Oil product tanker geography with emphasis on the Handysize segment

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Novel movement data are used to chart worldwide mineral oil product shipments by Handysize (15,000–59,999 dwt) and larger (60,000+ dwt) tankers. The data are from 2004 which allows comparisons with earlier studies about crude oil shipments. Theory about ship movements and attached freight rates (RP Rule) gets indirect support. Non-existence of global data below the Handysize enforces the use of fragmentary data from a refinery company and a world-class port. Both data sets are believed to be representative for the purposes used. Export shipments of the refinery company reveal a linear non-logarithmic distance function for vessel classes in the 2,000–67,000 dwt range. The function is practically identical with oil product exports from the said port. The thinking is then extended to larger vessel sizes and crude oil cargoes, the principle of fungibility.

Keywords: distance function, fungibility, Handysize, novel data, oil product tankers

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Introduction

This report is the final part of a tanker project that was started in 2005 with crude oil tankers (Laulajainen 2010), and continues now with product tankers carrying light and medium ("clean") oil distillates, a geographically unchartered corner of our discipline (for terminology, see Stopford 1997). These are the external frames. The overall angle is to chart vessel movements and investigate possibilities for rationalizing their routing. The availability and quality of empirical data is central to such ambition. Some progress has been made down to the Panamax size class (60,000 dwt) but beyond that possibilities deteriorate markedly, as will become apparent below. Focus on routing shall not overshadow other fruitful research avenues such as the build-up of maritime supply/demand balances for the some 275 coastal refineries worldwide, or the ownership structure and operating areas of tanker companies, assumedly connected with the availability of shipping finance. These alternatives imply book-size reports and must be shelved for the time being.

The idea's realization remained uncertain for a long time because most product cargoes were thought to be too small and local to rise wider interest. There were only a few precedents to look for tangible advice and they were about dry bulk, not tanker, shipping and from time periods when today's small cargoes were quite normal, if not outright large. Isserlis (1938, Tables IX and X) analyzed 12,491 dry cargo "voyages" by UK-registered vessels of above/below 3,000 grt (4,500 dwt) in 1935, recording sailing frequencies, cargoes, cargotons and gross freight revenues on all significant trade routes, with loading and discharging ports/regions given in remarkable detail. British ships accounted for 27% of the world tonnage and the ubiquitous Empire comprised 25% of its population, which made the report a fair proxy about the global market. It only lacked proper analysis. Nossum (1996) continued the tradition by mapping global dry bulk flows during 1945–1990. Citing escalating data effort, but also reacting to growing vessel size, he raised the minimum size as follows ('000 dwt: 7–8): 10/1945, 14/1960, 18/1968, 40/1978 and 50/1988. The series indi-

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rectly suggests the exclusion of vessels used for minor bulk commodities – or oil products if the study were about tankers. The mapping was done at five-year intervals by variable vessel size class. The major ports are there, but flows receive only verbal commentary. The emphasis was on economics, not geography, and description overwhelmed analysis. These monographs are paralleled by numerous reports about shortsea shipping and port overseas connections (forelands). The former are spatially constrained, by definition, and emphasize economics (e.g. Wijnolst et al. 1993; Musso & Marchese 2002). The latter can handle only a few ports, at best, and are constrained in that way (e.g. Matheson 1955; Laulajainen 2011). Closest to the theme comes this author's excursion to Handysize dry bulk carriers in 1997, in which current data problems surfaced in a diluted form (Laulajainen 2006).

The perception of clean product marginality rested on two ideas. Refineries locate close to markets, to minimize shrinkage during transport and storage, and to respond to host-government preferences. Refining technology is widely available and scale economies are benign enough to allow location in most industrialized countries (Stell 2003). These shibboleths need to be modified. Refineries are conglomerates of production units with specific threshold sizes and optimal capacities whose mix cannot be decided at will. Capacity can be built only at discrete intervals, whereas consumption changes smoothly. Feedstock and output can be varied by selecting suitable technologies but only at a cost. It follows that, although aggregate volumes may be in balance, there still are qualitative imbalances to be evened out by product transports. Refineries also supply feedstocks, naphta in particular, for the petrochemical industry which need not be co-located (Chapman 1991: 84–86, 132; Laulajainen & Stafford 1995: 247–250). The other consideration is that refineries are not particularly welcome as neighbors. They occupy seaboard locations which have many competing uses. They pollute environment and are an eyesore. The difficulty to get building permits has pushed much US refining capacity to the Canadian seaboard and small Caribbean islands (Cellineri 1976: 61–68). Capacity growth in the Middle East Gulf (MEG) is partially credited to similar problems in Western Europe and parts of Asia, too. Then there are other factors. Multinationals can maximize operational flexibility and minimize taxes and red tape by locating close to, but not within, crude-oil production areas such as Venezuela (Verlaque 1975: 219; Laulajainen 2011). MEG exemplifies the desire of producing countries to maximize value added. It is not by chance that the largest 120,000 mt (mt = tonne, metric ton) movements in our data are from MEG to Asia Pacific. Most shipments are much smaller, however, and quite numerous. A typical size might be 30,000 mt and the total number several thousands. But beyond that, the worldwide picture is hazy, to say the least.

Specifically, are product tankers and particularly the dominant Handysize class amenable to a profound geographical analysis in the first place? If it is, is route planning feasible, in line with dry bulk and crude oil shipping (Laulajainen 2006, 2008)? For this to be meaningful at oceanic scale, the trading network must have a fair degree of connectivity. Another condition is that rates are high enough to make their differentiation, i.e., regional markets, possible. The Handysize segment ends at 25,000 dwt, or 15,000 dwt depending on author, but product transports continue down to 2,000 dwt (Stopford 1997, Table 11.9; Glen & Martin 2002: 263). The wider definition is adopted here because a larger piece of a little-known sector will then be uncovered. The low end is rather opaque but geographical features familiar from previous studies can still be recognized. Neste Oil, the Finnish refinery company, and the port of Amsterdam then play an important role. Three more world-class ports are outlined in a parallel study (Laulajainen 2011). The simultaneous use of several data sources creates occasionally problems of compatibility, and these are in no way mitigated by their dispersion over extensive geographical areas. Therefore, one shall not expect accounting accuracy but accept the wider views offered as a substitute.

The beginning is made by selecting and organizing the data of vessel movements, to be substantiated later on with refinery and port data. The major trade flows, their connectivity and rate functions are identified after principles developed for dry bulk carriers and "dirty" tankers. The functions are applied to vessels typical for each trade and profitabilities explained by respective logistical characteristics. The refinery's competitive position is set against its relative location, technological sophistication and changing price structure. Its maritime exports are described by a vessel size–distance function, substantiated by similar functions for Amsterdam and the LMIU data at large. To the extent functions from various sources link smoothly, it is justified to speak about vessel fungibility.

Global market

Two types of data are used for measuring the market size, about vessel movements and vessel charters (fixtures). Movements originate from *Lloyd's Marine Intelligence Unit* (LMIU Large and Handy Movement Data 2004). The former file is administered, meaning that vessel characteristics, cargo quality and size, loading and discharging ports and sea canals with dates are indicated. The latter is semi-administered, meaning among others that cargo status and quality are unknown (Appendix 1). An example clarifies the geographical basics.

Consider a 30,000 dwt tanker loading in the following sequence: Flushing – Shell Haven – Amsterdam (multiporting) and unloading everything in Bremen. It sails under one charter, carries three separate cargoes (part cargoes) estimated at 8,000 mt each, and visits four ports. The total sequence comprises three data lines. The three part cargoes combined are a cargo leg. The preceding ballast leg is implied to begin in the latest discharging port. The ballast and cargo legs combined give a full cargo cycle, also called trip.

A vessel's arrival and departure can be determined by direct observation if nothing else. Its cargo status (loaded/ballast) is a harder nut to crack. Deduction may be the only alternative and it becomes increasingly hazardous when vessel size declines and crude oil carriers are substituted by product tankers. One should be able to tell, for example, whether a tanker en route from Rotterdam to Milford Haven, both refinery locations, is in ballast or laden, and with what. The problem has been solved by LMIU down to 60,000 dwt. Thereafter the files are semi-administered which enforces considerable shortcuts by the analyst and constrains his/her activity. The necessary details are elaborated in Appendix 1 and the outcome in Table 1 and Appendix 2. The geographical breakup is a 11-region mesh, which broadly corresponds chartering practice when larger areas are substituted for ports (Fig. 1). The new feature is that the Pacific is given a separate region.

