Globalisation, Transport and the Environment

Chapter 1

Introduction and Main Findings

1.1. Introduction

OECD and the International Transport Forum (ITF) held a *Global Forum on Transport and Environment in a Globalising World*, 10-12 November 2008 in Guadalajara, Mexico.* There were around 200 participants from 23 countries at the Global Forum, representing national and local governments, academia, business, environmental organisations, etc. The main purpose of the Global Forum, and of this book, was to discuss the impact globalisation has had on transport levels, the consequences for the environment and the policy instruments that can be used to limit any negative impacts for the environment. This book is based on the papers addressing globalisation issues that were prepared for that forum. The papers have been somewhat edited, in an attempt to present a continuous story, and to avoid much overlap among chapters. Some additional or updated material has also been added, but the *systematic* research for the various chapters was ended in the autumn of 2008.

Box 1.1. **What is globalisation?**

The term "globalisation" is often used to describe the increased flow of knowledge, resources, goods and services among nations. The term is sometimes defined as "the development of an increasingly integrated global economy marked especially by free trade, free flow of capital and the tapping of cheaper foreign labour markets".*

Globalisation can also be described as a process by which the people of the world are unified into a single society and function together. This process is a combination of economic, technological, socio-cultural and political forces. The term is, however, often used to refer in the narrower sense of economic globalisation, involving integration of national economies into the international economy through trade, foreign direct investment, capital flows, migration and the spread of technology.

OECD (2005) highlights that three major forces have contributed importantly to the globalisation process: *i)* the liberalisation of capital movements and deregulation, of financial services in particular; *ii)* the further opening of markets to trade and investment, spurring the growth of international competition; and *iii)* the pivotal role played by information and communication technologies (ICT) in the economy.

* See *www.merriam-webster.com/dictionary/globalization*.

1.2. Main findings

How globalisation affects the environment – Overall impacts

In general, increased economic openness (mainly trade and investment liberalisation) seems to have had, at worst, a benign effect on emissions of *localised pollutants*. It has, for example, been found that (for the statistically average country), a 10% increase in trade intensity leads to approximately a 4% to 9% reduction in SO_2 concentrations (Antweiler,

* See *www.oecd.org/env/transport/GFSD*.

Copeland and Taylor, 2000). Other studies have found that openness appears to have a beneficial impact on SO_2 and NO_2, but no statistically significant impact on PM emissions. Still another study found that trade intensity *increases* land releases, but either reduces or has no statistically significant effect on air, water and underground releases (Chintrakarn and Millimet, 2006).

In broad terms, the evidence suggests that it is not clear how the relative price changes that result from openness will affect the environmental *composition* of economic activity: some countries will produce more environmentally intensive goods, others will produce fewer. On the other hand, liberalisation will raise incomes, perhaps increasing the willingness to pay for environmental improvements: these potential *income effects* could well outweigh the negative *scale effects* associated with increased economic activity. When combined with the positive effects associated with *technology* transfer, the net effect on local pollutants is quite possibly a positive one.

However, the evidence concerning *carbon dioxide and other greenhouse gas emissions* is less encouraging. Here, the evidence suggests that the net effect of trade liberalisation is likely to be negative. One study, using a cross-section of 63 countries (and correcting for trade intensity and income) concluded that a 1% increase in trade leads to a 0.58% increase in CO_2 emissions for the average country in her sample (Magani, 2004). Other studies similarly find openness raises CO_2 emissions, but also find the detrimental impact disappears when corrections are made for income levels, etc.

One of the explanations for the consistently pessimistic assessments of trade's impact on greenhouse gas emissions is their global nature. Not only are the costs of CO_2 emissions shared with citizens abroad, but many greenhouse emissions are associated with fossil fuel use, for which few economically viable substitutes have emerged to date. The *income* and other *technique* effects that are largely responsible for reductions in *local* air pollutants do not seem to have the same force when the pollutant in question burdens the global population – and requires global solutions – rather than just citizens residing within any one government's jurisdiction.

