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SPECIAL ISSUES IN CARBON/ENERGY TAXATION: MARINE BUNKER FUEL CHARGES

Annex I Expert Group on the United Nations Framework Convention on Climate Change

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FOREWORD

This Working Paper is one of a series of eighteen studies carried out under the project: "Policies and Measures for Possible Common Action". The project was carried out by the OECD, together with the International Energy Agency, in 1996 and 1997 for the Annex I Expert Group on the United Nations Framework Convention on Climate Change (UNFCCC). The goal of the project was to assess a range of cost-effective greenhouse gas mitigation policies and measures for countries and Parties listed in Annex I to the UNFCCC. The eighteen working papers have been made widely available as analytical input to negotiations under the UNFCCC Ad hoc Group on the Berlin Mandate. The working papers may also provide input to national decision making processes on greenhouse gas mitigation policies. The measures analysed do not necessarily represent policy preferences of Annex I Parties.

The project benefited greatly from substantial input from delegates. Three successive chairmen of the Annex I Expert Group provided outstanding leadership for the project: Doug Russell (Canada); Ross Glasgow (Canada); and Ian Pickard (United Kingdom). The work was supervised by Jan Corfee Morlot (OECD). Fiona Mullins (OECD) drafted the initial framework which was used to structure the eighteen working papers.

The Annex I Parties or countries referred to in this document refer to those listed in Annex I to the UNFCCC: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Czechoslovakia (now Czech Republic and Slovakia), Denmark, the European Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States. Where this document refers to "countries" or "governments" it is also intended to include "regional economic organisations," if appropriate.

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EXECUTIVE SUMMARY

Context

Marine bunker fuel combustion in 1990 was responsible globally for approximately 370 million tonnes of CO_2 emissions (102 million tonnes of carbon), rising to 400 million tonnes of CO_2 (109 million tonnes of carbon) in 1994.

Bulk carriers (mainly carrying oil, iron ore, bauxite, coal and grain) account for about three quarters of maritime freight traffic, but only a quarter of maritime transport energy use. Most of the rest of the energy is used by container ships, Ro-Ro[1] ferries and general cargo ships. This study does not attempt to examine military fuel use; military bunkers are not included in international bunkers in the IPCC inventory guidelines.

Bunker demand in 1994, at 130.5 million tonnes, was 50 per cent higher than in 1983, when demand reached its low point during the period of high oil prices (1974-1985). Much of the increase came from a growth in container, Ro-Ro and other general freight traffic. Annex I countries accounted for the sale of about 60 per cent of bunker fuel sales in 1994.

Despite recent rapid growth, maritime transport remains responsible for only 7 per cent of global transport sector CO_2 emissions, or about 2 per cent of global CO_2 emissions from fossil fuel use (see Figure 1a). Shipping is also the most energy-efficient means of freight transport. Air freight, the only alternative for inter-continental and much international trade, has a CO_2 intensity two orders-of-magnitude higher than that of maritime freight (see Figure 1b: note logarithmic scale).

Figure 1a. Share of World Transport CO2 Emissions

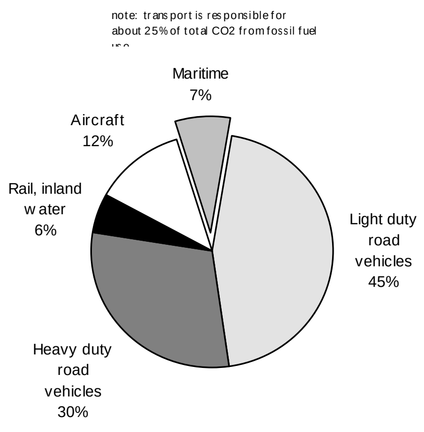
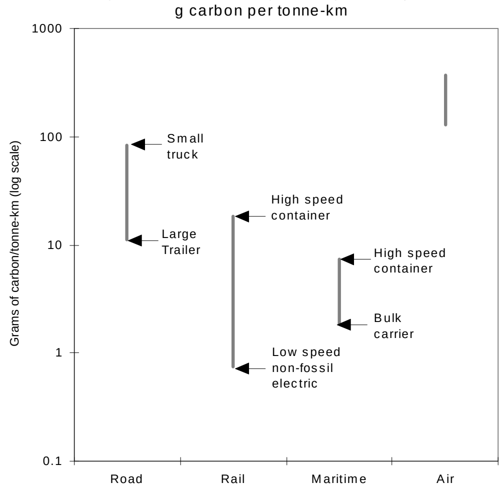


Figure 1b. CO2 Intensity of Freight Transport
g carbon per tonne-km



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[1] Roll-on; roll-off. Ro-Ro ferries carry cars and trucks, normally over relatively short distances. They account for a very small share of total maritime freight transport but have a high energy intensity.

Description of Measures and their Policy Objectives

As a special issue related to the consideration of carbon and energy taxes, this paper considers carbon charges on maritime transport fuels, aiming to reduce greenhouse gas emissions from international maritime transport. The main rationale for such carbon charges would be to internalise the social costs of climate change resulting from CO_2 emissions from maritime transport. However, a carbon charge on bunker fuel would only be feasible, fair, and economically efficient in a context where such a charge is globally imposed, and where other transport modes pay their full social costs.

There are many ways in which a bunker charge could be implemented. The level of a charge might fall anywhere in a wide range. Charge levels of $5, $25 and $125 per tonne of carbon have been investigated. These represent about 5 per cent, 25 per cent and 125 per cent of the price for residual fuel oil (at $90/tonne), and 3 per cent, 15 per cent and 75 per cent of marine diesel fuel prices (at $150/tonne). Various methods of collection are possible (e.g. based on sales of fuel from bunkers to ships, sales from oil companies to bunker dealers, fuel out of the refinery gate) which might influence the ease of implementation, potential for avoidance, and hence greenhouse gas impacts of the measure.

Alternative Measures for Greenhouse Gas Mitigation

The study briefly mentions a number of alternative measures which might be a more feasible means of greenhouse gas mitigation in international maritime transport. These measures include the use of alternative charges and fees (such as port fees related to ship energy efficiency); regulations on ship technology; voluntary agreements with ship-builders and operators; best practice programmes; technology prizes; and supports for research, development and demonstration of energy-efficient ship technology.

Approach and Methodology

The study considers: the potential impact of a marine bunker charge on maritime CO_2 emissions; the direct and wider economic costs that might be associated with the charge; the other policy issues associated with bunker charges, including trade, employment and competition; issues that need to be considered in the implementation of any charge; the rationale for common action to implement a charge; and the possible approaches that Annex I countries might take to implement a bunker charge in common.

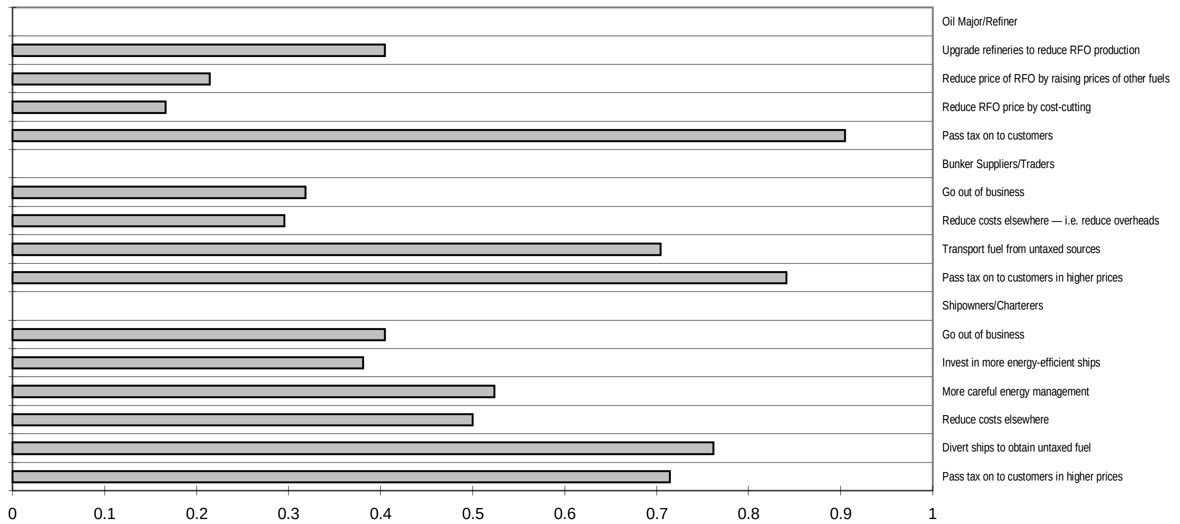
Background information on the characteristics of maritime transport is based on a review of the literature, discussions with maritime industry experts and comments from reviewers of the study. No existing quantitative analysis has been identified on the impact of bunker prices on maritime transport greenhouse gas emissions. It is extremely difficult to discern the effects of bunker prices on maritime traffic using historical data: bunker prices are closely correlated with crude oil prices, which affect countries' terms of trade. Additional qualitative insights were sought through a questionnaire sent to a large number of firms, including ship owners and operators, bunker traders and suppliers, and oil companies. The extended outline of the study was also widely circulated in the industry, with the aim of obtaining additional comments, although few were submitted.

Greenhouse Gas Reduction Potential, Costs and Timing, Rationale for Common Action

The OECD Secretariat distributed a questionnaire through an industry newsletter to survey their contacts in the three industry areas identified in Figure 2. This questionnaire asks how likely they consider each of the effects to be for each of three levels of charge ($5, $25 and $125 per tonne of carbon). While the results have no statistical significance, they provide some perspective on possible industry attitudes to a bunker charge. It is perhaps most interesting to note that, whereas respondents from all three industry areas anticipated that the most likely action of oil companies and bunker suppliers would be to pass the charge on to their customers, shipowners and charterers generally did not think that they would be able to pass the charge on by increasing their shipping rates. If this were true, shipowners would bear most of the cost of any charge.

Figure 1. Expected Responses to a $25/tC Charge on Bunker Fuel

Based on a Questionnaire Survey (Mean of 22 respondents to date of which 13 bunker suppliers, 6 shipowners and 3 oil companies) 1=very likely to occur; 0=not very likely



It is not possible to separate the historical effect of bunker prices on maritime freight traffic from the broader effects of crude oil prices on international trade. Thus, the effects of a bunker fuel charge on traffic cannot be estimated, although they would be expected to be small unless the bunker charge formed part of a wider carbon tax. Bulk freight traffic, apart from crude oil and coal, has not been affected by oil price changes except in the short term following sudden, large price rises. This may be due to a lack of alternatives for the buyers and sellers of bulk commodities. Non-bulk freight traffic has been reduced by oil price increases and this may reflect more flexibility in markets for manufactured and agricultural goods, although it may be an effect of changes in international terms of trade rather than a response to bunker prices. Crude oil traffic is strongly affected by the oil price: high oil prices in the 1970s and 1980s both reduced the demand for oil and resulted in its being produced closer to the main markets, resulting in a halving of traffic in ton-miles.

For the majority of international trade, there is no real alternative to maritime transport. However, high-value and time-sensitive consignments are increasingly shipped by air, and road and rail are serious alternatives for some international freight currently moved by sea. It is possible that a bunker charge, if not matched by fuel price increases for other transport modes, could reduce the price advantage of maritime transport relative to those modes. If a bunker charge were to lead to a decrease in the share of freight carried by sea and an increase in road and air transport, this might result in increased CO_2 emissions.

Energy intensity in shipping has been affected by the oil price, along with other factors including the rate of new-building and the level of over-capacity in the industry. A large number of orders placed in the 1960s, as well as high prices in the 1970s and 1980s, accelerated efficiency improvements in engines. Subsequent overcapacity in the 1980s led to changes in operational practices, including reduced ship speeds. Over the last ten years, with lower oil prices and the elimination of overcapacity, energy intensity reductions have been small. However, opportunities do remain for reducing the energy intensity of maritime transport. Some, such as improved propeller maintenance and the use of antifouling hull paint, may be cost-effective in their own right and offer a few per cent (<10 per cent) energy savings. Technological developments in new ships, such as improved hull forms, engine technologies and propeller designs, may also offer small energy savings compared to the existing fleet, but the current maritime freight market does not favour early fleet replacement. Greater energy savings might be achieved by designing ships for lower speeds, but again, this would run counter to current market pressures. In the very long term, greenhouse gas mitigation may be achieved through changes in the source of energy for maritime transport. Nuclear power and a variety of alternative fuels have been used in ships in the past, although they are not economic for new ships at current fuel prices.