The Handysize segment dominates clean tanker geography. When Panamaxes and Aframaxes operate mainly from the MEG and from/in North Atlantic, Handysizes have an integrated worldwide network. This is made tangible by trades with at least one cargo per week, the minimum traffic density that allows a degree of route planning on a continental scale (Fig. 2). The system's connectivity is good. There is only one isolated region, although a closer look also discloses one sink and one source, which either absorbs or generates external cargoes. Then there are imbalances in opposite flows that support differentiated freight rates. The share of local traffic is very large, with three regions capturing a 68% share of the total. All this fits perfectly with the industry's general characteristics as outlined in the Introduction. Perhaps unexpectedly, correspondence appears best with the largest crude oil vessels which ply the longest routes (Table 2). The conclusions are qualified by the caveat that the movements are derived as much as observed.

Table 1. Cargo leg overview, 2004.

	Upper lim		Clean cargoes			Dirty cargoes	
Class	'000 dwt/mt	Legs	Fixt	Ratio	Legs	Fixt	Ratio
Handysize	60/50	12,186	3,383	3.60	n.a.	n.a.	n.a.
Large		1,100	588	1.87			
Panamax	80/67	498	282	1.76	2,227	620	3.67
Aframax	120/100	586	302	1.94	9,081	3,175	2.86
Suezmax	175/145	16	3	n.a.	3,880	1,444	2.69
Vlcc	300/250	0	1	n.a.	3,527	1,271	2.77
Total		13,286	3,971	3.35	18,715	6,510	2.87

Notes: Roundings possible. Selected estimate underlined. Class limits approximate.

Sources: Drewry Fixture Data (2004); LMIU Handy Movement Data (2004); LMIU Large Movement Data (2004); LMIU Vessel Data (2004); Woodhouse (2004).

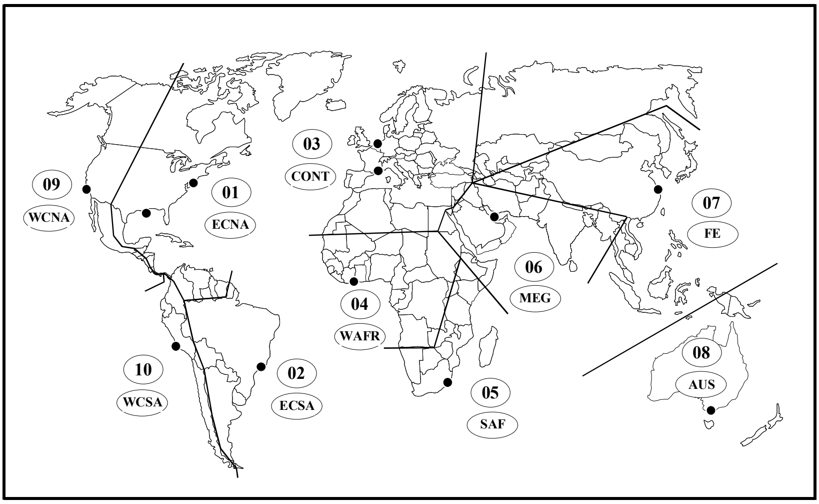


Fig. 1. Clean fixture regions – 11-region mesh, 2004.

Note: Region 11 is Pacific Ocean. Identification numbers and regional acronyms are used interchangeably.

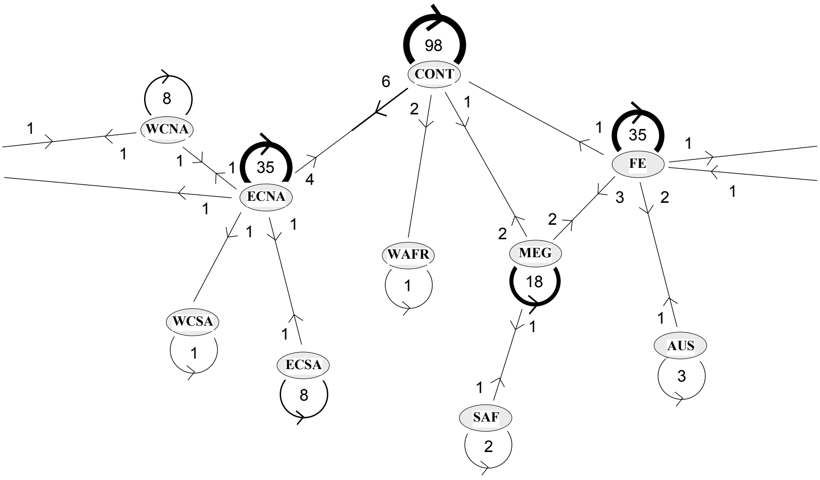


Fig. 2. Clean handysize shipments per week, 2004.

Note: Annual shipments/50 rounded upwards to closest integer; n = 244.
Sources: LMIU Handy Movement Data (2004).

Table 2. Network systemic elements, 2004.

Segment	Nodes active	Arcs no-loop	Systems separate	Arcs in largest node
Handysize, clean	10	18	2	8
Panamax, dirty	7	5	3	4
Aframax, dirty	8	9	3	6
Suezmax, dirty	7	9	2	6
Vlcc, dirty	7	11	1	7

Note: Region 11 ignored on Handysize line.
Sources: Fig. 2; Laulajainen (2008, Table 2).

Rate structure

Rates underlie profitability calculations. Differentiated rates reflect differentiated costs, distance- and volume-related costs in particular. Only spot fixtures have the geographical detail to allow analytical conclusions. They were supplied by *Drewry Shipping Consultants* (Drewry Fixture Data 2004). The smallest vessel was 14,369 dwt and 53 fixtures were below 25,000 dwt. Small vessels are too many and offer too little commission to be of much

Table 3. Fixture overview, 2004.

	Clean fixtures			Dirty fixtures		
Segment	WS	Lump	Total	WS	Lump	Total
Class by dwt						
Handysize	2,320	1,005	3,325	n.a.	n.a.	n.a.
Panamax	156	63	219	483	137	620
Aframax	240	62	302	2,808	367	3,175
Suezmax	1	2	3	1,345	99	1,444
Vlcc	1	0	1	1,169	102	1,271
Class by mt						
Handysize	41	17	58	n.a.	n.a.	n.a.
Panamax	57	6	63	n.a.	n.a.	n.a.
Total	2,816	1,155	3,971	5,805	705	6,510
%	71	29	100	89	11	100

Note: Twenty of the Handysize fixtures are for cargoes below 20,000 mt.
Sources: Drewry Fixture Data (2004); Woodhouse (2004).

interest for international consultants and are mostly traded at local platforms (Fagerholt 2004: 46). Cargo tonne is the preferred size indicator and dwt is often left unreported. LMIU's Movement and Vessel Data, and *E.A. Gibson Shipbrokers*' Tanker Book (Woodhouse 2004) were consulted to close such gaps. The remaining cases were allocated to size classes by cargo tonnes (Table 3). A conversion ratio 1.0 dwt = 0.800 mt was observed.

The link between rate and cost need not be so intimate as to preclude surplus profits. The dirty tanker segment offered indications to that effect (Laulajainen 2008, App. 3). There were 6,500 fixtures for 18,700 cargo legs in four size classes when there are now 4,000 fixtures for 13,300 cargo legs in three size classes, mostly Handysizes (Table 1). The 11-region set is used for specifying the trades and deriving their rate functions (Fig. 1). The larger classes have only three routes with a meaningful number of fixtures: 3-1, 6-3 and 6-7, plus two local markets in 3-3 and 6-6. There is no sharp boundary between Handysizes and Panamaxes. Overall, ports are the same and trades have their typical, distance-related vessel sizes (Table 5). Therefore, it is reasonable to consolidate all Handy to Afra fixtures into one set. The number of functions gets almost halved and the 12 trades with an acceptable number of observations leave only 115 fixtures redundant (Table 4). Vessel size is controlled by cargo tonne.