For example, unlike emissions by nationally based emission sources, international transport-related emissions often involve third parties, *i.e.* many goods are moved via vessels not bound by operational regulations in the importing or exporting country. This is a particular issue for ocean shipping. Thus, even if voters in high-income countries want stringent environmental regulations attached to the transport of traded goods they consume, shipping emissions may be outside their government's jurisdiction. An international response may be the only practical approach to this problem.

Globalisation and international transport activity

The 21st century has seen the continued internationalisation of the world's economy. There is also evidence of greater globalisation of cultures and politics. Economically, globalisation helps to facilitate the greater division of labour, and to exploit its comparative advantage more completely. In the longer term, globalisation also stimulates technology and labour transfers, and allows the dynamism that accompanies entrepreneurial activities to stimulate the development of new technologies and processes that lead to global welfare improvements.

Increasing globalisation has led to a strong increase in *international shipping* activity. Trade and shipping are closely linked, although some disagreement remains about the degree to which energy use in shipping is coupled with the movement of waterborne commerce. The estimates depend *inter alia* on the number of at-sea or in-port days that are assumed in the analysis. The available evidence largely indicates that world marine fleet energy demand is the sum of international fuel sales, plus domestically assigned fuel sales. Some debate continues about the best estimates of global fuel usage, but the major elements of activity-based inventories are widely accepted. Considering the range of current estimates using activity-based input parameters, ocean-going ships now consume about 2% to 3% – and perhaps even as much as 4% – of world fossil fuels (see Chapter 3).

Air transport has also played a key part in fostering globalisation. However, airlines (and to an even greater degree, air transport infrastructure) have had to respond to changing demands for their services. These demands come from the requirements for high-quality, fast and reliable international transport. Globalisation, almost by definition, means demands for greater mobility and access, but these demands are increasingly different for different types of passengers and cargoes, to different places, and over different distances, than was previously the norm.

Many structural changes have taken place in the aviation sector as a result of globalisation. Air markets have been liberalised, the networks that airline companies operate have changed (often to hub-and-spoke networks), many new (often low-cost) companies have entered the market, and many (low-cost and other) airline companies have gone out of business or merged (most of the remaining airlines have already united into three major alliances).

International air transport is now a major contributor to globalisation and is continually reshaping to meet the demands of the economic and social integration that globalisation engenders. Some 40% of world trade (by value) now moves by air (see Chapter 4). To allow the flows of ideas, goods and persons that facilitate efficiency on a global scale, air transport has played a key role in the past, and is poised to continue this role in the future. Yet, as the strong growth in air transport activity is straining air-related infrastructure (such as airports), future economic growth in the sector could well be constrained by capacity limits.

With new developments to remove bottlenecks, combined with operational improvements, there is scope for considerable improvement in the efficiency of international *road and rail freight* in many regions. Of course, it is not simply a question of transit time and reliability (although both are important), it is also a question of cost.

One study has compared total door-to-door transport costs and transit times for a range of transport solutions carrying cargo from Asia to Europe (Chamber of Commerce of the United States, 2006). Air transport had the highest cost, but very short transit times. Sea transport provided the lowest cost, but had long transit times. The road freight results fall between air and sea, both in terms of cost and transit time. Rail transport exhibited a very wide range of costs and transit times, and showed major differences between the officially scheduled transit times and the actual transit times achieved.

Within the next 15 years, there seem to be limited opportunities to dramatically increase the speed of either ships or aircraft. Indeed, concern about CO_2 emissions could lead to changes in the role of air freight within the supply chain. There have even been calls for sea freight transport to operate at *slower* speeds, in order to save fuel. Given these uncertainties, it is interesting to note the particular potential for *rail* movement to offer opportunities for shorter transit times, and possibly, reduced costs. *Road* freight times may not have the scope to be reduced to the same extent. For both road and rail freight transport, border crossings represent an important barrier to trade. Safety for drivers and cargo is a major issue, especially for road transport.