A bunker charge might cause significant economic costs in many countries, especially a) those competing in markets for agricultural and manufactured goods and relying on maritime transport for a large share of their exports and b) those exporting raw materials. A bunker charge might also be economically damaging for countries heavily dependent on imports for manufactured and agricultural goods. The United States, Netherlands and Japan account for most of Annex I country bunker sales, but would not be likely to feel most of the negative impacts of a charge, which would be mostly passed on to customers in higher bunker prices. It is possible that revenue recycling could offset some of the negative economic impacts of the charge, but an evaluation has not been possible for the current study.

A bunker charge could be evaded easily by bunker suppliers and ship operators, unless it were globally implemented as part of a general carbon tax. Offshore refuelling is already normal practice, making it a simple matter to bring fuel from any untaxed source. Bunker charges in excess of $10-20 per tonne of fuel would provide an incentive for widespread evasion, provided sufficient untaxed fuel existed, and would possibly result in a net increase in greenhouse gas emissions. Alternative measures focused on technical improvements (best practice programmes, research and development, funding, etc.) could reduce greenhouse gas emissions without risk of evasion. Such measures would be much less dependent on common action, although technology effects are likely to depend on incentives being applied in several countries.

Implementation Issues

There are clearly major political barriers to implementing a bunker fuel charge. These mostly relate to the potential effects of a charge on international trade. Because of these effects, many implementation details would need to be carefully discussed and agreed. Even if a charge only involved a small number of countries, it would be important for them to negotiate a range of issues with non-participating states. Any Annex I country initiative would need to be negotiated in a wider international framework including developing countries. Discussion would need to address issues such as the point of application of the charge, the question of which governments would be responsible for collecting and disbursing the proceeds of the charge, and the question of transfers of charge revenues among countries.

The International Maritime Organisation (IMO) has pre-eminent competence in the fields of maritime safety and protection of the marine environment. IMO Member states are currently discussing Annex VI of the MARPOL convention, providing a regulatory framework for the prevention of air pollution from ships. The new Annex would address a variety of pollutants including ozone depleting substances, VOCs, NO_x and SO_x. Negotiation to implement any bunker charge would need to be carried out with the co-operation or under the auspices of the IMO.

The World Trade Organisation would also need to play an important role, given the trade implications of a bunker charge, including the likely different impacts on bulk and non-bulk traffic and other effects on trade competitiveness. The complex economic and political issues involved in the implementation of a bunker charge, and the large number of countries that would need to be involved, would be likely to make the negotiation process very lengthy, perhaps taking several years. Meanwhile, the charge would not necessarily lead to significant net greenhouse gas emission reductions (due to the likelihood of avoidance strategies and modal shifts).

Conclusions

A carbon charge on bunker fuel could internalise social costs resulting from CO_2 emissions from maritime transport, but would only be feasible, fair, and economically efficient if globally imposed and if all other transport modes also paid their full social costs. However, a bunker fuel charge would not necessarily lead to significant net greenhouse gas emission reductions, mainly due to the likelihood of avoidance strategies and modal shifts. Such a charge could also have significant negative impacts on international trade, and would therefore need to be carefully negotiated on a multilateral basis.

Several types of common action are possible:

- **Replication of Successful Measures.** This approach is not likely to be relevant for a bunker fuel charge, although it might be for other measures briefly mentioned in the study, such as technology prizes, best practice programmes for ship operators, voluntary agreements with shipbuilders, and port fees or other measures related to the environmental performance of ships.
- **Agreement to Take Action in the Transport Sector Toward an Aim or Target.** Countries might agree explicitly to take effective action, with the objective of reducing bunker emissions. Countries might further agree on a method for allocating national responsibility for bunker emissions, bringing them into the scope of existing commitments under the UNFCCC to introduce and report on measures to mitigate national greenhouse gas emissions.
- **Co-ordination to Implement the Same or Similar Measures.** This type of common action, with all countries applying charges at similar levels but without full harmonisation, might avoid some of the distorting effects and enforcement difficulties identified for non-uniform charges. However, the approach is more appropriate for some of the alternative measures mentioned in the study, such as the application of port fees linked to ship energy efficiency, charges on "embedded carbon" in imports, etc.
- **Specific Policies and Measures Implemented Together.** All countries or some group of countries might agree to introduce a measure, such as a bunker fuel charge, at a harmonised level at the same time.

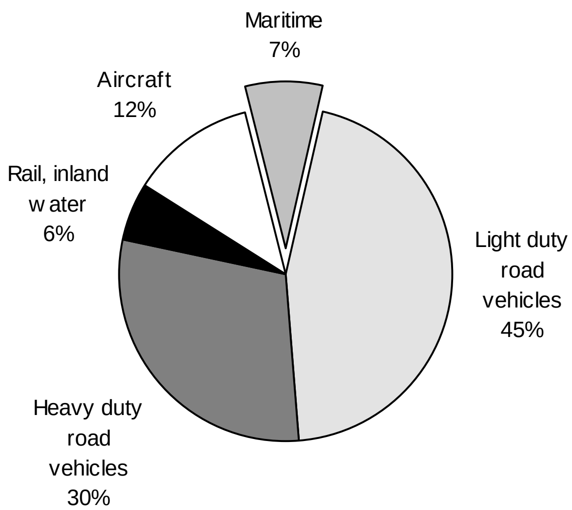
Any approach to reducing greenhouse gas emissions from marine bunker use might be influenced by the decision taken by SBSTA and the UNFCCC Conference of the Parties on bunker allocation. Allocation to individual countries is not a prerequisite for greenhouse gas mitigation in this sector. However, if bunker emissions remain unallocated, or are allocated to an international category, mitigation is more likely to depend on common action.

CONTEXT

Bunker Fuel and CO_2 Emissions

Marine bunker[2] demand in 1990 was 122 million tonnes, growing to 130.5 million tonnes by 1994 (IEA statistics). Combustion of this fuel was responsible globally for approximately 370 million tonnes of CO_2 emissions (102 million tonnes of carbon) in 1990, rising to 400 million tonnes of CO_2 (109 million tonnes of carbon) in 1994. As Figure 0 shows, maritime transport accounted for 7 per cent of world transport CO_2 emissions in 1990, or about 2 per cent of overall CO_2 emissions from fossil fuel combustion. Estimates of CO_2 emissions from international marine bunkers in national greenhouse gas inventories submitted to the UNFCCC COP vary substantially among countries as a share of national CO_2 emissions, from less than 1 per cent for the United States to 24 per cent for the Netherlands. Many countries did not report emissions in this category.

Figure 2. Share of World Transport CO_2 Emissions



Note: The transport sector accounts for 25 per cent of total CO_2 emissions from fossil fuel use.

[2] To avoid confusion: although originally the word “bunker” referred to the hold in which coal was kept on board ships, it now refers to the fuel used by ships. Thus, ships consume bunkers. “Bunker” is even a verb. A bunker supplier can “bunker” a ship. A ship can also call at a port to “bunker”.

Residual fuel oil accounts for 80 per cent of marine bunker consumption while gas-oil is used for some smaller vessels and on large vessels to run auxiliary motors, and also to run the main ship engines in and near port to ensure reliability in maneuvering (IEA Statistics; Wright, 1996).

Annex I countries accounted for 60 per cent of total bunker fuel sales in 1994, little changed from 1971, although the pattern of sales has shifted away from Europe and Japan towards the United States. A few countries account for the majority of Annex I country bunker fuel sales. The United States is the largest, supplying nearly a fifth of world demand, followed by the Netherlands, Japan, Greece, Belgium and Spain. Outside the Annex I group the largest suppliers are Singapore, the United Arab Emirates and South Korea, with Brazil, Panama and South Africa acting as major regional suppliers.

As Figure 0 shows, world bunker demand has grown rapidly since its low point in 1983, at just over 3.5 per cent per year to 1992 with a slight reduction in 1993. Demand is now at about the level of the early 1970s.

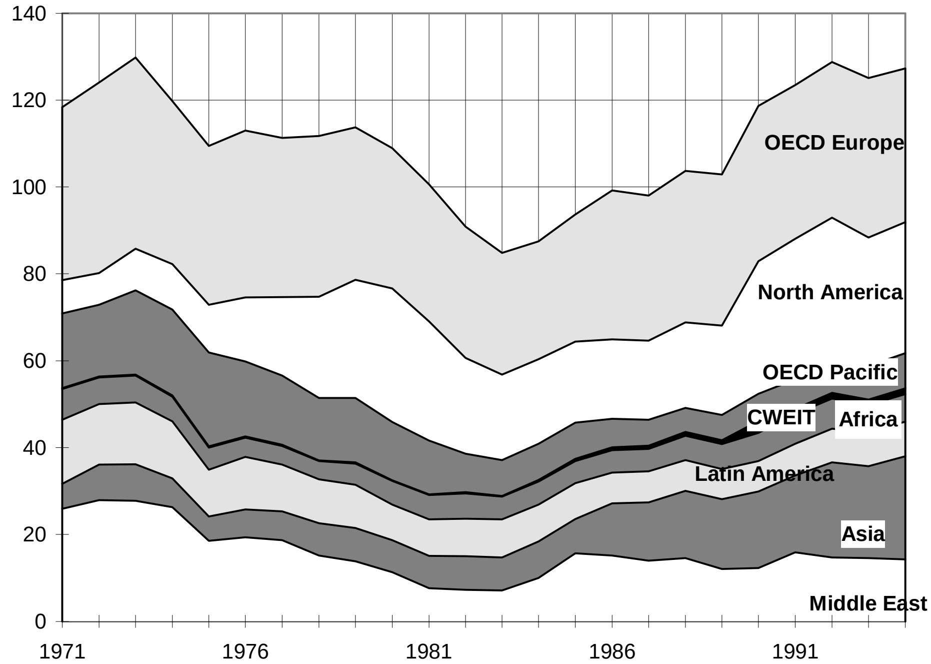


Figure 3. World Sales of Marine Bunker Fuel (million tonnes)

Source: IEA Statistics

Other Emissions from Shipping

While CO_2 is the main greenhouse gas emitted by ships, bunker fuel contains large amounts of sulphur (commonly in the range 3-4 per cent) and result in 7.5-11.5 million tonnes per year of sulphur dioxide emissions. This is about 7 per cent of sulphur emissions from all sectors (Oftedal *et al.*, 1996). Ships also emit about 9.3 million tonnes per year of NO_x (11-12 per cent of the world total from fossil fuel sources). Other gases from ships are probably less significant as greenhouse gass or greenhouse gas precursors, but include about 1.5 million tonnes per year of VOC emissions (Oftedal *et al.*, 1996).

Projections of Traffic, Energy Intensity and Greenhouse Gas

Projections generally indicate a continuation of the growth trend in bunker demand. The IEA world energy model estimates bunker demand based on GDP and oil demand. Many national energy models appear to be similarly formulated.

Australian greenhouse gas projections (BTCE, 1995) include a detailed discussion of marine freight and bunker demand. These indicate 0.7 per cent annual growth in CO_2 emissions to 2015 for fuels lifted in Australia. UNFCCC document UNFCCC/SBSTA/1996/9/Add.1 notes projections of marine traffic in the region of 1-2 per cent annual growth, with no expected reduction in energy intensity, leading to 1-2 per cent annual CO_2 emission growth. Wright (1996) quotes "some commentators" as expecting world trade to grow at 4 per cent per year with 70 per cent growth in seaborne trade in the next decade.

