# Dispelling the myths of transport growth:

## a critical appraisal and some introductory remarks

*Ida J. Koppen*

**The connection between economic growth, transport growth and environmental pollution is not inevitable**

The ever-growing quantity of goods transported in Europe is normally seen as an unavoidable consequence of the increase in economic activity and the improvement of the standard of living. The creation of the internal market and the opening of new markets in Central and Eastern Europe exemplify this trend. Transport is accompanied by a number of socio-economic externalities, including environmental pollution, which are generally assumed to increase with increasing transport volumes: more freight transport implies more emissions, more infrastructural works, more noise, more visual pollution and more energy consumption. At closer scrutiny, however, these assumptions turn out to be false or at least refutable.

In this issue the reader will be confronted with a number of facts and analyses which attempt to demonstrate how the bond in which economic growth, transport growth and environmental degradation can be broken. Taking recent EU initiatives in this area as a starting point, the authors each look at a different aspect of the relationship between freight transport and environmental protection.

### Dispelling the myths of transport growth

The positive correlation between economic activity and transport is for the moment a statistical fact. Indeed, until now, an increase in economic activity has been accompanied by an increase in transport volume (tonne-kilometres). This connection, however, might not be as inevitable as it now seems. If we look at the energy sector, we find that prior to the energy crisis in 1974, a similar coupling existed between energy consumption and economic activity. When energy prices rose and energy became a scarcer resource, a decoupling took place. National and international policies directed at energy savings were responsible for achieving economic growth at a lower level of energy consumption. The decoupling of transport demand and economic growth is one of the central issues discussed in this issue.

The second assumption presented above concerns the correlation between transport growth and environmental pollution, in the broad sense of the word. It is undoubtedly true that the socio-economic costs associated with transport are high. Estimates for the European Union are as high as 5 per cent of the GDP. However, a distinction must be made between different transport modes that each have a very different impact on the environment. Road and air transport are by far the most polluting transport sectors. They are, moreover, the sectors in which the largest increase in transport has taken place. The percentage of road freight transport of the total volume of goods transported rose from 50 per cent in 1970 to 70 per cent in 1990. Hence, we can conclude that the environmental effects of transport depend on the transport mode that is chosen. A *shift to less polluting modes of transport*, e.g. rail and waterways, would result in a lower environmental impact for the same quantity of goods transported.

A final myth about transport that needs to be dispelled concerns the belief that technology can fix it. The “technological fix” approach assumes that technological development will be able to reduce transport-related pollution. Although technology can certainly make an important contribution, it is absolutely clear that with present trends in transport growth, any technological improvement achieved will be cancelled out by the projected growth in traffic volume in the long term. Moreover, certain technological changes shift externalities from one environmental sector to another. This is, for instance, the case when fuel consumption increases as a result of the installation of exhaust filters. Another problem arises when a technological improvement reduces not only the environmental impact but also the

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cost of transport and hence ends up stimulating transport growth. The "technological fix" must be taken with caution.

## Recent EC initiatives: "sustainable mobility"

The notion of "sustainable mobility" was introduced in the EC Commission's Green Paper on the impact of transport on the environment of February 1992. Parallel to the guidelines for sustainable development elaborated in the 1987 Brundtland Report, *Our Common Future*, the common strategy for sustainable mobility presented in the Green Paper "should enable transport to fulfil its economic and social role while containing its harmful effects on the environment". Although this is not a particularly clear definition of a policy strategy, it does indicate a recognition of the necessity to place environmental restraints on transport needs.

Until now, the area in which the EU has been most effective is the application of technical standards and technological improvements. The most important new elements presented in the Green Paper include:

- the introduction of telematics to improve the efficiency of transport operations;
- guiding public and private investment towards the more environment-friendly modes such as railways, inland waterways, combined transport and coastal shipping;
- the use of fiscal and economic instruments in favour of cleaner technology and the more environment-friendly transport modes;
- gearing urban and regional development planning towards reducing the need for transport.

Transport is also one of the five selected target areas in the fifth Environmental Action Programme of the EC Commission, *Towards Sustainability*, published in March 1992. The action programme summarizes the present state of affairs in the EU in clear terms: "Present trends in the Community's transport sector are all leading towards greater inefficiency, congestion, pollution, wastage of time and value, damage to health, danger to life and general economic loss. Transport demand and traffic are expected to increase even more rapidly with the completion of the Internal Market and the political and economic developments in Central and Eastern Europe". The programme repeats most of the measures spelled out in the Green Paper and adds an interesting new component. Along with the general idea of subsidiarity it introduces the notion of shared responsibility and identifies the different actors that must co-operate in order to execute the measures. The idea of a partnership between different actors involved, developed in some detail in the Dutch National Environmental Policy Plans, is for the first time introduced at the Union level.

In December 1992, the Commission published the White Paper on the future development of the common transport policy. In the section dedicated to the environment, the White Paper takes the debate that resulted from the publication of the Green Paper early that year as a starting point. Although the White Paper starts from the presumption that transport growth accompanies economic growth, it recognizes at the same time the need to reduce the total costs to society associated with transport, including the environmental costs. In order to achieve this objective efficient policies must be developed to internalize the external costs. Most of the measures proposed in the White Paper are rather general and do not indicate how the different objectives can be reconciled. The following issues are addressed:

- the progressive integration of transport modes;
- standard setting at the Community level for emissions and energy consumption in the transport sector;
- noise control around airports;
- the promotion of public transport;
- environmental impact assessment as part of the decision-making process for transport infra-structure policies, programmes and investment decisions;
- the use of economic and fiscal instruments.

