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Left on the High Seas

Global Climate Policies for International Transport

October 2008 update

Report

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Summary

The inclusion of international aviation and shipping emissions in a global climate policy framework has proved to be a difficult issue. In the run-up to the Kyoto Protocol, different options were studied to allocate emissions to countries and thus include them in the national totals, but no agreement could be reached. Instead, the Kyoto Protocol calls on Annex I countries to limit or reduce emissions 'working through the International Civil Aviation Organization and the International Maritime Organization' (KP, Article 2.2).

To date, the Annex I countries have not been successful in limiting or reducing greenhouse gas emissions from international transport.

As the IMO is considering greenhouse gas mitigation options and simultaneously the UNFCCC is engaging in several processes to define long-term cooperative action for all and further commitments for Annex I parties, the issue of bunker fuels is again attracting attention. This paper sets out to identify the conditions for progress on this issue. It also evaluates two basic architectures for climate policy for shipping.

The main reason for the current deadlock is the seemingly conflicting principles of the IMO and the UNFCCC. IMO policies are based on equal treatment of all ships, regardless of their nationality. IMO has regionally differentiated policies but even these apply to all ships in the specified regions. In contrast, the UNFCCC's Kyoto Protocol is based on the principle of Common but Differentiated Responsibilities. Under this principle, Annex I countries have to limit their emissions while non-Annex I countries do not. Simply applying this principle to shipping, e.g. by specifying that ships flying an Annex I flag would have to reduce their emissions while other ships do not, is widely agreed to be ineffectual as ships can easily change flag.

The main challenge for a global climate policy for shipping is to link these apparently conflicting principles in a creative way. There are two ways to do so:

1 Climate policy for maritime transport can start by differentiating commitments for Annex I and non-Annex I countries. In doing so, responsibilities have to be differentiated according to the route of vessels. National policies implemented to limit allocated emissions should not discriminate on the ground of nationality of the ship or its owner.

2 Alternatively, climate policy for maritime transport can start by having uniform policies for all ships. In that case, in order to satisfy the principle of common but differentiated responsibilities, the net impacts of the policy on non-Annex I countries should be less than the net impact on Annex I countries. One way to do so is to implement a revenue-raising uniform policy and differentiate between countries in the use of the revenue.

Both ways have their advantages and disadvantages. The first, route-based allocation combined with emission trading or emission charges, would have the least impact on developing countries. It would not affect their import costs and affect tourism only marginally. It could be designed so as to provide investments in adaptation and sustainable development. However, there would be scope for evasion and it would be difficult to cover ships involved in ship-to-ship transfer of goods.

The second, uniform revenue-raising policies with differentiation in the use of revenues, would affect import costs and tourism receipts in developing countries. To some extent, undesired impacts can be mitigated by a clever design of the scheme, but they cannot be eliminated altogether. This architecture would provide developing countries with investments in adaptation and sustainable development. As it would cover a greater amount of emissions, a uniform policy would be preferable from an environmental point of view. However, such a policy would include emissions from ships registered to non-Annex I countries. A decision to do so would have to specify that this does not set a precedent for land-based emissions and is done solely because of the characteristics of the maritime transport sector. It would be harder to evade this policy.

1 Introduction

The inclusion of international aviation and shipping emissions in a global climate policy framework has proved to be a difficult issue. In the run-up to the Kyoto Protocol, different options were studied to allocate emissions to countries and thus include them in the national totals, but no agreement could be reached. Instead, the Kyoto Protocol calls on Annex I countries to limit or reduce emissions 'working through the International Civil Aviation Organization and the International Maritime Organization' (KP, Article 2.2).

To date, the Annex I countries have not been successful in limiting or reducing greenhouse gas emissions from international transport. Both at the UNFCCC level and in ICAO and IMO, little progress has been made in working towards effective policy instruments.

As the world is engaging in several processes to define long-term cooperative action for all and further commitments for Annex I parties, the issue of bunker fuels is again attracting attention. This paper sets out to identify the size of bunker emissions and their growth, looks at the record to date of attempts to address them and outlines some conditions for progress on this issue. It also evaluates two recent proposals on bunker fuels against these conditions. In doing so, this report focuses on maritime transport.

1.1 Bunker emissions and their growth

Bunker emissions are currently estimated at 1,080 to 1,450 Mt of CO_2. IEA estimates of international aviation emissions are 400 Mt in 2004 (IEA, 2006)[1], while IMO's most recent 'best estimate' for shipping is 847 Mt in 2007, with a range from 682-1,052 Mt (MARINTEK et al., 2008). In order to put these figures in perspective, Table 1 lists CO_2 emissions of the fifteen most emitting countries together with emissions from international aviation and maritime transport.

[1] Note that total aviation emissions estimates (including domestic aviation) are considerably higher. For the year 2000, Lee et al. estimated total aviation emissions to be 182% of international aviation emissions, albeit with a considerably lower estimate than IEA.

Table 1 CO_2 emissions of largest countries, international aviation and maritime transport

Entity	CO_2 emissions from fossil fuels (Mt CO_2, 2004)
United States of America	6,046
China (Mainland)	5,007
Russian Federation	1,524
India	1,342
Japan	1,257
Maritime transport (2007)	847
Germany	808
Canada	639
United Kingdom	587
Republic of Korea	465
Italy (including San Marino)	450
Mexico	438
South Africa	437
Islamic Republic of Iran	433
International aviation	400
Indonesia	378
France (including Monaco)	373

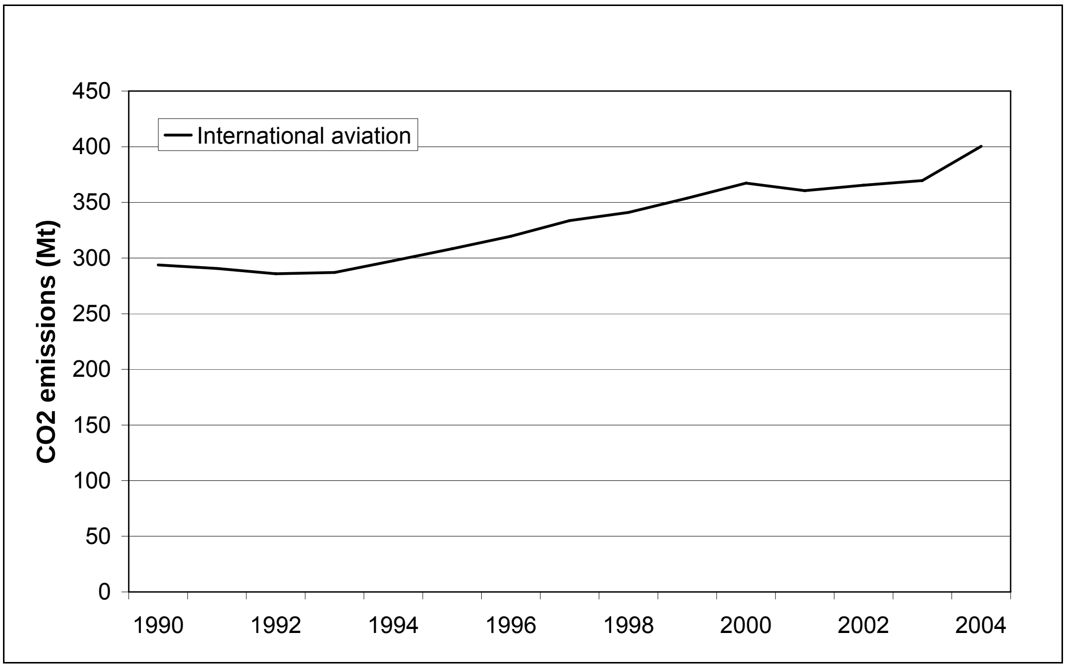
Source: Countries: CDIAC, 2008[2] ; Aviation: IEA, 2006; Maritime Transport: MARINTEK et al., 2008.

Both maritime and aviation emissions have been rising rapidly over the past decades. Figure 1 shows the rise in international aviation emissions has been 36% from 1990 to 2005. Figure 2 shows that emissions from international shipping have almost doubled in the same period. Total global CO_2 emissions are estimated to have increased by 28%[3].

[2] http://cdiac.esd.ornl.gov/trends/emis/tre_coun.htm, accessed 1 July 2008. CDIAC reports emissions in tonnes of C. In order to convert to CO_2, a molecular weight of CO_2 of 44.0095 and an atomic weight of C of 12.0107 have been used.

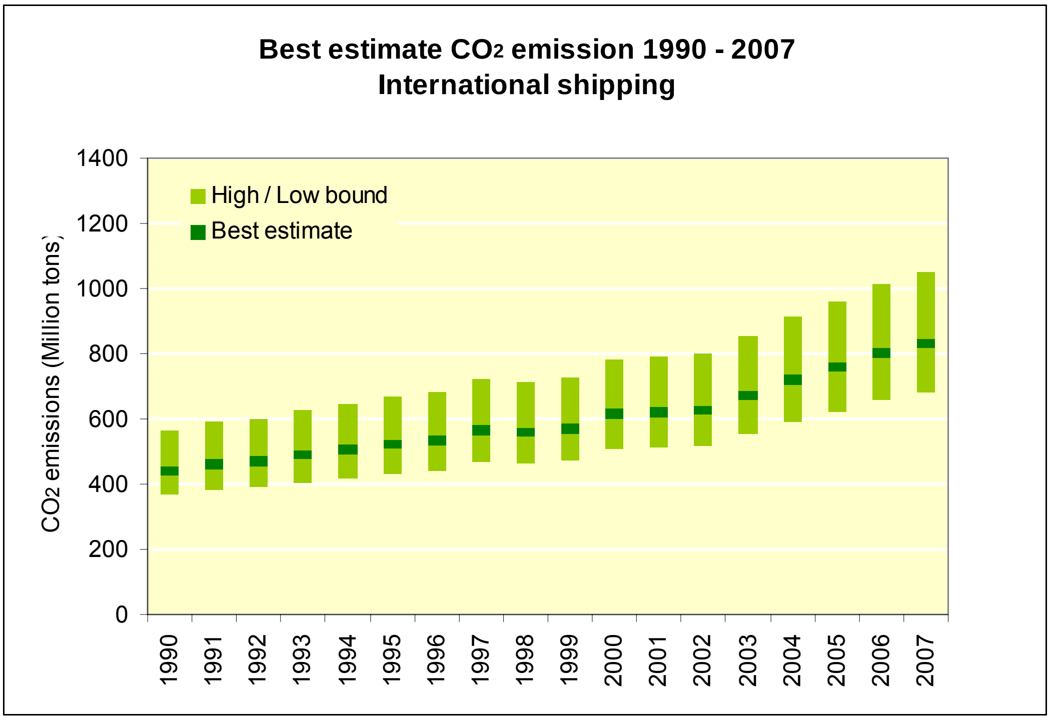
[3] Both CDIAC (2008) and IEA (2006) estimate this growth rate.