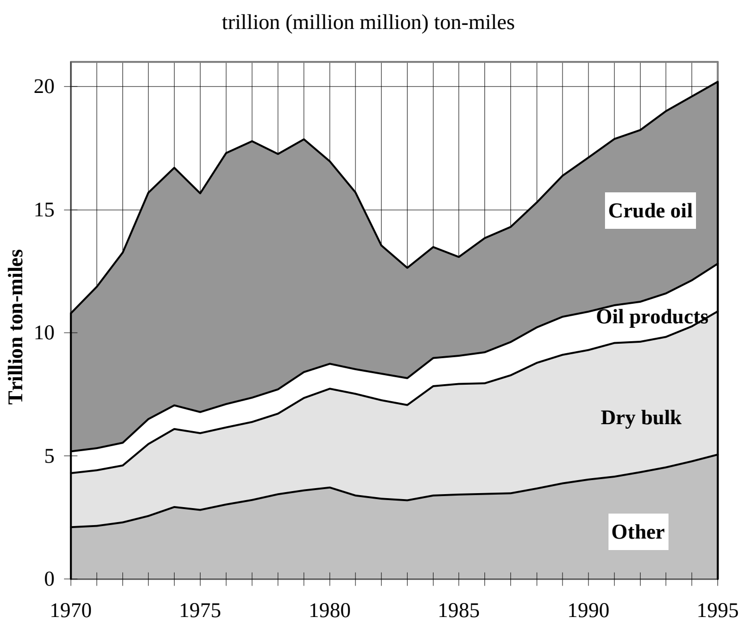
In conclusion, there is great uncertainty in future growth rates of world marine bunker demand, with literature estimates ranging from 1 per cent to 4 per cent per year to 2020. Reviewers' comments on the first draft of this paper indicate that industry projections of growth in shipping to 2005 range from 1 to 2 per cent per year.

Maritime Traffic and Fleets

Historical developments in bunker demand reflect the development in maritime freight traffic (Figure 0). No statistics are available on the breakdown of energy use by different types of vessel. Cargo-carrying vessels account for about 95 per cent of the gross tonnage of the global merchant fleet and are assumed in this report to be responsible for the majority of international marine bunker demand.

Most of the dip in maritime freight in the 1980s can be ascribed to the halving of oil shipments from the Middle East between 1979 and 1985 following the second oil price rise. Traffic in other goods fell in 1975 and again in 1981-1983. These drops can be explained largely by the effects of the oil price rises on the world economy, including recessions and changes in trade flows.

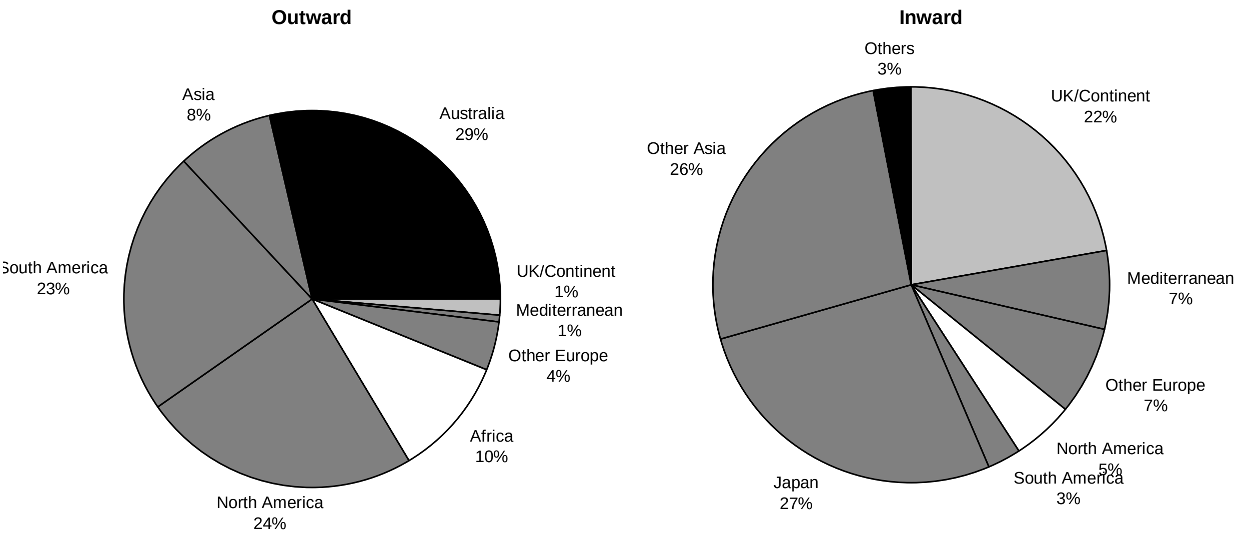
Figure 4. World Maritime Freight Traffic, 1970-1995



Source: Fearnleys

The majority of the world's bulk shipments either start or finish their journey in an Annex I country (see Figure 0: only 16 per cent of tons shipped in bulk carriers begin and end their journey in non-Annex I countries.

Figure5. Origin and Destination of World Bulk Shipments, 1994
Percentages by tons shipped.



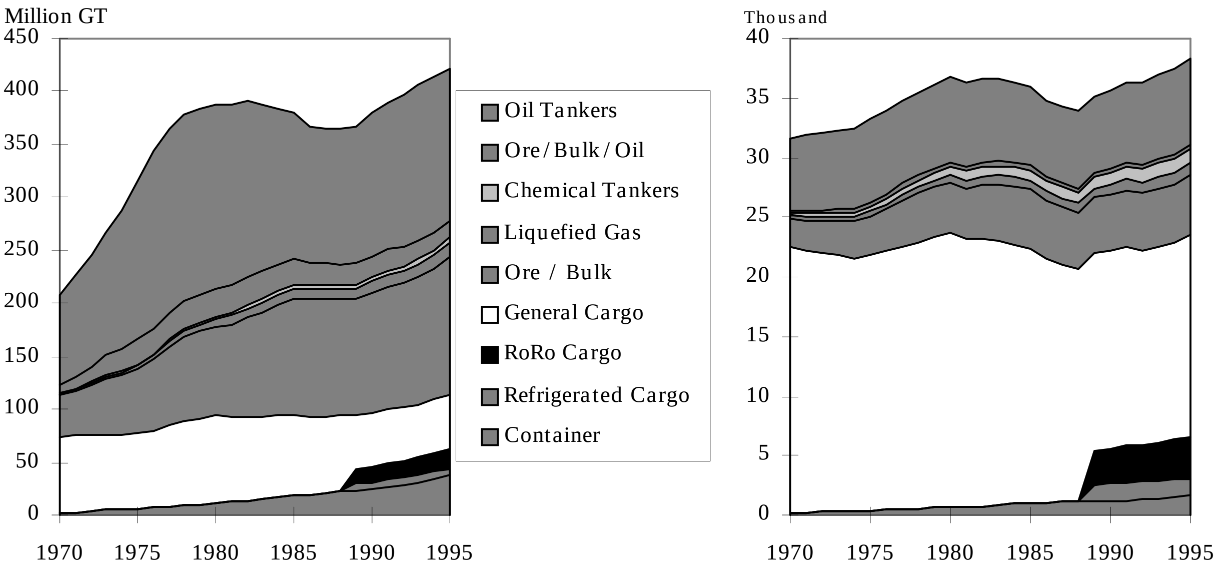
Source: OECD, 1996 quoting Fearnleys
Note: ships over 50,000 DWT[3] only: these account for under a third of bunker consumption.

As Figure 0 shows, the gross tonnage (a shipping industry measure of the overall weight of the ships) in the world shipping fleet has grown over the last 25 years in line with energy use. However, the number of cargo ships has hardly changed, reflecting a shift towards larger vessels. The large variation in oil tanker gross tonnage, but not in the number of tankers, is also evident. The fastest growth since 1990 has been in gross tonnage of Ro-Ro[4] cargo vessels and container vessels. These ships operate at high speeds, resulting in high energy intensity, and are intensively used. Their share of energy consumption is therefore much higher than their share of gross tonnage.

[3] Deadweight tonnes. See glossary for definitions of deadweight tonnage and gross tonnage.

[4] See glossary for definition.

Figure 6. World Cargo Fleet: Gross Tonnage[5] and Number of Vessels by Vessel Type

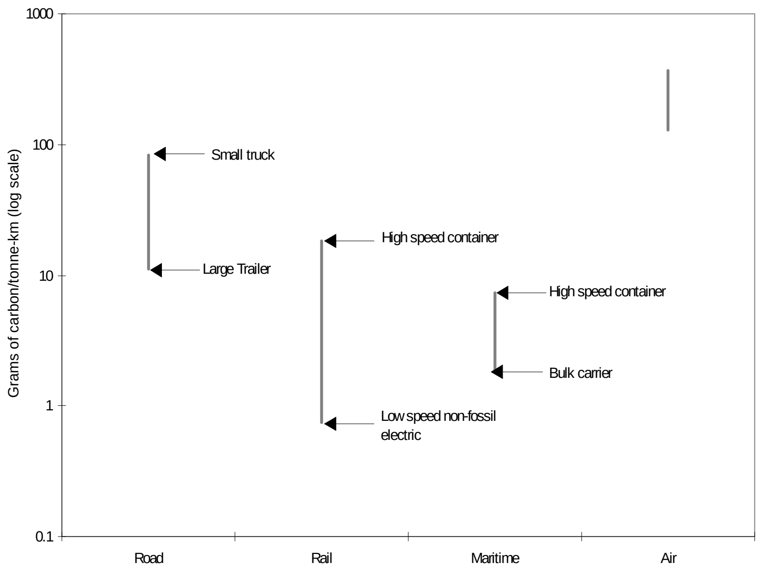


Source: Lloyds
Note: Ro-Ro and refrigerated cargo vessels were not recorded separately from other general cargo vessels until 1989.

Trends in Energy Intensity

Shipping is the most energy-efficient means of freight transport with the exception of rail transport powered by non-fossil fuel based electricity. Air freight, the only alternative for inter-continental and much international trade, has a CO_2 intensity two orders-of-magnitude higher than that of maritime freight (see Figure 0: note logarithmic scale).

Figure 7. Energy Intensity of Freight Transport Modes



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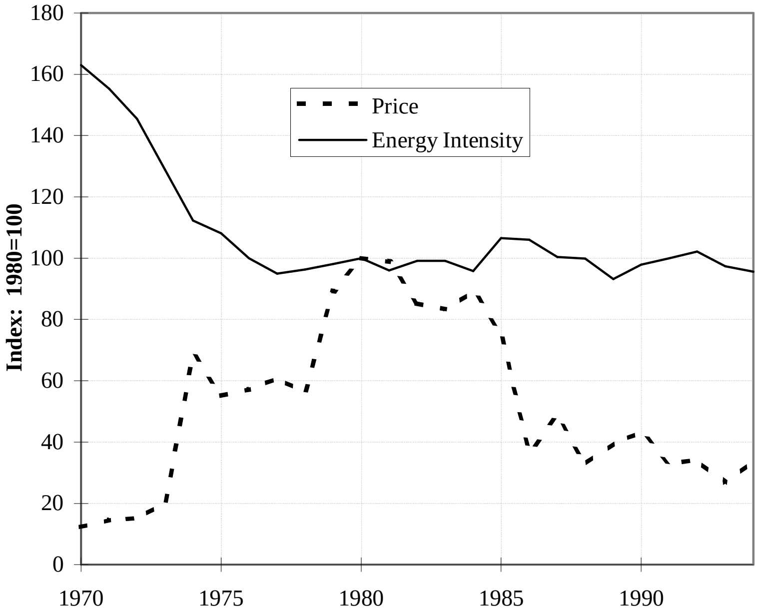
[5] See glossary for definition.

There is no sign of a downward (or upward) trend in the energy intensity of global maritime transport. As Figure 0 shows, there was a significant reduction up to about 1977, but since then, aggregate energy intensity has been more or less stable. The reduction through the 1970s can mostly be ascribed to a surge in orders of diesel powered vessels in the 1960s. These vessels replaced less efficient, steam turbine-powered vessels, although there were also some orders of large, steam-turbine powered tankers. Steam turbines give an energy efficiency rating in service of about 30 per cent, compared with 45 per cent for large, slow-speed, two-stroke diesel engines[6]. Over 98 per cent of the world's fleet is now diesel-powered, although the 2 per cent of steam-powered vessels account for about 17 per cent of the gross tonnage as they are typically tankers, bulk carriers and container ships (Lloyds, 1996). On current trends, most of these vessels will be replaced by diesel-powered ships in the next 10 years.

Figure 8. Indices of Energy Intensity of Global Shipping and Residual Fuel Oil Price



Energy intensity index is calculated by dividing total bunker fuel use (tonnes; from IEA statistics) by total freight movements (ton-miles; from Fearnleys. Residual fuel oil price from IEA Statistics. Note that bunker fuel use includes consumption for non-cargo-carrying purposes.