Two earlier reports should be mentioned which had already indicated the difficulties of reconciling environmental considerations with current transport trends. The Task Force Report on environment and the internal market, *1992, The Environmental Dimension*, published in 1989, called for measures to break the link between economic growth and environmental degradation. It identified the transport sector as the one posing the most important environmental challenge for the European Community. Similarly, a 1990 report of the Forward Studies Unit on *Transport and the Environment* pointed to the Community as the only appropriate level to conceive and co-ordinate a multimodal European transport network and to adopt provisions concerning the taxing of energy and vehicle emissions standards.

Recent documents prepared for the meeting on transport and the environment of the EC ministers of environment in Arhus in May 1993 repeat the measures formulated in the various policy documents with a special emphasis on the necessity to reduce $CO_2$ emissions and on the use of taxes and environmental performance targets as policy instruments.

Notwithstanding these explicit calls for action, it remains to be seen whether the EU is really willing to accept a radical shift in transport policy. The trans-European infra-structure networks that are planned are developing on the basis of existing trends with a very strong push for extensive development of the motorway network to keep up with the projected growth in road traffic and, until now, without an adequate integration of different modal networks into an intermodal Trans-European Transport Network. It is likely that a significant proportion of the Cohesion Fund will go into motorway construction in the four countries concerned – Portugal, Spain, Greece and Ireland. This points at yet another myth of transport growth: the assumption that the economies in the periphery will benefit from additional road construction. Even leaving aside the environmental aspects, this argument is questionable. New links obviously benefit both ends and thus do not essentially change the conditions of competition. The evidence of southern Italy, comparatively well served with motorways, does not suggest that they are an automatic boost to the economy.

## From problems to solutions

From the complex picture that has emerged, it is clear that no single solution will be able to adjust transport policy to environmental considerations. Improvements will be achieved only on the basis of an integrated approach. This should be kept in mind when the different elements of such an approach are discussed in the following articles.

In the first contribution, Jack Short describes the recent trends in transport growth and the accompanying environmental effects. He underlines the importance of decoupling transport and economic growth and discusses the possibility of changing the "modal split", i.e. the distribution of transport volumes over the different transport modes. Since the externalities of road transport are significantly higher than the externalities of rail and waterways, one of the ways to reduce the impact of transport on the environment is a shift in transport mode. Even without reducing the transport volume major improvements can be achieved in environmental performance by a modal shift. Even if road transport presently provides the best service for most connections, so-called combined transport systems offer a promising alternative.

In the area of research and development, the EC Commission has undertaken several research projects which look at vehicle design, engine performance and the substitution of fossil fuels by renewable resources. Martin, Cannell and Gwilliam describe the various research initiatives. As they explain, however, any technical improvement must be seen in the light of the policy context in which it will be placed. A research agenda for transport issues can be developed only as an integral part of a general policy on transport and environment.

An important element in changing transport behaviour is the use of economic instruments. Koopman gives an overview of the different kinds of economic instrument that might be used in a policy for sustainable mobility, e.g. emission charges for air pollution, road pricing to deal with congestion. He argues that fuel taxes by themselves are not an efficient way to reduce transport demand. Although research data about goods transport are scarce, the price elasticities seem to be low, suggesting low substitutability between transport modes. More innovative solutions are discussed which seem to offer promising alternatives.

The issue of fuel prices is further analysed by Arie N. Bleijenberg. According to Bleijenberg, fuel prices should be as high as 1.4 ECU per litre, of which 0.2 ECU are fuel costs, if transport is to pay its full cost. The additional revenue raised with the high fuel taxes should be used to reduce other taxes. Thus, the total tax burden for businesses and consumers remains unchanged and distributional distortions are avoided.

Markham, in his article on the railways' perspective, emphasizes that if the railways invested more in improving service and guaranteeing fast delivery, they could easily gain back part of the market share they have lost since 1970. In this respect, the new European initiatives to co-ordinate rail investments are a promising development.

## Regional diversification and market integration

The internal market will create new opportunities for producers to market their products in other parts of the Union. But is this aspect of market integration really always so desirable? And does it favour the economies in the peripheral regions? Besides the elimination of trade barriers, access to faraway markets is largely determined by the price of transport, the demand for foreign products and the existing infrastructure. We have already indicated how the use of financial instruments will be crucial in finding effective solutions to transport problems. Another trend that runs counter to the internationalization of the market and the resulting disappearance of regional differences is the emerging *revaluation of the region*. As Holzapfel points out, the advantages of regional differentiation should be rediscovered. In terms of supply markets, he explains that producers are very often not even aware of the available products in their own region. If, for example, this information is made more easily available through regional information systems, some manufacturers might shift their supply requirements to nearer suppliers. He demonstrates with a concrete example how transport distances may be reduced if regional suppliers are found.

In the final article, Henning A. Arp presents the policy package that might be composed with these different elements. The major challenge for sustainable mobility, he concludes, lies in the willingness of the actors involved, government, business and transport operators, to co-operate closely.

# Freight transport as an environmental problem

*Jack Short*

**Direct policy measures for road freight can be effective in reducing environmental harm**

## Transport trends

Freight transport in Europe by road, rail and waterway together has grown by about 60 per cent since 1970 (ECMT, 1992). Road transport has more than doubled, while rail and waterway traffic have remained static. Within the road sector, international traffic has grown the fastest.