Figure 1 Emissions from international aviation are estimated to have increased by a third since 1990



Source: IEA, 2006.

Figure 2 Emissions from maritime transport are estimated to have doubled since 1990



Source: MARINTEK et al., 2008.

1.2 Progress on climate policy for bunker fuel emissions to date

To date, progress on developing climate policies to address bunker fuel emissions at the international level has been limited. At the UNFCCC level, parties have not been able to agree on a methodology to assign responsibility for emissions to states, even though a recent workshop concluded that technically, a number of allocation issues are feasible[4].

In addition, neither the International Civil Aviation Organization (ICAO) or the International Maritime Organization (IMO) has been able to agree on effective implementation of mitigation policies, other than best practice in terms of air traffic management operations, in the case of ICAO, and voluntary guidelines for efficiency standards in IMO.

1.3 Outline

Chapter 2 analyses the reasons for the current deadlock in the inclusion of international transport and develops criteria that should be met for an effective climate policy for these emissions. Chapter 3 analyses how developing countries could be affected by including emissions from maritime transport. Two proposals to develop climate policy for shipping are analysed in Chapters 4 and 5, respectively. Chapter 6 concludes.

4 'Technical workshop on GHG emissions from aviation and maritime transport in Oslo 4-5 October - conclusions by the organisers'.

2 Requirements for a global climate policy

In over a decade of discussions on the inclusion of aviation and maritime transport in a global climate policy regime, one thing has become clear: the current architecture is incapable of overcoming obstacles that would enable limiting bunker fuel emissions. This chapter analyses the current architecture and the reasons for the deadlock on progress (Section 2.1). Based on this analysis, it provides several routes out of the current situation (Sections 2.2 and 2.3).

2.1 Why has there been little progress?

Before analysing the reasons for the current situation, we should remember the way in which the Kyoto Protocol deals with bunker emissions. It states in Article 2.2:

> The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

Although there have been various interpretations of this article, it is at least clear that the burden of reducing emissions is on Annex I countries and that ICAO and IMO have to be engaged in the process. Herein lies one of the main reasons for the current deadlock. The UNFCCC has a clear distinction between Annex I and non-Annex I countries. Under the Kyoto Protocol, the first have to limit their emissions, whereas the second do not. In contrast, in general IMO's policies have been flag neutral, that is applicable to all ships, regardless of their nationality. Regional differentiation is possible, for example to control emissions of sulphur dioxide, but still these policies apply to all ships. Individual IMO members may set higher standards for ships under their jurisdiction, i.e. ships flying their flag, but these rules only apply to these ships and are not IMO policies.

In short, under the Kyoto Protocol, only Annex I countries have quantitative targets and legally-binding commitments, with other countries having no quantitative targets of any kind. This differentiation originates in the principle that countries have 'common but differentiated responsibilities (CBDR) and respective capabilities', which is enshrined in the Framework Convention. In contrast, ICAO and IMO generally develop global policies as their sectors are global. Within IMO and ICAO, many non-Annex I countries have argued that it would be not be in line with current global climate policies to impose mitigation measures on their aircraft and ships (CE et al., 2004; CE et al., 2006a; Stochniol, 2008).
A second reason for the current situation is the lack of co-ordination of negotiations: Policies and measures (PAMs) are discussed within ICAO and IMO, while allocation of responsibility is discussed within UNFCCC SBSTA, with little coordination between the two. Nor is there yet any well-developed arena for

discussion of possible targets for the sectors, with only limited discussion taking place to date in the Ad Hoc Working Group on Further Commitments for Annex I Parties. Effective climate policy requires agreement on allocation, targets and PAMs. In particular, it is difficult for parties to take responsibility for emissions in the absence of any internationally-coordinated policy instruments to limit those emissions.

The development of policies to address the climate impact of bunker fuel emissions will only be successful if the current obstacles to it are removed. The next sections show possible ways to break the current deadlock. Section 2.2 analyses ways to differentiate responsibilities, while Section 2.3 looks at ways to co-ordinate negotiations.

2.2 The key issue: reconciling Common But Differentiated Responsibilities with No More Favourable Treatment

As stated above, one of the key obstacles to incorporating international transport in a global climate policy is the difficulty of applying ‘common but differentiated responsibilities and respective capacities’ (CBDR) to international transport. CBDR is based on two principles. First, it recognises that industrialised countries have contributed more than developing countries to the current concentrations of greenhouse gases in the atmosphere and therefore have a moral responsibility to reduce their emissions. Second, it recognises that on average, there is a correlation between economic development and greenhouse gas emissions. Developing countries should not be restricted in their development by restrictions on emissions, or be provided with more sustainable ways of developing.

The Kyoto Protocol has implemented CBDR by capping emissions of industrialised (Annex I) countries but not of developing (non-Annex I) countries. The caps relate to emissions in the territory of the respective countries. For international maritime transport, applying caps to *territorial* emissions would mean that very few emissions would in fact be capped, as a major share of emissions are on the high seas. Moreover, territorial policies could violate the legal principle of innocent passage, which guarantees that ships may sail through territorial waters as long as they comply with global standards.

Therefore, one could argue that the *principles* of CBDR should be applied to international shipping, rather than try to force the *implementation* of CBDR in the Kyoto Protocol on shipping.

With regard to the first principle, the historical responsibility, it is likely that historically most shipping has been to and from Annex I countries. This is because there is a clear link between the size of an economy and its demand for shipping. So it could be argued that because of the historical responsibility, the emission reductions should fall primarily on ships on routes to Annex I countries. Alternatively, it is likely that before the advent of open registries, a large part of ships engaged in traffic to and from Annex I countries would have been under the flag of the country in question. Following this argument would lead to the conclusion that emission reductions should fall primarily on ships flying flags of

Annex I countries. This, however, would have two disadvantages. First, it would distort the market and would probably lead to a displacement of emissions, not a reduction. Second, it would violate an established principle in international transport, viz. non-discriminatory treatment of foreign vessels or aircraft. It would thus go against current IMO principles. Yet another argument could be that historically, the majority of the world fleet has been under control of nationals of Annex I countries. This argument could be used to justify reducing emissions of ships controlled by Annex I nationals.

The second principle, the link between greenhouse gas emissions and economic development could be applied to maritime transport by reducing emissions that contribute to developed economies more than emissions that contribute to developing economies. Registered fleet would not be an appropriate option, as most of the fleet is registered in non-Annex I countries. In fact, as Table 2 shows, only one country among the ten countries with the largest fleet is an Annex I country. Together, these ten countries account for over two thirds of the total registered tonnage.

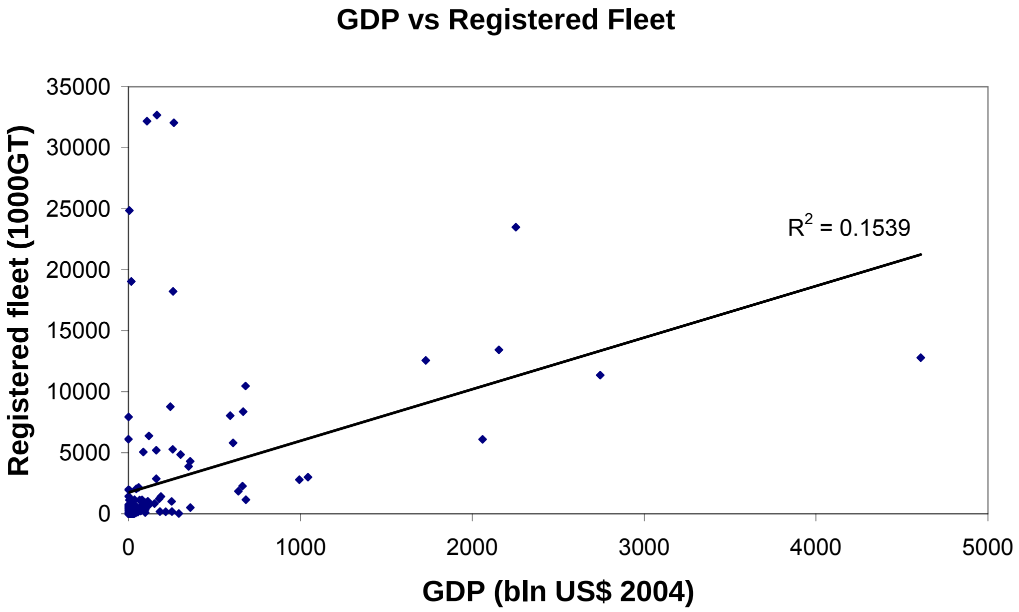
Table 2 The majority of the world fleet is registered in non-Annex I countries

Country	Registered fleet (1,000 dwt)
Panama	232,148
Liberia	105,227
Bahamas	55,238
Greece	55,145
Marshall Islands	54,644
Hong Kong (China)	54,341
Singapore	51,043
Malta	40,201
China	34,924
Cyprus	29,627

Source: UNCTAD, 2007.

It is not surprising, then, that there is a weak correlation between GDP and registered fleet, as depicted in Figure 3.

Figure 3 There is a weak correlation between GDP and registered fleet



Source: UNCTAD (registered fleet); IMF (GDP).

In contrast to fleet registration, fleet ownership is concentrated in Annex I countries. Table 3 shows that six of the ten largest ship-owning countries are Annex I countries. Of all the countries for which fleet ownership is reported by UNCTAD (2007), over two thirds of the fleet is controlled by Annex I countries.