There has been a recent resurgence of interest in the possible use of gas turbine engines for use in high speed ferries and passenger ships. They have advantages for these applications of high power-to-weight ratios and low noise and vibration. Such engines would lead to an increase in energy intensity, and would need to be operated on middle distillate fuels.

The aggregate data do not indicate any reduction in energy intensity following higher fuel prices in the late 1970s and early 1980s. These data may hide energy efficiency improvements within individual classes of vessel which have been offset by a shift in the balance among classes.

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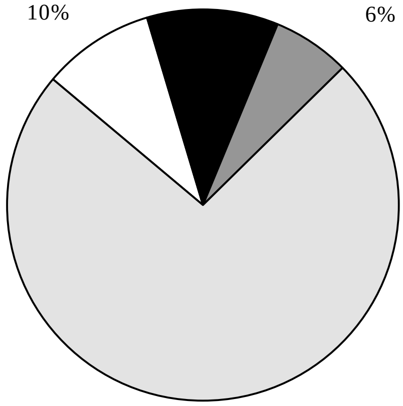
6 Slow speed (80-140 rpm) marine diesel engines are designed to operate on heavy fuel oils. These engines have 4-12 cylinders with 26-98 cm bore, generating up to 5.7 MW per cylinder. They can achieve efficiencies as high as 50 per cent in test-bed conditions. Medium speed (400 rpm) diesel engines, operating on gasoil, are also used to propel smaller ships and to generate electric power. Medium speed diesel engines can have up to 20 cylinders generating a maximum of 2 MW per cylinder. Vessels under 1000 Gt tend to use high speed diesel engines similar to those used in road vehicles.

As Figure 0 shows, energy use by world shipping is dominated by high energy-intensity non-bulk traffic, which includes container and Ro-Ro vessels, as well as non-cargo vessels.

Figure 9. Approximate Breakdown of Energy Use in World Shipping, 1995



Freight categories do not correspond exactly to classes of ship in Figure 0. Crude oil is assumed to be carried in oil tankers, oil products in more energy intensive ships characteristic of chemical tankers, and dry bulk in bulk carriers. "Non-bulk/non-cargo" includes all other uses of marine bunker fuel, including container ships, Ro-Ro and refrigerated vessels, general cargo ships, passenger ships, fishing and military vessels and other miscellaneous uses. Breakdown is author's estimate based on the fleet size distribution, load factor and energy intensity data in each vessel class from Lloyds and traffic data in the classes shown here from Fearnleys: individual shares have at least ±20 per cent uncertainty[7].

Other Trends Affecting Energy Intensity

In addition to technological developments in ship design and propulsion, energy intensity has been improved in the past by operational changes. These include the increased use of information technology — for example, the general introduction of GPS (global positioning by satellite), and the use of computers to optimise routing and scheduling.

Slow steaming is reported to have been common during the early 1980s, resulting in energy intensity reductions in the region of 10-20 per cent (e.g. Oftedal *et al*., 1996). This practice was motivated partly by high oil prices and partly by over-capacity in the industry. More recently, market pressures, in

7 Average energy intensities for dry bulk and liquid bulk carriers have been estimated based on data for over 200 new vessels delivered in 1995, supplied by Lloyds Register. These data were used to plot the relationship between vessel size and energy intensity. The fleet (old and new) mean size (averaged over tonnage rather than over the number of ships in each size group) was calculated. The energy intensity of the fleet was then estimated as the energy intensity of new vessels at the mean vessel size, plus 10 per cent. Given the low rate of energy intensity reduction over the period from 1975, this is likely to result in a slight overestimate. The effective cargo load factor was taken to be 50 per cent. On this basis it was estimated that the energy intensity of dry bulk transport is 0.05 MJ/tkm, that of crude oil transport is 0.045 MJ/tkm and that of oil products is 0.1 MJ/tkm. For comparison, R. Nielsen estimates the breakdown of maritime energy use as: oil tankers: 15 per cent; dry bulk: 8 per cent; general cargo and non-cargo: 77 per cent.

particular, the high cost of capital for new vessels and relatively low oil prices, tend to encourage the use of higher speeds, resulting in higher energy intensities (to include ref.).

Other trends have tended to increase energy intensity. These include

- the move towards "just in time" manufacturing, involving more frequent transportation of small quantities of intermediate goods

- market liberalisation which has tended to lead to a transfer of production to regions where wages or other costs are lower — again, this leads to increased transportation of intermediate and finished goods with higher energy intensity than raw materials

- the introduction of ultra-high speed ships (the higher energy use by these ships is not yet visible in the statistics).

POLICY OBJECTIVES

As a special issue related to the consideration of carbon and energy taxes, this paper considers carbon charges on maritime transport fuels, aiming to reduce greenhouse gas emissions from international maritime transport. The main rationale for such carbon charges would be to internalise the social costs of climate change resulting from CO_2 emissions from maritime transport. However, a carbon charge on bunker fuel may only be feasible, fair and economically efficient in a context where such a charge is globally imposed, and where other transport modes pay their full social costs.

A carbon charge on bunker fuels might reduce bunker demand and associated CO_2 emissions through:

- energy efficiency improvements in ship engines and ship design,
- changes in operating practices including load factors, routing and sailing speeds,
- switching to a different vessel type,
- switching to alternative energy sources such as LNG or renewables, and
- reductions in the amount of maritime traffic.

Such a charge might also contribute to other environmental objectives, including reducing SO_x, VOC and NO_x emissions.

DESCRIPTION OF SPECIFIC MEASURES

The study analyses a charge on maritime transport fuels and briefly considers some alternative measures. There are several ways a charge could be implemented:

- The **level** might fall anywhere in a wide range. Charge levels of $5, $25 and $125 per tonne of carbon have been investigated. These represent about 5 per cent, 25 per cent and 125 per cent of the 1994 average price for residual fuel oil (at $90/tonne: IEA statistics), and 3 per cent, 15 per cent and 75 per cent of the 1994 average marine diesel fuel price (at $150/tonne).

- Various **methods of collection** are possible — based on sales of fuel from bunkers to ships, sales from oil companies to bunker dealers, fuel out of the refinery gate, etc. — which might influence the greenhouse gas impacts of the measure.

- Various **uses of the revenue** are possible and will affect the economic implications of any charge.

Alternative Measures for GreenhouseGas Mitigation: Alternative approaches to greenhouse gas mitigation in international marine transport include: the use of alternative charges and fees (such as port fees); regulations on ship technology; and voluntary agreements with ship-builders and operators.

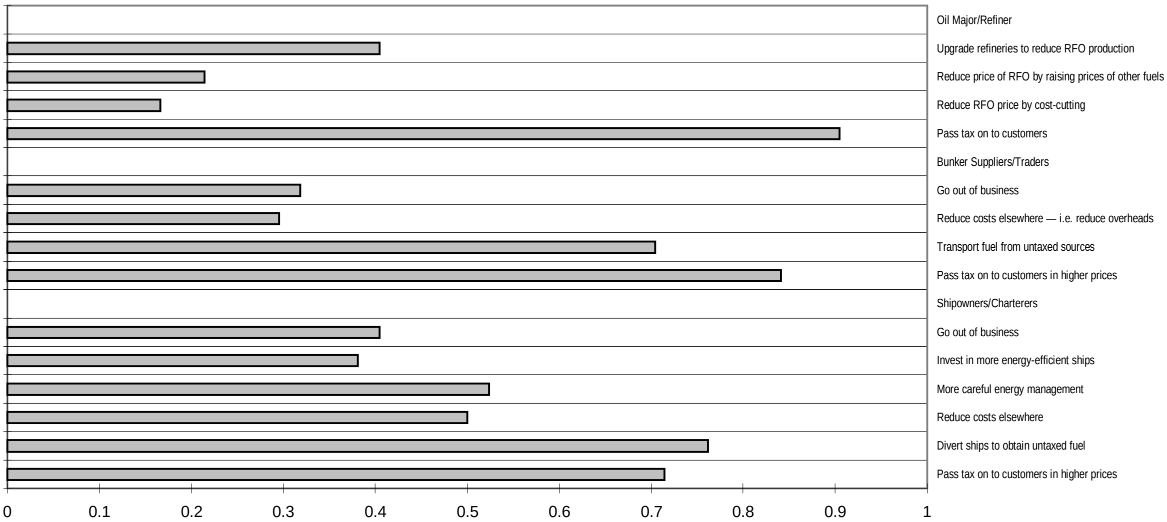
A charge might elicit various industry responses which are summarised in Table 1.

Table 1. Possible effects of a Bunker Fuel Charge on Industry

Shipowners/Charterers	Bunker Suppliers/Traders/Brokers	Oil Major/Refiner
Pass charge on to customers in higher prices	Pass charge on to customers in higher prices	Pass charge on to customers in higher fuel prices
Divert ships to obtain untaxed fuel	Transport fuel from untaxed sources	Reduce bunker pre-charge price by cost cutting
Reduce non-fuel costs	Reduce overhead and other costs	Raise price of other products to reduce bunker price
Reduce bunker use through more careful management	Reduce sales	Invest in upgrading capacity in refineries to reduce residual fuel oil production
Invest in more energy-efficient ships		
Reduce transport activity		

The Secretariat worked with an industry newsletter service, *Bunker News*, to survey their contacts in the three industry areas identified in Table 1 through a questionnaire. This questionnaire asked firms to relate the likelihood of each of the effects in the table, on a scale of 1 (unlikely) to 3 (very likely), for each of three levels of charge ($5, $25 and $125 per tonne of carbon). *Bunker News* followed up the questionnaire with a telephone/fax survey, and produced a report which is included in the annex to this report.

Figure 10. Expected Responses to a $25/tC Charge on Bunker Fuel Based on a Questionnaire Survey



(Mean of 22 respondents to date of which 13 bunker suppliers, 6 shipowners and 3 oil companies) 1=very likely to occur; 0=not very likely

The results of this survey should not be taken as an indication of what would happen if a bunker charge were introduced: individuals' ideas about what might happen in a new situation are likely to differsubstantially from what actually would happen. Nevertheless, they provide some perspective on possible industry attitudes to a bunker charge. Whereas respondents from all three industry areas anticipated thatthe most likely action of oil companies and bunker suppliers would be to pass the charge on to their customers, shipowners and charterers generally did not think that they would be able to pass the charge on by increasing their shipping rates. If this were true, shipowners would bear most of the cost of any charge.

Effects of Fuel Price Increases on Maritime Traffic

Fuel costs are a large proportion of shipping costs and so play an important role in the decisions of ship builders, owners and charterers. The relative importance depends on the type of vessel and the type of trade in which it is involved. Wright (1996) states that fuel typically comprises 20-25 per cent of overall capital and operating costs for container ships. According to Melissen *et al*. (1993), fuel costs are a much smaller share (in the region of 10 per cent or less) of overall costs for new bulk carriers, but a much larger share (over 30 per cent) for a fully-depreciated 15-year-old, steam turbine-powered tanker. The fuel share of costs is strongly influenced by the vessel speed. Higher operating speeds effectively reduce the capital costs (because the vessel can make more frequent voyages for a given capital investment) and increase the fuel costs (because energy use per kilometre increases with the square of speed).

Melissen *et al*. (1993) analyse the economics of specific voyages for different types of bulk carrier (a 4 700 nautical mile voyage for an iron ore carrier, and a 11 000 nautical mile voyage for an oil tanker). They evaluate the possible effect on costs of a hypothetical fuel price increase from $85/tonne to $170/tonne, resulting from sulphur controls. They include costs associated with the time taken for voyages based on interest and insurance costs on the cargo. They show that, for the particular voyages considered:

- while the overall costs for older oil tankers are 35 per cent lower than the costs for new vessels with fuel at $85/tonne, the gap is reduced to about 20 per cent with fuel at $170/tonne;
- whereas the fuel price increase results in 30 per cent lower optimum (minimum cost) operating speed for older vessels, newer vessels minimise their overall costs by operating at maximum speed even at the higher fuel price;
- a doubling in fuel prices would increase bulk transport costs by around 10 per cent.