The growth in goods traffic has mirrored economic growth (Short, 1992). Each 1 per cent growth in GDP has been accompanied by a 0.9 per cent increase in freight transport. For road transport, these elasticity figures are much higher and each 1 per cent growth in economic activity has been associated with a 1.7 per cent growth in traffic. In general, countries with rapid economic growth have also had rapid transport growth. There is also a strong correlation between the wealthiest and the most mobile countries.

These statistical relationships between transport growth and economic development are significant from an environmental and from a political point of view: environmentally, because transport growth is usually harmful for the environment; politically, because they make it difficult to suggest that transport growth should be restrained.

However, the transport and GDP trends seen here are significantly different from those linking the economy to the energy sector generally. The *energy intensity* of OECD economies – defined as the amount of energy needed to generate 1 GDP unit – has declined sharply since 1974. Thus, energy use and economic growth have become decoupled. From the data shown, transport and the economy have become even more coupled during the last decades and our economies have become even more transport-intense. It is, thus, a major challenge for the future, to *decouple* transport and economic growth. So far no economy has been able to achieve it and recent trends even go in the opposite direction.

## Forecasts

Forecasts for road freight transport are for a continuation of the extremely rapid recent growth – at rates of up to 4 per cent per annum for the next 15-20 years. For the other surface modes it is questionable whether any substantial growth will take place. Even a spectacular growth of combined transport may be at the expense of traditional rail traffic. An area of great uncertainty concerns traffic between East and West European countries. At an European Conference of Ministers of Transport (ECMT) seminar, forecasts of increased traffic varying from 50 per cent to 1,000 per cent were presented for the period to the year 2000 (ECMT, 1991).

These forecasts for large traffic increases, on top of already over-congested networks, have stimulated an intense public debate on the possibilities and the desirability of catering for ever-growing traffic. The forecasts are being criticized increasingly because they reflect past relationships and because they threaten to become self-fulfilling prophesies. While there is no evidence that a turning point has yet been reached in traffic growth perhaps there is such a turning point in the ways of thinking about the problem.

## The environmental effects of transport

The environmental effects of transport have been described many times and it is not intended to repeat them here (for the freight transport effects see, for example, Mitchell (1991)). Most of the emissions are due to road transport. For road freight we can say that the main quantified emission concerns are $NO_x$, hydrocarbons (HC), CO, $CO_2$, particles and noise emissions.

To give an idea of magnitudes, for The Netherlands 40 per cent of $NO_x$, 25 per cent of HC, 15 per cent of CO, 30 per cent of $CO_2$ and 65 per cent of particles emitted by vehicles are due to road freight vehicles. For $NO_x$ especially the relative share from freight transport will rise as cars fit

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catalytic converters. Carbon dioxide will most probably also become a relatively greater problem as cars become relatively more fuel-efficient. Noise cannot diminish much below 78 dB(A): at present it is well over 80 dB(A).

It is also clear that the focus of discussion on environmental effects has been on the more quantifiable effects. There is evidence that the aspects of traffic which cause most annoyance are those which are less easy to quantify. If, as seems likely, these subjective annoyances are increasing, then, even if traffic and emissions stabilize, new demands to reduce transport's adverse effects will arise. Many of these subjective nuisances concern trucks and are reflected in fear or hostility towards them.

It is widely accepted that rail transport is less harmful to the environment than truck transport. For example, pollution rates per tonne-km of truck transport are four times higher for $NO_x$, 45 times for HC and 35 times higher for CO than for rail transport (Befahy, 1992).

The policy questions which arise concern the extent to which these environmental consequences justify intervention in the operation of the transport market and the effectiveness and costs of measures which might be used. Before looking at these issues, the concept of sustainable development and in particular, sustainable mobility will be examined.

## Sustainable development

Definitions of sustainable development are very worthy but are of limited immediate use as guides to action. Despite this, it is clear that development is a broader concept than economic growth and includes all factors that lead to increases in societal wellbeing.

Two main approaches can be identified in attempting to make these definitions more concrete. Simplistically, these could be called the *economic* approach and the *ecological* approach. The economic approach puts the accent on maintaining the productivity of the total capital base (both man-made and natural assets) while the ecological approach focuses on maintaining the stock of natural assets.

Uncertainty about whether or not processes of environmental change are reversible, uncertainty about the risks and about the possibilities of substituting man-made for natural products, are combining to shift the balance of political thinking more towards an ecological approach, although in practice most countries' actions are still very much based on an economic, even financial concept of assets.

It is argued that the sustainability concept can be made more operational by paying particular attention to natural capital and by treating international aspects, in addition to attempting to increase the wellbeing of present generations. Thus, recent analysis concentrates on the need to transmit to future generations a stock of capital capable of maintaining prevailing rates of welfare growth. However, the extent to which reductions in the overall capital stock should be permitted and the degree of permissible substitution between environmental and man-made assets are unresolved. While all of this is still not particularly concrete, the term sustainable development is here to stay. For the transport sector it is therefore worth asking what the concept might indicate.

## Transport and sustainability

It is difficult to define sustainability in the transport sector. It may be easier to begin by taking some examples of what is not sustainable: ever-increasing total $CO_2$ emissions are not sustainable. Despite uncertainty about the timing and extent of global warming, the minimum requirements are for sharp reductions in emissions. Because of this, almost the entire transport sector is put in question. Further increases in private car traffic in towns are not sustainable. For numerous cities limits have been reached in space occupation and air quality. Increases in traffic in sensitive areas like the Alps are not sustainable. Here the population no longer accepts traffic growth.