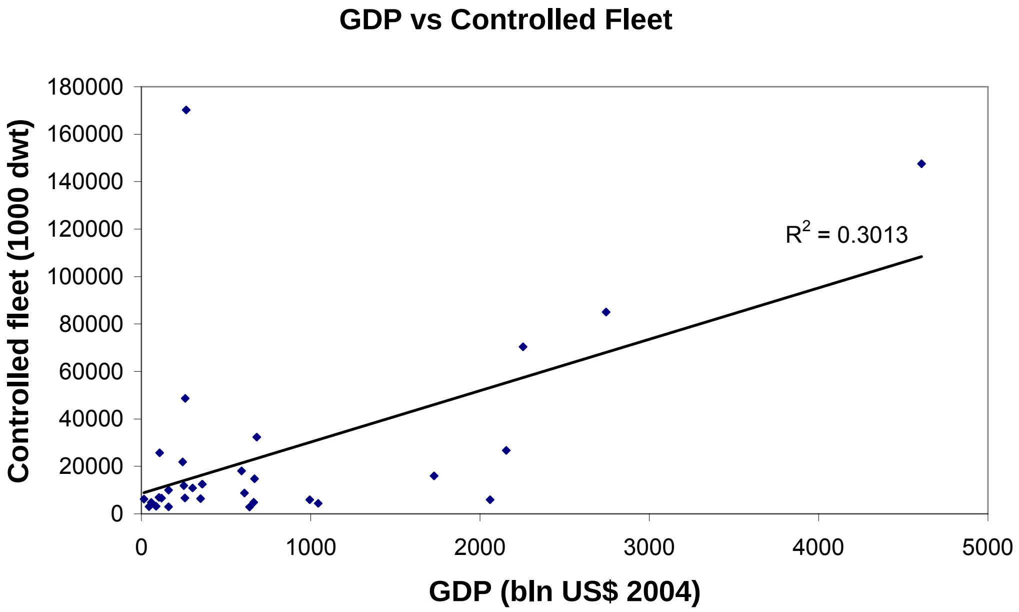
Table 3 The majority of the world fleet is controlled by nationals of Annex I countries

Country	Total controlled fleet (1,000 dwt)
Greece	170,181
Japan	147,507
Germany	85,043
China	70,390
Norway	48,697
United States	48,261
Hong Kong (China)	45,053
Republic of Korea	32,287
United Kingdom	26,757
Singapore	25,723

Source: UNCTAD RMT, 2007.

The correlation between GDP and fleet ownership is a little stronger than between registered fleet and GDP, but still quite weak. See Figure 4.

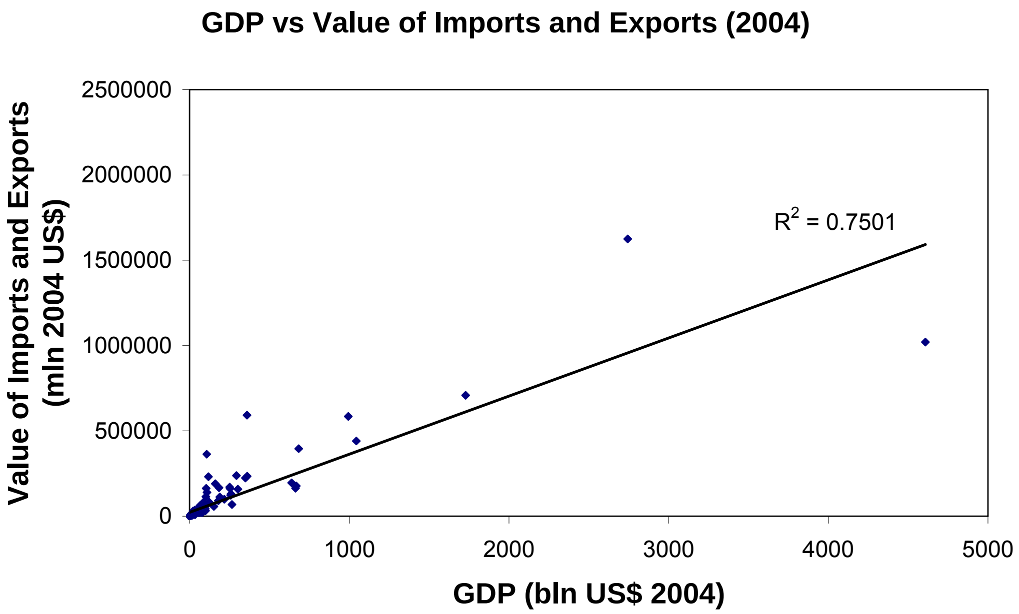
Figure 4 There is not a strong correlation between GDP and fleet ownership



Source: UNCTAD (controlled fleet); IMF (GDP).

At present, there is insufficient data on ship routes to and from countries to assess the relationship between *maritime* transport and GDP. It is however possible to assess the correlation between value of imports and exports and GDP. Unsurprisingly, this relationship is quite strong, as shown in Figure 5. The wealthier a country is, the more it trades.

Figure 5 There is a good correlation between GDP and trade value



Source: UNCTAD (registered fleet, value of imports and exports).

The reason for the strong correlation between GDP and international trade is, of course, that international transport contributes to economic growth by linking markets and enhancing the possibilities to exploit comparative advantages (Krugman, 1991; Kessides, 1993). It does so irrespective of where the fuel is bought or under which flag the transport link is operated. With a sizeable share of world trade being transported over sea, it is likely that this relation holds for maritime transport as well albeit only for coastal states, of course. Available data on the geographical location of ship emissions suggests that most emissions are on sea lanes to and from Annex I countries (Wang et al., 2008).

In sum, without regard to the feasibility, the historical principle of CBDR would be served by differentiating commitments according to route or possibly ownership. The economic principle of CBDR would be served primarily by differentiating by route; differentiation by ownership would not be a preferred option.

In practice, if the principle of CBDR were applied to international aviation and maritime transport, Annex I countries could have reduction targets that are different from non-Annex I countries. In this case, the UNFCCC COP/MOP could instruct Annex I countries to reduce bunker emissions or include them in their national totals. For the mandate to have any effect, it would have to specify how the emissions would be allocated, otherwise the current deadlock would be continued. So in this case the text in a new protocol should instruct Annex I countries to include emissions on routes to these countries in their national totals and to limit emissions included in their national totals. Assistance of the IMO could be invoked to design policy measures.

Alternatively, if global uniform policy instruments were developed for these sectors, a clear mandate has to be given to *all* parties engaging in international transport to limit or reduce their emissions. Just mandating Annex I countries to do so would extend the current deadlock. In this case, emissions on all traffic routes would be affected. As this could potentially harm the sustainable development of some countries, a mechanism could be set up to compensate these countries, for instance by designing mechanisms that generate a flow of finance to developing countries. Ear-marking any such finance flow for either adaptation to or mitigation of climate change would in turn have implications for the broader climate negotiations and could thus lead to wider discussion of the topic.

2.3 Targets, policies and perhaps allocation

Apart from reconciling CBDR with uniform approaches of IMO, a second hurdle has to be cleared before maritime transport emissions can be included in a global climate policy framework. If emissions are allocated and included in national totals, national targets or base year emissions need to be adjusted. Furthermore, because shipping is a global industry, policies need to be coordinated globally. If, on the other hand, a uniform approach is taken, policies need to be developed and a target would need to be set.

This section addresses these issues. In any case, much closer coordination is needed between policy makers within IMO and UNFCCC than currently.

If emissions of international transport are to be allocated to countries, those countries should have a good understanding of which policy instruments are available to limit or reduce emissions. Likewise, they need to have a broad understanding of how a reduction target or a cap can be set for these sectors, or how the additional emissions under their national targets would affect their cap and the costs of meeting the caps. If these things are not known, countries face an unquantifiable risk and could react by opposing the inclusion of these emissions in their national totals.

As for allocation options and policies, CE et al. (2006a) have identified which policy instruments are compatible with different allocation options. These are shown in

Table 4. Please note that even though policy instruments may be compatible with certain allocation options, not all combinations will result in effective emission reductions.

Table 4 Policy instruments and compatible allocation options

Policy instrument	Gives states control over	Appropriate allocation options
R&D funding	Rate of technological progress	Nationality of transporting company, operator or country of registration
Technology standard	Rate of technology adoption by aircraft and vessel within jurisdiction	Nationality of transporting company, operator or country of registration Country of departure or destination of trip Country of departure or destination of cargo
Performance standard	Rate of technology adoption and performance by aircraft and vessel within jurisdiction	Nationality of transporting company, operator or country of registration Country of departure or destination of trip Country of departure or destination of cargo
Fuel taxes	Emissions from fuel sold within its jurisdiction	Country of fuel sales
Emission related charges	Emissions from aircraft and vessels within its jurisdiction	Nationality of transporting company, operator or country of registration Country of departure or destination of trip Country of departure or destination of cargo
Emission trading	Total emissions within the trading system	Country of fuel sales Nationality of transporting company, operator or country of registration Country of departure or destination of trip Country of departure or destination of cargo

Source: CE et al. (2006).

As for targets, they could be set much in the same manner as the Kyoto Protocol targets, i.e. a growth limit or reduction target on the basis of a historical baseline. For aviation, several inventory models can be used to calculate historical baselines. A well known application is Lee et al. (2005) which uses the FAST model to generate historical baselines for 1990 and 2000. For shipping, until recently no such studies were available. However, recently models have been developed to calculate historical baselines from available ship movement data (Paxian et al., 2008).

2.4 Conclusions

Since the most important principle in global climate policy is the principle of Common but Differentiated Responsibilities and the most important principle in international maritime policy is equal treatment of all ships, a global climate policy for shipping has to link these apparently conflicting principles in a creative way. There are two ways to do so:

1. Climate policy for maritime transport can start by differentiating commitments for Annex I and non-Annex I countries. In doing so, it cannot rely on the nationality of ships, as these can be changed easily and would thus lead to evasion rather than limitation of emissions. Instead, responsibilities have to be differentiated according to the route of vessels or, perhaps, according to the nationality of the ship-owner. National policies implemented to limit allocated emissions should not discriminate on the ground of nationality of the ship in order to be compliant with the principle ruling international maritime transport and in order to allow for effective policies.

2. Alternatively, climate policy for maritime transport can start by having uniform policies for all ships (perhaps above a certain size threshold or starting with certain specific ship types). In that case, in order to satisfy the principle of common but differentiated responsibilities, the net impacts of the policy on non-Annex I countries should be less than the net impact on Annex I countries. One way to do so is to implement a revenue-raising uniform policy and differentiate between country types in the use of the revenue.

3 Potential impacts on developing countries

Inclusion of maritime transport in a global climate policy could bring significant climate benefits. In order to reduce emissions, ship owners and operators will incur costs, which they will pass on to their clients. As a result, the cost of shipping will rise. This may have several impacts on developing countries, ranging from direct impacts such as higher costs of food imports to indirect impacts such as changed incentives for fragmentation of production. This report focuses on three potentially adverse impacts, viz. increasing costs of food imports, increasing costs of exports and tourism. These are discussed in Sections 3.1, 3.2, and 3.3 respectively. Section 3.4 focuses on the potential benefit of increased fleet turnover that may occur as ships with relatively high CO_2 emissions may become unviable.

3.1 Impacts on food import costs

Some countries are highly dependent on maritime transport for their food imports. Table 5 shows which countries have a high amount of food imports relative to their GDP. Islands in this table will import most of their food by sea (with the possible exception of perishables which may be imported by air).