The existence of two parallel rating systems is another, although minor, complication. The dominant system is the Worldscale (Worldscale 2004, Preamble 3). Its essential feature is "flatrate" (= WS 100), a tonne rate for a round trip between a given port pair by a standard vessel in standard conditions. The actual quotes are related to the flatrate and reflect the state of the market and vessel size. Larger vessels have smaller unit costs when fully employed and WS quotes decline with increasing ship size. The alternative system is Lumpsum, which quotes an undifferentiated total freight case-by-case. Both systems give identical results in identical circumstances (fungible) and their relative use seems to escape rational explanation. There is a pronounced geographical dimension, however – Lumpsum dominates the clean trades 6-3 and 7-9 and is well-entrenched in the local markets 6-6 and 7-7 (Table 4). The fungibility is exploited here and both types of quote are consolidated into one set which naturally enhances the information value of available data. WS quote and Lumpsum reflect the angle of a cargo owner. The ship owner angle is provided by Time Charter Equivalent (TCE/day). It is derived by dividing total freight revenue minus major costs (bunkers, port charges, possibly capital costs) by the time at sea and in port (cf. Laulajainen 2007, Table 3). The indicator is used routinely in time charters.

Weekly rates for each trade are estimated from the function:

$$\text{Rate} = a + b_1 * \text{BCTI} + b_2 * \text{Dist} + b_3 * \text{Cargo} + b_4 * \text{Lump} + e$$

in which

Rate = \$/mt
BCTI = Baltic Clean Tanker Index
Dist = nautical miles between regional reference ports (26 regions)
Cargo = estimated payload, mt
Lump = 1/0 variable, 1 when a Lumpsum and 0 when a WS quote
a, b_i = parameters
e = error term.

BCTI (2004) indicates the general state of the market and is indispensable for explaining temporal data. It should be noted that the clean index does not follow closely the index for dirty cargoes. Since many tankers can be used for both type of cargo, a fair amount of arbitrage is possible.

Distance is necessary because longer transports are more expensive (Worldscale 2004). One-way distance is used to emphasize the point that round voyages (rv, two-way) cannot be assumed. The relation is linear when terminal charges are overlooked. When not, approximate linearity can be assumed at long, but not short, distances. Logarithmic transformation reduced the R-sqrs by about 0.100 and was rejected.

Vessel size measures economies of scale. Cargo tonnage originates from charterparty or is an educated guess, typical for the trade. It functioned equally well as deadweight tonnages. Scale economies suggest linearization by taking logarithms. The effect on R-sqr was negligible, however, and the idea was abandoned.

It appeared plausible that the ratio cargo mt/dwt (= load factor) affects the rate when the charterer is compelled to pay for unused cargo space (part cargo). The idea is connected to the state of the market and therefore tricky to use. Vessel size is probably the ship owner's reference point in a bull market, whereas in a bear market he/she is content to charge for the cargo tonnes only. In experiments, the variable usually lacked statistical significance and was rejected.

Although fixtures based on WS quotes and Lumpsums appear fungible, they may be used by different types of market actor. A dichotomous variable Lump is consequently added.

The estimation succeeds well. Nine of the twelve equations have R-sqrs at or above 0.50 (Table 4). The main coefficients, when significant, have logical signs and are internally consistent. The Lump coefficient is inconsistent but it is also the most speculative one. The implied profits are standardized by:

Table 4. Rate functions, 2004.

Trade	Fixt.	Lump	Rate	R-sqr	SEE	Coefficients				Interc.
		%	\$/mt	(adj)		BCTI	Dist	Cargo	Lump	
1-1	561	0.13	13.19	0.656	2.20	0.00909	0.00328	–0.347		8.708
1-3	70	0.00	15.75	0.742	2.02	0.00781	0.00224	–0.167		2.765
3-1	575	0.02	24.57	0.742	4.02	0.01872	0.00514	–0.240	–3.556	–8.743
3-3	820	0.09	14.47	0.499	3.98	0.01154	0.00436	–0.119	–1.390	–1.723
3-4	96	0.03	27.23	0.616	5.07	0.02512	0.00667	–0.417	6.475	–15.948
6-3	128	0.97	29.65	0.416	7.21	0.01332	0.00188	–0.156	–14.654	25.927
6-5	55	0.05	25.21	0.671	3.02	0.01396	0.00429	–0.161	9.749	–3.869
6-6	101	0.64	15.15	0.310	10.12	0.01436	0.00484			–11.064
6-7	416	0.01	25.95	0.789	3.84	0.02324	0.00401	–0.197		–13.005
7-7	787	0.75	11.61	0.594	2.24	0.00609	0.00069	–0.112	–4.185	9.716
7-8	105	0.03	27.59	0.743	3.75	0.01517	0.00433	–0.276	–15.469	0.149
7-9	62	0.98	34.42	0.354	6.05	0.01350	0.00368			–2.902
Rest	115									
All	3,967	0.29	18.62	0.691	5.31	0.01242	0.00420	–0.179	–1.971	–1.506

Notes: Based on Handysize, Panamax and Aframax fixtures. Rest consists of small trades. Distances one-way. All coefficients at least 0.05 significant. Trade 7-6 with 34 observations does not support a function.
Source: Drewry Fixture Data (2004).

1. selecting for each trade typical input values,
2. applying the parameters to get weekly $/mt,
3. subtracting bunker costs, the main variable cost item,
4. scaling the net revenues by the total time.

The result is an approximation of the Time Charter Equivalent ($/day). The use of typical rather than average input values facilitates comparison. Similar trades are grouped into five cases (Table 5).

Case A When one macro system (Table 3) includes several local trades, their TCEs tend to stabilize at the same level. See also Case E.
Case B Similar logistics lead to similar TCEs. This is a variation of Case A. The two trades begin in Europe and MEG and end in West and East/South Africa, respectively. There are no return cargoes. The distances are the same, the cargoes almost the same and both trades use the WS system exclusively.
Case C Imbalance in opposite trades is reflected in their relative TCEs.
Case D Opportunities for new cargoes at destination are reflected in relative TCEs; the idea has been elaborated by Laulajainen (2007, Table 8 ff).
Case E Lumpsum system, even when inoperative (!), suggests lower TCE, reinforcing the effect of longer distance. The same phenomenon is visible in Case A.

The conclusions tally well with those derived in previous studies about "dirty" tankers.

A logical continuation would be to apply the Simulator developed for global bulk vessel movements (Laulajainen 2006, 2007, 2008). Unfortunately, the available data are insufficient for the purpose. The missing movement data about Handysize vessels, in particular, makes the effort

Table 5. Typical TCEs ("profits") explained, 2004.

Case	Trade		Variables			$/mt	TCE	Commentary
			Dist	Cargo	Lump		$'000/d	
A	Same macro system promotes similar profits in local trades							
	1-1		1,500	30.0	0.00	14.33	31.1	
	3-3		1,500	30.0	0.00	15.35	33.5	
	6-6		1,500	30.0	0/1	13.74	29.7	Lumpsum inoperative
	7-7	L	1,500	30.0	1.00	10.65	22.3	Lumpsum 100%
		WS	1,500	30.0	0.00	14.83	32.3	
B	Similar logistics lead to similar profits							
	3-4		4,000	30.0	0.00	28.92	29.0	West Africa
	6-5		4,000	35.0	0.00	24.72	28.9	East Africa
C	Imbalance in opposite trades reflected in profits							
	1-3		4,000	35.0	0.00	15.42	16.8	Backhaul (small flow)
	3-1		4,000	35.0	0.00	26.29	31.0	Fronthaul (large flow)
D	Opportunities at destination reflected in profits							
	6-3		6,000	55.0	1.00	30.25	34.0	Better
	6-7		6,000	55.0	0.00	28.62	35.3	Worse
E	Lumpsum although inoperative suggests lower profits							
	7-8		4,000	30.0	0.00	27.73	27.7	
	7-9		6,000	30.0	1.00	35.68	24.6	Lumpsum inoperative

Notes: Profit in accounting sense observes also capital charges, such as depreciation and interest on capital, now included in Worldscale's hire element. $/mt and TCE are annual averages. $/mt does not deduct bunkers, TCE does. $/mt is based on one-way distance and loading time, TCE on round-voyage distance and full port time. Trade 6-3 comprises Suez Canal charges $140,000 ($4,300/day) as a negative item. This is controversial because the WS system ignores canal charges. Trade 6-6 not split into WS and L because Lumpsum coefficient statistically insignificant.
Source: Worldscale (2004, Preamble 3).

meaningless. Fixtures can be used to approximate trade volumes but vessel and cargo histories, i.e., time sequences of loading and discharging ports and the weekly availability of cargoes, are needed for applying the formula of Rate Potential, the keystone of simulated rates. Since this is not possible, it is better to turn attention to a refining company with extensive maritime exports, made mostly with vessels smaller than Handysizes. It is then possible to compare its activity with data from other partial sources, viz. the Port of Amsterdam Authority (2004) and LMIU Handy Movement Data (2004).

