently distribute cargos to vessels or operators so that they can operate with a higher productivity by for instance minimizing the number of berth calls per vessel thereby reducing port congestion. Simulating a central planner I first composed 36 different routes in order to create network equilibrium by which all demand would be met. Based on Christiansen´s model of the scheduling problem for vessels with multiple cargoes I have been able to find an optimal vessel assignment for the 36 routes. Using linear programing implementing and the CPLEX solver, the optimal assignment was calculated giving the results as shown in table 6.2 below (AMPL script available in Appendix D). When a vessel is assigned the route number "0", it indicates that the vessel is not used and can therefore be redistributed to other trade lanes. I assume that any vessel removed from this trade lane can be efficiently used on a different trade lane, thus removing it from the available capacity on this specific trade lane.

Table 6.2: Vessel Assignment under Central Planner

Vessel Name	Assigned Route (CP)
Amelia	29
Beech Galaxy	6
Bow Engineer	13
Bow Spring	28
Bunga Banyan	27
Chembulk Barcelona	15
Chembulk Virgin Gorda	4
Chemway Lara	16
Fairchem Colt	1
Fairchem Eagle	31
Fairchem Stallion	36
Formosa Thirteen	14
FPMC 24	12
FPMC 28	11
FPMC 30	0
MR Kentaurus	0
Ginga Bobcat	17
Ginga Eagle	21
Ginga Lion	18
Ginga Lynx	20
Golden Unity	25
Maemi	32
Maritime Jingan	0
Maritime North	26
Miramis	8

Vessel Name	Assigned Route (CP)
NCC Dammam	0
NCC Najem	23
NCC Nasma	0
NCC Noor	0
Pine Galaxy	5
Sichem Onomichi	24
Sira	7
Siteam Jupiter	35
Siteam Leader	34
Siteam Neptun	19
Siva Ghent	2
Stolt Achievement	0
Stolt Emerald	0
Stolt Focus	33
Stolt Sapphire	0
Stolt Sea	0
Stolt Sneland	22
Stolt Spray	3
Stolt Surf	30
Stolt Topaz	0
Sycamore	0
Sypress	9
Wawasan Emerald	0
Wawasan Ruby	10
Xena	0

In the same matter as in section 6.1.1 above, a summary of the vessels utilization rate (Table 1(G)), the voyage cost analysis (Table 2(G)), and an estimation of total CO2 emissions (Table 3(G)) under a central planner is found in Appendix G. I have provided a simple overview in table 6.3 below.

Table 6.3 Overall Calculations for Fleet under Central Planner

Central Planner Scenario	
Average Utilization	82 %
Total Fuel Cost for Fleet	$4 105 123,44
Total Port Cost for Fleet	$5 665 000,00
Total Voyage Costs for Fleet	$9 770 123,44
Total CO2 Emissions (tons)	130 132

The savings with regards to utilization and costs could possibly have be even greater if I were to optimize routes through a route optimization model, instead of roughly composing them in the manner I have done. However due to the limitation of the scope of this thesis I consider the savings potential to be sufficiently observable through this method, though it would cause for an interesting further study. In addition to this, it is important to take into consideration the assumption made that all cargoes may be stowed adjacent to all other cargoes. As presented in section 2.1.2, this is certainly not the case in the true market. Therefore it might not necessarily be possible in reality to assign these vessels to these routes. One should also consider the time horizon of the data set. There might have been specified delivery constraints for the customer within my time horizon that caused the cargoes to be chartered as they were. Redistributing freely within this time horizon might therefore not be acceptable for the customer based on their time requirements. Again however, I believe that the assessment is right and provides insight of the issue and the existence of possible productivity improvements in the chemical freight market.

6.2 The Comparison

In this section I compare the true free market scenario of the cargoes transported in the period 15th of October 2012 to the 15th of December 2012 with the simulated regulated market scenario of the central planner servicing the exact same cargoes. I compare, observe and discuss the impact the reduction in free competition would have had on productivity, costs and environmental footprint.

6.2.1 Productivity

Productivity is the effectiveness of productive effort measured in the rate of output per unit of input (Stopford 1988), in other words productivity is the rate of which vessels (input) effectively are able to transport cargo (output). In order to determine the impact a regulated market has on the productivity of the chemical freight market, I first discuss its impact on vessels utilization, followed by an assessment of the impact on port congestion.

6.2.1.1 Utilization

The utilization of vessels under free competition is indicated to be approximately 61% in the Asia Pacific trade lane from the US Gulf to Asia from the 15th of October to the 15th of December of 2012. This is given by estimating the utilization of each vessel used for transportation in this trade lane, in this given time period. I then averaged the utilization levels of all the vessels used. A utilization level of 61% indicates that there were many vessels sailing with close to half of their tank capacity empty, there is seemingly low productivity. The highest and the lowest utilization level were respectively 96% and 3%, considering that the latter might be a result of plotting errors in the received PIERS dataset. Nonetheless, what might be leading to operations at such a low utilization?

Looking briefly at the charter agreements from the US gulf to Asia in this period (Appendix A), one can observe that several of the cargoes are to and from the same ports. However the cargo is transported on several different vessels, not only contributing to port congestion, but reduced utilization or in other words productivity. For instance in my dataset I find that the operator INEOS Europe AG chartered 6 different vessels, from 6 different operators within the time period observed, to carry Acrylonitrile from Point Comfort to Ulsan, South Korea. In other words, 6 different ship operators carrying the same commodity, to and from the same ports, for the same customer. The average utilization of the vessel sailing with these cargos was approximately 68% (excluding Siteam Neptun), so there was access capacity available on the vessels. Would it not be sensible to redistribute these cargoes to be carried on fewer vessels, this way increasing productivity? Why would the customer not wish to consolidate these cargoes on a single vessel rather than 6 separate ships? One of the seemingly most obvious reasons might have been the freight rate achieved under prevailing market conditions. The freight rate tendered might have been different from ship owner, to ship owner so in order for the customer to minimize their costs they probably elected to split the cargo so to be delivered by 6 different operators, however inefficient this might be at port. The savings of doing this must have beem at such a level that the increases in costs connected to larger port cost as well as cargo handling dues (if assumed a function of number of berth calls) were compensated. In addition to this, the time of delivery might have been a determining factor. Although these vessels all sailed in the same period I believe that they all arrived Ulsan at different times. However only maybe days apart, these days might be crucial for the customer causing him/her to wish to split the cargo. Finally, the cargoes might also have been divided in this manner based on the customers wish to be able to resell only a portion of the cargo while in transit or deliver to different end users at the destination port. For instance if the charterer were to speculate on acrylonitrile prices he/she would be able to sell the bill of lading for one of the cargos on one of the vessels. However one must be allowed to ask, would it not be possible for the charterer to sell a portion of a cargo, or distribute to different end users even if it is transported on the same vessel, simply dividing and redistributing the cargo when having arrived at Ulsan? All in all the most sensible explanation to this inefficiency seems to be the large supply of operators giving the customer the possibility to minimize its transportation costs by splitting the cargo to several operators and by doing so contributing to a decrease in utilization.

Would we be able to deliver the same level of transport (output) using fewer vessels (input) under a central planner? Comparing the total average utilization in the two scenarios we see an increase from 61% (under free competition) to 82% (under central planner). The increase in utilization is a result of utilizing fewer vessels, but still carrying the exact same cargoes. Under the central planner it would have been possible to eliminate 14 vessels. I also observe that under a central planner there would be several vessels operating at utilization levels close to 100% and that the lowest level of utilization would be only at 57%. Differences in utilization under these two scenarios are seemingly prominent, a portion of the potential improvement would likely have to be disregarded since the assumption of disregarded stowage regulations as well as the customer time constraints have not been taken into account.

6.2.1.2 Port Congestion

In terms of port congestion it is said that chemical tankers use a considerable amount of time in port. As mentioned in the introduction, Odfjell estimates that their vessels spend on average approximately 44% of the time available, in port (Walderhaug, 2013). Ship operators believe that an expected affect of a planned market scenario, is that there would be a reduction in the number of berth calls per vessel, therefore naturally causing a reduction of congestion at port and as a result, also a reduction in the time spent waiting. I have observed in my dataset that today under free competition there are a considerable number of berth calls per voyage. On average the vessels operating the Asia-Pacific trade lane in the given time period, spent approximately 35% of its total time in port, given that on average each vessel spends 3 days per berth call. Even though this is a rough estimate and I am not able to identify the exact time spent waiting, it indicates that there is a large potential for productivity improvement in this area.

Port congestion can be a result of many different things. It can be a momentary congestion as a result of bad weather or sailing conditions causing delays resulting in several vessels arriving at port simultaneously (Stopford 1988). At port, bad weather might also make cargo handling difficult, contributing to even further increased congestion. Port congestion can also be a result of a rapid increase in activity. When there is an increase in the number of vessels requesting to berth, without there simultaneously being an increase in port capacity, there will naturally be an increase of congestion. In this assessment however, I analyze to what extent free competition in the chemical freight market might be a contributing factor to the increase in port congestion.

The chemical freight market is characterized by combining several customers' cargo on a single vessel. This results in each vessel being in need to call at several different ports in order to load and discharge for a single Asia-Pacific voyage. Under free competition, with low vessel utilization, there are a larger number of vessels in use than would be the case under the simulated central planner, cf. 6.2.1.1. Looking at a similar example to the one presented above, VINMAR International chartered three different vessels (Ginga Bobcat, Sira and Wawasan Emerald) from three different operators (Tokyo Marine, Navig8 Chemicals and IMC/Aurora) all to load from Houston for discharging at Lianyungang within this time period. They were all carrying Acrylonitrile and the total cargo volume was approximately 15300 metric tons divided between them. Like in my discussion above there could be several motives causing the customer to split similar cargo in this manner. As mentioned above, factors like delivery time, possibilities for resale or end user constraints are examples of this. Since I do not have information about the freight rates for each of these charter agreements I cannot determine whether this distribution maximized the revenue of the operators or minimized the transportation costs for the customer. In terms of productivity at port, I would conclude that this was unfavorable, being as this resulted in three vessels being in need to call the same berth in Houston and Lianyungang instead of one. Did this result in access waiting? Seemingly, one single ship would have been able to load the entire capacity of the vessel at port A for discharging at port B. So in this instance reducing the number of berth calls in Houston and Lianyungang to just one operator. In order to increase productivity in this manner, a consolidation like a central planner is necessary. The central planner, like done in the simulation above, would in addition to other factors, put together routes which as far as possible would minimize the number of ports and berth the vessel would have to call before crossing the Pacific. In the chemical market the customers are located at many different ports making this task very challenging. However, simply by increasing utilization of each vessel, therefore reducing the number of overall berth calls, could result in a reduction in overall demand for time in port, increasing productivity at port and reducing port congestion. In my simulation the total time spent in port based on the same estimate of 3 days per berth call, was 2 days in port per 5 days at sea (2:5), whereas under free competition the vessel spent 5 days in port per 9 days at sea (5:9).

As a result of fewer vessels being needed to handle the cargoes and therefore reduced port congestion and time spent waiting, a cost reduction for the customer in the form of a reduced demurrage payments, could possibly be expected. Demurrage is the cost that is charged for any additional time in port out side of what was negotiated in advanced, regardless of how the time is spent. When congestion is reduced, waiting is also reduced and again the charged demurrage will be reduced. Odfjell collected in 2012 approximately 60 million USD in demurrage in 2012, representing 5.6% of the gross freight revenue. To what extent this demurrage would be reduced is difficult to determine without information on the actual time vessels spent in port and to what extent the pre-negotiated time was exceeded.

To conclude, in terms of utilization and port congestion, the productivity of the chemical freight market indeed would increase under a market regulated by a central planner. In other words, free competition seemingly contributes to reduced productivity in the market.

6.2.2 Changes in Cost

When considering the changes in costs, I have focused on the voyage specific costs; fuel costs and port costs. In the model used to solve the scheduling problem (section 4.3.2) the object function minimizes the total voyage costs for the fleet. By doing this, the central planner at the same time minimizes the total fuel consumed as well as the number of berth calls, intending to increase the market productivity for all participants. The central planner determines the distribution of cargoes on stipulated routes and assigns them to vessels with the object of minimizing the total fuel and port costs for the fleet. The fuel costs and port costs applicable to each route, for each vessel, is in the model pooled together. After receiving the redistribution as a result of the optimization, I have computed a voyage cost analysis determining the fuel costs with regards to a change in fuel consumption in port, as well as separating out port costs, see Appendix E. This way I have been able to illuminate the impact of regulation on fuel costs and port costs independently. An overview of the results is shown in table 6.2.2 below.

Table 6.2.2 Overview of Differences in Cost

	Free Competition Scenario	Central Planner Scenario	Difference (%)
Total Fuel Cost for Fleet	$6 687 512,75	$4 105 123,44	-39 %
Total Port Cost for Fleet	$11 065 000,00	$5 665 000,00	-49 %
Total Voyage Costs for Fleet	$17 752 512,75	$9 770 123,44	-45 %

What are the causes of the reduction in costs? Looking at table 6.2.2 above I have estimated that the largest savings can be made in terms of reduced port costs. Being as the port fees are the same in both scenarios, I can contribute this change to the reduced number of calls to berth (302 vs. 152). In my simulation I have considered cargo-handling costs to be the same under both scenarios due to the assumption that cargo handling costs are a function of $ per ton handled and the amount of cargo being handled is the same under both scenarios. However, one might consider that the cost of handling large cargo quantities on one vessel implies higher costs than small cargo quantities on several vessels. Considering the advanced piping systems on board a chemical tanker, cf. section 2.2.1, I would assume that the costs of handling large versus small cargo quantities would be close to equal. In simplified terms the cargo handler only would have to connect the port pipes to the vessels pipe system and run the pumps longer for larger quantities than smaller quantities. In contrast to chemicals shipping I would assume that the differences in cargo handling costs will be larger in other shipping segments like for instance in container shipping, where handling cargo is a more costly process per unit.

Comparing the fuel costs of the two scenarios (table 6.2.2), the reduction is predominantly a result of fewer vessels in service due to the central planners ability to increase the utilization of vessels, cf. section 6.2.1. The average distance sailed by the vessels in service in the two scenarios is fairly similar. Under free competition the vessels travelled approximately 11 000 miles/vessel in service within this period, while under the central planner the average distance travelled per vessel in service was approximately 10 500 miles. This underpins the assumption that reduced fuel costs would have been a result of the reduced number of vessels necessary to serving the demand. As implied earlier, there might be even more savings to be acquired under the regulated market if the central planner was to optimize the composition of routes based on minimizing these costs, as apposed to roughly minimizing as I have done in my simulation.

As presented in section 4.1.1 the supply curve of a chemical freight market is determined by the capacity of a fleet at a given bunker price. The curve is a summation of all the vessels capacity in a fleet. The supply curve is often referred to as a hockey stick due to a vessels ability to increase capacity by increasing the speed at which the vessel is sailing. If the market is weak and bunker prices are high, they will slow down and if the market is strong and bunker prices are low, they will speed up. The concept of regulating one´s capacity according to the current market condition using the speed of vessels is called speed optimization. If the result of using a central planner causes for the demand of a fewer number of vessels (due to the increase in utilization and unchanged demand), one might expect ship operators to reduce the speed of their vessels, or slow steam in order to adapt their supply and deliberately reduce fuel costs. However, as mentioned in section 4.5.1, there are empirical indications that capsize dry bulk vessels do not in the same degree as theoretically indicated adapt their speed (Ådland 2013). This could possibly also be true for chemical tankers.

Overall with regards to costs, there are seemingly large potential savings to be made by going from free competition to central planning, in terms of fuel savings and reduced port costs.

Based hereon I can conclude that free competition in this case does not contribute to the optimal usage of vessels and thus an optimal cost level.

6.2.3 Environmental Footprint

When roughly comparing the CO2 emissions under the two scenarios I see a clear reduction of the environmental footprint under the central planner due to the reduction in total travelled distance as well as a reduced number of total days spent in port. As indicated in the study by Psaraftis and Kontovas (2009) an increase in utilization is directly linked to a reduction in CO2 emissions. As discussed above there are indications of increased productivity both in terms of utilization and in port congestion under a central planner, cf. 6.2.1, thus I can assume that this reduction in environmental footprint is linked to the increase in productivity or in other words a more optimal use of the chemical tanker fleet.

Table 6.2 Comparison of Total CO2 Emissions Estimate

	Free Competition Scenario	Central Planner Scenario	Difference (%)
Total CO2 emissions in transit (tons)	154 649	103 633	-33 %
Total CO2 emissions in port (tons)	57 345	26 438	-54 %

Table 6.2 shows a considerable reduction in estimated CO2 emissions. As the level of CO2 emissions are calculated based on the amount of fuel consumed, I can assume that part of the reduction is ascribed to the reduced total distance sailed under a central planner. The reduced total distance sailed is a result of fewer vessels in service, which again is a result of the increase in utilization. This contributes to confirming that there is a correlation between increased utilization of vessels and decreased CO2 emissions. The increased utilization and therefore reduced number of vessels in service under the regulated market, contributes to an overall more environmentally friendly industry.

Looking at the environmental effect of reduced CO2 emissions at port, the reduced total number of days spent in port as a result of fewer vessels in service, contributed to a 54% decrease in CO2 emissions. In addition to this one has to take into account how port congestion contributes to vessels waiting and thus unnecessary fuel consumption. When waiting a vessel burns fuel using auxiliary engines to generate the power necessary to maintain the crew as well as the cargo. These engines have a lower level of fuel consumption and therefore possibly lower CO2 emissions, however they do still contribute to the environmental footprint, particularly in the form of local pollution. When reducing the number of vessels in service and therefore also the number of vessels requesting to berth, one automatically reduces the port congestion given port capacity remains unchanged. Doing this, vessels are no longer in the same degree forced to wait, thus reducing unnecessary fuel consumption. This most likely reduces the total environmental footprint in addition to contributing to a cleaner local port environment.

6.2.4 Summary

To sum up my comparison, I conclude that a regulated market under a central planner, would have contributed to; increased utilization and reduced port congestion, voyage costs and environmental footprint. Keeping in mind the possible errors in the data set provided, I must keep in mind whether the differences observed are in fact significant. In order to achieve more accurate results one must be able to in a more precise manner simulate the central planner. In further studies one could complete a comparative study using a much larger dataset as well as an increased time horizon to avoid static from seasonal trends. However having considered the possible discrepancies, overall one can state, based on this simulation, that free competition does in fact not contribute to the optimal use of vessels and the lowest possible environmental footprint.

6.3 Who are the beneficiaries?

Having determined that there are in fact gains to be made by implementing regulations on the market in the form of a central planner, thus reducing free competition, one must consider who would benefit from a central planned chemical freight market? Is this something all market participants potentially would agree to be a part of?

It is seemingly beneficial for the ship operator to operate in a regulated market as this would result in a cut of costs and therefore also increased margins. Comparing the estimated costs connected to the two market situations there are clear savings to be made using a planner. Taking into consideration that this only is a rough estimate, there could potentially be 45% reduction of costs under a planning scheme, cf. section 6.2.2. In addition to a reduction of voyage costs, the ship operator would also most likely experience a reduction in demurrage revenue. However, being as this only accounts for a small portion of total revenue I would assume that the savings in voyage costs would outweigh the tiny reduction in revenues.

Determining whether the regulated market is beneficial for the customer is difficult. In a sense, the increased productivity as a result of central planning contributes to a more efficient transport of their cargoes. I estimate an increase in utilization of approximately 34% indicating that the total available supply of transport would be increased. There would also be a 50% reduction in the number of berth calls, most likely causing a reduction in potential demurrage costs as well as a reduction in the risk connected to timely deliverance as a result of reduced port congestion, which is beneficial for the customer.