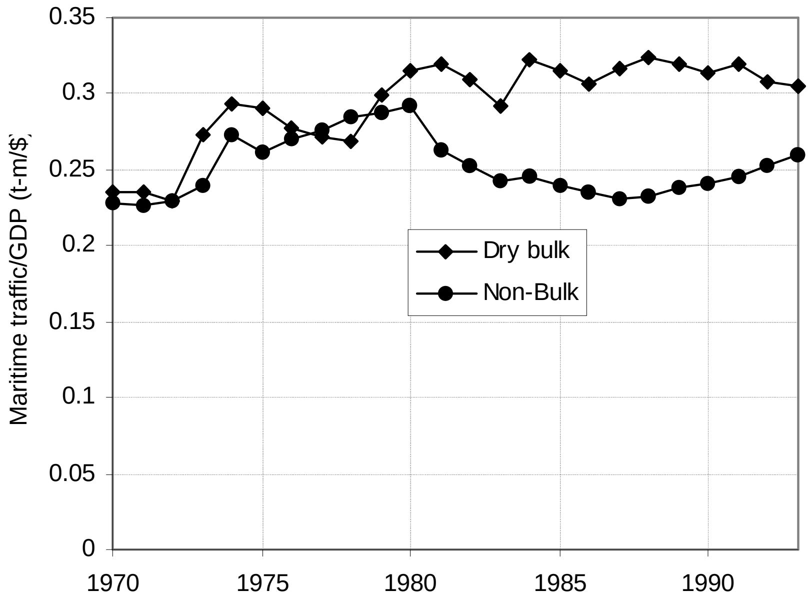
These findings have implications for the way a bunker tax might affect greenhouse gas emissions from bulk carriers:

- the remaining steam turbine-powered fleet would be less economical to operate and would probably be operated at lower speeds, resulting in more demand for new vessels with lower energy intensity and higher optimum operating speeds;
- slow steaming by old vessels and accelerated fleet replacement would lead to reduced energy intensity;
- higher transport costs would dampen the growth in demand for maritime transport.

No econometric analysis has been identified on the effects of bunker prices on maritime traffic or energy intensity. Literature does exist on price elasticities for marine freight. Oum *et al*. (1990) report a very wide range, depending on commodity and origin/destination: -0.06 to -0.24 for coal; -0.11 for iron ore; liquid bulk -0.21; -0.02 to -1.64 for grain. This clearly indicates a very large probable difference in the effects of a fuel charge on short vs. long distance maritime freight. Oum *et al*. do not identify any estimates of price elasticities for container and other freight.

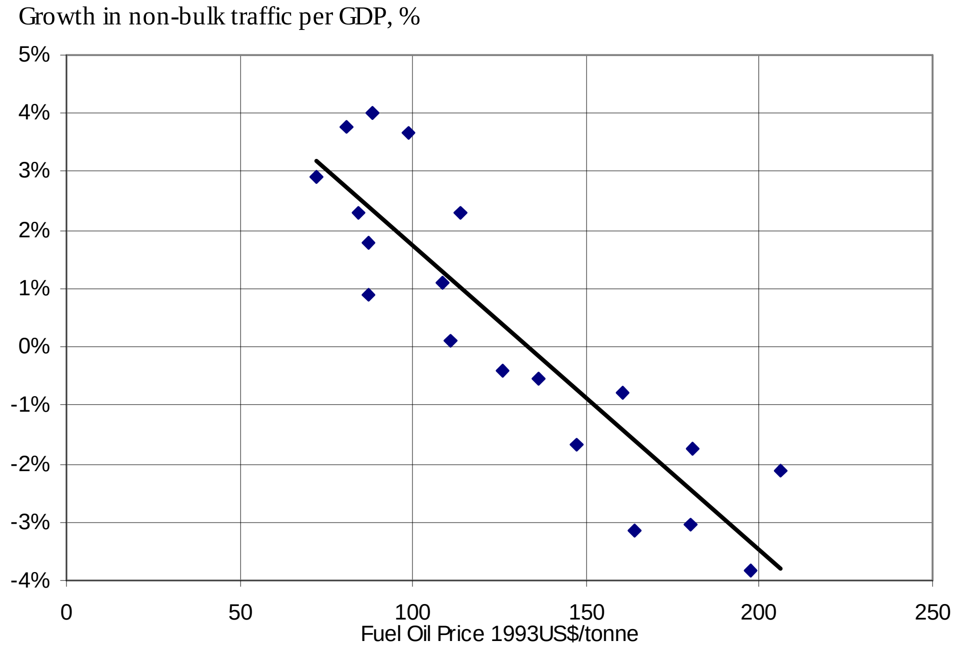
Some analysis has been carried out for this study using global data to attempt to evaluate the role of fuel price in maritime traffic and energy use. Figure 9 shows that the ratios of world dry bulk and general cargo traffic (including container and other traffic) to total OECD GDP have changed little in the last 25 years. Traffic in crude oil and oil products has been strongly affected by swings in oil prices and oil demand, and is not shown in Figure 9. It is noticeable that the ratio for non-bulk cargo traffic dips following the two oil price rises of 1973/74 and 1979/80. This does not occur for dry bulk traffic, perhaps because of a lack of alternatives for the buyers and sellers of bulk commodities.

Figure 11. Dry bulk and non-bulk traffic per unit of OECD GDP
(US$1990)



The rate of growth of non-bulk cargo traffic has a strong negative correlation with the oil price, as shown in Figure 0. Recent low oil prices correspond to high traffic growth rates of about 3 per cent on top of the GDP growth rate. While this analysis appears to demonstrate an effect of oil prices on trade, it is impossible to separate the effects of increased transport costs from more general effects of oil prices on the economy, and in particular on trade balances. OECD trade statistics indicate that a reduction in the value of agricultural and manufactured goods traded following 1980 mirrors an increase in the value of energy goods traded.

Figure 12. Annual growth in non-bulk traffic per unit of GDP vs. fuel price
(5 year averages)



In conclusion, it seems likely that any bunker charge would affect both the level of maritime traffic and the mix of the shipping fleet. Fuel costs are a larger share of overall costs for container ships than for bulk carriers, and any fuel price increase might be expected to have more effect on containerised than bulk trade. If a bunker charge were implemented as part of a broader carbon tax, the effects on trade might be expected to be similar to those of past oil price rises — thus, oil trade would be most affected, and non-energy raw materials trade least affected. However, it is not possible to provide any quantitative evaluation of the effects of a bunker charge implemented separately from a general carbon tax.

Effects of a Fuel Charge on Ship Technology and Management

If a fuel charge could be implemented, it would provide an incentive for accelerated fleet replacement, as discussed in the last section, and would also encourage ship owners and operators to adopt more energy efficient technology and management practices. Wright (1996), Martin and Michaelis (1992), MARINTEK (1991), Heron (undated) and Oftedal *et al*. (1996) review a range of technologies and practices that can reduce energy use and greenhouse gas emissions. Some are summarised in Table 2.

Table 2. Technologies and Practices to Reduce Ship CO_2 Emissions

Practices/Maintenance Options	CO_2 Saving	Cost Effectiveness	Other Environmental Effects	Source
Regular propeller maintenance	<5 %	High	Reduced energy use/emissions	Wright
Antifouling paint (hull smoothness)	3-4 %	High	Negative (TBT)	Heron
"Weather routing"	4 %	High	Reduced energy use/emissions	Wright
Slow steaming — 10 % reduction in average speed	5 %	Only likely to be cost-effective for older vessels	Reduced energy use/emissions/wake, noise & vibration effects	Wright, Oftedal, Melissen
Adaptive (fuzzy logic) autopilot	2.5 %	High	Reduced energy use/emissions	Wright
New Ships, Engines , Fuels etc.				
Hull form	3 %	Only possible for new ships: moderate	Reduced energy use/emissions/wake	Wright
Propeller	small	Replacement depends on fuel cost: moderate	Reduced energy use/emissions/noise, vibration	Martin & Michaelis
Water jet propulsion (ultra-high speed ferries only)	small	Unknown	Reduced energy use/emissions	Oftedal
Wind assistance	10-20 %	Poor	Reduced energy use/emissions	Wright, Martin & Michaelis
Engine improvements (precision cooling, turbocompounding)	small	Moderate	Reduced energy use/emissions	Wright, Oftedal, Martin & Michaelis
Double ship size	30 %	Considerable barriers in port infrastructure capability	Increased wash	Wright
New engine forms (e.g. CCGT, fuel cells)	5-10 %	Poor	Reduced energy use/emissions	Author's estimate
Fuel switching to natural gas (CNG, LNG)	<20 %	Poor	Reduced energy use/emissions	MARINTEK/ Author's estimate
Fuel switching to biofuels	>80 %	Poor	Environmental impacts of fuel production	Author's estimate
Nuclear power	>90 %	Poor.	Risk of release of radioactive material	Oftedal

Note: many of these options are already in use, and savings may not be additive.
Potential CO_2 savings listed in the table are applicable to some individual ships, not to the global fleet.

It has not been possible to identify literature estimating the costs of different energy-efficiency options for ships. Oftedal *et al*. (1996) note some of the historical effects of fuel prices on technology development and ship maintenance. In particular, they show that:

- the frequency of antifouling paint applications is reduced in periods of low oil price;
- engine efficiency improvements in new engines were accelerated during periods of high oil price — according to graphs included in the study, the rate of fuel consumption per kWh fell at over 1.5 per cent per year during the period 1974-1985, but only 0.5 per cent per year during the period before 1974; there has been little reduction in new ship fuel consumption since 1985;

- new ship design speeds were reduced during the early 1980s — according to graphs included in the study, by about 1 per cent per year for container ships and 0.5 per cent per year for ferries.

These findings indicate that a doubling of fuel prices relative to 1990 levels might achieve energy intensity reductions in general cargo shipping in the region of 1 per cent per year at the most, relative to underlying trends, as a result of accelerated technological development. Operational changes resulting from a doubling in fuel prices might reduce energy consumption by an additional 0.5-1 per cent per year. Note that these responses are in the rate of change of energy intensity, not in the level of energy intensity. This is approximately one- to two-fifths of the effect described above through reductions in general cargo traffic.

Effects of Charges on Refinery Operations and Fuel Prices

Shipping accounts for an increasing share of the market for residual fuel oil, as other sectors (industry, power generation) continue to switch away from using fuel oil. Petroleum refiners have reduced their production of fuel oil partly by switching to lighter crudes, and partly by installing upgrading capacity (catalytic and hydro-crackers). A bunker fuel charge, applied in the absence of additional charges on other petroleum products, would result in some reduction in the demand and the pre-charge price of residual fuel oil, encouraging refiners to move further to light crudes and/or install additional upgrading capacity. These factors would tend to increase the prices of other petroleum products. Responses depend on the economics of upgrading residual fuel oil to higher-value products, the availability of lighter crudes, and the price elasticities in the various petroleum product markets. Quantitative evaluation of the various effects is not possible in this study.

Responses from the industry indicate that relatively little shift in refinery configurations would be expected, and the first response by refineries without upgrading capacity would be to move to lighter crudes. The likelihood of installing additional upgrading capacity would obviously increase with higher levels of charge.

Effects of Charges on Mode Choice

Unless a bunker fuel charge were implemented as part of a more general carbon tax, it would tend to lead to some mode switching away from maritime transport. Mode switching would be most likely to occur for coastal shipping where rail and road transport may be economic alternatives. However, this applies mainly to domestic freight transport, which is outside the scope of this study. For long distance international transport, the only alternative to sea transport is air transport, which is unlikely to be economic for the majority of consignments currently moved by sea. A charge applied to both international marine and aviation bunkers would be more likely to lead to mode shifting from air to maritime transport.

IMPLEMENTATION ISSUES

While it has already been noted that a marine bunker fuel charge would only be feasible, fair and effective in the context of a general carbon tax, this section will consider implementation issues for a charge on marine bunker fuel only. Unless bunker charges were applied globally as part of a general carbon tax on crude oil, there would be an incentive for avoidance by bunker suppliers and ship operators. The charge could be avoided by using bunker fuel from non-participating countries, or possibly by using untaxed crude oil. This section considers the case where a bunker charge is only applied by Annex I countries.

The choice of the most effective approach to implementation of any bunker fuel charge would depend on a number of circumstances, most importantly:

- the outcome of the discussion in the UNFCCC on the allocation to countries of greenhouse gas emissions from international bunkers;

- the development of controls on air pollution by ships, under the Marine Pollution Convention (MARPOL) of the IMO.