Micro level cases

LMIU's semi-administered movement data (Appendix 1) ends at the 15,000 dwt size. The frequent aggregation of ship movements on a particular data line makes the analysis of individual cargo legs impossible. The desire to penetrate to the bottom of matters makes the use of additional sources necessary. Port statistics come first in mind. The normal practice is that ships report at arrival and departure their latest or next port. In Scandinavia, the reports are available for academic research at port and national authorities. "Elsewhere" they seem to be semi-classified information, at best. When they are made available it is in an aggregate shape. In a fortunate case, aggregation may be a cascade by commodity group, country and vessel size class. Among four world-class ports contacted (Amsterdam, Antwerp, Rotterdam and Singapore) this happened to be the case in Amsterdam. That is the reason for Amsterdam's inclusion.

The favored alternative is naturally access to individual trips (loading–cargo leg–discharging–ballast leg). Business company databases routinely contain this information. The *clou* is to get access to it. Companies in general consider locational data about sales, revenues and costs too sensitive for release to the public domain. In our case, Neste Oil, the 2004 export shipments were thought to be only of historical interest, in a rapidly moving market where the changing price structure of crude oil was a central ingredient (Harki 2009b). Common language and ethnic background undoubtedly helped, too. The same request at some other companies operating in the Baltic was flatly turned down. From a wider angle, a refinery may not know where its sales will end if they are distributed by traders. Neste did not export through traders. Its data file comprised also the smallest shipments, down to 2,000 mt. These features allow a comprehensive analysis.

Neste Oil is Finland's dominant oil company, with the government as a majority owner. Its refineries in Sköldvik (Porvoo) and in 2004 Naantali imported 9.2 mmt crude oil by sea (Primorsk, Fredericia, Kaliningrad, etc.) and 4.3 mmt by rail, and distributed 13.4 mmt products 60/40 domestically/abroad (Fortum Ltd 2004). Maritime transports dominated exports. Their large share and penetration of the North Sea heartland may astonish. The foundation was laid in 1975 when the Sköldvik refinery had doubled capacity but faced muted demand at home, in the aftermath of the 1973 price hike. Fortunately, the surplus could be placed overseas (cf. Rodgers 1958: 349; Chapman 1991: 137–138, 220). This was an eye-opener and the refinery duly became a conduit of Soviet exports in a refined form. The task was facilitated by the extensive dismantling of refinery capacity in the EU in the 1980s, supported by widespread resistance to new refineries on the congested seaboard. Operation in constantly changing export markets called for flexibility, possible only by sophisticated technology such as catalytic cracking and hydrocracking, able to cope with numerous crude qualities and convert them to novel, environmentally friendly products. The hefty differential between low-quality and high-quality crudes, some $10/bbl ($73/mt), played directly into Neste's hands. That benefit has subsequently dwindled to $3.5/bbl (26$/mt) following the closure of low-quality Saudi fields and the upgrading of US refineries – but in 2004 it mattered (Blas 2009).

Neste Oil's operations are evaluated best against its competitors. Most of them were in Scandinavia or the Balticum, or at least exported through its ports (Table 6). Available information calls for care in interpretation. Roughly 60% of Neste's export tonnage was shipped in vessels small enough to escape the Handysize definition, and the Neste and LMIU data sets are only broadly comparable (Appendix 1). All quoted refineries supplied the local market, but exports could easily approach the 50/50 mark. Mažeikiu Nafta in Lithuania and Preem in Sweden being typical cases (Preem AB 2004; Maižeikiu Nafta 2005). Russian exports pose the main dilemma because no refinery was on the seaboard (Maižeikiu Lithuanian-owned) and most were far inland. Kirishi is only 110 km from St. Petersburg but Moscow, Yaroslavl and

Rjazan are already 650–900 km from Baltic ports. It is very much a question of rail tariffs, which at such distances comprise up to 10%–12% of the fob cost and are three times higher than pipeline tariffs (Byev et al. 2006: 88–89). Klaipeda even received crude oil from Kazahstan, a distance of 3,000 km. The terminal is a subport of Klaipeda and exports are registered there. The Gdansk refinery was half the size of Sköldvik (Atlas... 2003; George 2003; Lorimer 2003; Stell 2003; Tykkyläinen 2003; LMIU Handy Movement Data 2004; Byev et al. 2006: 38–40, 89–90; Surgutneftegaz 2009). Neste was thus in a favorable competitive position in the Baltic (Fig. 3). Competition intensified beyond the Baltic but it was less advanced technologically than one might expect[1]. Neste considered only the Swedes and Immingham as equals (Harki 2009b). The market shares in the core market Baltic–North Sea, Biscaya–Western Mediterranean tended to stay within 85%–90%, whereas the pull of North America grew on the North Sea and the relatively modest market in Québec and Maritime Provinces absorbed more than New York (Fig. 3). But geographical closeness alone was not sufficient. Technical excellence tuned to market preferences carried much weight, particularly in California, notwithstanding the distance (9,000 nm) and Panama Canal charges ($140,000). Neste also excelled there with three 35,000–40,000 mt cargoes of high-grade gasoline.

Globally, California is the *cul-de-sac* of oil logistics, with 15% of supplies coming from the outside, from Alaska and via refineries in the Vancouver area. It is comparatively isolated from the Caribbean by the congested Panama Canal and from the Asia Pacific by the vast spaces of the ocean. Yet, Korea and Japan were the closest overseas sources and also Neste Oil's keenest competitors. The surcharge toward Korea, "only" 5,000 nm distant, was 24 $/mt, which wiped away the calculatory 23 $/mt refinery margin[1]. An important reason for the comparatively low Korean presence,

Table 6. Handysize oil product exports from some refineries in NW Europe, 2004.

Company/class		Refin. no	Intake bbl/day	mmt	Maritime cargos by Region 1–3 %	6–8 %	Rest %	Cargos Trans
Neste Oil (Sköldvik, Naantali)		2	252	5.0				419
Aframax	84,000 dwt			0.1				2
Panamax	67,000 dwt			0.4				8
Handysize	15–59,999 dwt			2.4				138
Small	10–14,999 dwt			1.4				129
Mini	2–9,999 dwt			0.7				142
LMIU	15–59,999 dwt							
Finland (Sköldvik, Naantali)		2	252	1.7	12	85	3	127
North Baltic (Russia, Estonia)		1	336	17.1	2	97	1	702
Mid Baltic (Latvia, Litva, Kalin.)		1	260	13.2	8	89	4	576
Poland (Gdansk)		1	90	1.1	6	85	9	54
Denmark (Kalundb, Fredericia)		2	176	1.3	9	90	2	58
Sweden (Brofjord, Gothenburg)		3	406	5.1	11	85	4	218
Norway (Mongstad, Slagen)		2	310	3.0	11	87	2	145
UK (Immingham)		2	447	5.2	17	78	5	195
All LMIU		14	2,277	47.7	7	92	2	2,075
World, Seaboard		275	53,600	781.3				28,500

Notes: Domestic shipments excluded. Canary Isl., Puerto Rico, Virgin Isl. and similar are considered foreign territories. Neste data cargos and tonnes (dwt = 0.8 mt). LMIU data non-treated (100%) transits. Percentages from transits. Roundings possible. Region 1-3 refers to North American Atlantic Coast & Caribbean and Region 6-8 to Baltic & North Sea & Biscaya & W. Mediterranean. They originate from a 26-region mesh. Nynäshamn refinery specialized in bitumen and is outside this study. Global figures without scaling (App. 1).