Table 5 Food imports relative to GDP

Country	Food import (% of GDP, 1999-2004)
Sao Tome and Principe	28.02
Mauritania	24.36
Gambia	19.92
Liberia	19.30
Guinea-Bissau	18.96
Sierra Leone	17.82
Cape Verde	15.94
Occupied Palestinian Territory	14.77
Bosnia and Herzegovina	13.20
Guyana	13.16
Tonga	12.77
Lesotho	12.69
Senegal	12.65
Eritrea	11.63
Dominica	11.52
Samoa	11.23
Estonia	11.18
Mongolia	11.15
Suriname	10.99
Saint Lucia	10.95

Source: FAO statistical yearbook 2005-2006, Table C.13.

With the exception of Estonia, all countries listed in Table 5 are non-Annex I countries.

For the islands in Table 5, emissions associated with food imports have been estimated bottom-up using FAO figures on food imports. Details of the estimates are in Appendix I. We find that for these islands, emissions associated with food imports range from 0.6 to 1.0 kilotonnes of CO_2 for Dominica, which mainly imports from the USA and from other Caribbean islands, to 7 to 11 kilotonnes for Cape Verde, which has the highest imports in terms of weight. In total, emissions associated with food imports in these islands are 18 to 29 kilotonnes of CO_2 per year. The increase in the costs of food imports is presented in Table 6 under various carbon prices, assuming that all CO_2 emissions will be under the scheme.

Table 6 Increases in prices of imported food

Country	**Increase in costs of food imports (% of food import values)**		
	US$ 10/tonne of CO_2	US$ 30/tonne of CO_2	US$ 50/tonne of CO_2
Sao Tome and Principe	0.12-0.21%	0.37-0.62%	0.62-1.03%
Cape Verde	0.06-0.10%	0.18-0.30%	0.30-0.50%
Tonga	0.11-0.18%	0.33-0.55%	0.55-0.91%
Dominica	0.04-0.06%	0.11-0.18%	0.18-0.30%
Samoa	0.11-0.18%	0.32-0.53%	0.53-0.88%
Saint Lucia	0.01-0.02%	0.03-0.06%	0.06-0.09%

Source: See Appendix I. Note that these figures assume that all emissions will be included in the scheme and that impacts are not mitigated.

As a share of GDP, increased costs of food imports range from around 0.03% for a carbon price of US$ 10 to up to 1% for a carbon price of US$ 50, again assuming that all CO_2 emissions will be under the scheme and that impacts are not mitigates in any way (see Section 4.4. for examples).

3.2 Impacts on exports

Some countries are more export oriented than others. As a result, a significant share of their GDP may be in export-oriented industries. A large share of exports is transported over sea, certainly if measured on a weight basis. Climate policies that increase the costs of maritime transport may result in lower demand for exports from these countries.

The impact of climate policies on transport prices depends on the instrument. Market-based instruments on CO_2 emissions (or fuel use) raise the fuel costs of transport, which typically constitute between 30 and 60% of the total costs (Resource Analysis and CE, 2008). Table 7 indicates the additional costs for burning one tonne of HFO under a range of carbon prices. At a fuel price of around US$ 700 per tonne (the level of July 2008)[5], a carbon price of US$ 30 per tonne of CO_2 would add 13% to fuel costs and 4-8% on total transport costs. At a fuel price of around US$ 450 per tonne (the price level of January 2008)[5], the same carbon price would add 6-12% to total transport costs.

[5] Quoted prices on www.bunkerworld.com for IFO380 in Rotterdam.

Table 7 Impact of economic instruments on fuel costs

CO_2 price, direct or implied (US$/tonne of CO_2)	Fuel price increase (US$/tonne of HFO)
10	31
30	93
50	156

Note: One tonne of HFO yields 3.1144 tonnes of CO_2 on combustion (MEPC/Circ.471).

The impact of these cost increases of maritime transport on exports is hard to assess. In the short term, they are unlikely to have an impact on the exports of manufactured goods, as the transport costs make up only a small fraction of the total costs and even if these costs are passed through in the prices, they are unlikely to affect demand significantly. UNCTAD (2007) estimates total freight costs (for all modes of transport) to be 5.9% of the value of imports; the share is lower in developed countries (4.8 %) and higher in developing countries (7.7%, ranging from 4.4% in America to 10% in Africa). It is not known what the maritime freight costs are relative to the value of imports. Higher transport costs may have a larger impact on exports of raw materials, as transport costs make up a larger proportion of the total costs. Nevertheless, there will only be an impact if alternatives are available or if demand is reduced. In the longer run, higher transport costs could affect decisions to relocate production, bringing production closer to markets or halting the current trend of fragmentation of production. However, it has to be noted that many factors affect the choice of production locations, including relative costs of inputs of labour and materials, access to markets, et cetera.

Based on the estimates above, an increase in transport costs between 4 and 8% and a share of transport costs in value of 4 to 10%, it can be estimated that the increase in costs of import is less than 1% on average. This calculation assumes that all CO_2 emissions are included in the scheme which is different from e.g. the IMERS proposal.

As there are many other means to reduce transport apart from reducing exports (and even more ways to reduce emissions), the maximum impact of climate policies on profits would be the impact of higher costs on transport demand. This can be calculated by applying the price elasticity of demand to the cost increase.

There is only scarce information on price elasticity of maritime transport. Oum et al. (1990) present elasticities ranging from 0 to -1.1, with the low values (-0.06 to -0.25) typically for dry bulk for which there are hardly any alternative modes of transport, and the higher values (0 to -1.1) for general cargo. Meyrick and Associates et al. (2007) estimate the elasticity of non-bulk maritime transport to and from Australia at -0.23. Assuming an elasticity of -0.25, the 4-8% rise in transport costs could result in a reduction in maritime transport of 1-2% relative to a baseline which is forecasted to grow at over 3% per year (MARINTEK et al., 2008). So the cost increase would result in sacrificing about half a year of growth. As mentioned above, the reduction in exports is likely to be lower than this reduction in transport, as a share of the transport reduction will result from logistics improvements and other measures to reduce emissions, such as slow steaming.

3.3 Impacts on tourism

For some states, a significant share of GDP is earned in the tourism sector, and many tourists arrive by ship. Table 8 shows that for some tourist destinations in the Caribbean, cruise passengers arrivals exceed arrivals by other means by up to a factor of ten. And although arrivals are a very crude approximation of economic value, it is clear that the tourism sectors in these countries and regions are focused on cruise passengers.

Table 8 Importance of cruise tourism - the Caribbean as an example

Destination	Cruise Passenger Arrivals, including day visits (2005)	Total Arrivals of tourists who stay at least one night (2005)
Bahamas	3,349,998	1,514,532
Cozumel (Mexico)	2,519,179	276,515
US Virgin Islands	1,912,539	697,033
Cayman Islands	1,798,999	167,801
St Maarten	1,488,461	467,861
Puerto Rico	1,315,079	1,449,785
Jamaica	1,135,843	1,478,663
Belize	800,331	236,573
Barbados	563,588	547,534
Aruba	552,819	732,514

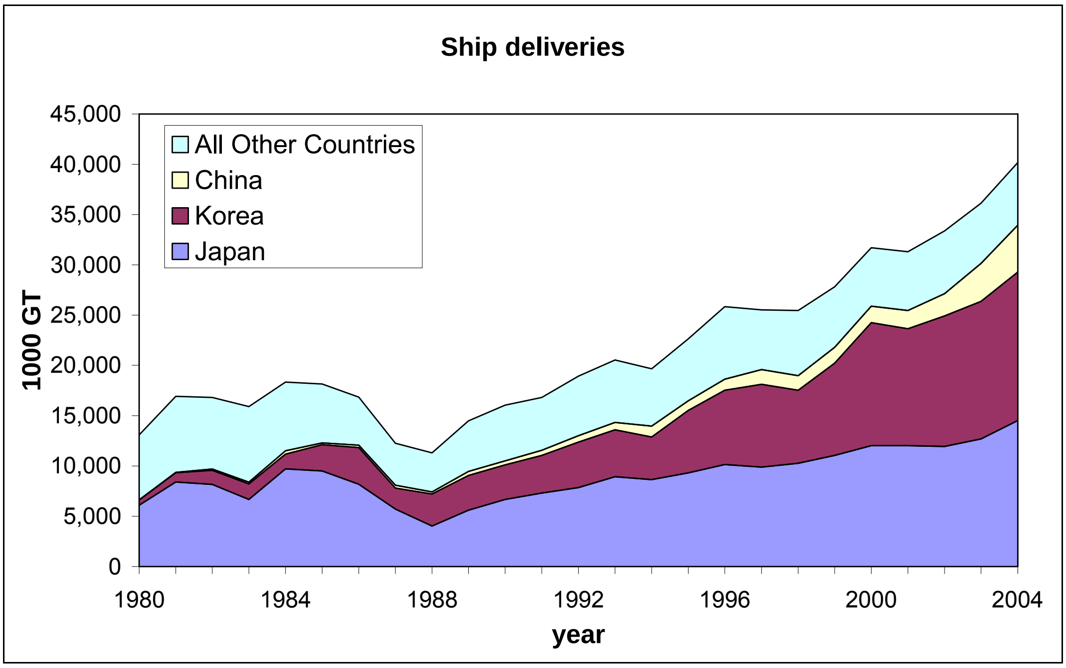
Source: Caribbean Tourism Organization.

Including maritime transport in a global climate policy regime could increase the costs of cruise travel and if this cost increase were to be passed through in prices, it could lower demand. This would not be primarily due to the own price elasticity of demand, as most studies find tourism demand to be price inelastic (price elasticities of -0.4 to -0.8, although there are notable exceptions) (Crouch, 1994). More important is the choice tourists face: cross-elasticities in tourism demand seem to be high (Maloney and Montes Rojas, 2005), implying that demand shifts easily from one destination to another. Cross-elasticities between modes of transport are not reported, but if these are as high as between destinations, one would expect a shift in demand to other modes of transport. However, these other modes also have emissions, and if these are also included in climate policy, relative prices of cruises are not expected to change much. The relative price of cruise holidays would only rise if maritime transport is included in climate policy, but aviation and car travel are not.

3.4 Impacts on shipbuilding

Including maritime transport in a climate policy is likely to result in a demand for ships with lower CO_2 emissions. This can be arrived at either by modifying existing ships or replacing them with new ships. As a consequence, including shipping is likely to have a positive effect on demand for shipyard services. As Figure 6 shows, most of the major shipyards are in Asia, and a significant number of them are in two non-Annex I countries.