Bunker Allocation under the UNFCCC

According to Article 4.2 of the UNFCCC, Annex I Parties are expected to introduce policies and measures aimed at returning "their" emissions of greenhouse gas emissions and absorption by sinks to 1990 levels by the end of the decade. However, the current IPCC guidelines for producing national greenhouse gas emission inventories currently provide for emissions from international aviation and marine bunker fuel use to be recorded under a separate category, not included under national totals. Thus, bunker emissions are not included in national emissions, and bunker emission allocation under the UNFCCC is ambiguous. Signatories to the UNFCCC have made a collective commitment in Article 2 of the Convention to prevent greenhouse gas concentrations in the atmosphere from rising to dangerous levels, and this commitment may imply managing greenhouse gas emissions from international bunker fuel use as well as emissions from national sources. One approach to managing these emissions would be to allocate them among countries, so that any greenhouse gas emission targets agreed by countries would include emissions from bunkers; another approach would be to agree on a collective approach to limit bunker emissions, which could be implemented regardless of the allocation of emissions among countries.

The UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA), meeting in December 1996, discussed a paper providing a number of options for emission allocation for Annex I Parties (UNFCCC, 1996). No decision was reached at that session. The options included:

1. No allocation;
2. Allocation of bunker emissions to Parties in proportion to national emissions;

3. Allocation to Parties according to the country where the bunker fuel is sold;
4. Allocation to Parties according to the nationality of the transporting company, the country where the aircraft is registered, or the country of the operator;
5. Allocation to Parties according to the country of departure or destination of an aircraft or vessel. Alternatively the emissions related to the journey of an aircraft or vessel could be shared between the country of departure and the country of arrival;
6. Allocation to Parties according to the country of departure or destination of passenger or cargo. Alternatively, the emissions related to the journey of a passenger or cargo could be shared by the country of departure and the country of arrival;
7. Allocation to Parties according to the country of origin of the passenger or owner of the cargo;
8. Allocation to the Party of emissions generated in its national space.

In the report of the SBSTA discussion (UNFCCC, 1997), it is noted that Options 1, 3, 4, 5 and 6 should be the basis of further work. In the context of Option 1, the report notes the role of ICAO and IMO in addressing international bunker fuel emissions, and the opportunity for UNFCCC Parties to work through these bodies.

Any approach to reducing greenhouse gas emissions from marine bunker use might be influenced by the decision taken by SBSTA and the UNFCCC Conference of the Parties on bunker allocation. Allocation to individual countries is not a prerequisite for greenhouse gas mitigation in this sector. However, if bunker emissions remain unallocated, or are allocated to an international category, mitigation is more likely to depend on common action. In this case, the most economically efficient means of managing bunker emissions would in theory be through a global carbon charge on all fuels including international bunkers, or through the inclusion of bunkers in an international emission trading scheme.

If Parties do agree to some means of allocation, the choice among Options 3 to 6 might have an influence on the implementation of policies and measures to manage bunker emissions. If the preferred measure were a carbon charge, Parties would in theory find it most economically efficient to impose that charge on the emissions that fell within their national inventories. Thus:

- The choice of Option 3 would imply that Parties had an incentive to reduce their national sales of bunker fuel, making a national charge on bunker fuel sales the most economically efficient measure.

- Option 4 would give each country an incentive to manage fuel use by national carriers — in the case of ships, it is ambiguous whether this implies those registered in the country, those owned by companies or individuals located in the country, or those operated by companies or individuals located in the country. An economically efficient national carbon charge in this case would in theory depend on recording the actual fuel use by ship owners or operators.

- Option 5 would imply managing fuel use at the point of departure or arrival of the vessel. Again, an efficient national carbon charge would in theory depend on recording the actual fuel use associated with a particular voyage and perhaps levying it through port fees.

– The implications of Option 6 are similar to those of Option 5, but in this case an efficient national carbon charge would depend on recording the actual fuel use associated with a particular voyage and somehow allocating it among passengers and/or freight.

In many cases, it might not be feasible or cost-effective to measure the actual emissions associated with a particular voyage, passenger or freight consignment. This might mean that any carbon charge adopted under Options 4-6 might have to be based on simple formulae — e.g. by classifying vessels according to their energy efficiency and imposing a charge based the vessel classification and the length of the voyage.

The nature of the shipping industry introduces a number of challenges which are likely to dominate the choice of policies. In particular, the international nature of shipping makes it easy for the industry to avoid costs imposed by the policies of individual countries. A ship may be owned by a company or individual in one country, registered in another, and operated by a company located in yet another. Policies introduced by any one country or group of countries that led to disadvantages for companies in those countries could simply lead to relocation of those companies abroad.

While a carbon charge on national fuel sales would be much simpler to implement than a charge on movements of vessels, passengers or freight, there would still be challenges. Bunker fuel differs from other petroleum products in that a large share of the global market is supplied by dealers independent of the major oil companies. The majors' share of supply is 40 per cent or less (Drewry, 1994). Charge collection at the point of sale would be administratively complex. In particular, an increasing proportion of bunker fuel is loaded offshore from supply barges so that ships can avoid calling at ports where they would have to pay port fees and might be subject to loading limits. Thus, the fuel can come from anywhere and be loaded anywhere.

Relationship to Existing Policies on Maritime Air Pollution[8]

Historically, the supply and use of marine oil fuels have been subject to little legal control. At present, world-wide legislation is confined to standards for the fuel flash point (for safety reasons). Prolonged black smoke emissions from ships are prohibited by environmental legislation in many countries, dating back to the use of coal as the predominant bunker fuel.

There are currently two lines of activity where attempts are being made to control ship exhaust emissions. The first is the process to develop an internationally agreed limit on certain exhaust emissions through the International Maritime Organization (IMO), and the second is the move to local emission control incentives in countries such as Sweden, or by individual port authorities such as that at Rotterdam. Experience in both of these areas may be relevant to the consideration of policies to limit greenhouse gas emissions from ships.

IMO is a UN technical organisation with 150 Member states, covering 98 per cent of world shipping tonnage. The organisation is currently considering an addition to the IMO Marine Pollution (MARPOL) Convention to cover air pollution matters. At present, there are four MARPOL Annexes in force, covering oil pollution, bulk chemicals, packaged chemicals and solid waste disposal. A fifth Annex covering sewage is currently awaiting ratification.

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8 This section is based on Lloyds (1996)

The proposed air pollution Annex, Annex VI, is intended serve several environmental purposes including: to phase out the use of ozone depleting substances (ODS); to control the design and use of incinerators and tankers vapour return systems; to limit emissions of NO_x and SO_x; and to control the composition of marine oil fuels. Annex VI will be voted on by the parties to the Convention in September 1997, and if accepted will go forward for ratification. This ratification would probably require the agreement of at least 15 states whose combined fleets constitute at least 50 per cent of the gross tonnage of world merchant shipping. Many of the details of the Annex, including the requirements for ratification, will need to be decided at the meeting in September 1997.

Any attempt to manage maritime CO_2 emissions may be affected by the form taken by MARPOL Annex VI, and in particular the provisions for controlling the level of sulphur in bunker fuel. If these provisions lead to some system of accounting for fuel used by individual ships, this same accounting system could be used in the implementation of CO_2 control measures. Similarly, measures implemented by individual ports, such as linking port fees to exhaust emissions, or offering prizes for "clean" ships, could also be applied to energy efficiency and CO_2 emissions.

Effect of Level of Charge on Avoidance

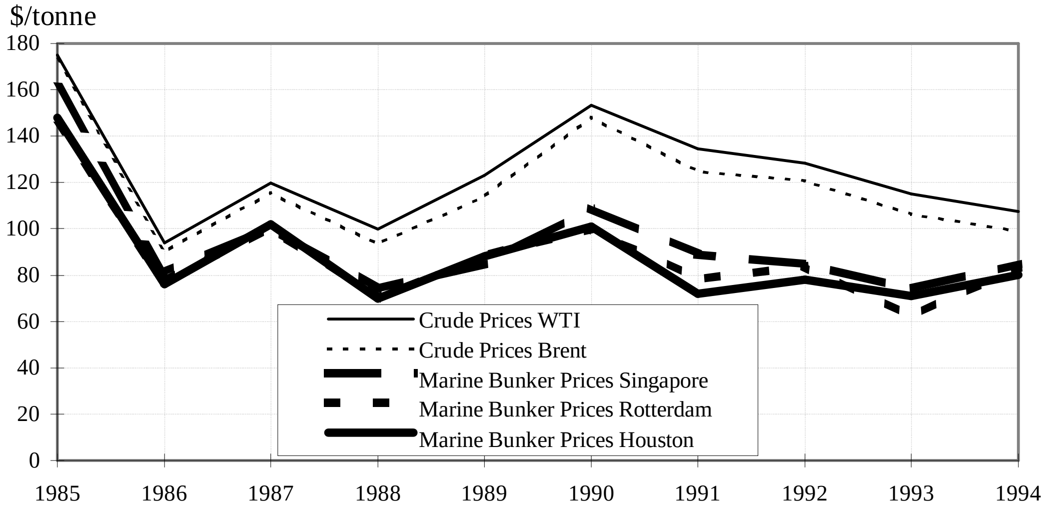
In the case of a charge on bunker fuel sales, avoidance would be very easy, provided that sufficient cheap, untaxed fuel was available somewhere in the world. Bunker suppliers would need to provide the fuel to ships offshore, outside the jurisdiction of participating countries. Offshore bunker supply is already normal practice to avoid paying port fees or being constrained by loading limits in ports. The cost of bringing fuel from a port in Africa or the Middle East to northern Europe, or from Latin America to north America, is of the order of \$10-15/tonne. Thus, any charge in excess of this level would provide an incentive for suppliers to transport untaxed fuel to supply points immediately outside the national waters of Annex I countries. At charge levels below \$10/tonne, avoidance would be less likely to occur through untaxed fuel being shipped around the world — differences in bunker prices between major supplying ports are in any case of this order of magnitude (see Figure 0). However, ships already choose their bunker source on the basis of small price differentials. Even a \$5/tonne bunker charge would introduce an incentive to bunker at ports of non-Annex I countries, and might reduce demand for residual fuel oil from the major bunkering ports in the United States and Europe. This would mainly affect bulk carriers (i.e. about a quarter of the bunker fuel market). For container and other ships whose consignments are more time-sensitive, and which operate on very tightly defined schedules, there would be less opportunity to avoid a small charge.

At higher levels of bunker charge there might be an incentive for ships to use untaxed crude oil which they could use instead of taxed bunker fuel. The size of the charge that would encourage this form of avoidance depends on the pre-charge price differential of bunker fuel and crude oil which, as Figure 13 shows, typically varies between about \$20 and \$40/tonne.

Effect of Implementation Point on Avoidance

The previous section mentioned that the option chosen for allocating bunker emissions under the UNFCCC might affect the approach taken by Parties to managing those emissions, and in particular the basis for any carbon charge. The basis for the charge would also need to take account of the ease with which it could be avoided:

Figure 13. Bunker and Crude Prices, 1985-1994
(current US$/tonne)



1. The charge could be raised from oil companies at the refinery gate and from importers at the point of import. This option is relatively secure: oil companies routinely act as tax collectors for governments; they are large organisations whose accounts are thoroughly audited in most countries; the charge would be reliably imposed on all bunker fuel sold from participating countries' refineries and all bunker fuel taken on shore before sale. It would not be reliably imposed on bunker fuel shipped from non-participating countries and would encourage increased bunkering at sea. Hence, it would be likely to lead ship operators to bunker offshore or in non-participating countries.

2. The charge could be raised from oil companies at the point of sale to the bunker dealer, and from importers at the point of import. This charge can be avoided where transactions take place at sea. Again, it would encourage increased bunkering at sea and in non-participating countries to avoid the charge.

3. The charge could be raised from bunker dealers at the point of sale to the ship operator. This is one of the least reliable options. The large number of bunker dealers, with no history of tax collection for governments, means that it would be harder to collect the charge than in options 1 and 2. Meanwhile, it could easily be avoided where transactions take place at sea.