These examples illustrate a number of points. First, where agreed health standards for air or noise quality are breached it is evident that transport must be curtailed. Mobility makes an important contribution to welfare but where this is harmful (in ways that can be defined, e.g. exceeding World Health Organisation (WHO) guideline concentrations) it must give way to the higher goal of the health of the population or nature. Second, since the tolerances of people and nature to traffic vary, sustainability cannot easily be defined rigorously in numeric terms. Clearly too, sustainability can have local, regional or global connotations. Third, setting global targets for emissions runs into equity problems when these targets are applied to sectors or regions because of differing initial levels and varying abatement costs. Fourth, in the face of uncertainty, strategies of risk avoidance should be chosen. This especially concerns pollutants with longer-term or cumulative effects. Moreover, at least in the short term, transport and emission growth can occur in markets or sectors where economic development or emission levels are relatively low.

A fundamental issue is the extent to which growth itself is "unsustainable", since several environmental impacts are directly correlated with traffic volume. Even countries with progressive policies, like The Netherlands, have talked only in terms of reducing the rate of growth and not in terms of reducing the levels of traffic. In summary, these few points make it clear that much more work is needed to define and make workable the concept of sustainable development.

## Relationship to cost-benefit analysis

Existing appraisal methodology for transport projects is based largely on cost-benefit analysis (CBA). A key question is to what extent should the methodology be modified to deal with the sustainability concept? The cost-benefit approach applies a reasonably consistent assessment of the advantages and disadvantages of projects. The strength of the method is in comparing alternative projects. Its weakness lies in its attempts to measure all costs and benefits in monetary terms.

Areas where CBA could be modified to take account of the sustainability concept could include:

- Less reliance on time savings, either through lower money valuation or equivalently higher valuation for other factors.
- More explicit valuation of environmental factors like noise and air pollution, at present not valued explicitly. Indeed, this is happening in several places. In Norway, for instance, 40 per cent of road investment is in projects specifically planned to reduce adverse environmental effects.
- For construction costs use of estimates that include best possible environmental protection.

Several countries are moving towards including more environmental or safety considerations in the traditional CBA. For instance, it is now common to see bypasses built for environmental reasons and not just because of time savings to those using the bypass. However, the results can also be surprising. For example, a substantially higher value for the cost of accidents (deaths and injuries) can decrease the economic return on road building. There are changes under way and some innovative ideas about, as for example a proposal in the UK to "invest" the NPV (net present value, a theoretical sum representing the net benefits of the scheme) back into the project, by building on better environmental features.

## The EC Green and White Papers and sustainability

The Commission of the European Communities' Green Paper on transport and the environment includes, in paragraph 128, an outline of Commission thinking on what sustainable transport is (Commission of the European Communities, 1992a):

(1) it should contain the impact on the environment;

(2) it should allow transport to continue to fulfil its economic and social functions;

(3) it should contribute to social and economic cohesion…and to the creation of new opportunities for the peripheral regions;

(4) and within this it should safeguard the freedom of choice for the user.

This text is a typical political compromise containing something for everyone but with no clear indications of new policy directions. Some of the questions which arise, concerning each of the four points mentioned, are:

(1) Which impacts are to be contained? What does "contain" mean?

(2) The principle is beyond reproach but what does it mean in practice? In one sense, all trips have an economic or social function and therefore no intervention in trip making is warranted, especially when (4) is taken into account. (For (1) and (2) together, the obvious question is, how can conflicts between them be resolved?)

(3) New opportunities for peripheral regions implies more infrastructure to these regions, more regional policy measures (agreed at Maastricht) and probably more dispersed industry location patterns. This has probably got a trade-off for the environment, viewed as a whole. It also implicitly recognizes that pollution will increase in peripheral regions.

(4) This is the standard political red herring. The "free" choice is an emotive term and is stated without consideration of costs or other factors. If the population of a region will not accept more traffic what is to be done? If the limits that nature or health can bear are reached what policy should be followed? How does this square up with (1)?

The EC White Paper takes up the environmental theme in its subtitle "a global approach to the construction of a Community framework for sustainable mobility" (Commission of the European Communities, 1992b). However, like the Green Paper, it does not define sustainable mobility or clarify how conflicts between mobility demands and environment might be resolved. In general, the White Paper seems to step back from the positions in the Green Paper. In terms of priorities for action, the emphasis is on further improving technical norms, and the difficult pricing and internalization issues are left somewhat to the side.

These observations confirm the need to continue to work on the concept of sustainable mobility. Even though the concept is not precisely defined, it is not a "soft" idea and its achievement will require difficult choices that cannot be sidestepped by careful wording.

## Some policy measures

In this final section some policy issues are briefly discussed. The possibilities of changing modal split are examined; measures to reduce the environmental damage caused by road transport are suggested. Finally, the possibilities of limiting transport demand are set out.

### *Changing modal split*

It must be emphasized that the possibilities for changing modal split are limited by simple arithmetic. One year's growth in road transport in the late 1980s was equivalent to three times the entire combined transport output. Switching 10 per cent of lorries to rail would require a rail capacity increase of 35 per cent. To get back to their 1970 modal share, European railways would have to carry three-quarters more traffic than they do.