Figure 6 Korea, Japan and China are the major shipbuilding nations

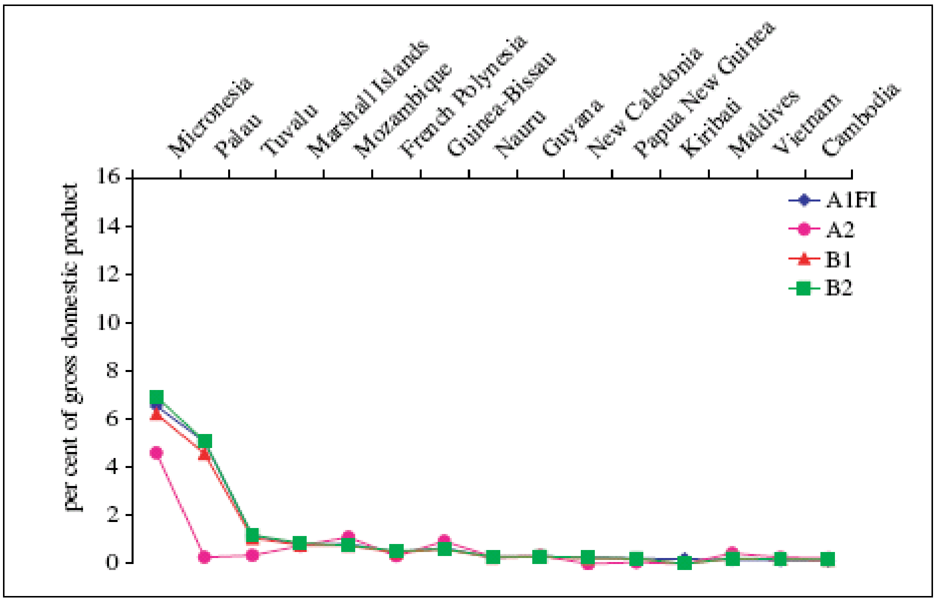


Source: Lloyds register.

3.5 Adaptation costs

Global adaptation costs are estimated to be US$ 4-37 billion this year and rise to US$ 28-67 billion in 2030, although higher estimates have been made (UNFCCC 2007, Stern Review 2006). There are few studies that systematically present costs for adaptation for different countries (IPCC, 2007a). Among the few studies that present global estimates, Tol (2002) estimates global protection costs for a one-metre sea level rise at approximately US$ 1,000 billion. Of these costs, approximately US$ 720 billion would be in non-Annex I countries. Nicholls and Tol (2006) estimate that a limited number of developing countries would be most heavily hit. Figure 7 shows that in 2020 Micronesia and Palau would face the highest relative costs, at 5-7% of GDP, depending on the scenario.

Figure 7 Estimated costs of adaptation to sea level rise in developing countries as a percentage of GDP, 2020



Source: Nicholls and Tol, 2006.

4 Architecture 1: uniform policies

Architectures for climate policy for maritime transport emissions have to reconcile the UNFCCC principle of Common But Differentiated Responsibilities with the IMO principle of No More Favourable Treatment. One way to do so would be to have a uniform policy instrument that raises revenue and then to differentiate the use of the revenue so that the net costs to developing countries would be zero or less (see Section 2.2). This chapter analyses proposals that have been made along these lines (Section 4.2). It briefly assesses their feasibility (Section 4.3) and evaluates ways to reduce undesired impacts on developing countries (Section 4.4). But first it expresses two basic requirements that have to be met for these policy options to be acceptable both to Annex I and non-Annex I countries (Section 4.1).

4.1 Basic requirements

The basic principle of uniform policy instruments with differentiated use of revenues would need to be in line with CBDR. So even though such an instrument would include emissions of non-Annex I countries (irrespective of how these would be defined), it has to be made clear that this would be exclusively for maritime transport emissions and that it would be done solely because of the specific characteristics of maritime transport emissions. The inclusion of these emissions should not set a precedent for including land-based emissions of non-Annex I countries as these have very different characteristics. If inclusion of land based emissions of non-Annex I countries would be considered desirable at some future point in time, it should be dealt with in a separate agreement.

At the same time, in order to be effective, the policy instrument should not reimburse the revenue proportional to emissions. After all, in that case there would not be an incentive to reduce emissions. So the use of the revenue should not be linked to maritime emissions or any other parameter directly related to it, such as exports, imports or transport work.

If these two requirements are not met simultaneously, the policy would likely be unacceptable to either Annex I or non-Annex I countries.

4.2 Proposed architectures

In recent years, a number of proposals have been made to address bunker fuel emissions with uniform instruments. This section evaluates two, viz. IMERS (Stochniol, 2008) (similar to the so-called Danish proposal and the similar Norwegian proposal and IMERS (MEPC 57/4/4; MEPC 56/4/9)) and METS (Kågeson, 2008) (similar to the so-called German proposal) (GHG-WG 1/x). IMERS (International Maritime Emission Reduction Scheme) proposes a levy on fuel acquisitions, the revenues of which would be used for funding adaptation, funding mitigation by acquisition of JI/CDM credits and REDD (Reducing emissions from deforestation and ecosystem degradation) credits, and funding research and development of low-emission ship technology. METS (Maritime Emissions Trading Scheme) proposes an emission trading system for maritime transport, linked to other emission trading schemes and open to JI/CDM credits. The emission allowances would initially be auctioned. The proposal for the use of the proceeds of the auction is not as elaborated as in IMERS, but reimbursement to the shipping industry has been mentioned, as well as funding of adaptation and REDD.

4.2.1 International Maritime Emission Reduction Scheme IMERS

IMERS would impose a levy on all fuel used by all ships above a certain size threshold (Stochniol, 2008). The levy would be proportional to the difference between actual emissions and an agreed global cap for shipping, so that as maritime emissions increase the levy per amount of fuel would be higher. Likewise, over time the levy would increase as the target for that year would be below the previous target. Upon entering a port, a ship would have to show that the levy has been paid on fuel it bought in the months preceding the port call. The revenues of the levy would feed into a global fund, from which the proceeds would be distributed as presented in Table 9.

Table 9 Use of revenues of IMERS as proposed in Stochniol (2008)

Total revenue	42%	Adaptation	32%	LDCs
			8%	SIDs
			60%	Other developing countries and EITs
	42%	Mitigation	50%	REDD
			50%	JI/CDM
	16%	Technology	50%	Short-term technology transfer
			50%	Long-term R&D

Source: Stochniol, 2008.

Stochniol (2008) has assessed the costs and benefits of IMERS for different country groups. As the calculations are not presented in a transparent way, we can just represent the results here. Stochniol (2008) assumes that the costs of IMERS are the additional costs of imports and that the proceeds will be distributed as in Table 9. The shares in total costs and receipts are presented in Table 10. Developed countries would pay the lion’s share of total revenue but receive only little from the funds. In contrast, all other country groups receive more than the increased costs of their imports. For these country groups, the components for which they receive funds differs. The LDCs and SIDS would benefit most from the scheme due to the significant adaptation financing. In contrast, the BRIC countries will benefit mostly from the CDM/JI investments and REDD funding.

Table 10 Revenue payment and receipts of IMERS according to Stochniol (2008)

Country group	Share of revenue payment	Share of revenue receipts
Developed Countries	59%	5%
Economies in Transition (without Russia)	2%	3%
BRIC	16%	30%
Least Developed Countries	1%	15%
Small Island Developing States	1%	4%
Other Developing Countries	22%	44%

Source: Stochniol, 2008.

The total revenue collected by IMERS depends on its parametrisation, especially the target, carbon price and emissions development. An example in Stochniol (2008) for a levy of US$ 27 per tonne of fuel, the receipts would approximate approximately US$ 10 billion per annum[6]. Of this, 42% would be used for offsetting emissions through JI/CDM and REDD, representing a net decrease of emissions of 140 Mt below the baseline. Least developed countries would receive US$ 1.3 billion annually and small islands developing states US$ 300 million, mainly for adaptation purposes. These receipts would increase over time, as carbon prices are likely to increase and the reduction target increases as well.

4.2.2 Maritime Emissions Trading Scheme METS

The Maritime Emissions Trading Scheme would set a cap for maritime transport emissions (Kågeson, 2008). The cap would be divided up into emission allowances. Ships would need to surrender allowances (or prove that they have done so) for emissions under the system when in port. The METS could be a system with global coverage, but Kågeson (2008) allows for a regional start of the system, e.g. only covering all traffic to ports in Annex 1 countries. Since this would clearly be a different architecture, this section concentrates on a uniform global scheme.

Kågeson (2008) proposes to auction the emission allowances. He mentions various options for use of the auction revenues, including direct reimbursement to the shipping sector (see also Resource Analysis and CE, 2008), adaptation and to reduce emissions from deforestation and ecosystem degradation (REDD). The proceeds would not be used to offset carbon emissions but by allowing ships to

[6] Using the more recent estimate of maritime bunker fuel sales the receipts would be 15-20% lower (MARINTEK et al., 2008).

surrender JI/CDM credits, it would result in investments in sustainable development of developing countries.
Depending on the prevailing carbon price which in turn is determined by the cap and the marginal abatement cost in the system, the proceeds of the auction may be in the order of US$ 30-45 billion per annum. This is actually higher than IMERS, but in both systems the revenues can be increased or lowered by changing design parameters of the system, such as the amount of emissions under the system, the carbon price, et cetera.

4.3 Feasibility

Both IMERS and METS need accurate monitoring and reporting of emissions or alternatively fuel use and carbon content. This should not be a problem once appropriate reporting mechanisms have been developed, since all the data is available on board ships and in the information systems of ship operators. The 2007 Technical workshop meeting on emissions from aviation and maritime transport concluded that 'fuel consumption data needed for present and future reporting purposes are available … in the shipping sector'[7]. One of the bases for fuel consumption or purchase data would be the bunker delivery notes that ships have to keep on board. There may be need for external verification of the data (GHG-WG 1/x), which can be organised in much the same way as verification is currently organised within the EU ETS.

Both schemes depend on Port State Control (PSC) for enforcement. As the ultimate penalty Port States have is detention of the ship, PSC generally has high levels of compliance. Port states may also ban ships that do not comply from their ports (Kågeson, 2008).

4.3.1 Possibility for evasion

When enforcement is done by PSC, some countries may not enforce METS or IMERS. In that case, the system could be evaded by just sailing to ports in these countries. Doing so would reduce the costs of shipping considerably, but it would be very expensive for such a ship to sail to an enforcing country. After all, before entering a port in such a country it would have to pay the IMERS levy or surrender METS allowances for the last relevant period. If many countries fail to enforce, a situation could arise in which some ships sail on routes to enforcing countries and others just sail between non enforcing countries.