A major increase in road and rail transport from eastern parts of Asia to Europe would require major infrastructure investments, in particular for road transport. Although the Trans-Siberian rail connection already exists, gauges of rail networks still differ among countries involved.

There are many opportunities to improve the efficiency and reduce the environmental impact of international road and rail freight transport. Many of these developments require government intervention in the form of changes to regulatory policy, improvements to infrastructure and the breaking up of public monopolies that currently often offer ill-adapted services. This is a complex area when considered within one country; when it concerns international developments, it is even more complicated.

When looking ahead 15 years, it is important to note the growing role played in international transport by *major logistics companies*. The consolidation that is evident means that single companies are now able to provide truly integrated services in a way that was not possible a few years ago.

Environmental impacts of increased international transport

Shipping

Global CO_2 *emissions* from maritime shipping (estimated based on sales of bunker) almost tripled between 1925 and 2002 (Endresen *et al.*, 2007). The corresponding SO_2 *emissions* more than tripled over the same period. The majority of today's ship emissions occur in the northern hemisphere, within a well-defined system of international sea routes.

Activity-based modelling for 1970-2000 indicates that the *size* and the *degree of utilisation* of the fleet, combined with the *shift to diesel engines*, have been the major factors determining yearly energy consumption. One study indicates that (from about 1973 – when bunker prices started to raise rapidly) growth in the fleet was not necessarily accompanied by increased energy consumption (Endresen *et al.*, 2007). The main reason for a large deviation among activity-based emissions estimates is the number of days assumed at sea. Data indicate a strong dependency on ship type and size: activity-based studies have not considered ships less than 100 GT (*e.g.* some 1.3 million fishing vessels), and this fleet could account for a substantial part of additional fuel consumption.

Recent studies indicate that the emission of CO_2, $NO_{x,}$ and SO_2 by ships correspond to about 2% to 3% (perhaps 4%), 10% to 15%, and 4% to 9% of global anthropogenic emissions, respectively. Ship emissions of *e.g.* NO_2, CO, NMVOCs, SO_2, primary particles, heavy metals and waste cause problems in coastal areas and harbours with heavy traffic. Particularly high increases of short-lived pollutants (*e.g.* NO_2) are found close to regions with heavy traffic *e.g.* around the North Sea and the English Channel. Model studies tend to find NO_2 concentrations to be more than doubled along the major world shipping routes. Absolute increases in surface ozone (O_3) due to ship emissions are pronounced during summer months, with large increases again found in regions with heavy traffic. Increased ozone levels in the atmosphere are also of concern with regard to climate change, since ozone is an important greenhouse gas.

Formation of sulphate and nitrate resulting from sulphur and nitrogen emissions causes acidification that might be harmful to ecosystems in regions with low buffering capacity, and lead to harmful health effects. Coastal countries in western Europe, western North America and the Mediterranean are substantially affected by ship emissions in this way.

The large NO_x emissions from ship traffic lead to significant increases in hydroxyl (OH), which is the major oxidant in the lower atmosphere. Since reaction with OH is a major way of removing methane from the atmosphere, ship emissions *decrease* methane concentrations. (Reductions in methane lifetimes due to shipping-based NO_x emissions vary between 1.5% and 5% in different calculations, see Chapter 6.) The effect on concentrations of greenhouse gases (CO_2, CH_4 and O_3) and aerosols have differing impacts on the radiation balance of the earth-atmosphere system. Ship-derived aerosols also cause a significant *indirect* impact, through changes in cloud microphysics.

In summary, most studies so far indicate that ship emissions actually lead to a *net global cooling*. This net global cooling effect is not being experienced in other transport sectors. However, it should be stressed that the uncertainties with this conclusion are large, in particular for indirect effects, and global temperature is only a first measure of the extent of climate change in any event.

The contribution to climate change from the different components also acts at different temporal and spatial scales. A long-lived well-mixed component like CO_2 has *global* effects that last for centuries. Shorter-lived species like ozone and aerosols might have effects that are strongly *regional* and last for only a few days to weeks. The net cooling effect that so far has been found primarily affects *ocean areas*, and thus does not help alleviate negative impacts of global warming for human habitats.