The factor that has the most impact on whether a central planner would be beneficial for market participants, is price. When productivity increases under a free market scenario and the demand is met utilizing a fewer number of vessels, thus reducing the total fleet utilization, the freight rate would decrease. Market theory indicates that when the market is regulated and ship owners no longer compete for cargo, the freight rate for the given transport will increase. The customer is therefore in an unfavorable situation with a possibility of increased price. When reducing competition in a market, it becomes increasingly difficult to determine what the correct price will have to be. Markets characterized by no competition are markets with only one supplier, markets under monopoly. If the market were to enter a state of monopoly the freight rate would no longer represent the marginal cost of production, but exceed the marginal cost (Pindyck and Rubinfeld 2009). Doing this there would be a dead weight loss, which is the net loss of surplus (gain in producer surplus minus the reduction in consumer surplus) in the market (ibid.). In this situation the customer also would be worse off, in other words would not benefit from market regulation. Further one can question whether an increase in productivity and reduction in potential demurrage and risk for the customer, would justify the potential increase in freight rates?

The difficulties of price setting under a regulated market could possibly be problematic for ship operators as well. How would price be determined under the central planner, and which costs would be included in this decision? Seeing as shipping operators are subject to different cost structures based on the differences in size and specialty of their vessels, how can a centrally set, common freight rate contribute to cover their different capital and running costs? The result of a price set to low would for instance possibly cause for ship owners to layup, causing an under supply. This is seemingly something ship operators would not agree to be a part of.

Overall there are pros and cons for both customer and ship operator. Whether they in the end benefit from a market under a central planner depends on what degree the correct price is possible to set, as well as the magnitude of the productivity gains. Thus answering whether this is something market participants would agree to be a part of.

6.4 Challenges in the Implementation of a Central Planner

Based on the assumption that a central planner would be beneficial both for ship owner and customer, I would like to briefly consider the challenges of implementing such regulations in a market. How will the information necessary be made available to the central planner? Who would the central planner be? These are all challenging questions that would need to be answered and discussed thoroughly before implementation. I can however, only provide some of my own reflections around these topics.

How would a central authority receive the necessary information in order to compose the most efficient routes? I would believe that there would be reluctances in the market to hand over certain information to a potential central planner. For instance which routes an operator would be interested in serving might for strategic purposes be unfavorable to share. One might also consider the possibility of data manipulation or corruption occurring in order to capture the “best” routes from the central planner. This is of course not desirable.

When it comes to whom the central planner could be, it is naturally important to consider that the chemical tanker market is a global market and the authority in this case would have to be a global authority. The central planner would have to be able to subjectively distribute cargoes to routes, control that what is set is complied to, and impose sanctions when deviation occurs. The most well-known central planner systems through history are those of Eastern Europe during WW2. The communist party would centralize distribution as well as production of a number of commodities, creating a planned market economy based on their authority from military power. As indicated above, when competition is reduced, or in the case of Easter Europe completely removed, the price of the product was also here difficult to determine. Looking at prices of products in Eastern Europe contra Western Europe, one would see large discrepancies. Due to prices not truly reflecting the costs of the goods, the supply in Eastern Europe would shift therefore leading to for instance very low bread prices and at the same time very long lines at the baker (low supply) (Encyclopædia Britannica Inc. 2013). I can assume that implementing a central planner in the chemical freight market would also here cause for difficulties in determining the price of transport as discussed above, and also potentially cause undersupply in the market. This might also contribute to charterers resorting to bribes or under the table transactions in order to acquire the necessary transportation of their products. In the worst case black markets might be formed. However looking at recent developments in Chinas planned economy, one might become slightly more optimistic. The Chinese economy maintains some level of competition while at the same time using a central planner composing 5-year plans, one might heed that a combination of the two could possibly succeed also else where, gaining the benefits of productivity improvements in the chemical freight market through consolidation while at the same time being able to determine a close to correct price. Could it be possible under a central planner, to maintain enough competition to obtain a representative freight rate and at the same time ensure the optimal usage of vessels? Would a possible solution for instance be distributing cargoes to different operators according to geographical area? For example, one could consolidate and compose routes from all cargoes at the ports in Houston, Freeport and Texas City. One could then give the possibility to bid on these routes to a limited number of ship operators like for instance Odfjell and Jo Tankers. They would then compete for the central planners composed routes from this area. With only two operators there would be some level of competition, assisting to determine a close to correct price, however still a much lower level of competition then under the current free market situation. I would assume this would still reduce port congestion, as there are only two operators at these ports. The question however arises whether all of the same efficiency gains observed in my simulation above, also would exist under this type of consolidation? If it were possible to carry through something like this, obtaining a fair freight rate for the customer, as well as ensuring the gains discussed in my comparison above, the customer and the ship operator could possibly primarily benefit from the regulated market.

7. Concluding Remarks

Through this thesis, my goal was to shed light upon whether a chemical tanker market under free competition caused for the optimal use of vessels, as well as the lowest possible environmental footprint. By comparing two scenarios, where both were exposed to the same input data, thus only separating the two by market regulation, I established a sensible platform for a comparative study. The first scenario was a true market situation of a geographical segment, over a specified period of time, under free competition. The other scenario was a regulated market scenario under a simulated central planner. I compared the two scenarios in terms of productivity, costs and environmental footprint. Doing this I was able to determine that market regulation, being the only thing differentiating the scenarios, can potentially cause increased utilization of vessels, and reduced port congestion, voyage costs and overall environmental footprint. In other words, free competition did in fact, based on this assessment, contribute to neither the optimal use of vessels nor the lowest possible environmental footprint. However, when that is said, I also shortly evaluated who the beneficiaries of a potential market regulation would be, and examined crucial challenges of implementing a central planner. Though the challenges are many and certainly cause for further research, the most predominant and vital challenge is that of setting the correct freight rate in a non-competitive setting. Assuming that it is possible in an efficient manner to achieve a correct price under market regulation, both ship operator and customers would reap the indicated benefits, as free competition in the chemical tanker market is not cause for the optimal use of vessels and the lowest environmental footprint.

Bibliography

Ahuja, R., T. L. Magnanti, J. B. Orlin, and M. R. Reddy. *Applications of Network Optimization.* June 1994.

Ådland, Roar Os. "Speed choice in the Capesize sector: An empirical survey across routes and loading conditions." *IAME 2013, Marseilles*, 2013.

Buhaug, Øyvind. "Seas At Risk Climate & Oceans Conference, Brussels 5th November 2008 ." *Seas At Risk.* November 5th, 2008. http://www.seas-at-risk.org/1mages/oyvind_presentation.pdf (accessed May 20th, 2013).

Burden, Kit, Lyde Barlow, and Gilbert Barlow. "EDI and bills of lading." *Computer Law & Security Review*, December 1992: 269-270.

CEMT/ITF. "CONGESTION: A GLOBAL CHALLENGE." *International Transport Forum.* May 31, 2007. http://www.internationaltransportforum.org/sofia/pdf/KeyMessages/ITF200701e.pdf (accessed May 27, 2013).

Christiansen, Marielle, and Kjetil Fagerholt. *Ship routing and scheduling - Status and trends.* Trondheim, September 6, 2002.

Christiansen, Marielle, Kjetil Fagerholt, Bjørn Nygreen, and David Ronen. "Maitime Transportation." In *Handbook in OR & MS*, by C. Barnhart and G. Laporte, 189-284. Elsevier B.V., 2007.

Clarkson Reasearch Service. *Clarksons Shipping Intelligence Network.* 2010. http://www.clarksons.net/sin2010/ (accessed June 1, 2013).

Daly, Erin Marie. "EU Scuttles Probe Into Sea Shipping Price-Fixing." *Law360.* May 8, 2008. http://www.law360.com/articles/55559/eu-scuttles-probe-into-sea-shipping-price-fixing (accessed May 30, 2013).

Devanney, Jack. *The Impact of Bunker Price on VLCC Spot Rates.* Prod. Martingale Inc. 2010.

Drewery Shipping Consultants. *Seaborne Chemical Trades and Vessel Demnad.* 2009.
Encyclopædia Britannica Inc. *Tanker.* 2013. http://www.britannica.com/EBchecked/topic/582652/tanker (accessed April 19, 2013).

Escola Superior Na´utica Infante D. Henrique . "DEPARTAMENTO DE ENGENHARIA MAR´ITIMA." *ESCOLA SUPERIOR NA´UTICA INFANTE D. HENRIQUE.* May 2011. http://www.enautica.pt/publico/professores/jorgetrindade/NaviosTanque/Docs/apont_NaviosQuimicos.pdf (accessed April 23, 2013).

EU Commission. "AGREEMENT ON THE EUROPEAN ECONOMIC AREA." *EU Commission.* 1994. http://ec.europa.eu/competition/mergers/legislation/eea_agreemt_comp.pdf (accessed March 20, 2013).

Evans, and Marlow. "Chapter 8: Ships´Cost; Voyage Estimates; World Scale." By Evans and Marlow, 96-106. 1990.

Frydenbø Marine. *Frydenbø Marine Services.* 2008. http://www.frydenbo-marine.no/bilder/bilder/fms/vesselforsale/mega_7700oilChemicaltankercopy.jpg (accessed May 5, 2013).

IMO. *Construction Requirements for Oil Tankers.* 2013. http://www.imo.org/ourwork/environment/pollutionprevention/oilpollution/pages/constructionrequirements.aspx (accessed April 12, 2013).

Jetlund, Audun S., and I. A. Karimi. *Improving the logistics of multi-compartment chemical tankers.* Singapore: Elsevier Ltd. , August 27, 2003.

Lun, Y.H.V, O.P. Himola, A.M. Goulielmos, K.H. Lai, and T.C.E. Cheng. "Chapter 2: The Tanker Shipping Market." In *Oil Transport Management*, by Y.H.V Lun, O.P. Himola, A.M. Goulielmos, K.H. Lai and T.C.E. Cheng, 13-25. London: Springer, 2013.

Maritime and Port Authority of Singapore. "Circulars and Notices." *MPA Singapore.* November 10, 2008. http://www.mpa.gov.sg/sites/circulars_and_notices/pdfs/port_marine_circulars/pc08-20.pdf (accessed April 14, 2013).

Meersman, Hilde, Tom Pauwels, Eddy Van de Voorde, and Thierry Vanelslander. *Applying SMC pricing in PPPs for the maritime sector .* Antwerp: Elsevier Ltd., 2010.

Nagurney, Anna. *MATHEMATICAL MODELS OF TRANSPORTATION AND NETWORKS.* Amherst, Massachusetts, 2007.

Norman, Victor. *Organization of the Tanker Market.* Bergen, 1980.

Oxford Dictionary of English. *Oxford Advanced Learner´s Dictionary .* 7th edition. Oxford: Oxford University Press, 2010.

Pindyck, Robert S., and Daniel L. Rubinfeld. *Microeconomics.* 7. utgave. Upper Saddle River, New Jersey: Pearson International Education, 2009.

Psaraftis, Harilaos N., and Christos A. Kontovas. "CO2 Emissions Statistics for the World Commercial Fleet." *WMU Journal of Maratime Affairs*, 2009.

Rex, Christopher, Brian Thorsen, Kenneth Liere Rasmussen, Stinus Nielsen, and Kristine Marie Thøgersen. *Shipping Market Review: Oktober 2012.* Danmarks Skibskredit, 2012.

Sea Distances.com. *SEA DISTANCES - VOYAGE CALCULATOR (nautical miles) .* 2013. http://sea-distances.com/ (accessed March 13, 2013).

Stopford, Martin. *Maritime Economics.* London: Routledge, 1988.

Strandenes, Siri Pettersen. *INB426 Shipping Economics: Shipping cost structure and Speed optimization .* Lecture, Bergen: NHH, 2012.

Strandenes, Siri Pettersen. "Is there potential for a two-tier tanker market ?" *MARIT. POL. MGMT ., 1999, VOL. 26* , no. 3 (1999): 249-264.

Strandenes, Siri Pettersen. *Port Pricing Structures and Ship Efficiency.* Bergen: Review of Network Economics, NHH, June 2004.

Walderhaug, and Hammer. *Them Chemical Tanker Market.* Internal Rapport-Unpublished, Bergen: Odfjell Seacam, 2007.

Wright, Robert. "Triton builds up chemical tanker fleet." *Financial Times.* April 10, 2012. http://www.ft.com/cms/s/0/0869fc1e-7d9a-11e1-bfa5-00144feab49a.html#axzz2UOhlmp3N (accessed April 24, 2013).

Y.H.V. Lun, K.-H. Lai, T.C.E. Cheng. "Chapter 2: Freight Rate Mechanism." In *Shipping and Logistics Management* , 17-32. Springer London, 2010.

Østensjø, Pernille. *A Competititve Norway: Chemicals Shipping.* SNF-Report, Centre for Research in Economics and Business Administration, Bergen: NHH, 1992.

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Appendix A: Cargo Charters

Here I have provided a segment of the PIERS data set displaying the 532 cargoes serviced on the Asia Pacific trade lane between the 15th of October and the 15th of December of 2012. I have chosen to only display the data of importance for my assessment.

OPERATOR	LOADDATE	VESSEL	LOADPORT	DISCHARGE PORT	COUNTRY	COMMODITY	MTONS	CHARTERER
Berlian Laju Tankers	121124	CHEMBULK VIRGIN GORDA	BATON ROUGE	CHANGSHU	CHINA	CHLOROFORM UN1888	3 059,02	OCCIDENTAL CHEMICAL
Berlian Laju Tankers	121128	CHEMBULK VIRGIN GORDA	LK CHARLES	NINGBO	CHINA	MIX XYLENE	5 000,01	SUMMIT PETROCHEMICAL TRADING INC
Berlian Laju Tankers	121128	CHEMBULK VIRGIN GORDA	LK CHARLES	ULSAN	SOUTH KOREA	STYRENE MONOMER	5 229,40	TRAMMOCHEM
Chembulk	121024	CHEMBULK BARCELONA	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	4 000,00	INEOS EUROPE AG
Chembulk	121024	CHEMBULK BARCELONA	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	4 000,00	INEOS EUROPE AG
Chembulk	121030	CHEMBULK BARCELONA	HOUSTON	ULSAN	SOUTH KOREA	MIX XYLENE	4 857,89	TOTAL PETROCHEMICALS
Chembulk	121030	CHEMBULK BARCELONA	TEXAS CITY	ULSAN	SOUTH KOREA	MIX XYLENE	4 769,41	CHEMIUM INTERNATIONAL
Chembulk	121102	CHEMBULK BARCELONA	LK CHARLES	ULSAN	SOUTH KOREA	STYRENE MONOMER	4 756,75	TRAMMOCHEM
Chembulk	121102	CHEMBULK BARCELONA	LK CHARLES	XIAMEN	CHINA	ETHYLENE DICHLORIDE	10 000,01	MITSUBISHI
Dorval Tankships Pty Ltd	121213	GOLDEN UNITY	BATON ROUGE	TIANJIN	CHINA	ETHYLENE DICHLORIDE	12 000,01	TRICON SHIPPING
Eitzen Chemical	121203	SICHEM ONOMICHI	HOUSTON	DALIAN	CHINA	MIX XYLENE	11 000,01	KOCH SUPPLY & TRADING
Eitzen Chemical	121019	SITEAM JUPITER	CORPUS CHRSTI	MAILIAO	TAIWAN	MIX XYLENE	5 261,01	KOLMAR AMERICAS
Eitzen Chemical	121022	SITEAM JUPITER	TEXAS CITY	ANPING	CHINA	STYRENE MONOMER	7 000,01	SUMMIT PETROCHEMICAL TRADING INC
Eitzen Chemical	121022	SITEAM JUPITER	TEXAS CITY	TAICHUNG	TAIWAN	FATTY ACID	6 300,01	ALPHA BIO ENERGY
Eitzen Chemical	121022	SITEAM JUPITER	TEXAS CITY	ULSAN	SOUTH KOREA	MIX XYLENE	5 225,39	CHEMIUM INTERNATIONAL
Eitzen Chemical	121018	SITEAM LEADER	BATON ROUGE	ULSAN	SOUTH KOREA	XYLENE ETHYLBENZENE	10 000,01	EXXONMOBIL CHEMICAL
Eitzen Chemical	121026	SITEAM LEADER	CORPUS CHRSTI	TIANJIN	CHINA	ORTHOXYLENE	4 998,01	TRAMMOCHEM
Eitzen Chemical	121028	SITEAM LEADER	HOUSTON	KAOHSIUNG	TAIWAN	STYRENE MONOMER	5 000,01	SUMMIT PETROCHEMICAL TRADING INC
Eitzen Chemical	121102	SITEAM LEADER	BATON ROUGE	DAESAN	SOUTH KOREA	ETHYLENE DICHLORIDE	3 333,34	MITSUI & CO
Eitzen Chemical	121102	SITEAM LEADER	BATON ROUGE	KASHIMA	JAPAN	ETHYLENE DICHLORIDE	3 333,34	MITSUI & CO
Eitzen Chemical	121102	SITEAM LEADER	BATON ROUGE	TIANJIN	CHINA	ETHYLENE DICHLORIDE	5 000,01	MITSUI & CO
Eitzen Chemical	121102	SITEAM LEADER	S LOUISIANA	TIANJIN	CHINA	ETHYLENE DICHLORIDE	5 000,01	MITSUI & CO
Eitzen Chemical	121102	SITEAM LEADER	S LOUISIANA	TIANJIN	CHINA	ETHYLENE DICHLORIDE	5 000,01	MITSUI & CO
Eitzen Chemical	121207	SITEAM NEPTUN	HOUSTON	ULSAN	SOUTH KOREA	ORTHOXYLENE	2 000,00	KOLMAR AMERICAS
Eitzen Chemical	121207	SITEAM NEPTUN	HOUSTON	ULSAN	SOUTH KOREA	ORTHOXYLENE	1 053,11	KOLMAR AMERICAS
Eitzen Chemical	121207	SITEAM NEPTUN	TEXAS CITY	MAILIAO	TAIWAN	MIX XYLENE	4 925,47	ICC CHEMICALS
Eitzen Chemical	121211	SITEAM NEPTUN	PNT COMFORT	ANPING	CHINA	ACRYLONITRILE	4 000,00	INEOS EUROPE AG
Eitzen Chemical	121211	SITEAM NEPTUN	PNT COMFORT	TIANJIN	CHINA	ETHYLENE DICHLORIDE	17 299,00	MITSUI STEEL INC
Eitzen Chemical	121211	SITEAM NEPTUN	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	3 761,00	INEOS EUROPE AG
Eitzen Chemical	121211	SITEAM NEPTUN	PNT COMFORT	YOSU	SOUTH KOREA	ETHYLENE DICHLORIDE	17 299,00	MITSUI STEEL INC
Eitzen Chemical	121214	SITEAM NEPTUN	TEXAS CITY	ZHANGJIAGANG	CHINA	PARAXYLENE	5 089,43	ICC CHEMICALS
Fairfield Chemical Carriers	121209	FAIRCHEM COLT	FREEPORT TX	DALIAN	CHINA	MIX XYLENE	8 920,72	KOCH SUPPLY & TRADING
Fairfield Chemical Carriers	121211	FAIRCHEM COLT	HOUSTON	DALIAN	CHINA	MIX XYLENE	9 081,02	KOCH SUPPLY & TRADING
Fairfield Chemical Carriers	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	MONOETHYLENE GLYCOL	5 000,01	TRICON SHIPPING
Fairfield Chemical Carriers	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	STYRENE MONOMER	5 000,01	TRICON SHIPPING
Fairfield Chemical Carriers	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	STYRENE MONOMER	5 000,01	TRICON SHIPPING
Fairfield Chemical Carriers	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	STYRENE MONOMER	2 500,00	TRICON SHIPPING
Fairfield Chemical Carriers	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	STYRENE MONOMER	2 500,00	TRICON SHIPPING
Fairfield Chemical Carriers	121116	FAIRCHEM STALLION	LK CHARLES	ULSAN	SOUTH KOREA	MIX XYLENE	6 007,64	TRAMMOCHEM
Formosa Plastics Marine	121207	FORMOSA THIRTEEN	LK CHARLES	KOBE	JAPAN	ETHYLENE DICHLORIDE	1 500,00	MITSUBISHI CORP BEVERAGE
Formosa Plastics Marine	121019	FPMC 24	BATON ROUGE	ULSAN	SOUTH KOREA	XYLENE ETHYLBENZENE	10 266,26	EXXONMOBIL CHEMICAL
Formosa Plastics Marine	121016	FPMC 28	CORPUS CHRSTI	TIANJIN	CHINA	MIX XYLENE	5 000,01	MITSUBISHI CORP
Formosa Plastics Marine	121116	FPMC 30	PORT ARTHUR	TAICHUNG	TAIWAN	METHYL ESTER	3 000,00	JP MORGAN VENTURES ENERGY CORP
Formosa Plastics Marine	121121	FPMC 30	LK CHARLES	KOBE	JAPAN	ETHYLENE DICHLORIDE	10 000,01	MITSUBISHI CORPORATION
Formosa Plastics Marine	121121	FPMC 30	LK CHARLES	MAILIAO	TAIWAN	MIX XYLENE	10 000,01	KOLMAR AMERICAS
Formosa Plastics Marine	121121	FPMC 30	LK CHARLES	MAILIAO	TAIWAN	MIX XYLENE	3 000,00	KOLMAR AMERICAS
Formosa Plastics Marine	121125	FPMC 30	BATON ROUGE	ULSAN	SOUTH KOREA	XYLENE ETHYLBENZENE	10 054,78	EXXONMOBIL CHEMICAL
Iino	121017	CHEMWAY LARA	HOUSTON	CHIBA	JAPAN	ETHYL TERTIARY BUTYL ETHER	33 648,45	LYONDELL CHEMICAL
IMC/Aurora	121114	MARITIME JINGAN	PNT COMFORT	ANPING	CHINA	ACRYLONITRILE	4 000,00	INOES EURODE
IMC/Aurora	121114	MARITIME JINGAN	PNT COMFORT	TIANJIN	CHINA	ETHYLENE DICHLORIDE	10 000,01	MITSUI & CO
IMC/Aurora	121114	MARITIME JINGAN	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	1 000,00	INOES
IMC/Aurora	121114	MARITIME JINGAN	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	3 000,00	INOES EURODE
IMC/Aurora	121114	MARITIME JINGAN	PNT COMFORT	YOSU	SOUTH KOREA	ETHYLENE DICHLORIDE	10 000,01	MITSUI & CO
IMC/Aurora	121125	MARITIME JINGAN	CORPUS CHRSTI	ULSAN	SOUTH KOREA	MIX XYLENE	5 000,01	MITSUBISHI INTERNATIONAL
IMC/Aurora	121202	MARITIME JINGAN	HOUSTON	ANPING	CHINA	STYRENE MONOMER	5 250,49	LYONDELL CHEMICAL
IMC/Aurora	121202	MARITIME JINGAN	HOUSTON	NINGBO	CHINA	ACRYLONITRILE	3 000,00	VINMAR OVERSEAS
IMC/Aurora	121018	MARITIME NORTH	HOUSTON	ANPING	CHINA	STYRENE MONOMER	4 769,09	LYONDELL CHEMICAL
IMC/Aurora	121018	MARITIME NORTH	HOUSTON	JIANGYIN	CHINA	VINYL ACETATE MONOMER	3 000,00	OXYDE CHEMICALS
IMC/Aurora	121018	MARITIME NORTH	HOUSTON	NINGBO	CHINA	ACRYLONITRILE	2 059,43	VINMAR INTERNATIONAL
IMC/Aurora	121018	MARITIME NORTH	HOUSTON	ULSAN	SOUTH KOREA	MIX XYLENE	5 840,02	MARUBENI AMERICA
IMC/Aurora	121021	MARITIME NORTH	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	4 000,00	INEOS EUROPE
IMC/Aurora	121030	MARITIME NORTH	FREEPORT TX	SHANGHAI	CHINA	ETHYLENE DICHLORIDE	10 000,01	TRICON SHIPPING INC
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	ANPING	CHINA	ACRYLONITRILE	4 000,00	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	JIANGYIN	CHINA	VINYL ACETATE MONOMER	2 000,00	OXYDE CHEMICALS
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 000,00	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 000,00	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 000,00	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 000,00	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	2 000,00	VINMAR INTERNATIONAL