4.4 Mitigating impacts on developing countries: exclusion criteria

One of the ways to minimise undesired impacts on developing countries could be to exclude certain ship types, sizes or classes, or certain types of cargo from the scheme. This chapter explores some possible thresholds and analyses their main advantages and disadvantages. Please note that it has not been possible within

7 'Technical workshop on GHG emissions from aviation and maritime transport in Oslo 4-5 October - conclusions by the organisers'.

the context of this study to carefully assess all the impacts of the thresholds in detail. Therefore this chapter should be regarded as a first exploration of the subject rather than the final word.

This chapter assesses three options to exclude certain ships, with special emphasis on administrative complexity and impacts on developing countries. The first option is to exclude ships on the basis of the type of cargo they carry. The second is to exclude certain ship types. And the third option is to exclude ships below a size threshold. In analysing the impacts on developing countries, the emphasis is on food imports to small island states, as previous chapters have shown this to be one of the main undesired impacts.

Note that the exclusion of routes based on the development status of the country of origin or destination is not considered in this chapter as it is the basis for the route-based differentiation as discussed in Chapter 5.

4.4.1 Exclusion criterion: type of cargo

One possibility would be to exclude certain types or cargo, such as food. Food can be defined unequivocally in terms of the Standard International Trade Classification (SITC). In this classification, food items are in SITC category 0 (Food and live animals), 1 (Beverages and tobacco), 22 (Oil-seeds and oleaginous fruits) and 4 (Animal and vegetable oils, fats and waxes). SITC or similar classifications are used worldwide by statistical agencies, customs and other organisations.

When a ship carries only food, all its emissions could be excluded from a climate instrument. If it carries several products, including food, a share of the emissions could be excluded proportional to the weight-share of the food in the total cargo carried.

Applying the criterion has a number of disadvantages. Ships would need to monitor fuel use or emissions on every trip as well as the nature of their cargo. Although this could be organised, it would be administratively complex. It would require countries to invest heavily in monitoring and enforcement as exempted cargo ahs to be distinguished from other cargo, thereby reducing the efficiency of the scheme. Furthermore, this criterion could be considered inequitable by countries that are self-sufficient in food but lack other basic materials. Expanding it to include other tradable items would be possible, but would reduce the scope of the scheme. Furthermore, as more items are excluded, the system would move to a differentiated scheme as discussed in Chapter 5, which would be simpler to implement.

In summary, the exclusion of certain types of cargo would be administratively complex and would reduce the efficiency of the scheme.

4.4.2 Exclusion criterion: ship type

Exclusion of ships on the basis of the type of ship could be a way to mitigate undesired impacts on certain countries. For example, if it is deemed undesirable that countries dependent on cruise tourism would be hit, one could exempt cruise ships from the scheme. This would be straightforward. It would be much harder to mitigate the other impacts that are central to this analysis. Food, for example, can be imported by a number of ship types: general cargo, dry bulk, reefer and container ships all carry food. And since ships are to a degree flexible in the type of cargo they carry, excluding ship types would distort shipping markets.

4.4.3 Threshold for ship size

A threshold on ship size would exclude all ships smaller than a certain size limit from the global scheme, irrespective of where they sail, what cargo they carry and what ship type they are. The basic idea is that small, developing economies trade considerably less than large developed economies. As a result, they may be serviced by smaller ships. Whether or not this assumption is reasonable will be discussed in this section below. A possible co-benefits of such a threshold would be a reduction of the total administrative burden. Disadvantages would be a reduced scope of the scheme and a distortion of some markets. All these issues will be briefly discussed below.

We have conducted a small survey to assess whether the assumption holds that small economies are serviced by small ships. The information received is sketchy, so the remainder of this section should be seen as a first exploration of the subject rather than the final answer[8].

Small and isolated economies such as small island states are generally serviced by small ships. For example, all ships sailing to the Cook Islands are smaller than 2,400 GT, although its main port can accommodate ships up to approximately 4,000 GT[9]. Slightly larger economies or ports that cater to cruise ships are often visited by larger vessels. For example, in St. Lucia most ships are smaller than 2,000 GT, except for cruise ships, car & truck carriers and container ships, which are generally well over 7,000 GT[10]. The main port of St. Kitts can accommodate the worlds largest cruise ship, the Queen Mary 2, which is almost 150,000 GT in size. Bangladesh, a still larger economy, imports and exports most goods with ships below 7,000 GT, although ships up to 11,000 GT sail to its ports[11].

This brief survey shows that a threshold of, for example, 3,000 GT would probably exclude most or all ships sailing to the smallest and most isolated economies, mainly small island states. Larger thresholds would exempt shipping

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8 In principle, it would be possible to use data from e.g. Lloyds MIU to assess ship sizes at different ports, or to do a full survey of all major ports in relevant countries. Both options were regrettably beyond the scope of this work.

9 Personal communication Pasha Carruthers and Glenn Armstrong Oyster.

10 http://www.slaspa.com/c_reports.php

11 personal communication Mozaharul Alam.

to an increasing number of states, but would have the disadvantage of distorting markets, as is shown below.

An advantage of this exclusion criterion is that it would be feasible to implement and enforce. A ships size is well documented and is also often the basis for port charges or registration fees. Another advantage is that it would reduce the total administrative burden of the scheme.

A disadvantage of this exclusion criterion is that it would reduce the scope of the scheme. MARINTEK et al. (2008) contains data on emissions per ship type and class. Based on these data, we estimate that a threshold of 1,000 GT would exclude approximately 1.5% of maritime CO_2 emissions. The exclusion is distributed unevenly across ship types. Whereas only a very small share of emissions from crude tankers and bulk carriers would be excluded (less than 0.5%), up to 10% of emissions of product tankers would be excluded. The reason is that on average bulkers and crude tankers are much larger than product tankers. A threshold of 3,000 GT would exclude around 5% of emissions, again with higher shares of emissions excluded from product tankers. Another disadvantage is that small ships are generally less efficient than large ships (CE Delft et al., 2006). It could be considered to be inequitable to exclude inefficient ships from the scheme.

Yet another disadvantage is that this exclusion criterion could distort markets. To assess the size of this distortion, we contacted three European Ports[12]. All of these ports indicated that they had very few ships smaller than 1,000 GT. representatives of these ports indicated that ships below this size would mainly be fishing ships. One of the ports indicated that it had quite a few ships smaller than 3,000 GT, and also a lot in the category just above 3,000 GT. This indicated that both thresholds could distort the shipping market in Europe, and that the market distortion would be higher for a higher threshold. The other ports, however, had very few ships below 3,000 GT.

Smaller ships generally sail shorter distances. Analysis of port call data of the port of Antwerp shows that in 2005, 2% of port calls were made by ships smaller than 1,000 GT, two thirds of which came from other European ports. 28% of calls were made by ships smaller than 3,000 GT. Of these, only 2% did not come from other European ports. These data seem to indicate that a threshold of 3,000 GT could distort regional markets but would not affect markets for maritime transport over large distances. A lower threshold would still distort markets, but the distortion would be significantly less severe.

Based on this assessment, we conclude that the exclusion based on ship size merits more analysis. It seems to be able to shield small island states and perhaps least developed countries from some of the impacts of a global scheme.

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[12] These are Rotterdam, Antwerp and Zeebrugge.

This comes at the price of a slightly smaller scope of the system and a possible distortion of markets, at least in Europe.

4.4.4 Conclusion

Of the three exclusion criteria examined in this chapter, exclusion of small ships on the basis of their size seems to be the best was to mitigate undesired impacts on small island states and perhaps also on least developed countries. It would have some disadvantages that should be considered, but these seem less severe than the disadvantages of the other criteria. It has to be stressed that this conclusion is based on a limited survey of relevant data. Therefore, it should not be regarded as the final conclusion on this subject but rather as a conclusion of the first evaluation.

4.5 Conclusion

Both the International Maritime Emission Reduction Scheme (IMERS) and the Marine Emissions Trading Scheme are effective and equitable architectures for a global climate policy for shipping. They are uniform policies that raise revenue. The use of this revenue can be differentiated between country groups so as to ensure that the burden of reducing emissions would be on Annex I countries and non-Annex I countries may benefit on balance.

In order to be acceptable to non-Annex I countries, these policies would need to specify that the inclusion of emissions from non-Annex I countries (however defined) is exclusive for maritime transport emissions. The sole reason for doing so lies in the specific characteristics of maritime transport emissions. The inclusion of these emissions should not set a precedent for including land-based emissions of non-Annex I countries as these have very different characteristics.

For most non-Annex I countries, impacts on food prices would be limited. There could also be other undesired impacts. For small island states and other small economies, the exclusion of small ships would be a way to reduce the negative impacts. On balance, all groups of developing countries would receive more funds from the scheme than the prices of their imports would rise. Both policies could raise significant funds for adaptation to climate change. However, it is unlikely that these funds alone could cover all the costs of adaptation.

5 Architecture 2: allocation

As noted in Chapter 2, one of the reasons for not having international transport incorporated in a global climate policy regime is that the Kyoto Protocol requires Annex I countries to pursue limitation or reduction of emissions of greenhouse gases from marine bunker fuels, but it fails to specify which emissions these countries should reduce. By making a reference to the IMO which develops policies that need to be adhered to by all ships (and enforced by Port States) and allows countries only to surpass policies or standards for ships under their flag, the impression could arise that Annex I countries are to reduce emissions of ships flying their flag. However, most observers agree that this would not result in global emission reductions or even limitations because of the relative ease of registering a ship in another country.

One way of breaking the deadlock would be to continue to require of Annex I countries to reduce emissions, but to specify which emissions they should reduce in such a way that it would enable the development of effective policies. This chapter explores this route of allocation of emissions to countries. Section 5.1 presents the main allocation options and selects two for further analysis. Appropriate policy instruments for these allocation options are assessed in Section 5.2, Section 5.3 addresses evasion. Impacts on developing countries are assessed in Section 5.4. Section 5.5 concludes.

5.1 Allocation options

In the process that led to the Kyoto Protocol, studies were made on the allocation of bunker emissions to countries for inclusion in their national totals. At the Conference of the Parties (COP) 1 in 1995 the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) was requested to address the issue of allocation and control of emissions from international bunker fuels[13]. The UNFCCC secretariat presented a paper at SBSTA 4 (1996), including eight allocation options for consideration. These options were:

1 No allocation.
2 Allocation of global bunker sales and associated emissions to parties in proportion to their national emissions.
3 Allocation according to the country where the bunker fuel is sold.
4 Allocation according to the nationality of the transporting company, or to the country where an aircraft of ship is registered, or to the country of the operator.

[13] For a more elaborate background on the process within the UNFCCC, consult its website at: http://unfccc.int/adaptation/methodologies_for/vulnerability_and_adaptation/items/3416.php (consulted 7 July 2008).