Projections up to year 2020 indicate growth in maritime fuel consumption and emissions in the range of 30%. However, if more weight is given to the large increase in emissions during the last few years, even larger increases in ship emissions could take place in the coming decades. By 2050, CO_2 emissions from maritime shipping could reach two to three times current levels (Eyring *et al.*, 2005).

More specifically, most scenarios for the next 10 to 20 years indicate that the effects of regulations and other policy measures will be outweighed by increases in traffic, leading to a significant global increase in emissions from shipping. Global emission scenarios for non-ship (land-based) sources also indicate that the relative contribution to pollutants from shipping could increase, especially in regions like the Arctic and South-East Asia, where substantial increases in ship traffic are expected.

Limiting the sulphur content in fuel in the North Sea and English Channel seems to be an efficient measure to reduce sulphate deposition in nearby coastal regions. Several technologies also exist to reduce emissions from ships beyond what is currently legally required (*e.g.* by the use of scrubbers and filters to capture emissions from the exhaust gases and by the use of low-NO_x engines).

Aviation

Expected technological innovations will probably not prevent an increase in CO_2 emissions from aviation either, in light of expected increase in demand – but the rate of technological progress will likely depend on the extent to which the sector faces a price on the CO_2 it emits. Depending on the technology and scenario used, the average "external" (*i.e.* environmental) cost of air travel is about EUR 0.01 to EUR 0.05 per passenger-kilometre (Dings *et al*., 2003).

Major airlines use "hub-and-spoke" networks, which means that selected airports receive a relatively large share of all take-offs and landings in the network. As a result, noise pollution in the surrounding areas is relatively high, and passengers travelling indirectly have to make a detour (thereby increasing the total emissions related to their trip). But hub-and-spoke networks might also have environmental *benefits*, due to environmental economies of scale: larger aircraft with lower emissions per seat can be used because passenger flows are concentrated on fewer links. The literature suggests, however, that the negative environmental effects of hub-and-spoke networks tend to exceed the positive effects. If the large airline companies focus their networks on a few intercontinental hubs, traffic levels will increase at these hubs due to the generally expected increase in demand, but also because more people need to make transfers.

Air travel connects regions to the world economy, and gives individual travellers the opportunity to explore the world. But as long as the full external cost is not covered by the ticket price, environmental damage caused by aviation will continue to grow beyond socially optimal levels.

Road and rail

International road and rail freight transport account for a minor, but increasing, share of global transport emissions of air pollutants (*e.g.* NO_x) and noise emissions. The contribution of these emissions to local air pollution is actually *decreasing* in most parts of the world, mainly due to various vehicle emission standards that have been implemented (and periodically tightened) all over the world. Only in those parts of the world that have an extremely high growth in transport volumes have overall transport-related emissions of local air pollutants not yet decreased.

On the other hand, CO_2 emissions from international road freight transport are increasing all over the world (and could roughly double to 2050), and there is not yet a sign that this trend is to be curbed soon. For this challenging problem, there is no single cure available, and the scale effects will likely outweigh the technological options. A mix of measures, such as road pricing, higher fuel taxes, stricter fuel efficiency standards for vehicles, use of alternative fuels and logistical improvements, will be needed to reverse these trends.

Policy instruments

Theory suggests that *all* policy instruments, if properly designed, will reflect the right level of policy ambition (*i.e.* where marginal benefits just equal marginal costs). However, theory also suggests that a cost-effective result is more likely to be realised via market-based instruments (such as taxes and tradable permits) than by using regulatory or voluntary approaches.

On the other hand, there is no silver bullet that can solve all the environmental problems created by transport activity. In some cases, for example regarding emissions of local air pollutants, standards will be the most effective and efficient instruments. A *mix of instruments* will in many cases be needed. It is, however, important to assess carefully what each instrument adds to the mix, and how the instruments interact. Policy needs in OECD countries are likely to be different from policy needs in developing countries. The optimal instrument mix will therefore vary from situation to situation.