IMC/Aurora	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	500,00	VINMAR INTERNATIONAL
IMC/Aurora	121106	WAWASAN EMERALD	CORPUS CHRSTI	JIANGYIN	CHINA	PARAXYLENE	5 000,01	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN RUBY	HOUSTON	JIANGYIN	CHINA	ACETONE	500,00	VINMAR INTERNATIONAL
IMC/Aurora	121105	WAWASAN RUBY	HOUSTON	ZHUHAI	CHINA	PARAXYLENE	15 000,02	EXXONMOBIL CHEMICAL
Koyo Kaiun	121120	AMELIA	BATON ROUGE	ULSAN	SOUTH KOREA	PHENOL	2 079,33	MITSUI & CO
Koyo Kaiun	121127	AMELIA	FREEPORT TX	MAILIAO	TAIWAN	MIX XYLENE	8 248,80	KOLMAR AMERICAS
Koyo Kaiun	121203	AMELIA	HOUSTON	DONGGUAN	CHINA	ETHYLENE GLYCOL BUTYL ETHER	200,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121203	AMELIA	HOUSTON	DONGGUAN	CHINA	ETHYLENE GLYCOL BUTYL ETHER	220,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121203	AMELIA	HOUSTON	DONGGUAN	CHINA	ETHYLENE GLYCOL BUTYL ETHER	80,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121203	AMELIA	HOUSTON	ULSAN	SOUTH KOREA	BUTYL ACETATE UN1123	419,98	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121203	AMELIA	HOUSTON	ULSAN	SOUTH KOREA	BUTYL ACETATE UN1123	210,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121203	AMELIA	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL BUTYL ETHER	500,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121015	XENA	BATON ROUGE	GUNSAN	SOUTH KOREA	PHENOL	2 622,92	MITSUBISHI INTERNATIONAL
Koyo Kaiun	121015	XENA	BATON ROUGE	ULSAN	SOUTH KOREA	PHENOL	2 083,79	MITSUI & CO
Koyo Kaiun	121020	XENA	LK CHARLES	ULSAN	SOUTH KOREA	MIX XYLENE	5 956,64	TRAMMOCHEM AG
Koyo Kaiun	121023	XENA	HOUSTON	DONGGUAN	CHINA	ETHYLENE GLYCOL BUTYL ETHER	220,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	DONGGUAN	CHINA	ETHYLENE GLYCOL BUTYL ETHER	80,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	GUANGZHOU	CHINA	ETHYLENE GLYCOL BUTYL ETHER	1 250,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	GUANGZHOU	CHINA	ETHYLENE GLYCOL BUTYL ETHER	250,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	GUANGZHOU	CHINA	ETHYLENE GLYCOL BUTYL ETHER	200,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	ULSAN	SOUTH KOREA	DIETHYLENE GLYCOL BUTYL ETHER	500,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	ULSAN	SOUTH KOREA	DIETHYLENE GLYCOL METHYL ETHER	500,00	ITOCHU CHEMICALS AMERICA
Koyo Kaiun	121023	XENA	HOUSTON	ULSAN	SOUTH KOREA	PROPYLENE GLYCOL METHYL ETHER UN309	500,00	ITOCHU CHEMICALS AMERICA
MISC	121113	BUNGA BANYAN	NEW ORLEANS	ZHANGJIAGANG	CHINA	CRUDE DEGUMMED SOYBEAN OIL	19 370,18	BUNGE NORTH AMERICA
Navig8 Chemicals - Stainless8 Pool	121119	SIRA	LK CHARLES	KOBE	JAPAN	ETHYLENE DICHLORIDE	10 000,01	MITSUBISHI CORPARATION
Navig8 Chemicals - Stainless8 Pool	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 000,00	VINMAR INTERNATIONAL
Navig8 Chemicals - Stainless8 Pool	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 499,93	VINMAR INTERNATIONAL
Navig8 Chemicals - Stainless8 Pool	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	1 000,00	VINMAR INTERNATIONAL
Navig8 Chemicals - Stainless8 Pool	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	2 000,00	VINMAR INTERNATIONAL
Navig8 Chemicals - Stainless8 Pool	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	500,00	VINMAR INTERNATIONAL
NCC Odfjell	121212	NCC DAMMAM	TEXAS CITY	ULSAN	SOUTH KOREA	PARAXYLENE	5 272,48	CHEMIUM INTERNATIONAL
NCC Odfjell	121214	NCC DAMMAM	PNT COMFORT	TIANJIN	CHINA	ETHYLENE DICHLORIDE	3 669,00	ORDER OF SHIPPER
NCC Odfjell	121214	NCC DAMMAM	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	7 840,01	INEOS EUROPE AG
NCC Odfjell	121214	NCC DAMMAM	PNT COMFORT	YOSU	SOUTH KOREA	ETHYLENE DICHLORIDE	3 669,00	ORDER OF SHIPPER
NCC Odfjell	121207	NCC NASMA	HOUSTON	NINGBO	CHINA	ADIPONITRILE	3 999,85	INVISTA
NCC Odfjell	121207	NCC NASMA	HOUSTON	NINGBO	CHINA	PARAXYLENE	15 408,44	EXXONMOBIL LUBRICANTS TRADING
NCC Odfjell	121207	NCC NASMA	HOUSTON	ZHUHAI	CHINA	PARAXYLENE	9 963,82	EXXONMOBIL LUBRICANTS TRADING
NCC Odfjell	121025	NCC NOOR	CORPUS CHRSTI	TIANJIN	CHINA	ETHYLENE DICHLORIDE	2 615,00	MITSUI
NCC Odfjell	121025	NCC NOOR	CORPUS CHRSTI	YOSU	SOUTH KOREA	ETHYLENE DICHLORIDE	2 615,00	MITSUI
NCC Odfjell	121029	NCC NOOR	LK CHARLES	ULSAN	SOUTH KOREA	MIX XYLENE	5 265,74	MITSUBISHI INTERNATIONAL
NCC Odfjell	121101	NCC NOOR	HOUSTON	HONG KONG	CHINA	MIX XYLENE	3 147,79	TOTAL PETROCHEMICALS
NCC Odfjell	121101	NCC NOOR	HOUSTON	HONG KONG	CHINA	MIX XYLENE	3 148,07	TOTAL PETROCHEMICALS
NCC Odfjell	121115	NCC NOOR	S LOUISIANA	TIANJIN	CHINA	ETHYLENE DICHLORIDE	6 295,01	ORDER OF SHIPPER
NCC Odfjell	121115	NCC NOOR	S LOUISIANA	ULSAN	SOUTH KOREA	XYLENES ETHYLBENZENE	10 503,39	EXXONMOBIL CHEMICAL
NCC Odfjell	121115	NCC NOOR	S LOUISIANA	YOSU	SOUTH KOREA	ETHYLENE DICHLORIDE	6 295,01	ORDER OF SHIPPER
Nordic Tankers	121201	MAEMI	BATON ROUGE	SINGAPORE	SINGAPORE	NEODENE	1 500,00	SHELL CHEMICAL
Nordic Tankers	121114	SIVA GHENT	FREEPORT TX	SHANGHAI	CHINA	ETHYLENE DICHLORIDE	100 000,11	TRICON SHIPPING INC
Nordic Tankers	121114	SIVA GHENT	FREEPORT TX	ULSAN	SOUTH KOREA	MIX XYLENE	5 250,01	INTERCHEM INC
Nordic Tankers	121118	SIVA GHENT	HOUSTON	ZHANGJIAGANG	CHINA	MIX XYLENE	4 481,54	SHELLT RADING
Nordic Tankers	121118	SIVA GHENT	HOUSTON	ZHANGJIAGANG	CHINA	N BUTANOL	1 000,00	VINMAR OVERSEAS
Nordic Tankers	121123	SIVA GHENT	CORPUS CHRSTI	ULSAN	SOUTH KOREA	ORTHOXYLENE	4 896,01	IVNMAR OVERSEAS
Nordic Tankers	121123	SIVA GHENT	CORPUS CHRSTI	ULSAN	SOUTH KOREA	ORTHOXYLENE	2 074,00	IVNMAR OVERSEAS
Nordic Tankers	121123	SIVA GHENT	CORPUS CHRSTI	ULSAN	SOUTH KOREA	ORTHOXYLENE	1 074,00	IVNMAR OVERSEAS
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	HONG KONG	CHINA	MIX XYLENE	5 248,97	TOTAL PETROCHEMICALS
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	KAOHSIUNG	TAIWAN	METHYL ESTER	3 001,99	CHEMOIL CORPORATION
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	ALPHAPLUS TETRADECENE	1 019,70	CHEVRON PHILLIPS CHEMICAL
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	ETHYLENE GLYCOL BUTYL ETHER	524,81	EQUISTAR CHEMICALS
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	ETHYLENE GLYCOL BUTYL ETHER	314,88	EQUISTAR CHEMICALS
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	ETHYLENE GLYCOL BUTYL ETHER	209,92	EQUISTAR CHEMICALS
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	SAKURAJIMA	JAPAN	HEXAMETHYLENE DIAMINE SOLN	1 803,58	TORAY INDUSTRIES AMERICA INC
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	SINGAPORE	SINGAPORE	ACETIC ANHYDRIDE	611,40	EASTMAN CHEMICAL
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	TAICHUNG	TAIWAN	NONENE	1 029,74	MITSUI STEEL INC
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ACETIC ANHYDRIDE	100,00	CELANESE CORP
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ACETIC ANHYDRIDE	99,86	CELANESE CORP
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ACETIC ANHYDRIDE	100,00	CELANESE CORP
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ACETIC ANHYDRIDE	100,00	CELANESE CORP
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ALPHA OLEFIN	1 019,49	INEOS SINGAPORE
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ALPHA OLEFIN	509,82	INEOS USA LLC
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	ALPHA OLEFIN	1 014,68	INEOS USA LLC
Odfjell Tankers	121105	BOW ENGINEER	HOUSTON	ZHANGJIAGANG	CHINA	DIISOBUTYLENE	1 007,59	JANEX CHEMIN DEL FLEURETTES

Odfjell Tankers	121111	BOW ENGINEER	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	4 999,01	INOES
Odfjell Tankers	121111	BOW ENGINEER	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	1 000,00	INOES
Odfjell Tankers	121125	BOW SPRING	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	1 000,00	INEOS USA LLC
Odfjell Tankers	121125	BOW SPRING	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	6 999,01	INEOS EUROPE AG
Odfjell Tankers	121202	BOW SPRING	BEAUMONT	SINGAPORE	SINGAPORE	CHEVRON NEUTRAL OIL	1 985,56	CHEVRON CORPORATION
Odfjell Tankers	121202	BOW SPRING	BEAUMONT	SINGAPORE	SINGAPORE	CHEVRON NEUTRAL OIL	1 985,56	CHEVRON CORPORATION
Odfjell Tankers	121202	BOW SPRING	BEAUMONT	TIANJIN	CHINA	PROPYLENE OXIDE	2 951,75	OXYDE CHEMICALS
Odfjell Tankers	121207	BOW SPRING	HOUSTON	KAOHSIUNG	TAIWAN	PARAFFIN	1 250,09	ICC CHEMICALS
Odfjell Tankers	121207	BOW SPRING	HOUSTON	ULSAN	SOUTH KOREA	ALPHA OLEFIN	407,92	INEOS USA LLC
Odfjell Tankers	121207	BOW SPRING	HOUSTON	ULSAN	SOUTH KOREA	ALPHA OLEFIN	1 219,03	INEOS USA LLC
Odfjell Tankers	121207	BOW SPRING	HOUSTON	ULSAN	SOUTH KOREA	ALPHA OLEFIN	1 017,69	INEOS USA
Odfjell Tankers	121207	BOW SPRING	HOUSTON	YOKOHAMA	JAPAN	DURASYN	510,75	INEOS USA
Odfjell Tankers	121207	BOW SPRING	HOUSTON	YOKOHAMA	JAPAN	DURASYN	510,21	INEOS USA
Odfjell Tankers	121207	BOW SPRING	HOUSTON	ZHENJIANG	CHINA	ORTHOXYLENE	2 099,55	ICC CHEMICALS
Odfjell Tankers	121208	BOW SPRING	FREEPORT TX	ULSAN	SOUTH KOREA	PROPYLENE OXIDE	2 098,06	OXYDE CHEMICALS
Odfjell Tankers	121213	BOW SPRING	HOUSTON	SAKURAJIMA	JAPAN	HEXAMETHYLENE DIAMINE SOLN	2 141,63	TORAY INTERNATIONAL AMERICA INC
Odfjell Tankers	121213	BOW SPRING	HOUSTON	SINGAPORE	SINGAPORE	ACETIC ANHYDRIDE	1 019,34	EASTMAN CHEMICAL
Odfjell Tankers	121213	BOW SPRING	TEXAS CITY	SINGAPORE	SINGAPORE	METAXYLENE	3 976,06	ICC CHEMICALS
Odfjell Tankers	121120	NCC NAJRAN	HOUSTON	ULSAN	SOUTH KOREA	MIX XYLENES	5 320,09	MARUBENI AMERICA
Odfjell Tankers	121120	NCC NAJRAN	HOUSTON	ULSAN	SOUTH KOREA	MIX XYLENES	5 223,90	CHEMIUM INTERNATIONAL
Odfjell Tankers	121130	NCC NAJRAN	BATON ROUGE	ULSAN	SOUTH KOREA	XYLENES ETHYLBENZENE	5 253,87	EXXONMOBIL CHEMICAL
Odfjell Tankers	121130	NCC NAJRAN	BATON ROUGE	ULSAN	SOUTH KOREA	XYLENES ETHYLBENZENE	5 253,87	EXXONMOBIL CHEMICAL
Odfjell Tankers	121130	NCC NAJRAN	BATON ROUGE	YOSU	SOUTH KOREA	ETHYLENE DICHLORIDE	10 479,01	MITSUI & CO
Odfjell Tankers	121130	NCC NAJRAN	BATON ROUGE	YOSU	SOUTH KOREA	XYLENES ETHYLBENZENE	10 479,01	MITSUI & CO
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	BANGKOK	THAILAND	ISOPROPYLALCOHOL	998,64	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	MERAK	INDONESIA	ISOPROPYLALCOHOL	998,55	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	NINGBO	CHINA	NEODENE	500,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	200,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	300,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	200,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	500,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	250,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	150,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	NEODENE	300,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SINGAPORE	SINGAPORE	EXXAL TRIDECYL	701,22	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SINGAPORE	SINGAPORE	ISOPROPYLALCOHOL	998,64	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	SINGAPORE	SINGAPORE	LUBE OIL ADDITIVE	1 993,35	EXXONMOBIL LUBRICANTS TRADING
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	DIALKYL PHTHALATES	400,00	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	489,16	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	98,84	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	100,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	NEODENE	151,65	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	BATON ROUGE	YOSU	SOUTH KOREA	HEXENE	996,87	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	420,66	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	253,11	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	151,87	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	202,49	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	410,64	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	303,74	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	101,25	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	POLY ETHOXYLATES	50,62	SHELL CHEMICAL LP
Stolt Parcel Tankers	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SINGAPORE	SINGAPORE	NEODECANOIC ACID	502,03	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	BANGKOK	THAILAND	MMA 50 PPM AO 30 METHYL METHACRYLAT	449,45	ROHM AND HAAS
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	BANGKOK	THAILAND	MMA 50 PPM AO 30 METHYL METHACRYLAT	549,39	ROHM AND HAAS
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	KAOHSIUNG	TAIWAN	ARCOSLV PM PROPYLENE GLYCOL MONOALK	524,48	LYONDELL CHEMICAL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	KAOHSIUNG	TAIWAN	PROPYLENE GLYCOL INDUSTRIAL	644,54	LYONDELL CHEMICAL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	KOBE	JAPAN	CRUDE TALL OIL	1 501,41	HARIMATEC INC
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	KOBE	JAPAN	HEXAMETHYLENE DIAMINE	949,85	INVISTA SARL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	NINGBO	CHINA	ADIPONITRILE UN2205	4 500,01	INVISTA SARL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	ONSAN	SOUTH KOREA	ALIMET METHIONINE HYDROXY	1 499,80	NOVUS INTERNATIONAL

Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	SHEKOU	CHINA	BUTYL ACRYLATE UN2348	1 000,00	ARKEMA INC
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	839,64	LYONDELL CHEMICAL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL MONOALKYL ETHERS	917,29	EASTMAN CHEMICAL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL MONOALKYL ETHERS	803,57	EASTMAN CHEMICAL
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	HOUSTON	ULSAN	SOUTH KOREA	ISOBUTYL ACETATE	304,81	OXEA CORPORATION
Stolt Parcel Tankers	121127	STOLT ACHIEVEMENT	TEXAS CITY	MERAK	INDONESIA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	498,17	DOW CHEMICAL
Stolt Parcel Tankers	121206	STOLT EMERALD	NEW ORLEANS	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	1 410,45	CHEVRON ORONITE CO
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	BANGKOK	THAILAND	METHYLMETHACRYLATE	524,42	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	BANGKOK	THAILAND	METHYLMETHACRYLATE	474,48	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	DONGGUAN	CHINA	BUTYL ACRYLATE	1 000,00	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	KAOHSIUNG	TAIWAN	BUTYL ACRYLATE	1 499,55	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	KAOHSIUNG	TAIWAN	METHYLMETHACRYLATE UN1247	199,90	ARKEMA INC
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	KAOHSIUNG	TAIWAN	METHYLMETHACRYLATE UN1247	1 299,34	ARKEMA INC
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	KOBE	JAPAN	HEXAMETHYLENE DIAMINE	930,78	INVISTA S A R L
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	MAP TA PHUT	THAILAND	BUTYL ACRYLATE	399,88	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	MAP TA PHUT	THAILAND	BUTYL ACRYLATE	599,82	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	MAP TA PHUT	THAILAND	BUTYL ACRYLATE	199,94	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	MERAK	INDONESIA	BUTYL ACRYLATE	199,94	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	MERAK	INDONESIA	BUTYL ACRYLATE	999,70	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	NINGBO	CHINA	ADIPONITRILE UN2205	6 000,01	INVISTA SARL
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	SHEKOU	CHINA	BUTYL ACRYLATE STABILIZED UN2348	1 000,00	ARKEMA INC
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL MONOALKYL ETHERS	699,39	EASTMAN CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	ULSAN	SOUTH KOREA	HEXAMETHYLENE DIAMINE	2 827,87	INVISTA SARL
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	YOKOHAMA	JAPAN	BUTYL ACRYLATE UN2348	763,08	ARKEMA INC
Stolt Parcel Tankers	121023	STOLT FOCUS	HOUSTON	ZHANGJIAGANG	CHINA	BA 15 PPM MEHQ BUTYL ACRYLATE	1 000,00	ROHM AND HAAS
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	DONGGUAN	CHINA	BUTYL CELLOSOLVE ETHYLENEGLYCOL MON	750,00	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	KAOHSIUNG	TAIWAN	MONOETHANOLAMINE	599,95	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	KOBE	JAPAN	BUTYL CARBITOL SOLVENT	471,18	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	SINGAPORE	SINGAPORE	VORANOL COPOLYMER POLYOL	499,46	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	BUTYL CELLOSOLVE SOLVENT	549,70	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	ISOBUTANOL	525,58	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	MONOETHANOLAMINE	499,95	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	TRIETHANOLAMINE	300,26	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	TRIETHANOLAMINE	500,43	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	YOSU	SOUTH KOREA	BUTYL CELLOSOLVE ETHYLENEGLYCOL MON	250,00	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL CELLOSOLVE ETHYLENEGLYCOL MON	100,00	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL CELLOSOLVE ETHYLENEGLYCOL MON	600,00	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL CELLOSOLVE ETHYLENEGLYCOL MON	150,00	DOW CHEMICAL
Stolt Parcel Tankers	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL CELLOSOLVE ETHYLENEGLYCOL MON	150,00	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	SINGAPORE	SINGAPORE	DIPROPYLENEGLYCOL	367,36	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	525,80	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	730,87	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	DIPROPYLENEGLYCOL	209,92	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	EPICHLOROHYDRIN	2 309,51	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	PROPYLENE GLYCOL	1 049,50	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	YOSU	SOUTH KOREA	CRUDE MDI	1 052,67	DOW CHEMICAL
Stolt Parcel Tankers	121026	STOLT FOCUS	FREEPORT TX	ZHANGJIAGANG	CHINA	DER EPOXY RESIN	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	SHEKOU	CHINA	VORANOL	1 000,00	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	SINGAPORE	SINGAPORE	DER EPOXY RESIN	523,94	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	SINGAPORE	SINGAPORE	DIPROPYLENEGLYCOL	899,41	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	SINGAPORE	SINGAPORE	DIPROPYLENEGLYCOL	368,28	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	523,94	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	DIPROPYLENEGLYCOL	210,45	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	EPICHLOROHYDRIN	1 577,81	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	PROPYLENE GLYCOL	1 079,29	DOW CHEMICAL
Stolt Parcel Tankers	121017	STOLT SAPPHIRE	FREEPORT TX	ZHANGJIAGANG	CHINA	DER EPOXY RESIN	800,00	DOW CHEMICAL
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	AUCKLAND	NEW ZEALAND	ALIMET 2HYDROXY4METHYLTHIOBUTANOIC	299,85	NOVUS INTERNATIONAL
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	AUCKLAND	NEW ZEALAND	BA 15 PPM MEHQ BUTYL ACRYLATE	350,00	ROHM AND HAAS
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	AUCKLAND	NEW ZEALAND	MMA 50 PPM AO 30 METHYL METHACRYLAT	199,54	ROHM AND HAAS
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	BRISBANE	AUSTRALIA	METHYL ISOBUTYL CARBINOL	494,04	CELANESE CORP
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	FREMANTLE	AUSTRALIA	POTASSIUM HYDROXIDE SOLN UN1814	799,45	OCCIDENTAL CHEMICAL
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	MELBOURNE	AUSTRALIA	JAYFLEX DIDP	498,85	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	MELBOURNE	AUSTRALIA	POTASSIUM HYDROXIDE SOLN UN1814	1 200,01	OCCIDENTAL CHEMICAL
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	MELBOURNE	AUSTRALIA	PROPANOL	200,00	OXEA CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	EXXAL TRIDECYL	783,37	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	EXXSOL	258,08	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	ISOPAR FLUID NAPHTHA SOLVENT	504,42	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	706,39	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	201,37	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	402,58	THE LUBRIZOL CORPORATION

Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	314,51	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	1 592,12	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	200,52	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	200,14	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	805,38	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	202,53	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	SOLVENT NAPHTHA	299,86	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SYDNEY	AUSTRALIA	LUBRICATING OIL ADDITIVES	405,41	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121214	STOLT SEA	HOUSTON	SYDNEY	AUSTRALIA	LUBRICATING OIL ADDITIVES	500,01	THE LUBRIZOL CORPORATION
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	ARCOL POLYOL	2 100,44	BAYER MATERIAL SCIENCE
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	ARCOSOLV PM SOLVENT	944,19	LYONDELL CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	BUTANEDIOL	524,53	LYONDELL CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	GLYCOLETHER EB	524,82	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	PROPYLENE GLYCOL IND	842,39	LYONDELL CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	SINGAPORE	SINGAPORE	N BUTANOL	2 500,17	OXEA CORPORATION
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	1 049,92	LYONDELL CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL BUTYL ETHER	524,82	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	100,00	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	100,00	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	98,32	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	100,00	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	100,00	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	100,00	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	METHYL ISOBUTYL KETONE	100,00	CELANESE CORP
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	YOKOHAMA	JAPAN	PROPANOL	524,97	OXEA CORPORATION
Stolt Parcel Tankers	121025	STOLT SNELAND	HOUSTON	ZHANGJIAGANG	CHINA	PROPYLENE GLYCOL INDUSTRIAL	1 000,00	LYONDELL CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	SINGAPORE	SINGAPORE	VORANOL COPOLYMER POLYOL	495,53	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	ULSAN	SOUTH KOREA	BUTYL CELLOSOLVE SOLVENT	499,78	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	ULSAN	SOUTH KOREA	DIISOBUTYL KETONE	309,96	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	ULSAN	SOUTH KOREA	ETHYL ETHOXYPROPIONATE	944,51	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	YOKOHAMA	JAPAN	BUTYL CELLOSOLVE SOLVENT	299,87	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	YOKOHAMA	JAPAN	ETHYL ETHOXYPROPIONATE	209,89	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL CELLOSOLVE SOLVENT	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121025	STOLT SNELAND	TEXAS CITY	ZHANGJIAGANG	CHINA	DIETHANOLAMINE	838,38	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	KAOHSIUNG	TAIWAN	PROPYLENE GLYCOL	53,25	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	LANSHAN	CHINA	PPAPI TM 27 PLYMERIC MDI	1 200,00	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	NAGOYA	JAPAN	SPECFLEX TM NC630 POLYOL	457,60	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	SHANGHAI	CHINA	DER EPOXY RESIN	519,87	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	SHANGHAI	CHINA	DER EPOXY RESIN	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	SINGAPORE	SINGAPORE	METHYLENE CHLORIDE	730,80	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	1 254,29	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	729,06	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	415,89	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	METHYLENE CHLORIDE	313,20	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	PROPYLENE GLYCOL	1 672,39	DOW CHEMICAL
Stolt Parcel Tankers	121030	STOLT SNELAND	FREEPORT TX	ZHANGJIAGANG	CHINA	DER EPOXY RESIN	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	AUCKLAND	NEW ZEALAND	BUTYL ACRYLATE	399,64	ROHM AND HAAS
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	AUCKLAND	NEW ZEALAND	MMA METHYLMETHACRYLATE	349,87	ROHM AND HAAS
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	ACETIC ANHYDRIDE	149,72	CELANESE CORP
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	ALIMET DL 2HYDROXY4 METHYLTHIO BUTA	499,89	NOVUS INTERNATIONAL
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	GAS OIL	253,16	NYNAS AB
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	PROCESS OIL NYTEX	205,21	NYNAS AB
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	PROCESS OIL NYTEX	579,26	NYNAS AB
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	TRANSFORMER OIL	1 050,19	PETROLEUM SPECIALTIES
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	TRANSFORMER OIL	1 516,86	NYNAS AB
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	BRISBANE	AUSTRALIA	METHYL ISOBUTYL CARBINOL	799,84	CELANESE CORP
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	FREMANTLE	AUSTRALIA	LUBRIZOL	199,54	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	FREMANTLE	AUSTRALIA	POTASSIUM HYDROXIDE SOLN	849,62	OCCIDENTAL CHEMICAL
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	BA 15 PPM MEHQ BUTYL ACRYLATE	999,09	ROHM AND HAAS
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	EXXSOL FLUID NAPHTHA SOLVENT	198,47	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	EXXSOL FLUID NAPHTHA SOLVENT	203,97	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	JAYFLEX DIDP	1 925,55	EXXONMOBIL CHEMICM ASIA PACIFIC
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	MMA 50 PPM AO METHYL METHACRYLATE	1 149,57	ROHM AND HAAS
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	POTASSIUM HYDROXIDE SOLN	2 300,02	OCCIDENTAL CHEMICAL
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	PROPYL ACETATE	199,67	OXEA CORPORATION
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	MERAK	INDONESIA	PROPYLENE OXIDE	2 071,70	BAYPO II LLC
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	SINGAPORE	SINGAPORE	METHYL ISOBUTYL CARBINOL	299,85	CELANESE CORP
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	SINGAPORE	SINGAPORE	N BUTANOL	2 950,88	OXEA CORPORATION
Stolt Parcel Tankers	121106	STOLT SPRAY	HOUSTON	SYDNEY	AUSTRALIA	LUBRIZOL	799,91	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT SPRAY	TEXAS CITY	BRISBANE	AUSTRALIA	METHYL ISOBUTYL CARBINOL	501,25	DOW CHEMICAL

Stolt Parcel Tankers	121106	STOLT SPRAY	TEXAS CITY	MELBOURNE	AUSTRALIA	BUTANOL	249,58	DOW CHEMICAL
Stolt Parcel Tankers	121109	STOLT SPRAY	FREEPORT TX	MELBOURNE	AUSTRALIA	DER EPOXY RESIN	469,55	DOW CHEMICAL
Stolt Parcel Tankers	121123	STOLT SURF	HOUSTON	ANPING	CHINA	METHYLMETHACRYLATE UN1247	1 498,62	ARKEMA INC
Stolt Parcel Tankers	121123	STOLT SURF	HOUSTON	ANPING	CHINA	METHYLMETHACRYLATE UN1247	499,54	ARKEMA INC
Stolt Parcel Tankers	121123	STOLT SURF	HOUSTON	NINGBO	CHINA	ADIPONITRILE UN2205	4 000,00	INVISTA SARL
Stolt Parcel Tankers	121129	STOLT SURF	BATON ROUGE	NINGBO	CHINA	NEODENE	500,00	SHELL CHEMICAL LP
Stolt Parcel Tankers	121025	STOLT TOPAZ	NEW ORLEANS	SINGAPORE	SINGAPORE	LUBRICATING OIL ADDITIVES	812,20	CHEVRON ORONITE CO
Stolt Parcel Tankers	121025	STOLT TOPAZ	NEW ORLEANS	YOKOHAMA	JAPAN	LUBRICATING OIL ADDITIVES	301,29	CHEVRON ORONITE CO
Stolt Parcel Tankers	121025	STOLT TOPAZ	NEW ORLEANS	YOKOHAMA	JAPAN	LUBRICATING OIL ADDITIVES	559,61	CHEVRON ORONITE CO
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	BUSAN	SOUTH KOREA	LUBRIZOL	449,72	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	ARCOL POLYOL	2 624,93	BAYER MATERIAL SCIENCE
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	BUTYLENE GLYCOL	1 049,97	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	DIPROPYLENE GLYCOL INDUSTRIAL	523,68	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	ETHYLENE GLYCOL	1 049,73	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	GLYCOL ETHER DB POLY28ALKYLENE GLYC	944,50	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	GLYCOL ETHER EB ACETATE ETHYLENE GL	477,72	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	METHYL	524,69	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	METHYL METHACRYLATE	1 000,04	ROHM AND HAAS
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	MM PPM METHYL METHACRYLATE	699,24	ROHM AND HAAS
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	PROPYLENE GLYCOL INDUSTRIAL	734,88	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	PROPYLENE OXIDE	2 428,27	BAYPO II LLC
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	KAWASAKI	JAPAN	CRUDE TALL OIL	1 425,52	HARIMATEC INC
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	LUBRIZOL	203,86	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	LUBRIZOL	355,45	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	LUBRIZOL	499,60	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	LUBRIZOL	305,24	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	LUBRIZOL	699,65	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	ULSAN	SOUTH KOREA	LUBRIZOL	204,63	LUBRIZOL CORP
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	YOKOHAMA	JAPAN	ARCOSOLV PM SOLVENT	629,73	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	YOKOHAMA	JAPAN	ARCOSOLV PM SOLVENT	1 364,41	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	HOUSTON	YOKOHAMA	JAPAN	ARCOSOLV PM SOLVENT	524,77	LYONDELL CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	249,90	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	699,72	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	JIANGYIN	CHINA	EASTMAN 2ETHYLHEXANOL OCTANOL	2 022,51	EASTMAN CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	KOBE	JAPAN	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	249,90	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	KOBE	JAPAN	BUTYL POLY28ALKYLENE GLYCOL MONOALK	209,62	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	499,80	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	DIISOBUTYL KETONE	307,17	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	OCTANOL ETHYLHEXANOL	1 022,50	EASTMAN CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	UCAR ETHYL3ETHOXYPROPIONATE ESTER E	817,26	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	XIAOHUDAO	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	449,90	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	YOKOHAMA	JAPAN	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	249,90	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	YOKOHAMA	JAPAN	MONOETHANOLAMINE	498,35	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	ZHANGJIAGANG	CHINA	DIETHANOLAMINE	2 048,41	DOW CHEMICAL
Stolt Parcel Tankers	121106	STOLT TOPAZ	TEXAS CITY	ZHANGJIAGANG	CHINA	EASTMAN 2ETHYLHEXANOL OCTANOL	2 022,51	EASTMAN CHEMICAL
Stolt Parcel Tankers	121109	STOLT TOPAZ	FREEPORT TX	SINGAPORE	SINGAPORE	DER EPOXY RESIN	501,57	DOW CHEMICAL
Stolt Parcel Tankers	121109	STOLT TOPAZ	FREEPORT TX	SINGAPORE	SINGAPORE	DIPROPYLENEGLYCOL	574,79	DOW CHEMICAL
Stolt Parcel Tankers	121109	STOLT TOPAZ	FREEPORT TX	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	1 566,73	DOW CHEMICAL
Stolt Parcel Tankers	121109	STOLT TOPAZ	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	469,22	DOW CHEMICAL
Stolt Parcel Tankers	121109	STOLT TOPAZ	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	802,50	DOW CHEMICAL
Stolt Parcel Tankers	121109	STOLT TOPAZ	FREEPORT TX	ULSAN	SOUTH KOREA	PROPYLENE GLYCOL	522,24	DOW CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	BUTYLENE GLYCOL	1 049,27	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	GLYCOL ETHER DB	869,76	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	GLYCOLETHER EB	839,76	EQUISTAR CHEMICALS
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	METHYLPYRROLIDONE	524,96	LYONDELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	PROPYLENE GLYCOL INDUSTRIAL	839,65	LYONDELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	KOBE	JAPAN	HEXAMETHYLENE DIAMINE	925,51	INVISTA SARL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	MAP TA PHUT	THAILAND	BA PPM MEHQ BUTYLATE ACRYLATE	600,11	ROHM AND HAAS
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	MAP TA PHUT	THAILAND	PHENOL	2 905,87	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	MAP TA PHUT	THAILAND	PHENOL	974,68	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	NINGBO	CHINA	PROPANOL	1 000,00	OXEA CORPORATION
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	PASIR GUDANG	MALAYSIA	PHENOL	974,68	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	100,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	250,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	180,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	400,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	200,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	150,00	SHELL CHEMICAL

Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	150,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	ALCOHOL POLY ETHOXYLATES	200,00	SHELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SINGAPORE	SINGAPORE	HEXAMETHYLENE DIAMINE	1 999,49	INVISTA SARL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	734,91	LYONDELL CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	HOUSTON	ULSAN	SOUTH KOREA	HEXAMETHYLENE DIAMINE	3 665,49	INVISTA SARL
Stolt Parcel Tankers	121203	SYCAMORE	TEXAS CITY	JIANGYIN	CHINA	BUTYL ALCOHOL	1 000,00	EASTMAN CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	250,00	DOW CHEMICAL
Stolt Parcel Tankers	121203	SYCAMORE	TEXAS CITY	ZHANGJIAGANG	CHINA	BUTYL ETHYLENE GLYCOL MONOALKYL ETH	500,00	DOW CHEMICAL
Stolt Parcel Tankers	121204	SYCAMORE	FREEPORT TX	KINUURA	JAPAN	EPICHLOROHYDRIN	136,73	DOW CHEMICAL
Stolt Parcel Tankers	121204	SYCAMORE	FREEPORT TX	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	572,17	DOW CHEMICAL
Stolt Parcel Tankers	121204	SYCAMORE	FREEPORT TX	SINGAPORE	SINGAPORE	PROPYLENE GLYCOL	525,25	DOW CHEMICAL
Stolt Parcel Tankers	121204	SYCAMORE	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	291,84	DOW CHEMICAL
Stolt Parcel Tankers	121204	SYCAMORE	FREEPORT TX	ULSAN	SOUTH KOREA	DER EPOXY RESIN	336,93	DOW CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	KOBE	JAPAN	HEXAMETHYLENE DIAMINE	930,73	INVISTA SARL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	KOBE	JAPAN	PHENOL	1 015,49	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	MAP TA PHUT	THAILAND	PHENOL	1 015,49	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	MAP TA PHUT	THAILAND	PHENOL	2 538,71	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	MAP TA PHUT	THAILAND	PHENOL	2 030,98	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	MERAK	INDONESIA	ALPHA OLEFIN	1 010,13	INEOS SINGAPORE
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	MERAK	INDONESIA	NAPHTHA SOLVENT ISOPAR	500,83	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	NINGBO	CHINA	ADIPONITRILE UN2205	4 000,00	INVISTA SARL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	NINGBO	CHINA	HEXAMETHYLENE DIAMINE	1 660,00	INVISTA SARL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	NEODOL	100,00	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	NEODOL	300,00	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	NEODOL	500,00	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	NEODOL	220,00	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	NEODOL	280,00	SHELL CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	EXXSOL D 130 FLUID	204,08	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	EXXSOL D110 FLUID	150,24	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	EXXSOL HEPTANE	671,42	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	HEXAMETHYLENE DIAMINE	2 057,87	INVISTA SARL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	ISOPAR	179,45	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	ISOPAR M FLUID	209,40	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	PETR OIL	203,98	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	DB SOLVENT	781,84	EASTMAN CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL	996,08	EASTMAN CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	ETHYLENE GLYCOL MONOALKYL ETHERS	1 000,00	EASTMAN CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	HEXAMETHYLENE DIAMINE	981,78	INVISTA SARL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	ISOPAR	304,88	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	ISOPAR E FLUID	298,64	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	ISOPAR H FLUID	797,56	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	ISOPAR L BT VL NAPHTHA SOLVENT	300,50	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	POLYALKYLENE GLYCOL	509,86	EASTMAN CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	BUTYL BUTYRATE	500,00	EASTMAN CHEMICAL
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	NAPHTHA SOLVENT ISOPAR	200,00	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	NAPHTHA SOLVENT ISOPAR	180,00	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	NAPHTHA SOLVENT ISOPAR	300,00	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YOKOHAMA	JAPAN	DURASYN 166 NC	407,73	INEOS SINGAPORE
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YOKOHAMA	JAPAN	EXXSOL D110 FLUID	60,29	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	YOKOHAMA	JAPAN	ISOPAR	398,79	EXXONMOBIL CHEMICAL ASIA PACIFIC
Stolt Parcel Tankers	121108	SYPRESS	HOUSTON	ZHANGJIAGANG	CHINA	PHENOL	1 000,00	SHELL CHEMICAL
Tokyo Marine	121016	BEECH GALAXY	RICHMOND	MERAK	INDONESIA	PROPYLENE TETRAMER	2 484,28	CHEVRON ORONITE CO
Tokyo Marine	121016	BEECH GALAXY	RICHMOND	SINGAPORE	SINGAPORE	PROPYLENE TETRAMER	1 241,95	CHEVRON ORONITE CO
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	JIANGYIN	CHINA	BUTANOL UN1120	500,00	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	JIANGYIN	CHINA	BUTANOL UN1120	500,00	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	NINGBO	CHINA	ALKYLENE GLYCOL MONOALKYL	500,00	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	NINGBO	CHINA	DIETHYLENETRIAMINE UN2079	500,00	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	NINGBO	CHINA	ETHYLENEDIAMINE UN1604	700,00	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	SHANGHAI	CHINA	BUTANOL UN1120	1 000,00	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	ULSAN	SOUTH KOREA	BUTANOL UN1120	157,20	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	ULSAN	SOUTH KOREA	BUTANOL UN1120	419,20	DOW CHEMICAL
Tokyo Marine	121111	GINGA BOBCAT	NEW ORLEANS	ULSAN	SOUTH KOREA	BUTANOL UN1120	471,60	DOW CHEMICAL
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	KAOHSIUNG	TAIWAN	MEHQ BUTYL ACRYLATE	1 481,49	ROHM AND HAAS
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	400,00	VINMAR INTERNATIONAL
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	2 000,00	VINMAR INTERNATIONAL
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	LIANYUNGANG	CHINA	ACRYLONITRILE	400,00	VINMAR INTERNATIONAL
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	NINGBO	CHINA	2METHYL13PROPANEDIOL	525,00	EQUISTAR CHEMICALS
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	NINGBO	CHINA	DIETHYLENE GLYCOL METHYL ETHER	525,00	EQUISTAR CHEMICALS
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	NINGBO	CHINA	POLY GLYCOL	525,00	EQUISTAR CHEMICALS
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	ULSAN	SOUTH KOREA	NMETHYLPYRROLIDONE	300,00	BASF CHEMICAL COMPANY

Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	ULSAN	SOUTH KOREA	TETRAHYDROFURAN UN2056	1 450,00	BASF CHEMICAL COMPANY
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	YOSU	SOUTH KOREA	DIISOBUTYLENES	829,75	SI GROUP
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	ZHANGJIAGANG	CHINA	DIPROPYLENE GLYCOL INDUSTRIAL	525,00	LYONDELL CHEMICAL
Tokyo Marine	121127	GINGA BOBCAT	HOUSTON	ZHANGJIAGANG	CHINA	DIPROPYLENE GLYCOL INDUSTRIAL	735,00	LYONDELL CHEMICAL
Tokyo Marine	121128	GINGA BOBCAT	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	4 150,00	INEOS EUROPE AG
Tokyo Marine	121128	GINGA BOBCAT	PNT COMFORT	ULSAN	SOUTH KOREA	ACRYLONITRILE	1 999,00	INEOS USA LLC
Tokyo Marine	121201	GINGA BOBCAT	TEXAS CITY	KAOHSIUNG	TAIWAN	NEOL NEOPENTYLGLYCOL	600,00	BASF CORP
Tokyo Marine	121201	GINGA BOBCAT	TEXAS CITY	ULSAN	SOUTH KOREA	NEOL NEOPENTYLGLYCOL	700,00	BASF CORP
Tokyo Marine	121203	GINGA EAGLE	RICHMOND	KAOHSIUNG	TAIWAN	PROPYLENE TETRAMER	1 000,44	CHEVRON ORONITE CO
Tokyo Marine	121203	GINGA EAGLE	RICHMOND	SINGAPORE	SINGAPORE	PROPYLENE TETRAMER	990,46	CHEVRON ORONITE CO
Tokyo Marine	121203	GINGA EAGLE	RICHMOND	SINGAPORE	SINGAPORE	PROPYLENE TETRAMER	750,53	CHEVRON ORONITE CO
Tokyo Marine	121203	GINGA EAGLE	RICHMOND	ULSAN	SOUTH KOREA	PROPYLENE TETRAMER	1 250,75	CHEVRON ORONITE CO
Tokyo Marine	121130	GINGA LION	BATON ROUGE	ULSAN	SOUTH KOREA	CHEMICALS HARMLESS	500,00	BASF
Tokyo Marine	121205	GINGA LION	LK CHARLES	ULSAN	SOUTH KOREA	MIX XYLENE	6 000,01	TRAMMOCHEM
Tokyo Marine	121016	GINGA LYNX	NEW ORLEANS	NINGBO	CHINA	DIETHYLENETRIAMINE UN2079	500,00	DOW CHEMICAL
Tokyo Marine	121016	GINGA LYNX	NEW ORLEANS	NINGBO	CHINA	ETHYLENEDIAMINE UN1604	500,00	DOW CHEMICAL
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	KINUURA	JAPAN	DER EPOXY RESIN	525,55	DOW CHEMICAL
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	KINUURA	JAPAN	EPICHLOROHYDRIN	1 000,00	DOW CHEMICAL
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	KUNSAN	SOUTH KOREA	PHENOL	3 150,23	CEDAR PETROCHEMICALS
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	NANTONG	CHINA	CHLOROFORM	3 000,00	DOW CHEMICAL
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	NANTONG	CHINA	METHYLENE CHLORIDE	2 000,00	DOW CHEMICAL
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	ULSAN	SOUTH KOREA	EPICHLOROHYDRIN	400,00	DOW CHEMICAL
Tokyo Marine	121020	GINGA LYNX	FREEPORT TX	ULSAN	SOUTH KOREA	EPICHLOROHYDRIN	175,11	DOW CHEMICAL
Tokyo Marine	121105	GINGA LYNX	HOUSTON	KUNSAN	SOUTH KOREA	PHENOL	3 144,83	CEDAR PETROCHEMICALS
Tokyo Marine	121105	GINGA LYNX	HOUSTON	NINGBO	CHINA	ALPHA OLEFIN	1 000,00	INEOS SINGAPORE PTE LTD
Tokyo Marine	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	BUTYL ACRYLATE	100,00	ROHM AND HAAS
Tokyo Marine	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	BUTYL ACRYLATE UN2348	50,00	ROHM AND HAAS
Tokyo Marine	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	BUTYL ACRYLATE UN2348	50,00	ROHM AND HAAS
Tokyo Marine	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	TETRAHYDROFURAN UN2056	1 480,83	BASF CHEMICAL COMPANY
Tokyo Marine	121105	GINGA LYNX	TEXAS CITY	KAOHSIUNG	TAIWAN	NEOL NEOPENTYLGLYCOL	839,92	BASF CORP
Tokyo Marine	121105	GINGA LYNX	TEXAS CITY	ULSAN	SOUTH KOREA	NEOL NEOPENTYLGLYCOL	524,95	BASF CORP
Tokyo Marine	121105	GINGA LYNX	TEXAS CITY	ZHUHAI	CHINA	ETHYLHEXANOL	1 000,00	BASF CHEMICAL COMPANY
Tokyo Marine	121105	GINGA LYNX	TEXAS CITY	ZHUHAI	CHINA	ETHYLHEXANOL	1 000,00	BASF CHEMICAL COMPANY
Tokyo Marine	121016	PINE GALAXY	RICHMOND	ULSAN	SOUTH KOREA	PROPYLENE TETRAMER	2 252,59	CHEVRON ORONITE CO
Tokyo Marine	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	CRUDE DEGUMMED SOYBEAN OIL	489,47	CARGILL INC
Tokyo Marine	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	CRUDE OLEIC SAFFLOWER OIL	509,91	SUMITOMO CORPORATION AMERICA
Tokyo Marine	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	CRUDE OLEIC SAFFLOWER OIL	407,87	OILSEEDS INTL LTD
Tokyo Marine	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	CRUDE SAFFLOWER OIL	998,82	CALIFORNIA OILS CORPORATION
Trafigura	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	MIX AROMATICS	10 000,01	INTERCHEM PTE
Trafigura	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	MIX AROMATICS	10 000,01	INTERCHEM PTE
Trafigura	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	MIX AROMATICS	10 000,01	INTERCHEM PTE
Trafigura	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	MIX AROMATICS	4 350,98	INTERCHEM PTE
Ultragas	121111	MIRAMIS	HOUSTON	NINGBO	CHINA	PARAXYLENE	15 000,02	EXXONMOBIL CHEMICAL

Appendix B: Vessel Details

In this section I have presented the 50 vessels serviced in the period and geographical segment being observed, see section 5.1. I have chosen to remove some of the data that was provided, as it was not of importance for my assessment.

Table: Vessel Details

IMO_Number	Operator	VesselName	MDWT	Year	Total Capacity	Epoxy Capacity	Zinc Capacity	StSteel capacity
9624768	Koyo Kaiun	Amelia	21 287	2011	22000			22000
9340441	Tokyo Marine	Beech Galaxy	19 998	2007	22176	0	0	22176
9317860	Odfjell Tankers	Bow Engineer	30 087	2006	35563	0	0	35563
9215256	Odfjell Tankers	Bow Spring	39 942	2004	51084	0	0	51084
9458834	MISC	Bunga Banyan	45 444	2011	53200	53200	0	0
9278662	Chembulk	Chembulk Barcelona	32 345	2004	36122	0	0	36122
9294288	Berlian Laju Tankers	Chembulk Virgin Gorda	34 584	2004	38861	0	0	38861
9367530	Iino	Chemway Lara	37 982	2007	46917	0	46917	0
9304344	Fairfield Chemical Carriers	Fairchem Colt	19 998	2005	22184	0	0	22184
9423750	Fairfield Chemical Carriers	Fairchem Eagle	25 400	2010	28482			28482
9291456	Fairfield Chemical Carriers	Fairchem Stallion	19 992	2004	22184	0	0	22184
9272503	Formosa Plastics Marine	Formosa Thirteen	45 706	2005	52428	52428	0	0
9418573	Formosa Plastics Marine	FPMC 24	51 150	2010	54744	54744	0	0
9528378	Formosa Plastics Marine	FPMC 28	50 400	2011	53000	53000	0	0
9581679	Formosa Plastics Marine	FPMC 30	51 150	2012	54744	54744		0
9379131	Trafigura	MR Kentaurus	46 541	2007	52489	52489	0	0
9472737	Tokyo Marine	Ginga Bobcat	26 073	2010	28978	0	0	28978
9108104	Tokyo Marine	Ginga Eagle	19 999	1995	22996	0	0	22996
9278727	Tokyo Marine	Ginga Lion	25 451	2004	28837	0	0	28837
9442550	Tokyo Marine	Ginga Lynx	26 040	2009	28970	0	0	28970
9572575	Dorval Tankships Pty Ltd	Golden Unity	23 300	2011	24725	0	0	24725
9416044	Nordic Tankers	Maemi	19 858	2008	22761	0	0	22761
9251523	IMC/Aurora	Maritime Jingan	44 800	2003	52756	21663	31093	0
9308534	IMC/Aurora	Maritime North	44 487	2005	52759	11349	33418	0
9421271	Ultragas	Miramis	17 527	2009	18613	18613		0
9335056	NCC Odfjell	NCC Dammam	45 965	2008	53313	0	53313	0
9459022	NCC Odfjell	NCC Najem	45 500	2012	53000	30100	22900	0
9459008	NCC Odfjell	NCC Nasma	45 550	2011	53091	30112	22979	0
9399260	NCC Odfjell	NCC Noor	45 565	2011	52425	29761	22664	0
9272682	Tokyo Marine	Pine Galaxy	19 997	2004	21487	0	0	21487
9361471	Eitzen Chemical	Sichem Onomichi	13 105	2008	14064	14064	0	0
9408803	Navig8 Chemicals - Stainless8 Pool	Sira	19 990	2008	21600	0	0	21600

Table: Vessel Details Continued

IMO_Number	Operator	VesselName	MDWT	Year	Total Capacity	Epoxy Capacity	Zinc Capacity	StSteel capacity
9185487	Eitzen Chemical	Siteam Jupiter	48 309	2000	51136	37046	14090	0
9343194	Eitzen Chemical	Siteam Leader	46 190	2009	52461	29322	23139	0
9185499	Eitzen Chemical	Siteam Neptun	48 309	2000	51136	37046	14090	0
9565649	Nordic Tankers	Siva Ghent	33 600	2011	37730			37730
9124469	Stolt Parcel Tankers	Stolt Achievement	37 141	1999	41578	0	0	41578
8309543	Stolt Parcel Tankers	Stolt Emerald	38 720	1986	44866	0	13745	31121
9214305	Stolt Parcel Tankers	Stolt Focus	37 467	2001	39822	0	0	39822
8309531	Stolt Parcel Tankers	Stolt Sapphire	38 746	1986	44866	0	13745	31121
9149495	Stolt Parcel Tankers	Stolt Sea	22 198	1999	24713	0	0	24713
9352212	Stolt Parcel Tankers	Stolt Sneland	44 080	2008	45155	0	20155	25000
9168611	Stolt Parcel Tankers	Stolt Spray	22 147	2000	24717	0	0	24717
9168623	Stolt Parcel Tankers	Stolt Surf	22 273	2000	24705	0	0	24705
8309555	Stolt Parcel Tankers	Stolt Topaz	38 818	1986	44866	0	13745	31121
9198563	Jo Tankers	Sycamore	37 622	2000	40600	0	7895	32705
9150315	Stolt Parcel Tankers	Sypress	36 677	1998	38475	0	7777	30698
9412763	IMC/Aurora	Wawasan Emerald	19 800	2010	22500			22500
9477517	IMC/Aurora	Wawasan Ruby	19 990	2010	22100			22100
9360958	Koyo Kaiun	Xena	19 908	2007	21651	0	0	21651

Appendix C: Route Composition

Following are the routes composed by the central planner roughly minimizing distance as well as the number of port calls.