It is also worth noting that modal split can change without anyone actually changing mode. Indeed railways have maintained their tonnage carried. New clients may choose road. In many parts of the market and for many products this is what is happening. It should be noted also that about two-thirds of truck traffic in Europe is over distances of less than 50 kilometres.

There is evidence that price is becoming less important, and that reliability and service regularity are the most important choice factors. Nevertheless, price is crucial when the other quality requirements are met, as for example in combined transport. Road freight transport volumes, moreover, are less sensitive to price changes than rail or waterway transport.

The forces driving the changes in modal split are so powerful that very strong measures will be needed to halt and reverse the trends. All positive measures to improve the alternatives such as heavy rail investment and much improved services are necessary but are not likely to be enough. Therefore direct policy measures for the road freight sector are needed.

### *Measures for road freight transport*

The following measures can have effects on reducing environmental harm:

- Highest possible technical standards for engines, tyres, road surfaces; limiting vehicle power output.
- Good maintenance programmes for in-use vehicles – these are essential but virtually non-existent; tighter enforcement of existing rules is also needed.
- Improved efficiency in market organization through cabotage, telecommunications, liberalization of own-account transport.
- Optimizing vehicle sizes can also help but runs the risk of making road traffic more competitive and thereby generating demand. This is not, however, a valid argument against such measures.

The first two points can make a significant difference, at least in pollution per vehicle and the third, possibly, could lead to a reduction in the number of vehicles needed to carry out the same work. Nevertheless, all these together are unlikely, in particular, to reduce $CO_2$. Thus, further measures are necessary. Restrictions on trucks, at night, at weekends or in towns can encourage shippers to use alternatives but also risk the displacement nuisances. Increasing congestion may also have the effect of encouraging a shift to rail. More fundamental longer-term strategies need to be looked at, including the need to look at transport generation itself.

### *Reducing the need for transport*

Examples of what might be called "irrational" transport include the case of partially completed garments, sent by trucks from East Anglia in the United Kingdom to Morocco for the addition of buttons and zips and then back by truck to England; milk from the south of Germany transported across Switzerland to Italy where it is processed and retransported across Switzerland as mozzarella cheese. While such transport appears to be "irrational" it is perfectly rational from the point of view of the companies concerned. Moreover, there is no sensible administrative measure that can effectively eliminate it. The only way to get rid of "marginal" travel is to increase the price.

Indeed, it is inescapable that in order to limit traffic growth, higher prices are needed, through tolls or fuel charges or both. This is not arbitrary since in any case full costs are not covered. Indeed ECMT ministers of transport have agreed, in principle, that there needs to be a system of supplementary charging for environmental damage caused. The crucial issue is implementation and the fact that the levels of price increases required to achieve "sustainability" may be politically unacceptable in the short term.

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# Reducing the impact of freight transport on global warming:
## the potential of technical solutions

*David Martin, William Cannell and Ken Gwilliam*

**A technology strategy must be developed and integrated into a general transport policy**

### Technology in the context of sustainable mobility

The impact of transport on the environment is a multidimensional problem. Transport is at the same time a major source of economic wealth and welfare and a destroyer of environmental amenity. Given the underlying socio-economic trends of increased income, increased female participation rates, household fission and demographic ageing, this conflict is set to increase. The central policy issue for transport is how to reconcile its wealth-producing characteristics with its welfare-destroying characteristics.

Given the political and behavioural difficulties of reducing mobility by means of regulation or other imposed measures, governments at all levels would prefer a technology-based solution if it is available. Indeed, many people, not just governments, would see technology as playing an essential role in improving the balance between transport and the environment.

The European Commission's recent Green Paper on transport and environment points out the limitations to a "technological fix" approach to the problems of transport and the environment (Commission of the European Communities, 1992). This does not imply that a technology policy in this area is unimportant; the availability and characteristics of technologies to enable economic activities like transport to impose reduced environmental damage are crucial elements in identifying and shaping strategies for sustainable development. Certain technological options can also have pervasive effects outside the area of immediate application. This is the case for example with biofuels. Awareness of technological potential and active support for the realization of appropriate technologies are thus vital components of a strategy for sustainable mobility.

This article considers the way in which technology policy can contribute to the reduction of the global warming effects of transport, with particular reference to freight transport. The specific technologies considered – vehicle design, engine technology and alternative fuels – are those which were examined by the Energy Technology Support Unit (ETSU) in the context of a study carried out for the Strategic Analysis in Science and Technology Unit of the European Commission (SAST) (Martin and Michaelis, 1992).

### European Union research and technology development

The EU objectives and responsibilities regarding research and technology development (RTD) are set out in the EC Treaty. The revised treaty agreed at Maastricht states that the main objective is to strengthen the scientific and technological base of European industry and to encourage it to become more competitive at the international level, while promoting all the research activities deemed necessary by virtue of other EU policies.

In support of those responsibilities the Commission already has a substantial programme of research and technology development, including work in the transport sector, mostly funded through ongoing research programmes. Many of the specific programmes funded by the Commission are based on collaboration with industrial partners, including the BRITE/EURAM programme in industrial technologies and materials developments, the JOULE programme on new energy technologies, the STEP programme on environmental research and the EURET programme which concentrates specifically on transport. Programmes in other Commission services include the DRIVE programme of DGXIII and the THERMIE programme of DGXVII. These programmes usually involve

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cost-shared arrangements between the Commission and groups of collaborating companies.