On the one hand, a *multilateral approach* is preferable on both efficiency and effectiveness grounds (especially over the long term), provided sufficient political will exists internationally to co-operate on solving the underlying environmental problem. The international regulatory framework for greenhouse gases does, however, not assign responsibility to nations for managing emissions from shipping and aviation. Although international regimes can sometimes constrain governments' ability to regulate activities that are harmful to the environment, international law *does* provide many opportunities to adopt new instruments to regulate environmental impacts from increased international transport.

On the other hand, the constraints to successful international negotiations will sometimes be rather imposing. International agreements take a long time to put in place; they are also hard to enforce. They might also be characterised by significant "leakage" problems, in the sense that emitters might be able to shop around for less stringent jurisdictions. It may also be that emission control is actually too narrow an approach for such a complex sector as transport. In principle, an optimal international agreement related to transport and climate change should also include such elements as adaptation and technology development, rather than being limited to just controlling emissions.

International coalitions may also need to be built from the bottom up. One element of this approach would involve *regional arrangements* among like-minded countries, or among countries that share a common (regional) environmental problem (*e.g.* SO_X). These regional agreements can then serve as building blocks or demonstration experiments toward more international action over the longer term (*e.g.* linking up emission trading systems in different regions). One caveat here, of course, is that the difficulty of regional systems to draw important emitters into the regional system (*e.g.* China, and India, in the case of greenhouse gas emissions) will inevitably mean that a regional approach would be less efficient than a global approach.

Unilateral action also has a role to play, even at the international level. Not only is unilateral action often the most appropriate approach (*e.g.* when the pollution involved affects only the national territory, which is mostly the case for much of land-based transport), local policies can sometimes help to force subsequent changes within the international regime (*e.g.* EU noise standards for airplanes were eventually adopted by ICAO). In the case of climate change, this example could also play an important role in the future, inasmuch as the EU is poised to apply its greenhouse gas emission trading system unilaterally to international air (and potentially, even to sea) transport. The power of unilateral action to eventually lead to positive outcomes at the international level over the medium term should therefore not be underestimated.

Although international transport regimes have historically focused on *protecting transport activity*, there is now a trend toward countries recognising the need for the global transport regimes to deal with *environmental* problems. Two international organisations in particular – ICAO and IMO – have been explicitly tasked to address climate change and other environmental challenges arising from international transport. These are encouraging developments.

The *interface between global and local regulation* is key. Both forms of regulation are clearly legitimate in their own contexts, but there should be more energy expended on making these two sets of objectives compatible with each other. In particular:

- Global regimes should not be perceived as limitations on intelligent national action. National action has historically been the cornerstone of environmental policy, and this important role deserves explicit recognition when international agreements are being negotiated.

- On the other hand, any national action that is being considered should explicitly respect the basic principles of non-discrimination and national treatment, principles that are systematically built into all existing international regimes to protect against economic distortions.

Lowest priority for international action would seem to be to try to use Article XX of the GATT. Using trade-based regulation to resolve environmental problems in the transport sector seems a very indirect way of reaching transport-environment policy integration objectives.

Priorities for policy action

The *climate change* issue will clearly lie at the heart of efforts to deal with the environmental impacts of transport that result from globalisation. No other environmental issue has so many potential implications for transport sector policy today. Although the specific estimates vary, transport-based CO_2 emissions are projected to grow significantly in the coming years. Light duty vehicles on roads will continue to be the largest contributors to this problem, but air-based emissions will grow more rapidly. Some shift toward less carbon-intensive technologies is foreseen, but no significant shift to truly low-carbon technologies is anticipated in most of the current estimates. In other words, incremental, rather than drastic, technological change is foreseen.

Modes for which pre-existing policies are relatively weak, such as shipping and aviation, seem to be ideal candidates for integration into broader efforts to introduce climate change policy frameworks. Surface transport, on the other hand, is characterised by stronger existing policies, so its further integration into such broader frameworks seems less straightforward.