Table 1(C): Route Composition under a Central Planner

Route	LOADDATE	VESSEL	LOADPORT	DISCHARGEPORT	COUNTRY	MTONS	Distance
	121214	STOLT SEA	HOUSTON	AUCKLAND	NEW ZEALAND	299,850	
	121214	STOLT SEA	HOUSTON	AUCKLAND	NEW ZEALAND	350,000	
	121214	STOLT SEA	HOUSTON	AUCKLAND	NEW ZEALAND	199,540	
	121106	STOLT SPRAY	HOUSTON	AUCKLAND	NEW ZEALAND	399,640	
	121106	STOLT SPRAY	HOUSTON	AUCKLAND	NEW ZEALAND	349,870	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	149,720	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	499,890	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	253,160	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	205,210	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	579,260	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	1 516,860	
	121106	STOLT SPRAY	HOUSTON	BOTANY	AUSTRALIA	1 050,190	
	121214	STOLT SEA	HOUSTON	BRISBANE	AUSTRALIA	494,040	
	121106	STOLT SPRAY	HOUSTON	BRISBANE	AUSTRALIA	799,840	
	121106	STOLT SPRAY	TEXAS CITY	BRISBANE	AUSTRALIA	501,250	
	121214	STOLT SEA	HOUSTON	FREMANTLE	AUSTRALIA	799,450	
	121106	STOLT SPRAY	HOUSTON	FREMANTLE	AUSTRALIA	199,540	
	121106	STOLT SPRAY	HOUSTON	FREMANTLE	AUSTRALIA	849,620	
	121214	STOLT SEA	HOUSTON	MELBOURNE	AUSTRALIA	498,850	
	121214	STOLT SEA	HOUSTON	MELBOURNE	AUSTRALIA	1 200,010	
	121214	STOLT SEA	HOUSTON	MELBOURNE	AUSTRALIA	200,000	
	121106	STOLT SPRAY	TEXAS CITY	MELBOURNE	AUSTRALIA	249,580	
	121109	STOLT SPRAY	FREEPORT TX	MELBOURNE	AUSTRALIA	469,550	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	198,470	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	203,970	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	1 925,550	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	2 300,020	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	199,670	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	999,090	
	121106	STOLT SPRAY	HOUSTON	MELBOURNE	AUSTRALIA	1 149,570	
	121214	STOLT SEA	HOUSTON	SYDNEY	AUSTRALIA	405,410	
	121214	STOLT SEA	HOUSTON	SYDNEY	AUSTRALIA	500,010	
	121106	STOLT SPRAY	HOUSTON	SYDNEY	AUSTRALIA	799,910	
1						20 796,590	12299,51
	121123	STOLT SURF	HOUSTON	ANPING	CHINA	499,540	
	121123	STOLT SURF	HOUSTON	ANPING	CHINA	1 498,620	
	121114	MARITIME JINGAN	PNT COMFORT	ANPING	CHINA	4 000,000	
	121211	SITEAM NEPTUN	PNT COMFORT	ANPING	CHINA	4 000,000	
	121105	WAWASAN EMERALD	HOUSTON	ANPING	CHINA	4 000,000	
	121018	MARITIME NORTH	HOUSTON	ANPING	CHINA	4 769,090	
	121202	MARITIME JINGAN	HOUSTON	ANPING	CHINA	5 250,490	
	121022	SITEAM JUPITER	TEXAS CITY	ANPING	CHINA	7 000,010	
2						31 017,750	10389
	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	2 500,000	
	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	2 500,000	
	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	5 000,010	
	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	5 000,010	
	121215	FAIRCHEM EAGLE	HOUSTON	DACHAN	CHINA	5 000,010	
3						20 000,030	10339
	121209	FAIRCHEM COLT	FREEPORT TX	DALIAN	CHINA	8 920,720	
	121211	FAIRCHEM COLT	HOUSTON	DALIAN	CHINA	9 081,020	
	121203	SICHEM ONOMICHI	HOUSTON	DALIAN	CHINA	11 000,010	
4						29 001,750	10230
	121207	BOW SPRING	HOUSTON	ZHENJIANG	CHINA	2 099,550	
	121127	STOLT ACHIEVEMENT	HOUSTON	SHEKOU	CHINA	1 000,000	
	121023	STOLT FOCUS	HOUSTON	SHEKOU	CHINA	1 000,000	
	121017	STOLT SAPPHIRE	FREEPORT TX	SHEKOU	CHINA	1 000,000	
	121203	AMELIA	HOUSTON	DONGGUAN	CHINA	80,000	
	121023	XENA	HOUSTON	DONGGUAN	CHINA	80,000	
	121203	AMELIA	HOUSTON	DONGGUAN	CHINA	200,000	
	121203	AMELIA	HOUSTON	DONGGUAN	CHINA	220,000	
	121023	XENA	HOUSTON	DONGGUAN	CHINA	220,000	
	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	249,900	
	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	500,000	
	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	500,000	
	121106	STOLT TOPAZ	TEXAS CITY	DONGGUAN	CHINA	699,720	
	121023	STOLT FOCUS	TEXAS CITY	DONGGUAN	CHINA	750,000	
	121023	STOLT FOCUS	HOUSTON	DONGGUAN	CHINA	1 000,000	
	121023	XENA	HOUSTON	GUANGZHOU	CHINA	200,000	
	121023	XENA	HOUSTON	GUANGZHOU	CHINA	250,000	
	121023	XENA	HOUSTON	GUANGZHOU	CHINA	1 250,000	
5						11 299,170	11009
	121102	CHEMBULK BARCELONA	LK CHARLES	XIAMEN	CHINA	10 000,010	
	121106	STOLT TOPAZ	TEXAS CITY	XIAOHUDAO	CHINA	449,900	
	121101	NCC NOOR	HOUSTON	HONG KONG	CHINA	3 147,790	
	121101	NCC NOOR	HOUSTON	HONG KONG	CHINA	3 148,070	
	121105	BOW ENGINEER	HOUSTON	HONG KONG	CHINA	5 248,970	
6						21 994,740	10855
	121111	GINGA BOBCAT	NEW ORLEANS	JIANGYIN	CHINA	500,000	
	121111	GINGA BOBCAT	NEW ORLEANS	JIANGYIN	CHINA	500,000	
	121105	WAWASAN RUBY	HOUSTON	JIANGYIN	CHINA	500,000	
	121203	SYCAMORE	TEXAS CITY	JIANGYIN	CHINA	1 000,000	
	121105	WAWASAN EMERALD	HOUSTON	JIANGYIN	CHINA	2 000,000	
	121106	STOLT TOPAZ	TEXAS CITY	JIANGYIN	CHINA	2 022,510	
	121018	MARITIME NORTH	HOUSTON	JIANGYIN	CHINA	3 000,000	
	121106	WAWASAN EMERALD	CORPUS CHRSTI	JIANGYIN	CHINA	5 000,010	
7						14 522,520	10874
	121127	GINGA BOBCAT	HOUSTON	LIANYUNGANG	CHINA	400,000	
	121127	GINGA BOBCAT	HOUSTON	LIANYUNGANG	CHINA	400,000	
	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	500,000	
	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	500,000	
	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	1 000,000	
	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	1 000,000	
	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	1 000,000	
	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	1 000,000	
	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	1 000,000	
	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	1 000,000	
	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	1 499,930	
	121127	GINGA BOBCAT	HOUSTON	LIANYUNGANG	CHINA	2 000,000	
	121121	SIRA	HOUSTON	LIANYUNGANG	CHINA	2 000,000	
	121105	WAWASAN EMERALD	HOUSTON	LIANYUNGANG	CHINA	2 000,000	
8						15 299,930	10113
	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	4 350,980	
	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	10 000,010	

Route	LOADDATE	VESSEL	LOADPORT	DISCHARGEPORT	COUNTRY	MTONS	Distance
	121026	STOLT FOCUS	FREEPORT TX	SINGAPORE	SINGAPORE	367,360	
	121017	STOLT SAPPHIRE	FREEPORT TX	SINGAPORE	SINGAPORE	523,940	
	121017	STOLT SAPPHIRE	FREEPORT TX	SINGAPORE	SINGAPORE	899,410	
	121017	STOLT SAPPHIRE	FREEPORT TX	SINGAPORE	SINGAPORE	368,280	
	121030	STOLT SNELAND	FREEPORT TX	SINGAPORE	SINGAPORE	730,800	
	121030	STOLT SNELAND	FREEPORT TX	SINGAPORE	SINGAPORE	1 254,290	
	121109	STOLT TOPAZ	FREEPORT TX	SINGAPORE	SINGAPORE	501,570	
	121109	STOLT TOPAZ	FREEPORT TX	SINGAPORE	SINGAPORE	574,790	
	121109	STOLT TOPAZ	FREEPORT TX	SINGAPORE	SINGAPORE	1 566,730	
	121204	SYCAMORE	FREEPORT TX	SINGAPORE	SINGAPORE	572,170	
	121204	SYCAMORE	FREEPORT TX	SINGAPORE	SINGAPORE	525,250	
	121203	SYCAMORE	HOUSTON	PASIR GUDANG	MALAYSIA	974,680	
	121023	STOLT FOCUS	HOUSTON	MERAK	INDONESIA	199,940	
	121023	STOLT FOCUS	HOUSTON	MERAK	INDONESIA	999,700	
	121106	STOLT SPRAY	HOUSTON	MERAK	INDONESIA	2 071,700	
	121108	SYPRESS	HOUSTON	MERAK	INDONESIA	500,830	
	121108	SYPRESS	HOUSTON	MERAK	INDONESIA	1 010,130	
	121105	BOW ENGINEER	HOUSTON	SINGAPORE	SINGAPORE	611,400	
	121213	BOW SPRING	HOUSTON	SINGAPORE	SINGAPORE	1 019,340	
	121127	STOLT ACHIEVEMENT	HOUSTON	SINGAPORE	SINGAPORE	839,640	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	783,370	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	258,080	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	504,420	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	299,860	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	706,390	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	201,370	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	402,580	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	314,510	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	1 592,120	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	200,520	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	200,140	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	805,380	
	121214	STOLT SEA	HOUSTON	SINGAPORE	SINGAPORE	202,530	
	121025	STOLT SNELAND	HOUSTON	SINGAPORE	SINGAPORE	1 049,920	
	121025	STOLT SNELAND	HOUSTON	SINGAPORE	SINGAPORE	2 500,170	
	121106	STOLT SPRAY	HOUSTON	SINGAPORE	SINGAPORE	299,850	
	121106	STOLT SPRAY	HOUSTON	SINGAPORE	SINGAPORE	2 950,880	
	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	203,860	
	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	355,450	
	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	499,600	
	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	305,240	
	121106	STOLT TOPAZ	HOUSTON	SINGAPORE	SINGAPORE	699,650	
	121203	SYCAMORE	HOUSTON	SINGAPORE	SINGAPORE	1 999,490	
	121203	SYCAMORE	HOUSTON	SINGAPORE	SINGAPORE	734,910	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	204,080	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	150,240	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	671,420	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	179,450	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	209,400	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	203,980	
	121108	SYPRESS	HOUSTON	SINGAPORE	SINGAPORE	2 057,870	
	121213	BOW SPRING	TEXAS CITY	SINGAPORE	SINGAPORE	3 976,060	
	121023	STOLT FOCUS	TEXAS CITY	SINGAPORE	SINGAPORE	499,460	
	121025	STOLT SNELAND	TEXAS CITY	SINGAPORE	SINGAPORE	495,530	
22						42 829,730	12261
	121120	AMELIA	BATON ROUGE	ULSAN	SOUTH KOREA	2 079,330	
	121019	FPMC 24	BATON ROUGE	ULSAN	SOUTH KOREA	10 266,260	
	121125	FPMC 30	BATON ROUGE	ULSAN	SOUTH KOREA	10 054,780	
	121130	GINGA LION	BATON ROUGE	ULSAN	SOUTH KOREA	500,000	
	121130	NCC NAJRAN	BATON ROUGE	ULSAN	SOUTH KOREA	5 253,870	
	121130	NCC NAJRAN	BATON ROUGE	ULSAN	SOUTH KOREA	5 253,870	
	121018	SITEAM LEADER	BATON ROUGE	ULSAN	SOUTH KOREA	10 000,010	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	400,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	489,160	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	98,840	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	ULSAN	SOUTH KOREA	151,650	
	121015	XENA	BATON ROUGE	ULSAN	SOUTH KOREA	2 083,790	
23						47 331,560	9628
	121125	MARITIME JINGAN	CORPUS CHRSTI	ULSAN	SOUTH KOREA	5 000,010	
	121123	SIVA GHENT	CORPUS CHRSTI	ULSAN	SOUTH KOREA	4 896,010	
	121123	SIVA GHENT	CORPUS CHRSTI	ULSAN	SOUTH KOREA	2 074,000	
	121123	SIVA GHENT	CORPUS CHRSTI	ULSAN	SOUTH KOREA	1 074,000	
24						13 044,020	9653
	121208	BOW SPRING	FREEPORT TX	ULSAN	SOUTH KOREA	2 098,060	
	121020	GINGA LYNX	FREEPORT TX	ULSAN	SOUTH KOREA	400,000	
	121020	GINGA LYNX	FREEPORT TX	ULSAN	SOUTH KOREA	175,110	
	121114	SIVA GHENT	FREEPORT TX	ULSAN	SOUTH KOREA	5 250,010	
	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	525,800	
	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	730,870	
	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	209,920	
	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	2 309,510	
	121026	STOLT FOCUS	FREEPORT TX	ULSAN	SOUTH KOREA	1 049,500	
	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	523,940	
	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	210,450	
	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	1 577,810	
	121017	STOLT SAPPHIRE	FREEPORT TX	ULSAN	SOUTH KOREA	1 079,290	
	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	729,060	
	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	415,890	
	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	313,200	
	121030	STOLT SNELAND	FREEPORT TX	ULSAN	SOUTH KOREA	1 672,390	
	121109	STOLT TOPAZ	FREEPORT TX	ULSAN	SOUTH KOREA	469,220	
	121109	STOLT TOPAZ	FREEPORT TX	ULSAN	SOUTH KOREA	802,500	
	121109	STOLT TOPAZ	FREEPORT TX	ULSAN	SOUTH KOREA	522,240	
	121204	SYCAMORE	FREEPORT TX	ULSAN	SOUTH KOREA	291,840	
	121204	SYCAMORE	FREEPORT TX	ULSAN	SOUTH KOREA	336,930	
25						21 693,540	9601
	121203	AMELIA	HOUSTON	ULSAN	SOUTH KOREA	419,980	
	121203	AMELIA	HOUSTON	ULSAN	SOUTH KOREA	210,000	
	121203	AMELIA	HOUSTON	ULSAN	SOUTH KOREA	500,000	
	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	99,860	
	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	100,000	

	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	10 000,010	
	121119	FR8 FORTITUDE	HOUSTON	NAN SHA	CHINA	10 000,010	
9						34 351,010	10678
	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	180,000	
	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	200,000	
	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	300,000	
	121108	SYPRESS	HOUSTON	YANTIAN	CHINA	500,000	
	121124	CHEMBULK VIRGIN GORDA	BATON ROUGE	CHANGSHU	CHINA	3 059,020	
	121030	STOLT SNELAND	FREEPORT TX	LANSHAN	CHINA	1 200,000	
	121020	GINGA LYNX	FREEPORT TX	NANTONG	CHINA	2 000,000	
	121020	GINGA LYNX	FREEPORT TX	NANTONG	CHINA	3 000,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	NINGBO	CHINA	500,000	
	121129	STOLT SURF	BATON ROUGE	NINGBO	CHINA	500,000	
	121128	CHEMBULK VIRGIN GORDA	LK CHARLES	NINGBO	CHINA	5 000,010	
	121111	GINGA BOBCAT	NEW ORLEANS	NINGBO	CHINA	500,000	
	121111	GINGA BOBCAT	NEW ORLEANS	NINGBO	CHINA	500,000	
	121016	GINGA LYNX	NEW ORLEANS	NINGBO	CHINA	500,000	
	121016	GINGA LYNX	NEW ORLEANS	NINGBO	CHINA	500,000	
	121111	GINGA BOBCAT	NEW ORLEANS	NINGBO	CHINA	700,000	
10						19 139,030	10689
	121018	MARITIME NORTH	HOUSTON	NINGBO	CHINA	2 059,430	
	121023	STOLT FOCUS	HOUSTON	NINGBO	CHINA	6 000,010	
	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	209,920	
	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	314,880	
	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	524,810	
	121105	GINGA LYNX	HOUSTON	NINGBO	CHINA	1 000,000	
	121105	BOW ENGINEER	HOUSTON	NINGBO	CHINA	1 019,700	
	121108	SYPRESS	HOUSTON	NINGBO	CHINA	1 660,000	
	121108	SYPRESS	HOUSTON	NINGBO	CHINA	4 000,000	
	121111	MIRAMIS	HOUSTON	NINGBO	CHINA	15 000,020	
11						31 788,770	10033
	121123	STOLT SURF	HOUSTON	NINGBO	CHINA	4 000,000	
	121127	GINGA BOBCAT	HOUSTON	NINGBO	CHINA	525,000	
	121127	GINGA BOBCAT	HOUSTON	NINGBO	CHINA	525,000	
	121127	GINGA BOBCAT	HOUSTON	NINGBO	CHINA	525,000	
	121127	STOLT ACHIEVEMENT	HOUSTON	NINGBO	CHINA	4 500,010	
	121202	MARITIME JINGAN	HOUSTON	NINGBO	CHINA	3 000,000	
	121203	SYCAMORE	HOUSTON	NINGBO	CHINA	1 000,000	
	121207	NCC NASMA	HOUSTON	NINGBO	CHINA	3 999,850	
	121207	NCC NASMA	HOUSTON	NINGBO	CHINA	15 408,440	
12						33 483,300	10033
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	100,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	150,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	200,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	200,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	250,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	300,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	300,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SHANGHAI	CHINA	500,000	
	121030	STOLT SNELAND	FREEPORT TX	SHANGHAI	CHINA	500,000	
	121030	STOLT SNELAND	FREEPORT TX	SHANGHAI	CHINA	519,870	
	121030	MARITIME NORTH	FREEPORT TX	SHANGHAI	CHINA	10 000,010	
	121114	SIVA GHENT	FREEPORT TX	SHANGHAI	CHINA	10 000,110	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	100,000	
	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	100,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	150,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	150,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	180,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	200,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	200,000	
	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	220,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	250,000	
	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	280,000	
	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	300,000	
	121203	SYCAMORE	HOUSTON	SHANGHAI	CHINA	400,000	
	121108	SYPRESS	HOUSTON	SHANGHAI	CHINA	500,000	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	50,620	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	101,250	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	151,870	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	202,490	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	253,110	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	303,740	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	410,640	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SHANGHAI	CHINA	420,660	
	121111	GINGA BOBCAT	NEW ORLEANS	SHANGHAI	CHINA	1 000,000	
13						29 244,370	10510
	121102	SITEAM LEADER	BATON ROUGE	TIANJIN	CHINA	5 000,010	
	121213	GOLDEN UNITY	BATON ROUGE	TIANJIN	CHINA	12 000,010	
	121202	BOW SPRING	BEAUMONT	TIANJIN	CHINA	2 951,750	
	121025	NCC NOOR	CORPUS CHRSTI	TIANJIN	CHINA	2 615,000	
	121026	SITEAM LEADER	CORPUS CHRSTI	TIANJIN	CHINA	4 998,010	
	121016	FPMC 28	CORPUS CHRSTI	TIANJIN	CHINA	5 000,010	
	121102	SITEAM LEADER	S LOUISIANA	TIANJIN	CHINA	5 000,010	
	121102	SITEAM LEADER	S LOUISIANA	TIANJIN	CHINA	5 000,010	
	121115	NCC NOOR	S LOUISIANA	TIANJIN	CHINA	6 295,010	
14						48 859,820	10784
	121214	NCC DAMMAM	PNT COMFORT	TIANJIN	CHINA	3 669,000	
	121114	MARITIME JINGAN	PNT COMFORT	TIANJIN	CHINA	10 000,010	
	121211	SITEAM NEPTUN	PNT COMFORT	TIANJIN	CHINA	17 299,000	
15						30 968,010	10256
	121026	STOLT FOCUS	FREEPORT TX	ZHANGJIAGANG	CHINA	500,000	
	121030	STOLT SNELAND	FREEPORT TX	ZHANGJIAGANG	CHINA	500,000	
	121017	STOLT SAPPHIRE	FREEPORT TX	ZHANGJIAGANG	CHINA	800,000	
	121127	GINGA BOBCAT	HOUSTON	ZHANGJIAGANG	CHINA	525,000	
	121127	GINGA BOBCAT	HOUSTON	ZHANGJIAGANG	CHINA	735,000	
	121118	SIVA GHENT	HOUSTON	ZHANGJIAGANG	CHINA	1 000,000	
	121023	STOLT FOCUS	HOUSTON	ZHANGJIAGANG	CHINA	1 000,000	
	121025	STOLT SNELAND	HOUSTON	ZHANGJIAGANG	CHINA	1 000,000	
	121108	SYPRESS	HOUSTON	ZHANGJIAGANG	CHINA	1 000,000	
	121105	BOW ENGINEER	HOUSTON	ZHANGJIAGANG	CHINA	1 007,590	
	121118	SIVA GHENT	HOUSTON	ZHANGJIAGANG	CHINA	4 481,540	
	121113	BUNGA BANYAN	NEW ORLEANS	ZHANGJIAGANG	CHINA	19 370,180	
	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	100,000	
	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	150,000	