## SAST project no. 3

The SAST activity is part of the MONITOR Programme of DGXII which provides the European Commission with the means to carry out science and technology policy research and evaluation. SAST's role is to examine specific areas of RTD policy which have been identified as having immediate significance to the EU[1]. The strategic challenge for EU RTD policy and hence the basic objective of the SAST projects is to balance the different demands and perspectives relating to science and technology, taking account of the wider context of industrial competitiveness and societal needs. To achieve this, SAST commissions external contractors to carry out studies and organizes extensive consultations with the various interested parties. Internal consultations are carried out through regular meetings of established steering groups, which aim to ensure coherence with related areas of EU policy.

The aim of SAST project no. 3 is to develop a research and technology strategy to help to overcome the environmental problems in relation to transport, taking account of the many associated interactions. The project was based on an evaluation of the potential contribution of alternative technological options, leading to a reasoned assessment of the priorities for research and development. The project was organized into a series of interlinked study groups. The subject matter was divided by environmental impact into four areas, namely:

(1) local pollution (Environmental Resources Management, London);

(2) global pollution (ETSU, Harwell, UK);

(3) air, water and land resources (TPRI, Dublin);

(4) other quality of life effects (Roland Berger, Madrid).

These contracts were supplemented by a contract to examine the implications for the transport sector of technology developments outside the sector, particularly in telematics. This was undertaken by TNO-INRO, Delft. The whole project was co-ordinated by the Rotterdam Transport Centre in association with the Erasmus Centre for Environmental Studies.

## Global warming and transport technology

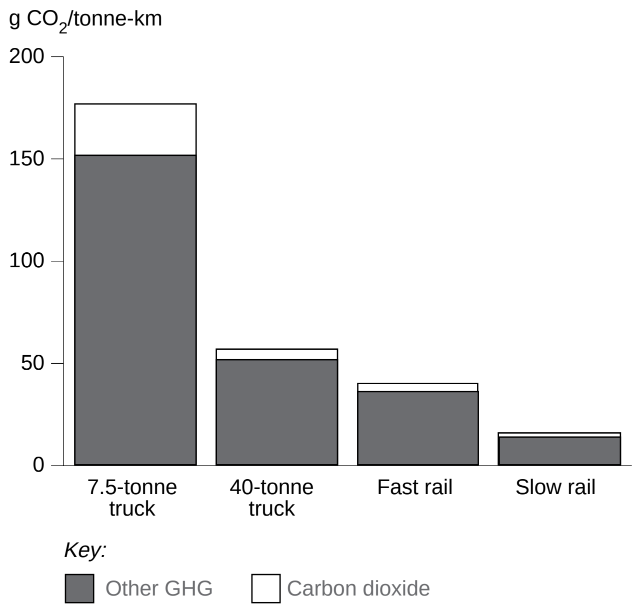
The major factor in the emission of greenhouse gases is the combustion of fossil fuels as the energy source for transport activities throughout fuel production and processing, and the manufacture, operation and disposal of road vehicles, aircraft, ships and trains. For this reason, the central focus of the analysis of global pollution in the SAST project was that of energy utilization, and the ETSU study examined the wide range of technological measures which are available to reduce energy consumption by means of alternative fuels, engine technology and vehicle design. The transport sector is responsible for around 30 per cent of total final energy use in the EU. Nearly 85 per cent of the energy used by transport is by road users, over two-thirds of this is by private cars. A further 11 per cent of transport energy use is by aircraft. Petroleum-derived fossil fuels supply over 98 per cent of transport energy, with the remainder coming from electricity, over 50 per cent of which is generated by fossil fuel power plants.

Carbon dioxide abatement represents the greatest technological challenge in the transport sector, but the global warming impact of transport is enhanced relative to other sectors by emissions of other gases, including nitrogen oxides and hydrocarbons. Figure 1 shows greenhouse gas emissions for a range of land-based freight transport modes.

## The outlook for technology development

In the SAST study, the relevant technologies were divided into a series of "clusters", which can be categorized into vehicle-related (engine technologies, vehicle technologies, alternative fuels), traffic-related (traffic management, demand management, modal transfer) and infrastructure-related (manufacturing technologies and infrastructural design). The evaluation of these technologies was carried out by means of a multiple criterion assessment, structured in such a way as to be capable of contributing usefully to decision making under different prevailing weights or value sets. The overall report of the study takes into account the different contributions which could be made by

**Figure 1.** *Greenhouse gas emissions: land-based goods transport*



the various technology options in the short and the long term (Gwilliam and Geerlings, 1992).

The ETSU contribution to the project considered three clusters of particular relevance to global warming: alternative fuels, engine technology and vehicle design. The principal characteristics of these technologies are discussed in the following sections.

### *Alternative fuels*

Alternative fuels offer the opportunity to reduce dependence on petroleum-derived fossil fuels which at present form the vast majority of the fuels used for transport. Substitution by alternative fuels is attractive when the combustion process can produce lower emissions of greenhouse gases per unit of useful energy. Some alternative fuels could also provide the opportunity to offset carbon dioxide emissions in use by carbon fixing in plant growth. Both these factors could make significant contributions to the reduction of global warming from transport, even when the complete fuel cycle is taken into account. Freight transport operators could benefit from the use of alternative fuels, in particular using biodiesel and compressed natural gas (CNG). However, many of these fuels are not commercial either because the economics of their use are not favourable or because research is still needed to develop them fully.