Sources: Stell (2003); LMIU Handy Movement Data (2004); Harki (2009a), Laulajainen (2010, Fig. 4).

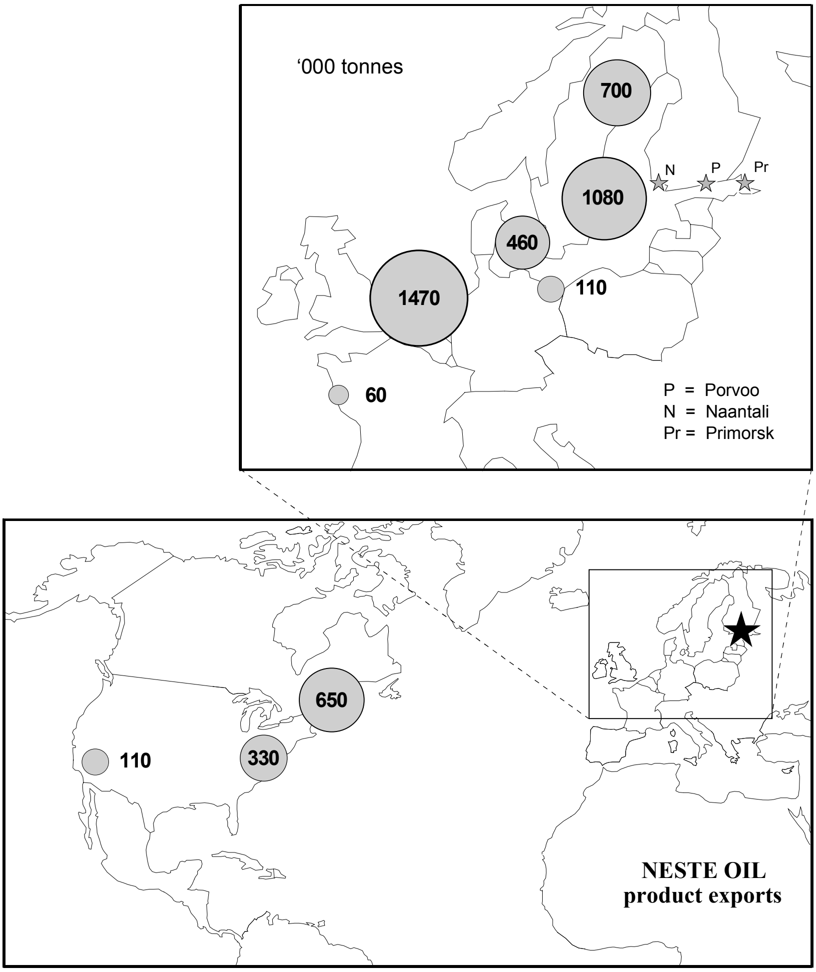


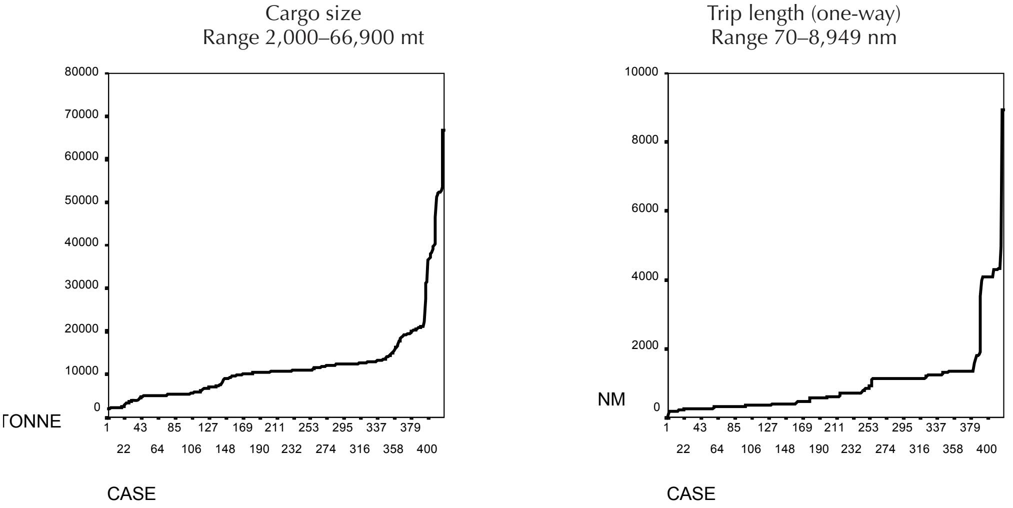
Fig. 3. Neste Oil maritime product exports, 2004. Source: Harki (2009a).

450,000 mt or 3% of the market, must have been the refineries' modest technical sophistication (LMIU Handy Movement Data 2004[2]). Of course, sophistication becomes expensive and is never an end in itself but a vehicle to gain meaningful competitive advantage.

Fungibility

Most of Neste's cargoes were quite small. Only 60% exceeded the approximate Handysize lower boundary 12,000 mt (15,000 dwt; Fig. 4). A full cargo often consisted of several qualities, up to five, but it was unusual that a vessel discharged in more than one port, and then close to each other. The smallest cargoes, down to 2,000 mt (2,500 dwt), were chemicals, bitumen and bunkers. Fuel oil cargoes could also be small, 3,000–4,000 mt, but only when channels and ports were shallow. The total share of non-clean cargoes was 3.5%. Distant shipments were always gasoline. Loading in both Sköldvik and Naantali for the same trip was unusual. Distances reflect the refinery locations at the far end of the Baltic. Three zones can be outlined: Northern Europe up to 2,000 nm (one-way), East Coast North America (ECNA) about 4,000 nm and Los Angeles 9,000 nm (Fig. 4).

Cargo size and distance seem to change *in tandem*, tying together the small end of the market and the rest. The link is weak when individual cargoes are considered, but quite strong when trips are aggregated by cargo size and distance. It may even be possible to speak about the fungibility of the oil tanker market; observations made in one


Cargo size
Range 2,000–66,900 mt

Trip length (one-way)
Range 70–8,949 nm

Fig. 4. Neste Oil maritime product export cargo sizes and distances, 2004.
Source: Harki (2009a).

part of the market having full validity elsewhere. The Neste data must then be complemented with other sets to bridge the gap to the LMIU product shipments above the 60,000 dwt mark, not to speak of "dirty" cargoes such as crude oil. In that purpose, oil-product export data was collected from some major ports. Amsterdam's data suits best for this report. The port has very little oil refining but functions as an outlet for Rotterdam refineries (Charlier 1996: 310–311). The exports almost double Neste's, and also cover Mediterranean and South Atlantic, with Singapore as the most distant destination (Fig. 5). The distribution radius of oil products thus approaches that of crude oil.

The data sets are only broadly comparable with each other (Table 7). The Neste data are detailed by vessel (except dwt), cargo and port. Distances are measured from Sköldvik/Naantali. The Amsterdam data are not about individual vessels or ports but aggregated first by dwt class (with cargo tonnage) and then by country. A dwt class is estimated here by its midpoint. One-way distances are measured from Rotterdam (proxy) to a country's most likely discharging port (2004). The LMIU data identify vessels with dwt, cargo tonne, loading and discharging ports. These distances are between regional reference ports in a 26-region mesh (e.g. Laulajainen 2010, Fig. 4).

The "clean" data are aggregated for the analysis, at Neste by region, i.e., distance (Fig. 3), Amsterdam and LMIU by dwt class. The Amsterdam class intervals are given in the source, the LMIU intervals are set at 10,000. Other reasonable classifications affected results only marginally. Classes with only one observation in Amsterdam and LMIU data were rejected. Also, the US westcoast observation was rejected from Neste data because of the Panama Canal effect. The modest fit of the LMIU function is due to the MEG–Far East trade. Vessels employed there were "too large" considering the distance! Otherwise, the estimates are reasonable to good (Table 8). Consolidation into one set gives a rising exponential curve (Fig. 6). Since its fit is slightly inferior to a linear equation, the latter parameters are reported. Dummy coefficients for Amsterdam and LMIU data confirm the figure's message.