	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	1 019,490	
	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	509,820	
	121105	BOW ENGINEER	HOUSTON	ULSAN	SOUTH KOREA	1 014,680	
	121207	BOW SPRING	HOUSTON	ULSAN	SOUTH KOREA	1 017,690	
	121207	BOW SPRING	HOUSTON	ULSAN	SOUTH KOREA	407,920	
	121207	BOW SPRING	HOUSTON	ULSAN	SOUTH KOREA	1 219,030	
	121030	CHEMBULK BARCELONA	HOUSTON	ULSAN	SOUTH KOREA	4 857,890	
	121127	GINGA BOBCAT	HOUSTON	ULSAN	SOUTH KOREA	300,000	
	121127	GINGA BOBCAT	HOUSTON	ULSAN	SOUTH KOREA	1 450,000	
	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	1 480,830	
	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	50,000	
	121105	GINGA LYNX	HOUSTON	ULSAN	SOUTH KOREA	50,000	
	121018	MARITIME NORTH	HOUSTON	ULSAN	SOUTH KOREA	5 840,020	
	121120	NCC NAJRAN	HOUSTON	ULSAN	SOUTH KOREA	5 223,900	
	121120	NCC NAJRAN	HOUSTON	ULSAN	SOUTH KOREA	5 320,090	
	121207	SITEAM NEPTUN	HOUSTON	ULSAN	SOUTH KOREA	2 000,000	
	121207	SITEAM NEPTUN	HOUSTON	ULSAN	SOUTH KOREA	1 053,110	
	121127	STOLT ACHIEVEMENT	HOUSTON	ULSAN	SOUTH KOREA	917,290	
	121127	STOLT ACHIEVEMENT	HOUSTON	ULSAN	SOUTH KOREA	803,570	
	121127	STOLT ACHIEVEMENT	HOUSTON	ULSAN	SOUTH KOREA	304,810	
	121023	STOLT FOCUS	HOUSTON	ULSAN	SOUTH KOREA	699,390	
	121023	STOLT FOCUS	HOUSTON	ULSAN	SOUTH KOREA	2 827,870	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	98,320	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	100,000	
	121025	STOLT SNELAND	HOUSTON	ULSAN	SOUTH KOREA	524,820	
	121106	STOLT TOPAZ	HOUSTON	ULSAN	SOUTH KOREA	204,630	
	121203	SYCAMORE	HOUSTON	ULSAN	SOUTH KOREA	3 665,490	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	781,840	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	996,080	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	1 000,000	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	509,860	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	304,880	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	298,640	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	797,560	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	300,500	
	121108	SYPRESS	HOUSTON	ULSAN	SOUTH KOREA	981,780	
	121023	XENA	HOUSTON	ULSAN	SOUTH KOREA	500,000	
	121023	XENA	HOUSTON	ULSAN	SOUTH KOREA	500,000	
	121023	XENA	HOUSTON	ULSAN	SOUTH KOREA	500,000	
26						52 561,640	9641
	121102	CHEMBULK BARCELONA	LK CHARLES	ULSAN	SOUTH KOREA	4 756,750	
	121128	CHEMBULK VIRGIN GORDA	LK CHARLES	ULSAN	SOUTH KOREA	5 229,400	
	121116	FAIRCHEM STALLION	LK CHARLES	ULSAN	SOUTH KOREA	6 007,640	
	121205	GINGA LION	LK CHARLES	ULSAN	SOUTH KOREA	6 000,010	
	121029	NCC NOOR	LK CHARLES	ULSAN	SOUTH KOREA	5 265,740	
	121020	XENA	LK CHARLES	ULSAN	SOUTH KOREA	5 956,640	
27						33 216,180	9516
	121111	BOW ENGINEER	PNT COMFORT	ULSAN	SOUTH KOREA	4 999,010	
	121111	BOW ENGINEER	PNT COMFORT	ULSAN	SOUTH KOREA	1 000,000	
	121125	BOW SPRING	PNT COMFORT	ULSAN	SOUTH KOREA	6 999,010	
	121125	BOW SPRING	PNT COMFORT	ULSAN	SOUTH KOREA	1 000,000	
	121024	CHEMBULK BARCELONA	PNT COMFORT	ULSAN	SOUTH KOREA	4 000,000	
	121024	CHEMBULK BARCELONA	PNT COMFORT	ULSAN	SOUTH KOREA	4 000,000	
	121128	GINGA BOBCAT	PNT COMFORT	ULSAN	SOUTH KOREA	4 150,000	
	121128	GINGA BOBCAT	PNT COMFORT	ULSAN	SOUTH KOREA	1 999,000	
	121114	MARITIME JINGAN	PNT COMFORT	ULSAN	SOUTH KOREA	1 000,000	
	121114	MARITIME JINGAN	PNT COMFORT	ULSAN	SOUTH KOREA	3 000,000	
	121021	MARITIME NORTH	PNT COMFORT	ULSAN	SOUTH KOREA	4 000,000	
	121214	NCC DAMMAM	PNT COMFORT	ULSAN	SOUTH KOREA	7 840,010	
	121211	SITEAM NEPTUN	PNT COMFORT	ULSAN	SOUTH KOREA	3 761,000	
28						47 748,030	9641
	121111	GINGA BOBCAT	NEW ORLEANS	ULSAN	SOUTH KOREA	157,200	
	121111	GINGA BOBCAT	NEW ORLEANS	ULSAN	SOUTH KOREA	419,200	
	121111	GINGA BOBCAT	NEW ORLEANS	ULSAN	SOUTH KOREA	471,600	
	121203	GINGA EAGLE	RICHMOND	ULSAN	SOUTH KOREA	1 250,750	
	121016	PINE GALAXY	RICHMOND	ULSAN	SOUTH KOREA	2 252,590	
	121115	NCC NOOR	S LOUISIANA	ULSAN	SOUTH KOREA	10 503,390	
29						15 054,730	11212
	121030	CHEMBULK BARCELONA	TEXAS CITY	ULSAN	SOUTH KOREA	4 769,410	
	121201	GINGA BOBCAT	TEXAS CITY	ULSAN	SOUTH KOREA	700,000	
	121105	GINGA LYNX	TEXAS CITY	ULSAN	SOUTH KOREA	524,950	
	121212	NCC DAMMAM	TEXAS CITY	ULSAN	SOUTH KOREA	5 272,480	
	121022	SITEAM JUPITER	TEXAS CITY	ULSAN	SOUTH KOREA	5 225,390	
	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	549,700	
	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	525,580	
	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	499,950	
	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	300,260	
	121023	STOLT FOCUS	TEXAS CITY	ULSAN	SOUTH KOREA	500,430	
	121025	STOLT SNELAND	TEXAS CITY	ULSAN	SOUTH KOREA	499,780	
	121025	STOLT SNELAND	TEXAS CITY	ULSAN	SOUTH KOREA	309,960	
	121025	STOLT SNELAND	TEXAS CITY	ULSAN	SOUTH KOREA	944,510	
	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	499,800	
	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	307,170	
	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	817,260	
	121106	STOLT TOPAZ	TEXAS CITY	ULSAN	SOUTH KOREA	1 022,500	
30						23 269,130	9515
	121102	SITEAM LEADER	BATON ROUGE	DAESAN	SOUTH KOREA	3 333,340	
	121015	XENA	BATON ROUGE	GUNSAN	SOUTH KOREA	2 622,920	
	121130	NCC NAJRAN	BATON ROUGE	YOSU	SOUTH KOREA	10 479,010	
	121130	NCC NAJRAN	BATON ROUGE	YOSU	SOUTH KOREA	10 479,010	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	YOSU	SOUTH KOREA	996,870	
31						27 911,150	9774
	121106	STOLT TOPAZ	HOUSTON	BUSAN	SOUTH KOREA	449,720	
	121127	GINGA BOBCAT	HOUSTON	YOSU	SOUTH KOREA	829,750	
	121026	STOLT FOCUS	FREEPORT TX	YOSU	SOUTH KOREA	1 052,670	
	121020	GINGA LYNX	FREEPORT TX	KUNSAN	SOUTH KOREA	3 150,230	
	121105	GINGA LYNX	HOUSTON	KUNSAN	SOUTH KOREA	3 144,830	
	121127	STOLT ACHIEVEMENT	HOUSTON	ONSAN	SOUTH KOREA	1 499,800	

	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	150,000	
	121203	SYCAMORE	TEXAS CITY	ZHANGJIAGANG	CHINA	250,000	
	121025	STOLT SNELAND	TEXAS CITY	ZHANGJIAGANG	CHINA	500,000	
	121203	SYCAMORE	TEXAS CITY	ZHANGJIAGANG	CHINA	500,000	
	121023	STOLT FOCUS	TEXAS CITY	ZHANGJIAGANG	CHINA	600,000	
	121025	STOLT SNELAND	TEXAS CITY	ZHANGJIAGANG	CHINA	838,380	
	121106	STOLT TOPAZ	TEXAS CITY	ZHANGJIAGANG	CHINA	2 022,510	
	121106	STOLT TOPAZ	TEXAS CITY	ZHANGJIAGANG	CHINA	2 048,410	
	121214	SITEAM NEPTUN	TEXAS CITY	ZHANGJIAGANG	CHINA	5 089,430	
16						44 168,040	10556
	121105	GINGA LYNX	TEXAS CITY	ZHUHAI	CHINA	1 000,000	
	121105	GINGA LYNX	TEXAS CITY	ZHUHAI	CHINA	1 000,000	
	121207	NCC NASMA	HOUSTON	ZHUHAI	CHINA	9 963,820	
	121105	WAWASAN RUBY	HOUSTON	ZHUHAI	CHINA	15 000,020	
17						26 963,840	10698
	121102	SITEAM LEADER	BATON ROUGE	KASHIMA	JAPAN	3 333,340	
	121207	FORMOSA THIRTEEN	LK CHARLES	KOBE	JAPAN	1 500,000	
	121121	FPMC 30	LK CHARLES	KOBE	JAPAN	10 000,010	
	121119	SIRA	LK CHARLES	KOBE	JAPAN	10 000,010	
	121025	STOLT TOPAZ	NEW ORLEANS	YOKOHAMA	JAPAN	301,290	
	121025	STOLT TOPAZ	NEW ORLEANS	YOKOHAMA	JAPAN	559,610	
	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	998,820	
	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	489,470	
	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	407,870	
	121016	PINE GALAXY	RICHMOND	YOKOHAMA	JAPAN	509,910	
18						28 100,330	11332
19	121017	CHEMWAY LARA	HOUSTON	CHIBA	JAPAN	33 648,450	9217
	121020	GINGA LYNX	FREEPORT TX	KINUURA	JAPAN	525,550	
	121020	GINGA LYNX	FREEPORT TX	KINUURA	JAPAN	1 000,000	
	121204	SYCAMORE	FREEPORT TX	KINUURA	JAPAN	136,730	
	121030	STOLT SNELAND	FREEPORT TX	NAGOYA	JAPAN	457,600	
	121106	STOLT TOPAZ	HOUSTON	KAWASAKI	JAPAN	1 425,520	
	121127	STOLT ACHIEVEMENT	HOUSTON	KOBE	JAPAN	1 501,410	
	121127	STOLT ACHIEVEMENT	HOUSTON	KOBE	JAPAN	949,850	
	121023	STOLT FOCUS	HOUSTON	KOBE	JAPAN	930,780	
	121203	SYCAMORE	HOUSTON	KOBE	JAPAN	925,510	
	121108	SYPRESS	HOUSTON	KOBE	JAPAN	930,730	
	121108	SYPRESS	HOUSTON	KOBE	JAPAN	1 015,490	
	121105	BOW ENGINEER	HOUSTON	SAKURAJIMA	JAPAN	1 803,580	
	121213	BOW SPRING	HOUSTON	SAKURAJIMA	JAPAN	2 141,630	
	121207	BOW SPRING	HOUSTON	YOKOHAMA	JAPAN	510,750	
	121207	BOW SPRING	HOUSTON	YOKOHAMA	JAPAN	510,210	
	121023	STOLT FOCUS	HOUSTON	YOKOHAMA	JAPAN	763,080	
	121025	STOLT SNELAND	HOUSTON	YOKOHAMA	JAPAN	524,970	
	121106	STOLT TOPAZ	HOUSTON	YOKOHAMA	JAPAN	629,730	
	121106	STOLT TOPAZ	HOUSTON	YOKOHAMA	JAPAN	1 364,410	
	121106	STOLT TOPAZ	HOUSTON	YOKOHAMA	JAPAN	524,770	
	121108	SYPRESS	HOUSTON	YOKOHAMA	JAPAN	60,290	
	121108	SYPRESS	HOUSTON	YOKOHAMA	JAPAN	398,790	
	121108	SYPRESS	HOUSTON	YOKOHAMA	JAPAN	407,730	
	121023	STOLT FOCUS	TEXAS CITY	KOBE	JAPAN	471,180	
	121106	STOLT TOPAZ	TEXAS CITY	KOBE	JAPAN	249,900	
	121106	STOLT TOPAZ	TEXAS CITY	KOBE	JAPAN	209,620	
	121025	STOLT SNELAND	TEXAS CITY	YOKOHAMA	JAPAN	299,870	
	121025	STOLT SNELAND	TEXAS CITY	YOKOHAMA	JAPAN	209,890	
	121106	STOLT TOPAZ	TEXAS CITY	YOKOHAMA	JAPAN	249,900	
	121106	STOLT TOPAZ	TEXAS CITY	YOKOHAMA	JAPAN	498,350	
20						21 627,820	9785
	121108	STOLT ACHIEVEMENT	BATON ROUGE	MERAK	INDONESIA	998,550	
	121201	MAEMI	BATON ROUGE	SINGAPORE	SINGAPORE	1 500,000	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SINGAPORE	SINGAPORE	701,220	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SINGAPORE	SINGAPORE	998,640	
	121108	STOLT ACHIEVEMENT	BATON ROUGE	SINGAPORE	SINGAPORE	1 993,350	
	121202	BOW SPRING	BEAUMONT	SINGAPORE	SINGAPORE	1 985,560	
	121202	BOW SPRING	BEAUMONT	SINGAPORE	SINGAPORE	1 985,560	
	121108	STOLT ACHIEVEMENT	NEW ORLEANS	SINGAPORE	SINGAPORE	502,030	
	121206	STOLT EMERALD	NEW ORLEANS	SINGAPORE	SINGAPORE	1 410,450	
	121025	STOLT TOPAZ	NEW ORLEANS	SINGAPORE	SINGAPORE	812,200	
	121016	BEECH GALAXY	RICHMOND	MERAK	INDONESIA	2 484,280	
	121203	GINGA EAGLE	RICHMOND	SINGAPORE	SINGAPORE	990,460	
	121203	GINGA EAGLE	RICHMOND	SINGAPORE	SINGAPORE	750,530	
21						17 112,830	12261

	121023	STOLT FOCUS	TEXAS CITY	YOSU	SOUTH KOREA	250,000	
	121025	NCC NOOR	CORPUS CHRSTI	YOSU	SOUTH KOREA	2 615,000	
32						12 992,000	9989
	121114	MARITIME JINGAN	PNT COMFORT	YOSU	SOUTH KOREA	10 000,010	
	121214	NCC DAMMAM	PNT COMFORT	YOSU	SOUTH KOREA	3 669,000	
	121211	SITEAM NEPTUN	PNT COMFORT	YOSU	SOUTH KOREA	17 299,000	
	121115	NCC NOOR	S LOUISIANA	YOSU	SOUTH KOREA	6 295,010	
33						37 263,020	10203
	121105	BOW ENGINEER	HOUSTON	KAOHSIUNG	TAIWAN	3 001,990	
	121207	BOW SPRING	HOUSTON	KAOHSIUNG	TAIWAN	1 250,090	
	121201	GINGA BOBCAT	TEXAS CITY	KAOHSIUNG	TAIWAN	600,000	
	121127	GINGA BOBCAT	HOUSTON	KAOHSIUNG	TAIWAN	1 481,490	
	121203	GINGA EAGLE	RICHMOND	KAOHSIUNG	TAIWAN	1 000,440	
	121105	GINGA LYNX	TEXAS CITY	KAOHSIUNG	TAIWAN	839,920	
	121028	SITEAM LEADER	HOUSTON	KAOHSIUNG	TAIWAN	5 000,010	
	121127	STOLT ACHIEVEMENT	HOUSTON	KAOHSIUNG	TAIWAN	524,480	
	121127	STOLT ACHIEVEMENT	HOUSTON	KAOHSIUNG	TAIWAN	644,540	
	121023	STOLT FOCUS	HOUSTON	KAOHSIUNG	TAIWAN	199,900	
	121023	STOLT FOCUS	HOUSTON	KAOHSIUNG	TAIWAN	1 299,340	
	121023	STOLT FOCUS	TEXAS CITY	KAOHSIUNG	TAIWAN	599,950	
	121023	STOLT FOCUS	HOUSTON	KAOHSIUNG	TAIWAN	1 499,550	
	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	2 100,440	
	121030	STOLT SNELAND	FREEPORT TX	KAOHSIUNG	TAIWAN	53,250	
	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	524,820	
	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	944,190	
	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	524,530	
	121025	STOLT SNELAND	HOUSTON	KAOHSIUNG	TAIWAN	842,390	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	2 624,930	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	2 428,270	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	1 049,730	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	944,500	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	477,720	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	1 049,970	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	523,680	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	524,690	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	734,880	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	1 000,040	
	121106	STOLT TOPAZ	HOUSTON	KAOHSIUNG	TAIWAN	699,240	
	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	1 049,270	
	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	869,760	
	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	839,760	
	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	524,960	
	121203	SYCAMORE	HOUSTON	KAOHSIUNG	TAIWAN	839,650	
34						39 112,370	10498
	121127	AMELIA	FREEPORT TX	MAILIAO	TAIWAN	8 248,800	
	121121	FPMC 30	LK CHARLES	MAILIAO	TAIWAN	10 000,010	
	121121	FPMC 30	LK CHARLES	MAILIAO	TAIWAN	3 000,000	
	121019	SITEAM JUPITER	CORPUS CHRSTI	MAILIAO	TAIWAN	5 261,010	
	121207	SITEAM NEPTUN	TEXAS CITY	MAILIAO	TAIWAN	4 925,470	
	121105	BOW ENGINEER	HOUSTON	TAICHUNG	TAIWAN	1 029,740	
	121116	FPMC 30	PORT ARTHUR	TAICHUNG	TAIWAN	3 000,000	
	121022	SITEAM JUPITER	TEXAS CITY	TAICHUNG	TAIWAN	6 300,010	
35						41 765,040	11120
	121108	STOLT ACHIEVEMENT	BATON ROUGE	BANGKOK	THAILAND	998,640	
	121127	STOLT ACHIEVEMENT	HOUSTON	BANGKOK	THAILAND	449,450	
	121127	STOLT ACHIEVEMENT	HOUSTON	BANGKOK	THAILAND	549,390	
	121023	STOLT FOCUS	HOUSTON	BANGKOK	THAILAND	524,420	
	121023	STOLT FOCUS	HOUSTON	BANGKOK	THAILAND	474,480	
	121023	STOLT FOCUS	HOUSTON	MAP TA PHUT	THAILAND	399,880	
	121023	STOLT FOCUS	HOUSTON	MAP TA PHUT	THAILAND	599,820	
	121023	STOLT FOCUS	HOUSTON	MAP TA PHUT	THAILAND	199,940	
	121203	SYCAMORE	HOUSTON	MAP TA PHUT	THAILAND	600,110	
	121203	SYCAMORE	HOUSTON	MAP TA PHUT	THAILAND	2 905,870	
	121203	SYCAMORE	HOUSTON	MAP TA PHUT	THAILAND	974,680	
	121108	SYPRESS	HOUSTON	MAP TA PHUT	THAILAND	1 015,490	
	121108	SYPRESS	HOUSTON	MAP TA PHUT	THAILAND	2 538,710	
	121108	SYPRESS	HOUSTON	MAP TA PHUT	THAILAND	2 030,980	
36						14 261,860	12620

Appendix D: Simulation Model

In order to solve the scheduling problem of the simulated central planner, I set up a model based on the mathematical formulation by Christiansen et al. (2002), as presented in section 4.3. I used AMPL to script the problem as shown below, and the AMPL•CPLEX solver to generate the solution. AMPL is a comprehensive and powerful algebraic modeling language for linear and nonlinear optimization problems, in discrete or continuous variables.

```
#Model File:

set VESSEL;
set CARGO;
set ROUTE;

param cost (VESSEL,ROUTE)
param assign(ROUTE, VESSEL, CARGO);

var X(VESSEL,ROUTE) binary;

minimize totalcost:
sum(v in VESSEL,r in ROUTE)cost(v,r)*X(v,r)=1;

subject to cargoassign (i in CARGO):
sum(v in VESSEL,r in ROUTE)assign(r,v,i)*X(v,r)=1;

subject to vesselassign (v in VESSEL);
sum(r in route)X(v,r)<=1;
```