### *Engine technology*

Engine technology determines the efficiency with which fuel is converted into engine power. It also determines the quantities and chemical compositions of gaseous emissions from the engine. Present-day engine technology utilizes petroleum-derived fuels and these are responsible for greenhouse gas emissions. There are many aspects of engine technology, including different engine types, which can improve energy efficiency and combustion conditions and hence reduce emissions of greenhouse gases.

### *Vehicle design*

Vehicle design determines the way in which engine power is converted into a useful transport product. Designs which improve the efficiency of this conversion require less energy and provided that they are integrated with an appropriate drive-train can reduce emissions of greenhouse gases. For example, in the UK an aerodynamic design for rigid and articulated trucks can offer fuel savings of between 15 and 25 per cent.

## The impact of technologies

Each of these technology classes can offer environmental improvements for freight transport. However, the size of the improvements available, the time scales required for successful commercialization and exploitation of the technologies and the extent of research, development and demonstration needs differ quite markedly between them.

Tables I, II and III illustrate the broad findings of the ETSU study for the three technology classes. It can be seen that the tables give data and reasoned judgements on the environmental, RTD and other characteristics of each technology, together with an indication of the implications for RTD strategy. These judgements are intended to help prepare the RTD recommendations for this study, and should not be used for comparisons between technologies. The intention of these tables is to give a broad picture of the technologies in respect to a variety of parameters. For example, these tables do not allow a clear distinction to be made between the nature of RTD required and the amount of effort required.

## The context of technology development

The appraisal of technology options presented above relates primarily to emissions with global warming impact. When a wider range of impacts and technologies is considered, as was the case in the SAST project, the situation becomes more complex.

The relationship between different areas of technological potential is not always benign and synergetic. Some technologies offer reductions in one impact only at the cost of deterioration in other environmental dimensions. For example, if CNG is compared with gasoline, it is likely to have lower emissions of carbon dioxide, carbon monoxide and volatile organic compounds. On the other hand, it may have much higher emissions of the greenhouse gas methane. On the side of cost and performance, it is more expensive to buy but cheaper to run. It gives lower performance for a given engine size, although energy efficiency is likely to be about the same. From the user's point of view the main disadvantage is likely to be the gas cylinders, which occupy storage space and are likely to give a shorter range between refuelling than is achievable with a gasoline engine.

Furthermore, the environmental performance of technologies depends crucially on the context in which they are developed and used. Technologies that bring about at least a 20 per cent improvement in vehicle efficiency are readily available without further research and development. However, much of this improvement will require substantial capital investment by vehicle manufacturers, who may be reluctant to undertake the necessary changes if there are no economic or regulatory incentives to do so.

It is also important to acknowledge the difference between improvements in environmental performance per unit of travel and the overall benefits to the transport system. On current forecasts, the energy savings benefit of 20 per cent increase in fuel efficiency will be overtaken in less than ten

**Table I.** *RTD appraisal of alternative fuels technologies*

| Technology | Economics | Greenhouse gas (GHG) reduction | Local reduction | Supply security | Performance | RTD needs | Strategy |
|---|---|---|---|---|---|---|---|
| *Light duty IC engines* | | | | | | | |
| Reformulated gasoline | 00 | – | 0 | X | – | 000 | 0 |
| Diesel | 00 | 0 | X | 0 | X | 00 | 0 |
| LPG | 00 | 0 | 00 | 0 | X | 0 | 0 |
| CNG | 00 | 0 | 00 | 0 | X | 00 | 00 |
| Biomethanol | 0 | 00 | 0 | 000 | X | 00 | 000 |
| Bioethanol | 0 | 00 | 0 | 000 | – | 00 | 000 |
| Vegetable oils | 0 | 00 | X | 000 | X | 00 | 000 |
| Hydrogen | 0 | 000 | 000 | 000 | XX | 000 | 000 |
| *Heavy duty IC engines* | | | | | | | |
| CNG | 00 | 0 | 00 | 0 | X | 000 | 00 |
| Biomethanol | 0 | 00 | 00 | 000 | X | 000 | 000 |
| Bioethanol | 0 | 00 | 00 | 000 | – | 000 | 000 |
| Vegetable oils | 0 | 00 | – | 000 | – | 00 | 000 |
| Hydrogen | 0 | 000 | 000 | 000 | XX | 000 | 000 |
| *Electric vehicles* | | | | | | | |
| On-board batteries | – | 0 | 000 | 00 | XXX | 000 | 000 |
| Fuel cells | – | 00 | 000 | 00 | XX | 000 | 000 |
| *Diesel-electric hybrid* | | | | | | | |
| Constant output diesel | 0 | 0 | 0 | 0 | XX | 000 | 000 |
| Variable output diesel | – | 0 | 00 | 0 | X | 00 | 00 |
| *Aircraft* | | | | | | | |
| Hydrogen | 0 | 0 | 00 | 00 | XX | 000 | 000 |
| Methane | 00 | 0 | 00 | 0 | X | 000 | 000 |

*Key*: See foot of Table III

years by increased traffic. Worse, if a technological improvement designed to ameliorate environmental impacts *also* reduces the cost of transport it will tend to further increase total amounts of travel.

This emphasizes the importance of obtaining and publicizing more information on the real magnitudes of many of the environmental problems and the capacity of alternative policies to address them. It also underlines the importance of having a strategy for technological development in respect of transport and the environment which is well integrated with policy for transport in general.