These gratifying results encourage a look at "dirty" cargoes. Can the concept of fungibility be extended also to them? There is no profound reason why not, not in the construction of vessels at least. The greater volatility of light over heavy fractions necessitates more sophisticated cargo-handling equipment and greater care by the crew, but these are differences of degree, not of substance. The idea is put to the test with the help of LMIU "dirty" cargoes, mostly of crude oil but also heavy distillates and residues (Fig. 7). The vessels carrying them are routinely classified as Panamaxes, Aframaxes, Suezmaxes and VLCCs, with limits at

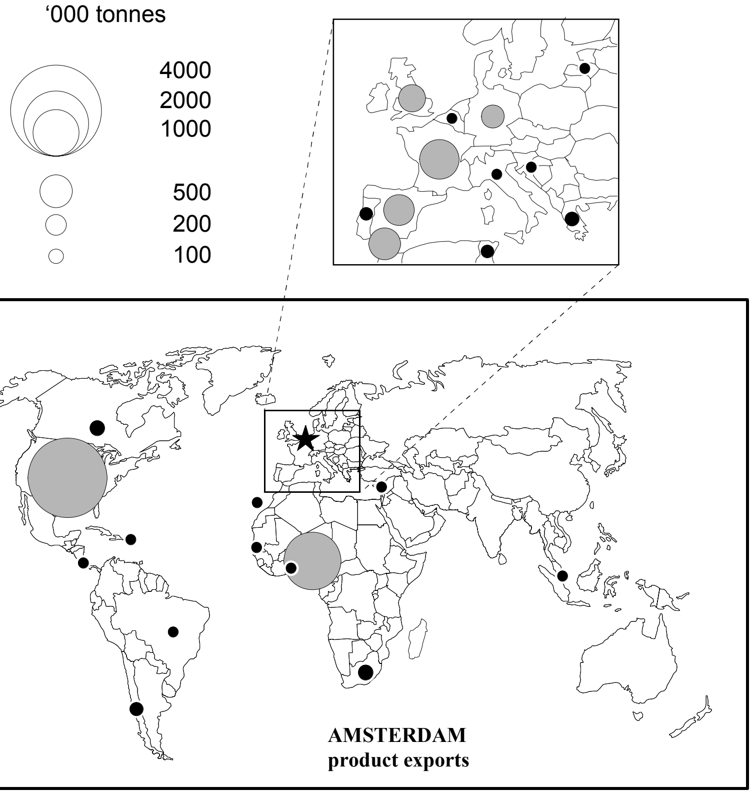


Fig. 5. Amsterdam Port product exports, 2004. Source: Port of Amsterdam Authority (2009).

Table 7. Data for functional relationships, clean cargoes 2004.

Data set	Mmt	Trips	Unit	Groups			Size variable
				Used no.	Reject no.	Tonnage pct	
Neste Oil	5.0	419	ship/port	9	1	2.2	mt/dwt
Amsterdam	8.0	n.a.	s-class/ctry	6	3	10.8	dwt
LMIU	74.2	1,100	ship/port	7	2	0.3	dwt/mt
Total	87.2	n.a.		22	7	1.4	

Notes: Conversion factors based on LMIU data: mt/dwt = 0.800; dwt/mt = 1.250.
Sources: LMIU Movement Data (2004); Port of Amsterdam Authority (2004); Harki (2009a).

80,000, 120,000 and 180,000 dwt. Scatterplots by 1,000 and 10,000 dwt classes (Panamax and the others) suggest acceptable functions for Panamaxes and VLCCs. The few outliers in the upper-left-hand corner are “special cases”, lifts from offshore oil fields to coastal Brazil, US Gulf and the North Sea (Panamaxes) or from MEG and Yanbu to Ain Sukhna, the beginning of the Sumed Pipeline (VLCCs). Aframaxes and Suezmaxes, by contrast, must be consolidated before anything like a function can be sensed. Obviously, these two size classes are veritable all-round workhorses suited for all situations: short distances, shallow ports and channels, and variable cargoes.

The functional fits are weaker than at “clean” shipments (Table 8). An obvious reason is that Neste and Amsterdam shipments both have one geographical origin. The same effect exists also in

Table 8. Vessel size as function of distance, clean and dirty cargoes 2004.

Data set	Obs.	R-sqr (adj)	SEE	Coefficients Dist	Coefficients Amst	Coefficients LMIU	Interc.
Clean							
Neste Oil	9	0.919	4,649	10.16			4,794
Amsterdam	6	0.940	3,145	8.84			–207
LMIU	7	0.666	11,703	18,74			9,527
All clean	22	0.956	8,294	11.04	–7,335	41,202	3,352
Dirty (LMIU)							
Panamax	18	0.468	3,862	5.95			56,582
AfraSuez	80	0.304	21,372	10.44			98,215
Vlcc	15	0.764	30,886	23.12			136,904
All dirty	26	0.839	37,700	32.42			68.824
LMIU							
Dirty (Pana)/Clean	25	0.767	7,809	10.74			46,402

Notes: Distance one-way, nautical miles. All functions linear. Coefficients significant at about 1% risk.
Excluded dirty classes: Panamax 78, 79 (not in All dirty); Vlcc 36, 40, 42.
Sources: LMIU Movement Data (2004); Port of Amsterdam Authority (2004); Harki (2009a).

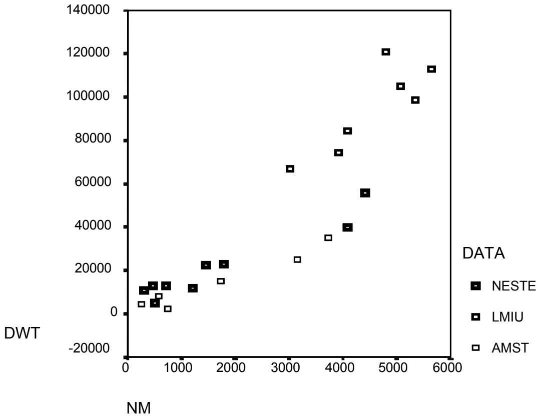


Fig. 6. Vessel size as function of distance, clean cargoes 2004.
Legend: Large marker Neste Oil; small marker above LMIU; small marker below Amsterdam Port. Vessel classes, see text. Distances one-way.
Sources: LMIU Movement Data (2004); Port of Amsterdam Authority (2004); Harki (2009a).

"dirty" shipments: MEG dominates large crude oil cargoes and the effect is visible in the good fit of the VLCC equation. When all the size classes are consolidated and the VLCC outliers above excluded, the joint function is quite acceptable. Not unsurprisingly, the parameters deviate from the "clean" parameters, a rather crucial test of fungibility. Therefore, the "clean" LMIU and "dirty" Panamax data are joined into one set, scatterplot prepared and parameters re-estimated. The "dirty" half has two-thirds of observations but the "clean" half has a wider range (Fig. 8). Therefore, it is impossible to decide which one dominates. Rather, the "clean" set continues the "dirty" set. This can be interpreted as a kind of proof for the fungibility.

Conclusion

This report took to its task to create a holistic idea about the "clean" oil product shipping market, particularly the thousands of smallish tankers that do not meet the minimum size criterion of a Panamax vessel, 60,000 dwt (50,000 mt). To that purpose, it has combined existing global and local databases and created from them a tangible idea about the "clean" market, described its structure and commented on its rationality. Because the underlying data are not readily available, the results have been extensively tabulated.