4. The charge could be raised from ship operators based on ship accounts. This option seems impracticable at first sight, but might be feasible if detailed fuel accounting were implemented by the IMO as part of the introduction of sulphur controls. The charge might be raised by flag states — in which this option would have relatively little effect if the charge were agreed only among Annex I countries, as two-thirds of vessels (on a gross-ton basis) are registered in non-Annex I countries. Alternatively, the charge might be collected at the ports visited by the ship, by port or customs authorities. In this case, an Annex I agreement could be effective, as the majority of goods shipments originate or end in Annex I countries.

5. The charge could be raised as an export or import surcharge on freight, as a ton-mile charge perhaps related to the type of vessel in which the freight is shipped. It might be possible to assign individual vessels an "environmental rating" similar to the aircraft rating being discussed for the Swiss airport charge (see Michaelis, 1996) and to use this rating to modulate the charge. This would not be a true bunker fuel charge as it would be extremely complicated to ascertain the exact amount of fuel consumption associated with each consignment. This means that it would provide ship operators with no new incentive to save energy through operational changes, although a ship rating system could provide an incentive for the introduction of energy-efficient technology. It would be easy to implement as an extension of existing customs procedures and duties, and would be hard to evade. An Annex I country common action would affect the majority of the world's trade. As noted earlier, only 16 per cent of world bulk shipments begin and end their journeys in non-Annex I countries.

Charges raised from oil companies at the refinery gate have the advantage of being relatively easy to collect. Accounting becomes increasingly complex for transactions closer to the point of use and enforcement of any charge could present an administrative challenge for port authorities. The charge would only be effective if all countries with major oil refineries (including many non-Annex I parties) agreed to participate. However this might be more feasible than achieving a common action among all countries with bunker dealers or registered ships.

ECONOMIC, EMPLOYMENT, TRADE, AND OTHER EFFECTS

The size and direction of the overall economic and employment consequences of a charge cannot be assessed in this study, and would depend on detailed evaluation using a world trade model.

Section 5 noted that oil price increases in the past have reduced non-bulk maritime freight traffic significantly, but have had less effect on non-energy bulk traffic. Any effects of a bunker charge might similarly be concentrated on shipments of higher value-added goods where countries' comparative advantage depends more on labour skills and costs than on the local availability of raw materials. Thus, countries trading over long distances mainly in non-bulk commodities would be affected most.

Changes in trade patterns could have negative economic consequences for both exporting and importing countries. Some or all of these consequences might be offset by tax recycling mechanisms. One possible argument for applying any tax as an export or import tax is that the countries whose trade would be affected by such a tax would receive the tax revenues. If the tax were placed on bunker sales within Annex I region, most of the revenue would be collected in the United States, Netherlands and Japan. Similarly, if the tax were collected from ships registered in Annex I countries, most of the revenue would be collected by Greece, Norway, Japan and the United States.

It has been mentioned that a non-uniform bunker charge could lead to increased voyage lengths as ship operators make detours to pick up cheaper fuel. This would increase ship operation and maintenance costs, as well as the time taken for voyages. A non-uniform charge might also lead to a shift in trade patterns for some commodities, favouring exports from non-participating countries.

CONCLUSIONS

A carbon charge on bunker fuel could internalise social costs resulting from CO_2 emissions from maritime transport, but would only be feasible, fair and economically efficient if globally imposed and if all other transport modes also paid their full social costs. However, a bunker fuel charge would not necessarily lead to significant net greenhouse gas emission reductions, mainly due to the likelihood of avoidance strategies and modal shifts. Such a charge could also have significant negative impacts on international trade, and would therefore need to be carefully negotiated on a multilateral basis.

Any approach to reducing greenhouse gas emissions from marine bunker use might be influenced by the decision taken by SBSTA and the UNFCCC Conference of the Parties on bunker allocation. Allocation to individual countries is not a prerequisite for greenhouse gas mitigation in this sector. However, if bunker emissions remain unallocated, or are allocated to an international category, mitigation is more likely to depend on common action. Several types of common action are possible:

- **Replication of Successful Measures.** This approach is not likely to be relevant for a bunker fuel charge, although it might be for other measures briefly mentioned in the study, such as technology prizes, best practice programmes for ship operators, voluntary agreements with shipbuilders, and port fees or other measures related to the environmental performance of ships.
- **Agreement to Take Action in the Transport Sector Toward an Aim or Target.** Countries might agree explicitly to take effective action with the objective of reducing bunker emissions. Countries might further agree on a method for allocating national responsibility for bunker emissions, bringing them into the scope of existing commitments under the UNFCCC to introduce and report on measures to mitigate national greenhouse gas emissions.
- **Co-ordination to Implement the Same or Similar Measures.** This type of common action, with all countries applying charges at similar levels but without full harmonisation, might avoid some of the distorting effects and enforcement difficulties identified for non-uniform charges. However, the approach is more appropriate for some of the alternative measures mentioned in the study, such as the application of port fees linked to ship energy efficiency, charges on “embedded carbon” in imports, etc.
- **Specific Policies and Measures Implemented Together.** All countries or some group of countries might agree to introduce a measure, such as a bunker fuel charge, at a harmonised level at the same time. This approach would only be fully effective if all countries introduced the charge — that is, if it were globally imposed.

Advantages and Disadvantages of Common Action

The market for marine bunkers may be unique among fuel markets, in that only a global charge would be fully effective, because any non-participating country could set up offshore supplies of untaxed fuel. However, the extent to which this occurs depends very much on the level of charge, point of taxation and means of enforcement. Some of the implementation approaches mentioned in Section 6 — such as taxation at the refinery gate — might be less dependent on global action, but would lead to significant leakage (i.e. bunker markets would shift to non-participating countries). Taxation of exports and imports based on the type of ship they are carried in and the length of the voyage (i.e. origin/destination) would also be effective, even if not implemented globally, and would result in less leakage than direct fuel taxation. However, taxation of exports by a subset of countries producing a given commodity would adversely affect their international competitiveness. Thus, global action would be the most effective approach, and would minimise trade distortions.

As noted already, one of the main reasons for considering common action rather than unilateral action in this area is to avoid the possibility of "leakage". Differences in marine bunker fuel price have a very strong effect on ship operators' choice of port for taking on fuel, so non-uniform application (e.g. Annex I countries only) of a charge at the point of sale would be likely to lead to a large proportion of ships taking on fuel at the port with the lowest charge, possibly resulting in a net increase in greenhouse gas emissions due to any additional voyage length.

Some of the alternative measures mentioned, such as the linking of port fees to ship energy intensity, would be much less dependent on common action — although technology effects are likely to depend on incentives being applied in several countries.

Political Feasibility/Barriers and Implementation Issues for Common Action

The International Maritime Organisation (IMO) has pre-eminent competence in the fields of maritime safety and protection of the marine environment. IMO Member states are currently discussing Annex VI of the MARPOL convention, providing a regulatory framework for the prevention of air pollution from ships. The new Annex would address a variety of pollutants, including ozone-depleting substances, VOCs, NO_x and SO_x. Negotiation to implement any bunker charge would need to be carried out with the co-operation or under the auspices of the IMO.

Any approach to common action to reduce greenhouse gas emissions from marine bunker use would also be influenced by the decision taken by the UNFCCC Conference of the Parties on bunker allocations. The issue of allocation of emissions among countries has been discussed in Section 6.1.

There are clearly major political barriers to implementing a bunker fuel charge. These mostly relate to the potential effects of a charge on international trade. Because of these effects, issues such as the point of application of the charge, the question of which governments would be responsible for collecting and disbursing the charge, and any question of transfers of charge revenues among countries, would all need to be carefully discussed and agreed. Discussion of these issues would need to include non-participating States and might need to be carried out with the co-operation or under the auspices of the World Trade Organization, given the trade implications.

Some possible means of implementing a charge depend on the outcome of discussions on the control of sulphur levels in bunker fuel, currently underway in the International Maritime Organization. IMO is the relevant expert organisation for matters of legislation applying to maritime transport, and would need to be involved in discussions of any charge applying to ships or bunker fuel.

The complex economic and political issues involved in the implementation of a bunker charge, and the large number of countries that would need to be involved, would be likely to make the negotiation process very lengthy, perhaps taking several years.

ANNEX: REPORT ON INDUSTRY QUESTIONNAIRE[9]

SUMMARY

The survey of representatives of the shipping and bunker industries included ship owners, ship charterers, oil majors, bunker traders, bunker brokers, independent suppliers, testing agencies and independent consultants from Europe and the Americas. The overall response to the concept of a carbon tax, set at any level, was negative, the main arguments against it being that it would not be a universal tax and so would not solve the perceived problems, as shipowners would simply buy fuel from untaxed sources, and that such a tax would effectively discriminate against sea transport compared to land-based methods when the former is actually more environmentally friendly than other haulage methods. In terms of alternative proposals to improve the emissions from shipping, most suggestions concentrated on upgrading the world's fleet to take advantage of advances in engine design and on-board pollution control equipment. Many of the industry players interviewed thought that the shipping community was already subject to pressure created by fuel costs and freight rates to minimise fuel consumption and invest in more efficient engines.

RESPONSE TO QUESTIONNAIRES

SECTION A: LIKELY RESPONSES TO TAX LEVELS

Would the tax result in higher prices for marine fuel?

At the highest tax level of $125 a tonne, practically all of the respondents believed that shipowners and charterers would almost certainly pass on the tax by charging higher prices for their services; only one ship operator varied from this consensus, although stating that such a reaction was possible.

At the $25 a tonne tax level opinion was also fairly consistent in the belief that higher charges to customers would result, with 81 per cent of respondents stating that such a tax would almost certainly have such an impact (67 per cent among shipowners and operators) while only 6 per cent thought that such a response was not very likely.

At the $5 tax level, 33 per cent of respondents thought an increase in charges was almost certain, 40 per cent felt such a reaction was possible, while 27 per cent did not feel that increased charges were very likely.

Similar patterns can be seen over the question of whether the bunker suppliers would pass the tax on to their customers. At the $125 level, 100 per cent of respondents felt such a reaction to the tax was almost

9. © *Bunker News*, 1997

certain. At the $25 level, 88 per cent of respondents felt that it was almost certain that the tax would be passed on (including all of the suppliers who responded), while the remainder thought it was possible. At the $5 level, 81 per cent of the respondents (including 80 per cent of the suppliers) felt such a reaction was almost certain.

An almost identical pattern can be seen in the predictions of the reaction by the major oil companies to a bunker tax. At the $125 level, 100 per cent of respondents felt that the tax would result in higher prices for fuel supplied at source by the majors, 93 per cent thought such a reaction to the $25 level almost certain, while 87 per cent thought it almost certain that prices would rise even at the $5 level.

Other likely responses by ship owners and operators

At the $125 tax level, 100 per cent of respondents thought that ship operators would almost certainly divert ships to other ports in order to obtain cheaper fuel. 69 per cent thought ships would almost certainly be diverted at the $25 level (6 per cent believing it to be unlikely), while at the $5 level, 27 per cent thought that shipowners would almost certainly divert. 20 per cent thought that such a reaction would be possible, while the remainder thought that such a reaction to be unlikely. (Among the ship operating respondents the reaction was 50 per cent, 33 per cent and 17 per cent, respectively.)

In terms of reducing costs elsewhere in the ship operation equation to overcome the tax penalty, 67 per cent thought such a reaction almost certain at the $125 tax level, 21 per cent thought such a reaction to be possible with the remainder deeming it unlikely. At the $25 tax level, 33 per cent thought that ship operators would almost certainly try to cut costs elsewhere, with 47 per cent thinking such a reaction to be possible. At the $5 level, 7 per cent of respondents felt that shipowners would almost certainly cut costs elsewhere, 26 per cent thought such a reaction to be possible, with the remainder feeling that it would not be very likely that ship operators would try and cut other costs in the face of a $5 tax. (83 per cent of ship operators and owners did not think that they would reduce costs elsewhere if a $5 tax was imposed.)

In terms of working to reduce the consumption of bunkers, opinion was split. At the highest tax levels, 67 per cent of respondents thought that such an approach was almost certain (83 per cent of ship operators), while 20 per cent thought such a reaction not very likely. At the $25 level, 40 per cent of respondents thought ship owners would be persuaded to attempt to cut bunker use (50 per cent of ship operators), while 30 per cent thought such a reaction possible. At the $5 tax rate, 20 per cent of respondents thought owners would try to reduce consumption (33 per cent of shipowners), while 38 per cent of respondents thought it unlikely that a $5 tax would have a noticeable effect on shipowners' consumption rates (50 per cent of shipowners).