Global economic activity also leads to problems *other than climate change* (including local air pollutants, such as NO_x, SO_x, particulates and noise): these problems will need to be addressed.

At the national or local level, the road transport sector is already quite heavily regulated in one form or another (through standards, taxes, etc.). This implies that further abatement in road transport emissions may be relatively more costly. More cost-effective opportunities may exist in other transport sectors (especially in aviation and shipping) but measures in these sectors will primarily have an impact near airports, harbours and major sea lanes.

At the international level, it may be possible to develop common fuel-efficiency standards, but this would not be straightforward. The international regime related to shipping in particular is still in its early stages of development, so there are opportunities to mould that regime. The IMO/MEPC is trying to work toward effective and efficient control polices for shipping, so there are some initiatives being taken toward this goal:

- First, movements of *highly hazardous substances* should continue to be controlled essentially by *regulatory* means: bans, prior informed consent rules (*e.g.* Rotterdam Convention), etc. When the problem involves serious health hazards, the environmental effectiveness objective should always take precedence over the economic efficiency goal. Outright bans, combined with total transparency, are the safest ways forward in these circumstances.

- Second, some environmental impacts, *e.g.* exhaust emissions, may effectively be addressed by standards, which should provide as much flexibility as possible for producers to come up with low-cost solutions.
- Third, as mentioned above, the bulk of the "heavy lifting" in the policy response should be given over to market-based instruments (taxes and tradable permits).

Inclusion of *aviation and maritime transport* in cap-and-trade systems would be especially desirable from a cost-effectiveness point of view. For both of these modes, technological abatement options are limited in the short run because of slow fleet turnover. In the maritime sector, operational measures seem capable of reducing CO_2 emissions in the short run, and at low cost. In aviation, there is also some scope for abatement through better air traffic control and airport congestion management, but the main abatement is likely to come from lower demand. Available estimates put an upper bound of about 5% on demand reductions, at prices of around EUR 20 per tonne of CO_2. Imperfect competition and airport congestion limit the extent of pass-through, and hence limit the demand responses. The aviation sector, hence, is likely to be a net buyer of emission allowances. Both in aviation and in shipping, there is considerable scope for leakage as long as trading schemes are not comprehensive. Nevertheless, inclusion of these modes in trading schemes is desirable if overall abatement is to be cost effective in the long run.

When it comes to *road transport*, however, taxes and tradable permits present a particular problem. The optimal policy response to *fuel-related* externalities (such as climate change) is different from the optimal policy responses to *distance-related* externalities (such as congestion, accidents and air pollution). Imposing a fuel tax induces *some* improvement in both distances travelled and fuel efficiency. But it does not reduce distance-related externalities much, while most studies suggest that distance-related externalities in road transport are significantly higher than fuel-related ones.

A more efficient approach would therefore seem to be to use *distance-related taxes*, such as road pricing. But the problem with this approach is that the distance travelled is not the most important contributor to GHG emissions – the most important target of climate policies. For *climate change*, fuel efficiency will remain the primary goal, and distance-related taxes would be too indirect.

For example, the EU has high fuel taxes and may soon introduce fuel economy standards. The US has relatively low fuel taxes, but fuel economy is regulated by a fuel-economy standard that is now being tightened. In the EU, road transport is not included in CO_2 emission trading system. In various US proposals, one idea is to eventually include the sector in carbon trading schemes, possibly through "upstream" trading. Since existing policies are relatively stringent, abatement costs for CO_2 in road transport are also relatively high (and exceed current and expected prices for carbon permits). Further tightening of regulations would therefore seem undesirable from only a climate change point of view, but since these prevailing policies serve other purposes than just greenhouse gas reductions, it is not clear if the welfare cost of further tightening would be very high. For example, higher fuel taxes in the US seem justified if the primary policy goal is to reduce *congestion*; this policy would also reduce greenhouse gas emissions.