Handysize product tankers apparently dominate shipments exceeding 3,000 nm, an opinion based on widely distributed spot fixtures. These accumulate on large trades and overshadow the dense net-

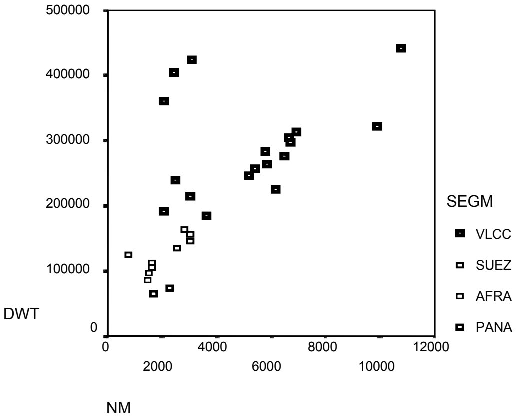


Fig. 7. Vessel size as function of distance, dirty cargoes 2004.
Legend: Trades in upper-left-hand corner MEG/Yanbu – Ain Sukhna. Vessel classes 10,000 dwt, distances one-way.
Sources: LMIU Large Movement Data (2004).

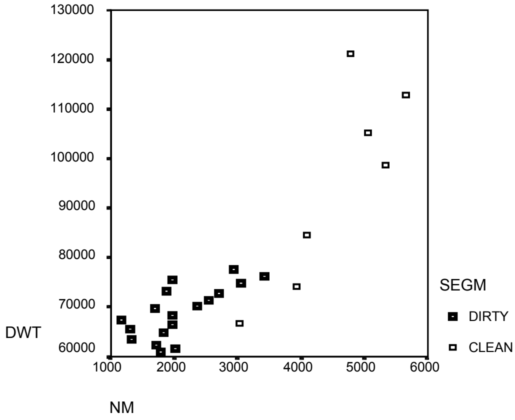


Fig. 8. Vessel size as function of distance, LMIU clean and dirty Panamax cargoes 2004.
Notes: Panamax classes 78 and 79 excluded. Distances one-way.
Source: LMIU Large Movement Data (2004).

work of small shipments which cover the tributary seas and their inlets. This disguised volume is probably comparable with the conventionally published one, but the number of movements is so large that they are likely to remain beyond the grasp of expensive commercial surveys.

The pattern of "clean" Handysize shipments does not radically differ from that of "dirty" shipments in general. Major crude-oil producing areas have developed sizable refining industries, high prices stimulate production all over the world, major consuming areas are increasingly reluctant to allocate seaboard locations to oil refineries, and the ownership of production and refining have never been as decentralized as they are now. Therefore, long-distance shipments reflect as much differences in crude-oil quality and pricing, and temporary imbalances between product demand and refinery capacity, than a split between resource owners and their customers.

There are 12 to 13 major trades worldwide. Three of them are actually clusters of within-region movements in EC North America, Continent and Asia Pacific, comprising two-thirds of the total volume. The major trades generate at least one cargo per week, the approximate threshold of cargo density for formal route planning. The other element is the trades' relative profitability for the ship owner. Since there are no data about actual vessel movements, dynamic simulation similar to the one about the "dirty" tanker market is ruled out. Plain TCE ($/day) estimates are the only possibility, and they give promising indications. Relative profits in various operative situations, basically local trade balances, are logical and in line with earlier results. Apparently, the principles already derived can be carried over to smaller size segments, the basic idea of fungibility.

Practical verification leads to the calculation of vessel size–distance functions. The first set of functions covers the "clean" shipments in the Neste Oil, Port of Amsterdam and LMIU data. The second set covers the "dirty" shipments in the LMIU data, differentiated by size class. The third set covers all "clean" and Panamax "dirty" shipments in the LMIU data. The three sets generate scatterplots where the subsets join neatly with each other. The statistical fits are acceptable and parameters logical, subsets included.

Perhaps more importantly than anything else, a seemingly impenetrable segment of ocean bulk shipping has been partially opened and shown to follow the same economic principles as the mainstream.

NOTES

[1] Finland's export price (fob) of oil products to the USA $394.7/mt and import price (cif) of crude oil worldwide $371.8/mt (UN Comtrade 2004, SITC 333 and 334).

[2] A rule-of-thumb indicator for technological excellence is the total of catalytic treatment charges out of the total crude oil intake. The percentage can be a bit vague because some streams are consecutive while others are parallel. It was 188% at the Conoco Immingham refinery, 136% at Sköldvik, 130% at Shell Gothenburg and 116% at Preem Brofjorden. The corresponding US figures were East Coast 142%, Gulf Coast 146% and California 155%. South Korea's most active refineries in Onsan and Ulsan had 81% and 51%, respectively (Stell 2003; see also Laulajainen & Stafford 1995, Figure 5.32).

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REFERENCES

Atlas zheleznyh i avtomobiljnyh dorog 2003. AST Astrelj, Moscow.

Baltic Clean Tanker Index (BCTI) 2004. Baltic Exchange, London.

Blas J 2009. Narrow oil spreads put pressure in modern refineries. *Financial Times,* 24, 23 June.

Byev D, Novikova A, Zelenina J, Zinkina I & Gubanova O 2006. *Logistika neftenalivnyh perevozok*. SeaNews, Saint Petersburg.

Cellineri LE 1976. *Seaport Dynamics, a Regional Perspective*. Lexington Books, Lexington.

Chapman K 1991. *The International Petrochemical Industry*. Blackwell, Oxford.

Charlier J 1996. The Benelux seaport system. *Tidschrift voor Economische en Sociale Geografie* 87: 4, 310–321.

Drewry Fixture Data 2004. Drewry Shipping Consultants, London.

Fagerholt K 2004. A computer-based decision support system for vessel fleet scheduling – experience and future research. *Decision Support Systems* 37: 1, 35–47.

Fortum Ltd 2004. Annual Report. <*www.fortum.com/webannualreport2004*> 12.4.2010.

George N 2003. Trucks trundle in from Russia while oil pipeline stays closed. *Financial Times*, 3, 25 November.

Glen D & Martin B 2002. The tanker market: current structure and economic analysis. In Grammenos CTh (ed). *The Handbook of Maritime Economics and Business*, 215–279. LPP, London.

Harki M 2009a. Exports of oil products 2004. Neste Oil, Helsinki.

Harki M 2009b. Phone interview. Neste Oil, Helsinki. 4 March.

Isserlis L 1938. Tramp shipping cargoes and freights. *Journal of the Royal Statistical Society* 101: 1, 53–146.

Laulajainen R 2006. *The Geographical Foundations of Dry Bulk Shipping*. Gothenburg School of Business, Economics and Law, Gothenburg.

Laulajainen R 2007. The geographical foundations of tanker (dirty) shipping. *Maritime Policy and Management* 34: 6, 553–576.

Laulajainen R 2008. Operative strategy in tanker (dirty) shipping. *Maritime Policy and Management* 35: 3, 315–341.

Laulajainen R 2010. Geography sets the tone to tramp routing. *International Journal of Shipping and Transport Logistics* 2: 4, 364–382.

Laulajainen R 2011. Port-turntable, the foreland concept repackaged. Manuscript.

Laulajainen R & Stafford HA 1995. *Corporate Geography*. Kluwer, Dordrecht.

LMIU Handy Movement Data (semi-administered) 2004. Lloyd's Marine Intelligence Unit, London.

LMIU Large Movement Data (administered) 2004. Lloyd's Marine Intelligence Unit, London.

LMIU Vessel Data 2004. Lloyd's Marine Intelligence Unit, London.

Lorimer A 2003. Russia's new oil gateways. *Lloyd's Shipping Economist*, 15–18, December.

Maižeikiu Nafta 2005. <*http://en.wikipedia.org/wiki/Ma*> 12.4.2010.

Matheson MH 1955. The hinterlands of Saint John. *Geographical Bulletin* 5–6, 65–102. Geographical Branch, Department of Mines and Technical Surveys, Ottawa.

Musso E & Marchese U 2002. Economics of shortsea shipping. In Grammenos CTh (ed). *The Handbook of Maritime Economics and Business,* 280–304. LPP, London.

Nossum B 1996. *The Evolution of Dry Bulk Shipping 1945–1990*. Fearnley & Egers, Oslo.

Port of Amsterdam Authority 2004. Trade statistics by country, unpublished.

Preem AB 2004. Annual Report. <*www.preem.se/upload/pdf*> 12.4.2010.

Rodgers A 1958. The port of Genova: external and internal relations. *Annals of the Association of American Geographers* 48: 4, 319–351.

Stell J (ed) 2003. Worldwide refining survey. *Oil & Gas Journal*, 1–41, 22 December.