5 Allocation according to the country of departure or destination of an aircraft or vessel; alternatively, emissions related to the journey of an aircraft or vessel shared by the country of departure and the country of arrival.
6 Allocation according to the country of departure or destination of passengers or cargo: alternatively, emissions related to the journey of passengers or cargo shared by the country of departure and the country of arrival.
7 Allocation according to the country of origin of passengers or owner of cargo.
8 Allocation to a party of all emissions generated in its national space.

Later, SBSTA decided that the options 1, 3, 4, 5 and 6 should be the basis of further work. The three discarded options have several important disadvantages. To name a few: option 2 would not be equitable and would lead to practical problems, such as assigning maritime emissions to land-locked countries that have no control over them; option 7 would suffer from heavy data requirements; and option 8 would leave emissions on and over the high seas outside the responsibility of any party.

Subsequent analyses have shown that some of the other allocation options have major disadvantages for maritime transport (CE et al., 2006a). When emissions are allocated according to fuel sales (option 3), countries would need to control these sales by means of fuel charges or taxes, or by linking fuel sales to an emission trading system. Regardless of the choice of policy, fuel in countries with a quantitative emission target would become more expensive. Past experience has shown that fuel sales can move to different locations very rapidly (Michaelis, 1997). Consequently, this allocation option would likely result in a transfer of emissions from Annex I to non-Annex I countries without a limitation or reduction of emissions.

When emissions are allocated to the country of departure or destination of cargo (option 6), the administration of any policy would be very complex, especially for ships that carry cargo to multiple destinations, which is often the case for container ships (CE et al., 2006b). In that case, emissions of a ship would have to be allocated to the different cargo items. So verifiable data needs to be reported both on emissions on every leg of a route and on cargo on every leg.

On the basis of these considerations, this Chapter analyses allocation options 4 (route-based allocation) and 5 (allocation to nationality of the owner of a vessel).

5.1.1 Route-based allocation

Route-based allocation would result in emissions from ships on routes to ports being added to the national totals of the countries in which the ports are located.

Port calls of ships are registered in logs and can be verified if needed with port authorities. In most cases, ships also register fuel use in their logs. In any case, they can be required to do so. So it is possible to calculate for example emissions on the last route of a ship to a port in an Annex I country on the basis of a ship's log. The only exception to this rule would be when ships transfer their cargo to other ships at sea. In the liquid bulk trade, ship-to-ship (STS) transfer is common, where often a large tanker offloads its cargo to several smaller tankers at sea, which in turn transport the cargo to the port. In 2007, tankers accounted for approximately one fifth to a quarter of total maritime CO_2 emissions, although only a fraction of these emissions were from ships engaged in STS (MARINTEK et al., 2008). For ships engaged in STS, special provisions would need to be made under route-based allocation.

If this allocation option were chosen, countries with emission targets would need to implement policies to control emissions on these routes. These are discussed in Section 5.2.

5.1.2 Allocation to the country of the owner of the vessel

Allocation to the country of the owner of a vessel would mean that all emissions by ships owned by a company located in a certain country would be added to that country's total. The main obstacle in implementing this option would be to define what 'located' means. Without going into details, the definition would probably start from where the parent company that owns a ship is registered. As shown in Table 3, the ownership of ships is concentrated in Annex I countries.

At present, UNCTAD reports regularly on ownership of the world fleet in its *Review of Maritime Transport* (UNCTAD, 2007). This suggests that at least in principle, the ownership of a vessel can be established in many, but not all cases. UNCTAD (2007) specifies that 'determining (the country of domicile of the owner) has required making certain judgements'. It remains to be seen whether such judgements can be ruled out by a clear definition of the nationality of the owner.

5.2 Policies and measures

When Annex I countries are required to limit or reduce emissions of ships on routes to their ports, they can do so by either levying emissions charges or including the emissions in a cap-and-trade system (CE et al., 2006a). If they do not want to use market-based instruments, they can also require ships sailing to their ports to meet with certain performance or technology standards, to reduce speed or to implement other measures to reduce emissions.

5.3 Possibility for evasion

Under any allocation option, countries would probably implement policies that would reduce ship emissions included in their national totals. As this would probably increase the costs of operating ships, operators would have an incentive to evade the policy. This section discusses the possibility and likelihood of evasion.

5.3.1 Allocation to the country of the owner of the vessel

Allocation to countries of ownership could in theory be evaded by relocating the domicile country. It is known from other sectors that the locations of company head offices are flexible and are often in countries with favourable tax regimes. Many ships are owned by investment vehicles such as Limited Partnerships (UK), Kommanditgesellschafte (Germany) or Commanditaire Vennootschappen (Netherlands). Provided that national legal systems enable such partnerships, these investment vehicles can choose their domicile freely and may change their domicile at little cost, just as other investment vehicles can. Currently, many are located in Annex I countries, probably because their investors are located in these countries, but there is if it would become financially attractive to move to other countries, they could do so easily. On these grounds, we do not consider allocation to the country of the owner of the vessel a viable option.

5.3.2 Route-based allocation

A route-based allocation would very likely coincide with route-based policies, i.e. policies that would increase the price of operating on certain routes. Such policies can in principle be evaded by not sailing on these routes or by artificially lowering emissions on these routes.

There are several ways to avoid sailing on a route. One could offload cargo in non-Annex I countries and transport it by another mode of transport to an Annex I country. Alternatively, a ship could make an extra port call in a non-Annex I country closest to its port of destination.

An extra port call would be costly, as a ship would have to reduce speed, sail into the port, turn around and accelerate to its cruise speed again. Furthermore, in many cases a port call would imply a detour. In general, the length of a port call is determined by the time it takes to unload and load cargo. A large bulk carrier or tanker may stay in a port for up to three days; a small containership may leave after eight hours. If no cargo was unloaded or loaded, and the port call only took a couple of hours, the total delay would be at least six to eight hours. Still, example calculations show that the incentive for evasion could be sufficient to overcome these costs (see Textbox 1).

Textbox 1: incentives and costs of evasion
A large (4,000 TEU) containership sailing from Shanghai to Antwerp sails approximately 10,500 nautical miles at 23 knots. This ship has an average fuel consumption of 200 tonnes per day, so it emits about 12,000 tonnes of CO_2 on the trip. At carbon prices of US$ 10, 30 and 50 per tonne of CO_2 these emissions would cost US$ 120,000, US$ 360,000 and US$ 600,000, respectively. Operating such a ship may cost between US$ 150,000 and 300,000 per day. So adding an extra stop just outside an Annex I country and reducing emissions by 80% would be feasible at carbon prices of US$ 30 per tonne of CO_2 if the port call took about one day (neglecting port dues).

A large (300 dwt) tanker sailing from the Persian Gulf to Rotterdam sails approximately 6,000 nautical miles at 16 knots. With an average fuel consumption of 95 tonnes per day it emits about 4,800 tonnes of CO_2 on the trip. At carbon prices of US$ 10, 30 and 50 per tonne of CO_2 these emissions would cost US$ 48,000, US$ 144,000 and US$ 240,000, respectively. Operating such a ship may cost between US$ 100,000 and 150,000 per day. So adding half a day to the trip in order to halve emissions could be worthwhile at carbon prices of US$ 30 per tonne of CO_2. For this ship, evasion could be ruled out if a route was defined as the route between the last port where at least half of the cargo was loaded or offloaded and the current port, as it would probably take more than one day to load of offload this amount.

5.4 Mitigating impacts on developing countries

5.4.1 Food imports

Under route-based allocation of emissions and associated policy instruments, such as emission charges or emission trading, costs of imports to these countries would not increase because the routes would not be subject to a cap. Under allocation according to the owner of the vessel, and assuming that the nationality of ownership would not change, many of these countries will be affected as 66.8% of the world fleet is controlled by nationals from developed countries (be they persons or companies) (UNCTAD, 2007, p34).

As a consequence, in a route-based system of allocation there would be no need to mitigate the adverse effects on food prices, as there would not be any.

In a system where emissions are allocated to owners, costs of food imports would be affected if the food is carried on ships owned by nationals of Annex I countries. In that case, it could be possible to exclude vessels carrying only food or predominantly food from the scheme, although this would be administratively complex for vessels carrying different types of cargo, such as container vessels and, to a lesser extent, general cargo vessels. If this could nevertheless be implemented, there could be a limited risk of market distortion.

5.4.2 Exports

Some countries are dependent on maritime transport for their exports. Some developing countries are claimed to have experienced periods of export-led economic growth[14]. Climate policy instruments such as cap-and-trade systems or

[14] Please note that the relation between exports and economic growth is still a topic of academic discussion among economists.

charges, but also technology standards, may raise the costs of exports. And even though the few studies on price elasticities of maritime transport show very low values on the short run (see section 3.2), it is likely that higher transport costs will lead to geographical concentration of production chains, lower exports and potentially lower economic growth.

Under route-based allocation and route-based policy instruments, trade between non-Annex I countries and Annex I countries would be affected, but trade amongst non-Annex I countries would not. This would exclude a significant share of exports[15]. For the remaining loss of exports, it would in principle be possible to compensate most affected countries in another way, using for example the proceeds of policy instruments. As is shown in

[15] According to UNCTAD, 57.9% of seaborne cargo was unloaded in developed countries in 2006 (UNCTAD, 2007).

Table 4, policy instruments that could be used to control emissions on routes are technology or performance standards, emission charges and emission trading. The latter two would have proceeds that may be used to fund adaptation or mitigation in developing countries. Also, policies may be designed as to enable offsetting emissions with CDM credits, thereby contributing to sustainable development of non-Annex I countries.

Assuming that the emissions of maritime transport on routes to Annex I countries would be proportional to the value of exports to these countries, approximately 60% of total maritime emissions could be included in national totals of Annex I countries by route-based allocation. If emission charges were levied or emission trading would be implemented with initial auctioning of emissions, a carbon price of US$ 30 would have yielded revenues of 60% * 847 Mt * US$ 30/tonne = US$ 15 billion. Of course, when only a share of the emissions (e.g. emission growth) would be covered under the scheme, revenues would be less.

Under allocation to countries of ownership both exports to Annex I countries and to non-Annex I countries would be affected by policy measures, assuming that the current ownership structure would not be affected. In that case, about two thirds of all maritime transport would be subject to emission reducing policies. Again, proceeds of economic instruments could be used to fund adaptation or mitigation, or owners could be allowed to offset their emissions by using CDM credits.

Assuming that the ownership structure of the fleet would remain stable and that ships owned by Annex I nationals emit as much as ships owned by non-Annex I nationals on average, over two thirds of total maritime emissions would be included in national totals of Annex I countries. If these countries impose a carbon price of US$ 10 per tonne of CO_2, the proceeds of an emission charge or an auction of emission allowances could be in the order of US$ 5.7 billion.