On the other hand, the case for tighter fuel economy standards taxes in road transport to reduce *greenhouse gas emissions* is weak, at least within the static welfare economic framework used above. It is, however, sometimes argued that these policies are needed to increase the dispersion of more fuel-efficient vehicles through the fleet. The reason is said to be that the market provides relatively weak incentives to improve fuel economy, given consumers' response to various uncertainties surrounding investments in fuel economy. If consumers are not willing to pay very much now for fuel economy improvements that only provide economic benefits over a long timescale, producers may not be willing to supply fuel-efficient vehicles either. If the goal is to change engine technologies, one way around this problem could be for the government to force fuel economy into the marketplace via a fuel-economy standard. The case for such standards would be strongest if fuel taxes are low and incomes are high (in these cases, drivers care even less about the fuel economy of their vehicles). However, a more cost-efficient approach could be to increase the fuel taxes.

Possibilities exist in both IMO and ICAO to find new ways of regulating GHG emissions (see Chapter 10). This could follow the partly successful model of regulating NO_x, SO_x and *noise* emissions from air and sea transport.

Aggressive GHG emission abatement strategies will inevitably require *technological change*. In particular, because of the point made earlier that the road transport market will not provide enough private incentives to improve fuel economy, government technology policies will be needed to overcome this reluctance. Similarly, the slow fleet turnover rates in both aviation and shipping may also need to be increased, via technology-based public policies. Carrots are always more easily implemented in policy practice than sticks, so well-designed *subsidy arrangements* could hold some promise for future policy directions – but there is always a risk that the cost-effectiveness could be low, as the subsidised activities would have been undertaken in any case.

A few other policy approaches also seem to have some issues associated with them:

- *Public procurement* policies can create competition problems.
- *Labelling* runs the risk of not generating more environmental benefits than would have been generated in any case (the "baseline" problem).

More generically, wider use could be made of the common interest of *shipping ports* in controlling environmental pollutants. Ports also have a regional context (not only a local/domestic one) that could be built upon more creatively in designing response strategies. Most shipping passes through a port of an OECD country at some time during the course of a shipment: this represents a key opportunity for more concerted action.

The *corporate responsibility angle* should also be more fully exploited. Although 75% of the global merchant vessel fleet is registered in non-Annex 1 countries, this fleet is mostly owned by shipping interests in Annex 1 countries. This represents an interesting opportunity to work towards *coalitions of shippers* that might eventually develop common guidelines related to environmental protection in the shipping community.

And finally, information programmes could be aimed at Flag states to illustrate that their competitiveness need not suffer from a more environmentally friendly approach, and might therefore be in their own long-term marketing interests.

References

Antweiler, Werner, Brian R. Copeland and M. Scott Taylor (2000), "Is Free Trade Good for the Environment?", *American Economic Review*, 91(4), pp. 877-908.

Chamber of Commerce of the United States (2006), *Land Transport Options between Europe and Asia: Commercial Feasibility Study*, Chamber of Commerce of the United States.

Chintrakarn, P. and D.L. Millimet (2006), "The Environmental Consequences of Trade: Evidence from Subnational Trade Flows", *Journal of Environmental Economics and Management*, 52(1), pp. 430-453.

Dings, J.M.W. *et al.* (2003), *External Costs of Aviation*, Environmental Research of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Research Report 299 96 106, UBA-FB 000411.

Endresen, Ø. *et al.* (2007), "A Historical Reconstruction of Ships' Fuel Consumption and Emissions", *Journal of Geophysical Research*, 112(D12301).

Eyring, V. *et al.* (2005), "Emissions from International Shipping: 2. Impact of Future Technologies on Scenarios Until 2050", *Journal of Geophysical Research*, 110(D17306), doi: *http://dx.doi.org/10.1029/2004JD005620*.

Magani, S. (2004), "Trade Liberalization and the Environment: Carbon Dioxide for 1960-1999", *Economics Bulletin*, 17(1), pp. 1-5.

OECD (2005), *Measuring Globalisation: OECD Handbook on Economic Globalisation Indicators 2005*, OECD, Paris.