Stopford M 1997. *Maritime Economics*. Routledge, London.

Surgutneftegaz 2009. General information. <*www.surgutneftegaz.ru/en/oil/about/*> 12.4.2010.

Tykkyläinen M 2003. North-west Russia as a gateway in Russian energy geopolitics. *Fennia* 181: 2, 145–177.

UN Comtrade 2004. United Nations Commodity Statistics Database, SITC 333 and 334, New York. <*http://comtrade.un.org.ezproxy.ub.gu.se*> 12.4.2010.

Verlaque Ch 1975. *Géographie des transports maritimes*. Doin, Paris.

Wijnolst N, Peters C & Liebman P (eds) 1993. *European Shortsea Shipping*. LLP, London.

Woodhouse Z (ed) 2004. *Tanker Book*. E.A. Gibson Shipbrokers, London.

Worldscale 2004. *New Worldwide Tanker Nominal Freight Scale*. Worldscale Association (London)Ltd & Worldscale Association (NYC) Inc.

Appendix 1. LMIU Handysize Movement File, 2004.

A large volume of mineral oil product ("clean") shipments are made by Handysize vessels of 15,000–59,999 dwt. When the question is sharpened to a percentage, only guesstimates can be given. *Lloyd's Marine Intelligence Unit* gives a fairly reliable estimate of the "Large" vessel classes, 60,000 dwt and over. In addition, it has compiled a semi-administered file of the Handysize class (LMIU Handy Movement Data 2004). About the classes below 15,000 dwt nothing is available worldwide, and it is unlikely that they will be covered by a global census in the near future. Yet, in the Neste Oil database these classes make two-thirds of export legs and one-third of tonnage (Table 6).

The best that can be done currently is to make use of the Handysize data. Its semi-administered state means many things. A line in the data file aggregates 1 to 95 individual "transits" ("legs"/"trips" in this author's terminology). Analysis of individual legs is thereby ruled out. The emphasis is on ocean traffic and legs from/to/within Great Lakes are also excluded here. Remain 49,200 legs. Liquid cargoes other than mineral oil products are included, such as liquid ammonia and vegetable oils. Ready examples are 100 legs from Ambes, Garonne estuary, and 157 legs from Pasir Gudang, Johore Strait. Such loading ports should be excluded here, case by case, but the workload becomes prohibitive. One goes the other way. Since mineral oil products originate from corresponding refineries, the seaboard (port) refineries identify important origins with a total of 26,600 legs. One half of them are guesstimated to be cargo legs. Following the same reasoning, 1,400 relevant cargo legs originate from the ports of the former Soviet Union. These ports seldom have refineries that are found far inland at major oil fields and consumption centers. Distances of 1,000–2,000 km by pipeline or rail are quite usual. Return legs from foreign refinery destinations to these export ports are 1,300, roughly in balance with calculatory cargo legs.

The small size of some port refineries, below 50 bbl/d, may raise doubts about their true export capacity. They are given the benefit of the doubt and retained, a total of 2,000 cargo legs. For example, Amsterdam has only a 10 bb/d refinery but is connected by pipeline with Rotterdam's refineries and handles a large share of its exports (Charlier 1996: 310–311). Because the cargo status of individual leg strings is not known, multiporting cannot be identified. Multiporting raises the number of port visits 16%–17% in the larger "clean" size classes and the "dirty" tanker segment and should also apply here. The corresponding discount reduces the number of calculatory mineral oil product legs to 12,300.

A factor of unknown magnitude are cargoes swapped between refinery ports, be it for quality difference or company affiliation. They, naturally, are very real ones but complicate the cargo/ballast split. They are identified best by asking cargo owners directly during data collection. Observations based on vessel draught are unreliable because pipelines connect refineries and tank farms into vast networks.

All legs	49,166
From seaboard refinery ports	26,568
Cargo from seaboard refineries, 50%	13,284
From former Soviet ports	2,796
Cargo from former Soviet ports, 50%	1,398
All cargo	14,682
Discount for multiporting, 17%	–2,496
Oil product legs, 244 per week	12,186
Fixtures	3,383
Ratio	3.60

Note: Figures rounded.

The cargo legs are tabulated within the 11-region mesh and the cell elements divided by 50 to arrive at average full week cargo flows between the regions. The Ratio Legs/Fixtures is compared with clean and dirty vessel classes of 60,000 dwt and above (Table 1). Compatibility is acceptable.

This is how things look at the global level. But it is a good policy to also have a look at the national level when there is an opportunity to do so. Finland is a good example, due to the availability of Neste Oil's export statistics and the author's familiarity with local conditions. The LMIU Handy Movement Data (2004) transits are disaggregated as follows. "Refinery" means a refinery location rather than a company or plant.

	From domestic	Refinery		Other		Total
		All	Oil	All	Oil	Oil
To	foreign refinery	40	40	5	0	40
	foreign other	43	43	42	0	43
	domestic refinery	25	13	22	0	13
	domestic other	19	10	20	10	20
Total	127	**106**	89	**10**	**116**	
	less 50%, remains	63.5		44.5		
	less 17%, remains	53		37		90
Difference						26

Notes: Estimates underlined in the body of table subject to discussion. Direct total estimates in **bold**. Strictly calculatory total estimate in normal text. Shipments from foreign refineries handled in the context of appropriate countries.

"Refinery" is the source of most oil product cargoes. The two first elements 40 + 43 correspond formally to Neste Oil's export cargoes in the Handysize class (Table 6). But Neste's own figure is 138. The difference originates from Bremen (44) and Kalundborg (11) where the vessels were very close to the 15,000 dwt limit used by LMIU. Since the conversion factor from mt to dwt is an approximation, the result falls easily within the measurement error. Therefore, both counts are used in parallel as seems fit (Table 6). Transits between the refineries, 25 legs, are inventory balancing or swaps of intermediates and the share of cargo legs can vary within 50%–100%. The smallest possibility is adopted here. The remaining 19 legs are deliveries to coastal depots, own or customers'. The corresponding 22 ballast legs are in the "Other" column on the way to "domestic refinery." The 20 "domestic other" originate from companies other than Neste and have some ballasting matches between port pairs. They need not be oil cargoes at all, but if they are, trader activity is again a possibility.

The grand total of 116 cargo legs is thus 26 legs larger than the calculatory total estimate of 90. The calculatory route can be used in a global discussion. A national discussion is preferably based on direct observation.

Appendix 2. Clean tanker cargo legs – 11-region mesh, 2004.

Handysize	1	2	3	4	5	6	7	8	9	10	11	Tot
1	1,736	24	201	8	4	3	52	2	44	24		2,099
2	43	378	16	2	14	5	10	1	3	20		493
3	274	16	4,766	66	6	32	20	2	12	1		5,196
4	4	6	14	50	2	5						81
5	1	5	4	9	101	46	19					185
6	19	1	90	6	40	879	118	1	1			1,155
7	6	5	40		9	159	1,843	102	45	5	10	2,224
8		1			2	2	25	130			3	163
9	40	1	2				44		380	12	5	485
10	19	5					2		21	41		88
11							7	1	5		4	16
Tot	2,143	443	5,133	141	177	1,132	2,141	240	513	103	22	12,186

Panamax	1	2	3	4	5	6	7	8	9	10	11	Tot
1	10	1	3						1			15
2					1							1
3	57	8	34		1	3	2		2			107
4					1							1
5												0
6	7		48	1	5	122	143	4	2			332
7						6	28	2	4			40
8	2											2
9												0
10												0
11												0
Tot	76	9	85	1	8	131	173	6	9	0	0	498

Aframax	1	2	3	4	5	6	7	8	9	10	11	Tot
1	3	1							1			5
2												0
3	48	2	59		1	2	6			5		123
4												0
5												0
6	13	2	58	2	1	25	334					435
7				1		3	17					21
8							2					2
9												0
10												0
11												0
Tot	64	5	117	3	2	30	359	0	1	5	0	586

Suezmax	3 to 3	1	6 to 7	14	7 to 7	1

Note: Roundings possible.
Sources: LMIU Handy Movement Data (2004); LMIU Large Movement Data (2004).