5.4.3 Tourism

Under route-based allocation of emissions and associated policy instruments, such as emission charges or emission trading, costs of tourism to non-Annex I countries would appear not to be affected, as routes to these countries would be included in national totals of these countries, which would not be subject to a target. However, assuming that cruises are often round trips, as least one leg of the cruise would be subject to climate policies.

Would this reduce demand for cruises? Probably not, if simultaneously to maritime transport, aviation were also included in a global climate policy. After all, elasticities indicate that as long as people's incomes increase, their demand for holidays increases, even if the costs of a holiday go up. However, people may choose the cheapest option available to them. Assuming a cruise ship emits less than an aircraft, the cost increase of a cruise holiday would be less than the cost increase of an air travel holiday and cruises may become more popular.

5.5 Conclusion

It is possible to allocate maritime transport emissions to countries in such a way that it would enable Annex I countries to effectively limit or reduce emissions. The most effective way seems to be route-based allocation. The definition of a route would need more attention in order to prevent evasion. This definition should probably include requirements to load or unload a significant amount of cargo in the port visited before setting sail to an Annex I country.

The impacts of allocation on food imports in developing countries would be zero. It would impact on exports from non-Annex I countries to Annex I countries, but these exports account for less than half of total exports in value. On the other hand, non-Annex I countries would most likely benefit from carbon offsetting CDM project investments. If required, undesirable impacts could be mitigated by instructing Annex I countries to use revenue-raising policy instruments to reduce emissions and use a share of the revenue to fund adaptation.

6 Conclusions

The inclusion of international aviation and shipping emissions in a global climate policy framework has proved to be a difficult issue. In the run-up to the Kyoto Protocol, different options were studied to allocate emissions to countries and thus include them in the national totals, but no agreement could be reached. Instead, the Kyoto Protocol calls on Annex I countries to limit or reduce emissions 'working through the International Civil Aviation Organization and the International Maritime Organization' (KP, Article 2.2).

To date, the Annex I countries have not been successful in limiting or reducing greenhouse gas emissions from international transport. Both at the UNFCCC level and in ICAO and IMO, little progress has been made in working towards effective policy instruments.

As the world is engaging in several processes to define long-term cooperative action for all and further commitments for Annex I parties, the issue of bunker fuels is again attracting attention.

Since the most important principle in global climate policy is the principle of Common but Differentiated Responsibilities and the most important principle in international maritime policy is equal treatment of all ships, a global climate policy for shipping has to link these apparently conflicting principles in a creative way. There are two ways to do so:

1. Climate policy for maritime transport can start by differentiating commitments for Annex I and non-Annex I countries. In doing so, it cannot rely on the nationality of ships, as these can be changed easily and would thus lead to evasion rather than limitation of emissions. Instead, responsibilities have to be differentiated according to the route of vessels. National policies implemented to limit allocated emissions should not discriminate on the ground of nationality of the ship in order to be compliant with the principle ruling international maritime transport and in order to allow for effective policies.

2. Alternatively, climate policy for maritime transport can start by having uniform policies for all ships (perhaps above a certain size threshold or starting with certain specific ship types). In that case, in order to satisfy the principle of common but differentiated responsibilities, the net impacts of the policy on non-Annex I countries should be less than the net impact on Annex I countries. One way to do so is to implement a revenue-raising uniform policy and differentiate between country types in the use of the revenue.

For the first option, it is possible to allocate maritime transport emissions to countries in such a way that it would enable Annex I countries to effectively limit or reduce emissions. The most effective way seems to be route-based allocation. The definition of a route has to carefully limit the possibilities of evasion. This definition should probably include requirements to load or unload a significant amount of cargo in the port visited before setting sail to an Annex I country. Furthermore, special provisions may need to be made for ships engaged in ship-to-ship transfer of cargo.

Allocation can be combined with either emission charges or emission trading. Both options could raise revenue, some of which may be used to fund adaptation projects or sustainable development.

The impacts of allocation on food imports in developing countries would be zero. It would impact on exports from non-Annex I countries to Annex I countries, but these exports account for less than half of total exports in value. On the other hand, non-Annex I countries would most likely benefit from carbon offsetting CDM project investments. If required, undesirable impacts could be mitigated by instructing Annex I countries to use revenue raising policy instruments to reduce emissions and use a share of the revenue to fund adaptation.

Both the International Maritime Emission Reduction Scheme (IMERS) and the Marine Emissions Trading Scheme are effective and equitable architectures for a global climate policy for shipping along the second line identified above. They are uniform policies that raise revenue. The use of this revenue can be differentiated between country groups so as to ensure that the burden of reducing emissions would be on Annex I countries and non-Annex I countries may benefit on balance.

In order to be acceptable to non-Annex I countries, these policies would need to specify that the inclusion of emissions from non-Annex I countries (however defined) is exclusive for maritime transport emissions. The sole reason for doing so lies in the specific characteristics of maritime transport emissions. The inclusion of these emissions should not set a precedent for including land-based emissions of non-Annex I countries as these have very different characteristics.

For most non-Annex I countries, impacts on food prices and import costs would be limited. In order to mitigate this small impact for the smallest and most remote economies, regard could be had to exclusion of ships below a certain size threshold. However, on balance, all groups of developing countries would receive more funds from the scheme than the increased price of their imports. Both policies could raise significant funds for adaptation to climate change. However, it is unlikely that these funds alone could cover all the costs of adaptation.

In comparing the differentiated and uniform policies, both have their advantages and disadvantages. Uniform policies have the advantage that they are hard to evade, but they would need inclusion of non-Annex I emissions and a new organisation to collect and spend the funds. Differentiated policies would provide incentives for evasion but would have a much more limited impact on non-Annex I countries.

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Left on the High Seas

Global Climate Policies for International Transport

October 2008 update

Annex

Report

Delft, October 2008

Author(s): Jasper Faber

A Calculating the cost increase of food imports

Cost increases of food imports have been calculated using the following formula:

$$\Delta C_{Food\,\mathrm{Im}\,ports,i} = \frac{p_{CO2} \times \eta_{CO2} \times T_{Food\,\mathrm{Im}\,ports,i}}{C_{Food\,\mathrm{Im}\,ports,i}}$$

Where:

$\Delta C_{FoodImports,i}$	: The change in food import costs for country i expressed as a percentage of GDP
pCO_2	: The prevailing price of CO_2
ηCO_2 –	: The CO_2 efficiency of food transport
TFoodImports,I	: The transport work (in tonne miles) of food imports in country i
CiFoodImports	: The value of foods imported in country i

The transport work of food imports has been calculated as:

$$T_{Food\,\mathrm{Im}\,ports,i} = D_i \times Q_i$$

Where:

D_i : The average distance between the largest port in i and the largest ports in its three main trading partners for food imports

Qi : The quantity of food imports in i (in tonnes)

GDP (mln. US$)

The plain data was taken from FAO's database The Compendium of Food and Agriculture Indicators 2006.
Selecting a country from http://www.fao.org/statistics/compendium_2006/list.asp provides the factsheet on food and agriculture indicators of that country, for source year 2004. Sources of the factsheets are both FAOSTAT and the World Bank.

Main Port

The First source was the WordPortRanking2006. The largest port for countries (on the basis of total cargo volume in millions of tonnes) was looked up in this list. For countries not listed here, the largest port was looked up via http://www.worldportsource.com/countries.php (listing ports per country), on the basis of size (large, medium, small, very small) and type (wharf, jetty, seaport). If on the basis of these criteria proper selection was not possible, the largest port was found via a general internet search.

Food Imports (million USD, 2004)

The plain data was taken from FAO's database The Compendium of Food and Agriculture Indicators 2006.
Selecting a country from http://www.fao.org/statistics/compendium_2006/list.asp provides the factsheet on food and agriculture indicators of that country, for

source year 2004. Sources of the factsheets are both FAOSTAT and the World Bank.

The subindicator 'Agricultural' of the indicator 'Foreign Trade - Imports' was assumed to represent the country's food import. However, this indicator refers to crop and livestock products only, i.e. fishery products are not included.

Food Imports (1,000 tonnes, 2004)
The data was derived from FAO's database The Compendium of Food and Agriculture Indicators 2006, as plain data on food import quantity was not available.
Selecting a country from http://www.fao.org/statistics/compendium_2006/list.asp provides the factsheet on food and agriculture indicators of that country, for source year 2004. Sources of the factsheets are both FAOSTAT and the World Bank.

The indicator 'Imports' shows a list of 'Main Agricultural Products', both as quantity (1,000 tonnes) and as value (million USD). In addition, it provides a 'Total of Agricultural Products', as value only (million USD). The sum of 'Main Agricultural Products' does not equal the subindicator 'Total Agricultural Products'. There is a gap of 20 to 50% between the two (depending on country). Assuming the emphasis of food import to the islands is on bulk products/commodities[16], the ratio of 'Total of Agricultural Products' over 'Main Agricultural Products' is expected to be approximately the same for value and quantity. Therefore, the indicator 'Food Imports (1,000 tonnes)' was derived by applying this ratio to the sum of 'Main Agricultural Products'.

Main Trading Partners
Plain data, both on trading partners and on traded quantities, was taken from FAO's statistics database FAOSTAT http://faostat.fao.org/site/537/default.aspx, for the most recent data year available. The latter varies per country and per commodity.

Distance to Trading Partners (nautical miles)
Within the scope of this project, it was not feasible to research in detail the trading routes between the countries examined. Therefore, we made the assumption that all trading routes are from main port of exporting country to main port of importing country. In some cases, the route to/from the main port implies a major detour, and may therefore not to be the most realistic route. For this reason, we give some additional distances to/from large ports other than the main ports.

[16] Commodities import (i.e. a mix of flour, meat, beverages, etc.) typically represent relatively low value per unit weight, as opposed to specialties (i.e. herbs, etc.) which typically have a relatively high value per unit weight.

For finding distances between ports, the website
http://www.portworld.com/map/?gsid=b89826df0ddfc1595be5808aface0854&asi=1
was primarily used. For ports not available from this website, a neighbouring port was considered instead. For the ports in question this was a safe assumption, as the distance to the neighbouring port was marginal. Neighbouring ports were found via a general internet search.

In addition, http://gc.kls2.com/ which is in fact a website on *flight* distances, was used to crosscheck some distances (only possible for straight line sea routing).

The CO_2 efficiency of food transport

The CO_2 efficiency of food transport is assumed to be the CO_2 efficiency of general cargo ships, which according to MARINTEK et al. (2008) is between 11.9 g CO_2/tonne km and 19.8 g CO_2/tonne km (or 6.4 g CO_2/tonne nm and 10.7 g CO_2/tonne nm)