In the table below displaying the data file, only a segment of the file is included, as it is far too large to be shown in full. It is also worth mentioning that the parameter "assign" limits the vessels to only be assigned to the routes of which their vessel capacity allows, indirectly including this limitation to the model.

```
#Data for Ship Scheduling

set VESSEL := AMELIA BEECH_GALAXY BOW_ENGINEER BOW_SPRING BUNGA_BANYAN CHEMBULK_BARCELONA
CHEMBULK_VIRGIN_GORDA (…);

set ROUTE := 1 2 3 (…) 35 36;

set CARGO := 1 2 3 4 5(…) 528 529 530;

param cost (tr):          AMELIA   BEECH_GALAXY     BOW_ENGINEER     (…) :=
1                         462014   462014           493817
2                         0        0                271759
(…)
36                        266899   266899           291679           (…);

param assign:=

[*,AMELIA,*](tr):         1        2        3        (…)      36:=
1                         1        0        0                 0
2                         1        0        0                 0
(…)
530                       0        0        0                 1

[*,BEECH_GALAXY,*](tr):   1        2        (…)      36:=
1                                  1        0                 0
2                                  1        0                 0
(…)
530                                0        0                 1

(…);
```

After running the model through the AMPL•CPLEX solver, a solution was generated as partially shown in the table below. Also here the file was too large to be shown in full.

```
AMPL Version 20051214 (x86_win32)
ampl: model ModelHilde2.mod;
ampl: data DataHilde2.dat;
ampl: solve;
CPLEX 10.0.0: optimal integer solution; objective 9770120
125 MIP simplex iterations
0 branch-and-bound nodes
ampl: display totalcost;
totalcost = 9770120
ampl: display X;
X [*,*]
:                        1   2   3   4   5   6   7   8   9  10  11  12  13  14 :=
AMELIA                   0   0   0   0   0   0   0   0   0   0   0   0   0   0
BEECH_GALAXY             0   0   0   0   0   1   0   0   0   0   0   0   0   0
BOW_ENGINEER             0   0   0   0   0   0   0   0   0   0   0   0   1   0
BOW_SPRING               0   0   0   0   0   0   0   0   0   0   0   0   0   0
BUNGA_BANYAN             0   0   0   0   0   0   0   0   0   0   0   0   0   0
CHEMBULK_BARCELONA       0   0   0   0   0   0   0   0   0   0   0   0   0   0
CHEMBULK_VIRGIN_GORDA    0   0   0   1   0   0   0   0   0   0   0   0   0   0
CHEMWAY_LARA             0   0   0   0   0   0   0   0   0   0   0   0   0   0
FAIRCHEM_COLT            1   0   0   0   0   0   0   0   0   0   0   0   0   0
FAIRCHEM_EAGLE           0   0   0   0   0   0   0   0   0   0   0   0   0   0
(…)

:                       29  30  31  32  33  34  35  36    :=
(…)
STOLT_SURF               0   1   0   0   0   0   0   0
STOLT_TOPAZ              0   0   0   0   0   0   0   0
SYCAMORE                 0   0   0   0   0   0   0   0
SYPRESS                  0   0   0   0   0   0   0   0
WAWASAN_EMERALD          0   0   0   0   0   0   0   0
WAWASAN_RUBY             0   0   0   0   0   0   0   0
XENA                     0   0   0   0   0   0   0   0
;
```

Appendix E:

In this segment I have presented the method of calculation for the utilization rate, the voyage costs, and the estimated CO2 emissions.

Estimation of Utilization:

Utilization = total cargo (for a single voyage Gulf-Far East for vessels *v*) / total vessel *v*´s capacity

Voyage Cost Calculations:

Input data:

		Xena
Vessel Data		
Ship Size	d.w.t	19908
Fuel Consumption (in transit)	ton/day	25
Fuel Consumption (in port)	ton/day	15
Average Speed	knots	14
Route		
Distance	nmiles	12672
Cargo	d.w.t.	14163
Freight Rate	$/ton	12
Fuel Price	$/ton	100
Number of Berthing:		
Houston		1
Other US Ports		2
Far East Ports		3

Port Cost		
Houston		$50 000,00
Other US ports		$35 000,00
Far East Ports		$35 000,00
Estimated days per port	3	

Output:

Days at sea = Distance /(Average speed*24h)

Days at port = Total # of berthing * Estimated # of days per port

Total days = Sum of all of the above

Fuel cost (in transit)	= Fuel consumption (in transit)*days at sea*fuel price
Fuel cost (at port)	= Fuel consumption (at port)*days in port*fuel price
Port cost	= (#of berthing (Houston)*Port cost estimate "Houston") + (#of berthing (other US ports)*Port cost estimate "Other US ports") + (#of berthing (Far East ports)*Port cost estimate "Far East ports")
Total Voyage Cost	= Sum of all of the above

Estimation of Emission:

Output:

Total Fuel Consumption	= (Fuel consumption (in transit)*days in transit) + (Fuel consumption (at port)*days in port)
* CO2 Emissions Factor	= 3,17
Total CO2 emissions	= (in total tons)

Appendix F: Free Competition

In this section I have complied the calculations and estimates from the free competition scenario.

Table 1(F): Utilization under Free Competition

Vessel Name	MDWT	Cargo	Utilization	Vessel Name	MDWT	Cargo	Utilization
Amelia	21 287	11958	56 %	NCC Najem	45 500	42010	92 %
Beech Galaxy	19 998	3726	19 %	NCC Nasma	45 550	29372	64 %
Bow Engineer	30 087	23715	79 %	NCC Noor	45 565	39885	88 %
Bow Spring	39 942	31172	78 %	Pine Galaxy	19 997	4659	23 %
Bunga Banyan	45 444	19370	43 %	Sichem Onomichi	13 105	11000	84 %
Chembulk Barcelona	32 345	21284	66 %	Sira	19 990	16000	80 %
Chembulk Virgin Gorda	34 584	13288	38 %	Siteam Jupiter	48 309	23786	49 %
Chemway Lara	37 982	33648	89 %	Siteam Leader	46 190	41665	90 %
Fairchem Colt	19 998	18002	90 %	Siteam Neptun	48 309	55427	115 %
Fairchem Eagle	25 400	20000	79 %	Siva Ghent	33 600	28776	86 %
Fairchem Stallion	19 992	6008	30 %	Stolt Achievement	37 141	28706	77 %
Formosa Thirteen	45 706	1500	3 %	Stolt Emerald	38 720	1410	4 %
FPMC 24	51 150	10266	20 %	Stolt Focus	37 467	33310	89 %
FPMC 28	50 400	5000	10 %	Stolt Sapphire	38 746	6983	18 %
FPMC 30	51 150	33055	65 %	Stolt Sea	22 198	11418	51 %
Ginga Bobcat	26 073	21893	84 %	Stolt Sneland	44 080	23679	54 %
Ginga Eagle	19 999	3992	20 %	Stolt Spray	22 147	21172	96 %
Ginga Lion	25 451	6500	26 %	Stolt Surf	22 273	6498	29 %
Ginga Lynx	26 040	20441	79 %	Stolt Topaz	38 818	37178	96 %
Golden Unity	23 300	12000	52 %	Sycamore	37 622	23147	62 %
Maemi	19 858	1500	8 %	Sypress	36 677	28797	79 %
Maritime Jingan	44 800	41251	92 %	Wawasan Emerald	19 800	17500	88 %
Maritime North	44 487	29669	67 %	Wawasan Ruby	19 990	15500	78 %
Miramis	17 527	15000	86 %	Xena	19 908	14163	71 %
NCC Dammam	45 965	20450	44 %	Total			61 %

As mentioned in section 5.1.1 there are possibilities of plotting errors in the PIERS data set, as well as the lack of last minute charter data, which might cause the unlikely low and high utilization levels shown in the table above. The utilization rates that I suspect might be a result of this are here marked with grey.

Shown in table 2(F) below is the calculation of total voyage cost for the entire fleet under free competition using the calculation method stipulated in appendix E. I have chosen to not display all calculations for limitation purposes, however I do believe it will provide you with a sufficient understanding of my calculations.

Table 2(F): Voyage Cost Calculations for the fleet under Free Competition

		Amelia	Beech Galaxy	Bow Engineer	(...)	Sycamore	Sypress	Wawasan Emerlad	Wawasan Ruby	Xena	
Vessel Data											Total
Ship Size	d.w.t	21287	19998	30087	(...)	37622	36677	19800	19908	19908	
Fuel Consumption (in transit)	ton/day	25	25	30	(...)	30	30	25	25	25	
Fuel Consumption (in port)	ton/day	15	15	20	(...)	20	20	15	15	15	
Average Speed	knots	14	14	14	(...)	14	14	14	14	14	
Route											
Distance	miles	11474	8167	12669	(...)	13821	14565	11225	11035	12672	555706
Cargo	d.w.t.	11958	3726	23715	(...)	23147	28797	17500	15500	14163	1000641
Freight Rate	$/ton	12	12	12	(...)	12	12	12	12	12	
Fuel Price	$/ton	100	100	100	(...)	100	100	100	100	100	
Number of Berthings:											
Houston		1	0	1	(...)	1	1	1	1	1	
Other US Ports		2	1	1	(...)	2	0	1	0	2	
Far East Ports		3	2	8	(...)	11	10	3	2	4	302
Sea Time	days	34	24	38	(...)	41	43	33	33	38	1654
Port Time	days	18	9	30	(...)	42	33	15	9	21	906
Total Days	days	52	33	68	(...)	83	76	48	42	59	2560
Houston	$	50 000,00									
Other US ports	$	35 000,00									
Far East Ports	$	35 000,00									
Estimated days per port		3									
Voyage Cost Calculation											
Fuel Cost (transit)	$	85 372,62	$ 60 762,65	$ 113 120,09	(...)	$ 123 398,84	$ 130 048,21	$ 83 518,82	$ 82 104,69	$ 94 288,32	
Fuel Cost (port)	$	27 000,00	$ 13 500,00	$ 60 000,00	(...)	$ 84 000,00	$ 66 000,00	$ 22 500,00	$ 13 500,00	$ 31 500,00	kr 6 687 512,75
Port Cost	$	225 000,00	$ 105 000,00	$ 365 000,00	(...)	$ 505 000,00	$ 400 000,00	$ 190 000,00	$ 120 000,00	$ 260 000,00	kr 11 065 000,00
Total Voyage Specific Cost	$	337 372,62	$ 179 262,65	$ 538 120,09	(...)	$ 712 398,84	$ 596 048,21	$ 296 018,82	$ 215 604,69	$ 385 788,32	kr 17 752 512,75
Total Cost Fleet	**$**	**17 752 512,75**									

In a similar matter as the cost calculations above, I have provided a segment of the CO2 emissions estimates for the entire fleet under free competition. This is displayed in table 3(F) below and is also based on the method of calculation as presented in appendix E.

Table 3(F): Estimated CO2 Emissions for entire fleet under Free Competition

		Amelia	Beech Galaxy	Bow Engineer	(...)	Sycamore	Sypress	Wawasan Emerlad	Wawasan Ruby	Xena	
Vessel Data											
Ship Size	d.w.t	21287	19998	30087	(...)	37622	36677	19800	19908	19908	
Fuel Consumption (in transit)	ton/day	25	25	30	(...)	30	30	25	25	25	
Fuel Consumption (in port)	ton/day	15	15	20	(...)	20	20	15	15	15	
Average Speed	knots	14	14	14	(...)	14	14	14	14	14	
Route											
Distance	miles	11474	8167	12669	(...)	13821	14565	11225	11035	12672	
Cargo	d.w.t.	11958	3726	23715	(...)	23147	28797	17500	15500	14163	
Freight Rate	$/ton	12	12	12	(...)	12	12	12	12	12	
Fuel Price	$/ton	100	100	100	(...)	100	100	100	100	100	
Number of Berthings:											
Houston		1	0	1	(...)	1	1	1	1	1	
Other US Ports		2	1	1	(...)	2	0	1	0	2	
Far East Ports		3	2	8	(...)	11	10	3	2	4	
Sea Time	days	34	24	38	(...)	41	43	33	33	38	
Port Time	days	18	9	30	(...)	42	33	15	9	21	
Total Days	days	52	33	68	(...)	83	76	48	42	59	
Estimated days per port		3									
Estimated CO2 Emissions											Total
Total Fuel Consumption (in transit)	(ton/day * days)	854	608	1131	(...)	1234	1300	835	821	943	48785
Total Fuel Consumption (in port)	(ton/day * days)	270	135	600	(...)	840	660	225	135	315	18090
CO2 emissions Factor	ton/day	3,17	3,17	3,17	(...)	3,17	3,17	3,17	3,17	3,17	3,17
Total CO2 Emissions per vessel	tons	3562	2354	5488	(...)	6575	6215	3361	3031	3987	211994
Total CO2 Emissions for Fleet	tons	211994									

Appendix G: Simulated Central Planner

In this section I have complied the calculations and estimates from the simulated regulated market scenario with a central planner.

Table 1(G): Utilization Rate under Central Planner

Vessel Name	Capacity	Cargo (ton)	Utilization
Amelia	22000	15055	68 %
Beech Galaxy	22176	21995	99 %
Bow Engineer	35563	29244	82 %
Bow Spring	51084	47748	93 %
Bunga Banyan	53200	33216	62 %
Chembulk Barcelona	36122	30968	86 %
Chembulk Virgin Gorda	38861	29002	75 %
Chemway Lara	46917	44168	94 %
Fairchem Colt	22184	20797	94 %
Fairchem Eagle	28482	27911	98 %
Fairchem Stallion	22184	14262	64 %
Formosa Thirteen	52428	48860	93 %
FPMC 24	54744	33483	61 %
FPMC 28	53000	31789	60 %
Ginga Bobcat	28978	26964	93 %
Ginga Eagle	22996	17113	74 %
Ginga Lion	28837	28100	97 %
Ginga Lynx	28970	21628	75 %
Golden Unity	24725	21694	88 %
Maemi	22761	12992	57 %
Maritime North	52759	52562	100 %
Miramis	18613	15300	82 %
NCC Najem	53000	47332	89 %
Pine Galaxy	21487	11299	53 %
Sichem Onomichi	14064	13044	93 %
Sira	21600	14523	67 %
Siteam Jupiter	51136	41765	82 %
Siteam Leader	52461	39112	75 %
Siteam Neptun	51136	33648	66 %
Siva Ghent	37730	31018	82 %
Stolt Focus	39822	37263	94 %
Stolt Sneland	45155	42830	95 %
Stolt Spray	24717	20000	81 %
Stolt Surf	24705	23269	94 %
Sypress	38475	34351	89 %
Wawasan Ruby	22100	19139	87 %
Total Average			82 %

Vessel Name	Capacity	Cargo (ton)	Utilization
FPMC 30	54744	0	0 %
MR Kentaurus	52489	0	0 %
Maritime Jingan	52756	0	0 %
NCC Dammam	53313	0	0 %
NCC Nasma	53091	0	0 %
NCC Noor	52425	0	0 %
Stolt Achievement	41578	0	0 %
Stolt Emerald	44866	0	0 %
Stolt Sapphire	44866	0	0 %
Stolt Sea	24713	0	0 %
Stolt Topaz	44866	0	0 %
Sycamore	40600	0	0 %
Wawasan Emerald	22500	0	0 %
Xena	21651	0	0 %

Shown in table 2(G) below is the calculation of total voyage cost for the entire fleet under free competition using the calculation method stipulated in appendix E. I have chosen to not display all calculations for limitation purposes, however I do believe it will provide you with a sufficient understanding of my calculations.

Table 2(G): Voyage Cost Calculation for entire fleet under Simulated Central Planning

		Amelia	Beech Galaxy	Bow Engineer	(...)	Wawasan Emerlad	Wawasan Ruby	Xena	
Vessel Data									Total
Ship Size	d.w.t	21287	19998	30087	(...)	19800	19908	19908	
Fuel Consumption (in transit)	ton/day	25	25	30	(...)	25	25	25	
Fuel Consumption (in port)	ton/day	15	15	20	(...)	15	15	15	
Average Speed	knots	14	14	14	(...)	14	14	14	
Route									
Distance	miles	11212	10855	10510	(...)	0	10689	0	377 813
Cargo	d.w.t.	15055	21995	29244	(...)	0	19139	0	1 033 442
Freight Rate	$/ton	12	12	12	(...)	12	12	12	
Fuel Price	$/ton	100	100	100	(...)	100	100	100	
Number of Berthings:									
Houston		0	1	1	(...)	0	1	0	
Other US Ports		3	2	3	(...)	0	4	0	
Far East Ports		1	3	1	(...)	0	5	0	152
Sea Time	days	33	32	31	(...)	0	32	0	1 124
Port Time	days	12	18	15	(...)	0	30	0	456
Total Days	days	45	50	46	(...)	0	62	0	1 580
Houston		$ 50 000,00							
Other US ports		$ 35 000,00							
Far East Ports		$ 35 000,00							
Estimated days per port		3							
Voyage Cost Calculation									
Fuel Cost (transit)		$ 83 422,62	$ 80 766,37	$ 93 839,29	(...)	$ -	$ 79 531,25	$ -	
Fuel Cost (port)		$ 18 000,00	$ 27 000,00	$ 30 000,00	(...)	$ -	$ 45 000,00	$ -	$ 4 105 123,44
Port Cost		$ 140 000,00	$ 225 000,00	$ 190 000,00	(...)	$ -	$ 365 000,00	$ -	$ 5 665 000,00
Total Voyage Specific Cost		$ 241 422,62	$ 332 766,37	$ 313 839,29	(...)	$ -	$ 489 531,25	$ -	$ 9 770 123,44
Total Cost Fleet		**$ 9 770 123,44**							

In a similar matter as the cost calculations above, I have provided a segment of the CO2 emissions estimates for the entire fleet under a simulated central planning. This is displayed in table 3(G) below and is also based on the method of calculation as presented in appendix E.

Table 3(G): Estimated CO2 Emissions for entire fleet under Simulated Central Planning

		Amelia	Beech Galaxy	Bow Engineer	(...)	Sycamore	Sypress	Wawasan Emerlad	Wawasan Ruby	Xena	
Vessel Data											
Ship Size	d.w.t	21287	19998	30087	(...)	37622	36677	19800	19908	19908	
Fuel Consumption (in transit)	ton/day	25	25	30	(...)	35	30	25	25	25	
Fuel Consumption (in port)	ton/day	15	15	20	(...)	25	20	15	15	15	
Average Speed	knots	14	14	14	(...)	14	14	14	14	14	
Route											
Distance	miles	11212	10855	10510	(...)	0	10678,4	0	10689	0	
Cargo	d.w.t.	15055	21995	29244	(...)	0	34351	0	19139	0	
Freight Rate	$/ton	12	12	12	(...)	12	12	12	12	12	
Fuel Price	$/ton	100	100	100	(...)	100	100	100	100	100	
Number of Berthings:											
Houston		0	1	1	(...)	0	1	0	1	0	
Other US Ports		3	2	3	(...)	0	0	0	4	0	
Far East Ports		1	3	1	(...)	0	1	0	5	0	
Sea Time	days	33	32	31	(...)	0	32	0	32	0	
Port Time	days	12	18	15	(...)	0	6	0	30	0	
Total Days	days	45	50	46	(...)	0	38	0	62	0	
Estimated days per port		3									
Estimated CO2 Emissions											Total
Total Fuel Consumption (in trai	(ton/day * days)	834	808	938	(...)	0	953	0	795	0	32 696
Total Fuel Consumption (in por	(ton/day * days)	180	270	300	(...)	0	120	0	450	0	8 355
CO2 emissions Factor	ton/day	3,17	3,17	3,17	(...)	3,17	3,17	3,17	3,17	3,17	3,17
Total CO2 Emissions per vessel	tons	3215	3416	3926	(...)	0	3403	0	3948	0	130 132
Total CO2 Emissions for Fleet	**tons**	**130132**									