Executive Summary

The increased flow of knowledge, resources, goods and services among nations that has occurred as a result of globalisation has led to a major increase over the years in transport activity. This has had an impact on the environment in a number of ways: through increased economic activity in general; through shifts in the location of production activities; and through developments in the volume and type of transportation required to meet demands of global trade. This report reviews the linkages between globalisation, transport and the environment, and identifies the policy challenges and potential solutions to address the environmental consequences that arise.

Globalisation and environment: Overall impacts

In general, increased economic openness seems to have had, at worst, a benign effect on emissions of localised pollutants, such as SO_2, NO_2 and PM (particulate matter). However, 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: such 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 of globalisation 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 could be negative. One of the explanations for the 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 gas 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.

Globalisation and transport activity levels

Increasing globalisation has led to strong growth 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 activity level. Considering the range of current estimates, ocean-going ships now consume about 2% to 3% – and perhaps even as much as 4% – of world fossil fuels.

Air transport has also played a key part in fostering globalisation. However, airlines have had to respond to changing demands for their services. These demands come from the requirements for high-quality, fast and reliable international transport. 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 airline companies have gone out of business or merged. Some 40% of world trade by value now moves by air.

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; it is also a question of cost. Air transport has the highest cost, but very short transit times. Sea transport provides the lowest cost, but long transit times. Road freight falls between air and sea, both in terms of cost and transit time. Rail transport has a very wide range of costs and transit times, and 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, the potential for rail movement to offer opportunities for shorter transit times, and possibly, reduced costs is interesting. 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. Safety for drivers and cargo is also a major issue, especially for road transport.

Environmental impacts of increased activity levels

The climate change issue clearly lies 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.

Global CO_2 emissions from maritime shipping almost tripled between 1925 and 2002. 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. Most studies so far indicate that ship emissions, in contrast to emissions from other transport sectors, lead to a net global cooling, due *i.a.* to cooling effect stemming from sulphur emissions. However, it is stressed that the uncertainties with this conclusion are large, in particular for indirect effects, and global temperature is in any event only a first measure of the extent of climate change.

Projections up to 2020 indicate growth in maritime fuel consumption and emissions in the range of 30%. However, 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. 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 also indicate that the relative contribution to other pollutants from shipping could increase, especially in regions like the Arctic and South-East Asia, where substantial increases in ship traffic are expected.

Expected technological innovations are unlikely to prevent an increase in CO_2 emissions from aviation either, in light of the 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 environmental cost of air travel is about EUR 0.01 to EUR 0.05 per passenger-kilometre. 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.

International road and rail freight transport account for a minor share of global transport emissions of local air pollutants (*e.g.* NO_x) and noise. 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 there is no sign as yet 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 unless price signals are radically changed. 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 limit these trends.

Policy instruments

The international regulatory framework for greenhouse gases does not assign responsibility to nations for managing emissions from shipping and aviation. A multilateral approach may be 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 problems. Although international regimes can sometimes constrain governments' ability to regulate activities that are harmful to the environment, this study demonstrates that international law *does* provide many opportunities to adopt new instruments to regulate environmental impacts from increased international transport.

International coalitions to address problems like climate change or acidification may 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 environmental problem (*e.g.* SO_x). These regional agreements can then serve as building blocks or demonstration experiments toward broader international action over the longer term (*e.g.* linking up emission trading systems in different regions). One caveat here, of course, is the difficulty of regional systems to include important emitters (*e.g.* China, and India, in the case of greenhouse gas emissions). This 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 (especially 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). This example could also play an important role regarding climate change 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 most suitable use of policy instruments vary among environmental problems. Movements of *highly hazardous substances* should continue to be controlled essentially by *regulatory* means: bans, prior informed consent rules, etc. Some other environmental impacts, *e.g.* exhaust emissions, may most effectively be addressed by standards, which, however, should provide as much flexibility as possible for producers to come up with low-cost solutions. But 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.

When it comes to *road transport*, 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. For *climate change*, fuel efficiency will remain the primary goal, and distance-related taxes would be too indirect.

It is sometimes argued that stricter standards are needed to increase the dispersion of more fuel-efficient vehicles through the fleet, because the market provides relatively weak incentives to improve fuel economy. If consumers are not willing to pay 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. 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 were low and incomes were high (in these cases, drivers care even less about the fuel economy of their vehicles). However, in such a situation, it could be more cost-efficient to increase the fuel taxes.