In terms of increased investment in more energy-efficient ships, 47 per cent of respondents believed that the highest tax rate would encourage such investment, while 20 per cent thought such a reaction to be unlikely. At the $25 level, only 20 per cent of respondents thought that ship operators would behave in this way (17 per cent of ship operators), while 33 per cent thought such a reaction to be unlikely. At the lowest tax rate, only 13 per cent of respondents (17 per cent of shipowners) thought that operators would react by investing in more energy-efficient ships, while 60 per cent thought such a reaction to be unlikely.

When asked whether a bunker tax would result in business closures for ship operators and owners, 47 per cent of respondents thought the $125 tax level would probably force ship operators out of business, while 13 per cent thought it unlikely that this would happen. The remaining respondents thought it was possible that business closures would ensue if such a tax were imposed. Only a third of the ship operators who responded thought that business closures were almost certain, while a third thought it unlikely, the remaining third accepted that business closures were possible. At the $25 tax level, only 12 per cent of respondents thought that ship operators would be forced out of business (no shipowners thought this themselves), while 30 per cent of respondents thought such a result to be unlikely. At the lowest tax level, only one respondent thought that closures would be almost certain, while 25 per cent thought such a result was possible.

Impact on suppliers, traders and brokers

At the highest tax level, 88 per cent of respondents thought it almost certain that suppliers would seek to transport fuel from cheaper, untaxed sources, falling to 60 per cent at the $25 tax level and to 40 per cent at the $5 tax level. 33 per cent of respondents thought such action unlikely at the $5 tax level.

Around 50 per cent of respondents thought that, at the $125 level, suppliers would almost certainly look to reduce costs elsewhere, although 46 per cent thought such action unlikely. At the $25 tax level, opinion is split 27 per cent/53 per cent--almost certain/unlikely, while at the $5 level, the opinion splits 13 per cent/69 per cent.

No respondents felt that suppliers would almost certainly be forced out of business at the $5 tax level (33 per cent thought such an outcome possible), while at the $125 tax level, 47 per cent of respondents thought business closures likely, while 27 per cent thought such a reaction to the tax unlikely.

Impact on oil majors

Few respondents believed that the oil majors would respond to a tax, at any level by cutting costs to reduce prices, even the oil majors themselves. At the $5 level, only one shipowner thought such action possible, while even at the $125 level, only 20 per cent of respondents thought such a reaction to be almost certain, and 74 per cent of people thought such a reaction to be unlikely.

Similarly, few people believed that the majors would respond to a tax by increasing the price of other fuels in order to compensate. At the $5 tax level, no one thought such a reaction to be likely, and only one thought it would be a possible response by the majors. At the $125 level, 20 per cent of respondents thought that the oil majors would increase the prices of other products while 60 per cent thought such action to be unlikely.

In terms of whether oil majors would respond to a bunker tax by upgrading refining capacity in order to produce less fuel oil; 47 per cent of respondents thought such a reaction to a $5 tax level to be unlikely while one oil major thought such a reaction to be almost certain. At the $25 level, 38 per cent of respondents thought upgrades to be an almost certain response with 31 per cent of respondents thinking it unlikely while, at the highest tax level, 46 per cent of respondents thought upgrades to be an almost certain response while 33 per cent thought such a reaction unlikely.

SECTION B: ARGUMENTS AGAINST THE TAX

Perhaps unsurprisingly, there was no support for a bunker fuel tax among the respondents and interviewees, at any level. Arguments against the tax concentrated on two levels. Firstly, there was a common concern that severe problems would be caused, and no problems solved, by introducing a tax which was not universal. This concern has been magnified in the industry by the experience of the United States West Coast bunker market, where a marine fuel tax introduced in 1992 was subsequently blamed for devastating the industry.

The second major argument against the tax was based on the anticipated effect it would have on the balance between sea transport and other forms of haulage, particularly road and rail. Many of the arguments in this area reflect views expressed during the deliberations of the International Maritime Organisation's efforts to introduce more stringent marine pollution measures. This includes emissions controls and the imposition of a cap on sulphur content in fuel.

The problem of introducing a tax on marine fuel which is not applied universally is that much of the world's bunker consumption is accounted for by the large container vessels, tankers and bulk carriers which trade internationally and tend to buy large quantities of fuel in each transaction. Although the smaller coastal and fishing vessels have less flexibility in choice of port, for many suppliers, the demand generated by this sector is not enough to sustain business. The distances involved, and the number of ports of call, allow the long-range shipowner considerable flexibility when choosing a bunkering location.

The California bunker tax has been the most profound demonstration of the negative effects a bunker tax can have and one that has coloured many of the responses to the study. Although the tax was lifted in 1992, it is still an issue in the United States, as the California State Assembly is currently considering its reintroduction.

The 8.5 per cent sales tax was imposed on bunker fuel for one year in 1991 before pressure from the industry forced politicians to reintroduce an exemption from the tax for marine fuel. Before the introduction of the tax, the Los Angeles/Long Beach bunker market was one of the biggest bunkers-only ports in the world, where around 4.5 million barrels of bunker fuel were sold to shipping every month. After the tax, these sales volumes dropped to a low of one million barrels a month in July 1992. The tax was rescinded in late 1992 in an attempt to save the industry. As a result, there has been some recovery since the 1992 low point, and the market is now estimated to average around 1.5 million barrels a month, still far from its previous levels.

The main beneficiary of the tax was the Panama market, as many ship operators which had Los Angeles as a port of call would also be using the Panama Canal, where bunker prices suddenly became competitive with Los Angeles after the introduction of the tax. Much of this custom has yet to return. In its current campaign to press the California state politicians to vote against reinstating the sales tax on bunker fuel, the Pacific Merchant Shipping Association (PMSA) claims that by reintroducing such a tax, bunker sales in the state would decline by around 50 per cent and around 740 jobs would be lost.

It should be stressed that when the tax was first introduced in 1991 it coincided with the first effects of the nationwide Oil Pollution Act 1990 (OPA'90), which also increased costs in the bunker market by enforcing considerable additional operational and insurance expenses. Although all of the players in the California market believe the tax had a major effect on the market, they also admit that the Oil Pollution Act also had a profound effect and that it was the combination of the two measures, rather than the tax alone, which was responsible for the market collapse.

The other main objection to the concept of a carbon tax on marine fuel is the effect it would have on the balance of global transportation methods. These concerns were clearly expressed in a detailed interview with an influential shipping company which handles between 80 to 130 ships a day and was responsible for transporting around 46 million metric tonnes of cargo in 1996.

The company argues that, instead of imposing new taxes on shipping through the bunker industry, the OECD and others should rather encourage the increased transportation of goods by sea rather than by land. If one compares the fuel consumption by transporting the goods by trucks, as opposed to sea-going vessels, fuel consumption, according to the company, is five times higher. The direct consequence of a taxation on bunker fuel will be that more cargo will be transported by road and less by sea, particularly in Europe and the Americas, where competition between sea and land transportation modes is already intense. This will result in increased air pollution caused by heavier traffic on the already overcrowded roads in highly populated areas.

This view echoes sentiments expressed by some factions involved in the drafting of the IMO Marpol regulations, where arguments have raged over the degree to which emissions from shipping contribute to pollution levels and to acid rain. For example, on the issue of global sulphur emissions, some environmental groups have put shipping's contribution to overall levels as high as seven per cent, while oil industry estimates of shipping's contribution is less than two per cent.

SECTION C: SUGGESTED POLICIES FOR REDUCING FUEL USE AND CARBON DIOXIDE EMISSIONS

In interviews and questionnaire responses, a high degree of consensus is obvious in terms of alternative proposals for the reduction of both marine fuel consumption and exhaust emissions. The subject has been a matter of debate within both the bunker and shipping industries for some time, prompted mainly by marine pollution initiatives by the International Maritime Organisation.

The main alternative approaches are involved in the areas of ship management, fleet management, fuel development and engine system technology.

By far the most popular approach, alluded to by most of the people who took part in the study, is that of fleet modernisation. This approach takes a relatively long-term view of the situation. The central argument is that it should be made mandatory for newly built ships to be fitted with the most fuel efficient engines possible, in addition to exhaust cleaning systems. With this approach, the natural upgrading of the world's fleet will gradually improve the consumption and emission status of the shipping industry.

Several respondents also addressed the matter of speeding up the modernisation process which, if left to market forces, could take upward of 20 years. The two suggested methods of enforcing a more rapid fleet modernisation involve imposing stricter international standards on ship quality and the introduction of some form of subsidy for shipowners to ease the expense of upgrading fleets. Such methods could be backed up by a more selective taxation system, where owners of the less efficient and most polluting vessels are taxed more than those owners of cleaner and newer ships.

It was noted by one large and respected shipping company that the drive to find and fit the most fuel efficient engines available is already a priority, and will have the effect of reducing emissions. While engine builders also recognise fuel efficiency as a major area for their own research and development.

In terms of basic ship management, several techniques were proposed which would act to promote fuel efficiency and a reduction in emissions. It was suggested that ship operators should be encouraged to take advantage of the increasingly accurate voyage planning tools available on the market to minimise the number and length of ballast legs and therefore the needless consumption of fuel. Also, ship operators should be encouraged to reduce speeds to the levels where fuel consumption/air pollution are kept to a minimum. It was also suggested that education standards for ship crews should be increased and imposed more emphatically, including the use of suitable codes of practice, for example the ISM Code.

From the ship management perspective, there is nothing new or revolutionary in these techniques, and several respondents pointed out that most owners are currently sailing at more economical speeds on routes which have been maximised to the full during what is perceived by many operators to be a sustained period of high bunker prices and depressed freight rates.

The other major alternative approach suggested by respondents and interviewees involved attacking the problem at the level of the fuel. Several of the participants in the study suggested that steps should be taken to ensure that fuel is purchased only from reputable suppliers who can provide fuel which meets the appropriate standards, particularly ISO 8217 (1996). As well as guaranteeing fuel quality, which should reduce the level of damaging emissions, such an initiative will help prevent the bunker market from being used as a dumping ground for used oil/chemical waste products. The idea that the bunker market is being abused in such a way has been an increasing concern by shipowners during the nineties, highlighted in particular by two well-reported cases of severe fuel contamination in Rotterdam in 1993. The arguments over the addition of waste products to marine fuel have re-emerged within the last year as a result of a celebrated court case in the United States in which the judge ruled against the shipowner and in favour of a supplier which has supplied marine fuel which contained used lubricating oil.

As well as trying to persuade suppliers to maintain fuel quality, a tax on the refiners was also suggested, which would be imposed on those refineries which produce high carbon fuels. The tax could be introduced at certain trigger levels determined by carbon content. It was suggested that such a tax would encourage refiners to produce a low carbon fuel by investing more in the refinery. It was pointed out that by trying to force refiners into improving fuel quality, the cost of the fuel itself would increase substantially, again presenting the economic problems alluded to earlier.

In trying to find an acceptable and workable synthesis of all of these approaches, it was proposed by one respondent that an international forum should be established, consisting of ship owners and operators, engine designers and oil companies. Such a forum would be an ideal vehicle for discussing the practicality and introduction of more efficient ship management techniques, improved engine design and the production of cleaner fuel.

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GLOSSARY

AGBM	Ad-Hoc Group on the Berlin Mandate. A subsidiary body of the UNFCCC.
DWT	Deadweight ton. The deadweight tonnage of a vessel is a measure of its maximum load including cargo, bunkers, stores, water etc.
GT	Gross ton. The gross tonnage of a vessel is a measure of its maximum water displacement, being the cubic capacity (in hundreds of cubic feet) of all spaces below the freeboard deck (the highest deck that can be fully sealed) and permanently closed in spaces above that deck except for certain exempted spaces (such as double bottoms used for water ballast, WCs, wheelhouse, galley, etc.).
IPCC	Intergovernmental Panel on Climate Change
LNG	Liquefied natural gas
Ro-Ro	Roll-on-roll-off ferry, designed to carry trucks and/or cars.
SBSTA	Subsidiary Body on Scientific and Technical Advice: one of the subsidiary bodies of the UNFCCC.
UNFCCC	United Nations Framework Convention on Climate Change