Further technological development can be envisaged which will reduce the adverse impacts of transport on the environment. But there are sufficient areas in which the potential of technology is so uncertain, or where the time scale of the necessary technological development is likely to be so protracted, that a policy concentrating solely on research and development support is not enough. What is required is a sophisticated appreciation of those time scales and balances and a strategy involving a whole range of instruments capable not only of getting the best technology we can, and getting the best out of the technology we have, but also of controlling the use of our technology to ensure that environmental standards are not irrevocably damaged while we wait for a "technological fix" that is unlikely to arrive in time.

## RTD strategy

In developing an RTD strategy for the areas of technology considered by ETSU, it is important to bear in mind the fact that R&D can be carried out for a number of different motives, such as to:

- improve economic cost-effectiveness;
- bring about performance improvements;
- increase safety and reliability;
- enhance supply security, particularly for energy;
- improve the environmental characteristics of the sector.

The three technology clusters examined are all essentially *engineering solutions* to the problem of reducing environmental pollution from transport. As such, they are very

**Table II.** *RTD appraisal of engine technologies*

| Technology | Economics | Greenhouse gas (GHG) reduction | Local reduction | Supply security | Performance | RTD needs | Strategy |
|---|---|---|---|---|---|---|---|
| *Up to 100kW IC engine* | | | | | | | |
| Catalytic converter | – | – | 0 | X | X | 000 | 00 |
| Turbocharge/intercool/MPI | 0 | 0 | 0 | 0 | 0 | 000 | 00 |
| Electronic valve timing | 0 | 0 | 00 | 0 | 0 | 000 | 00 |
| Ceramic engine | 0 | 0 | 0 | 0 | – | 000 | 000 |
| Direct injection gasoline/ stratified charge | 00 | 0 | X | 0 | X | 000 | 00 |
| Indirect injection diesel | 00 | 0 | X | 0 | X | 0 | 0 |
| Direct injection diesel | 00 | 0 | X | 0 | X | 0 | 0 |
| Direct injection diesel/ oxy-catalyst | 00 | 0 | 0 | X | X | 0 | 0 |
| Transmissions | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Two-stroke gasoline | 000 | 0 | X | 0 | 0 | 000 | 00 |
| *100-350kW IC engines* | | | | | | | |
| Intercool/turbocompound | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ceramic engine | 0 | 0 | X | 0 | – | 000 | 000 |
| Evaporative trap | – | X | 0 | X | X | 000 | 00 |
| Particle trap | – | X | 0 | X | X | 000 | 00 |
| Transmissions | 00 | 0 | 0 | 0 | 0 | 000 | 00 |
| *350-kW-20MW IC engines* | | | | | | | |
| Turbocompound | 000 | 0 | 0 | 0 | 0 | 00 | 00 |
| Ceramic engine | 000 | 0 | X | 0 | – | 000 | 000 |
| HP/retarded ignition | – | – | 0 | X | 0 | 00 | 00 |
| Precision cooling | 000 | 0 | 0 | 0 | X | 00 | 00 |
| Transmissions | 000 | 0 | 0 | 0 | 0 | 00 | 00 |
| Low-speed two-stroke diesel | 000 | 0 | X | 00 | X | 0 | 0 |
| Gas turbines | – | X | 0 | 0 | X | 00 | 000 |
| *Aircraft engines – efficiency improvement* | | | | | | | |
| Component improvement | 000 | 0 | 0 | 0 | 0 | 000 | 00 |
| Unducted propfan | 000 | 00 | XX | 00 | 0 | 000 | 00 |
| Ducted propfan | 000 | 0 | X | 0 | 0 | 000 | 00 |
| *Aircraft engines – $NO_x$ reduction* | | | | | | | |
| Modified engine | – | 0 | – | X | – | 000 | 00 |
| Staged combustion | – | 00 | 00 | X | 00 | 000 | 000 |
| Fuel catalyst | – | 0 | – | X | – | 000 | 00 |

*Key*: See foot of Table III

relevant to the transport equipment industry since this industry is capable of determining the nature and scope of developments in the three technology clusters. Furthermore, the rate of penetration of the technologies involved and their cost-effectiveness are strongly influenced by market factors such as economic growth rates, fuel prices and availability, environmental legislation and consumer choice. Thus, the sensitivities of the appraisal parameters need to be examined in relation to factors outside the transport sector.

With regard to the ETSU part of the SAST project, this has been done by means of a series of scenarios: a *pragmatic* scenario, in which the greenhouse effect either does not occur or is much less severe than predicted; a *laissez-faire* scenario, in which regulations remain as planned and manufacturers' strategies are driven by customer demands; a *fortress Europe* scenario, in which the EC is forced into materials and energy self-sufficiency; and an *environmental concerns* scenario, in which there is strong pressure for carbon dioxide abatement.

In the context of these scenarios, the principle consideration underlying the ETSU analysis is that an RTD strategy should be adopted which provides a "no regrets" policy with respect to overcoming global pollution problems from

**Table III.** *RTD appraisal of vehicle design technologies*

| Technology | Economics | Greenhouse gas (GHG) reduction | Local reduction | Supply security | Performance | RTD needs | Strategy |
|---|---|---|---|---|---|---|---|
| *Light duty road vehicles* | | | | | | | |
| Reduced aerodynamic drag | 000 | 0 | 0 | 0 | 00 | 0 | 0 |
| Weight reduction | 000 | 0 | 0 | 00 | 00 | 0 | 0 |
| Reduced rolling resistance | 000 | 0 | 0 | 0 | X | 0 | 0 |
| *Heavy duty road vehicles* | | | | | | | |
| Reduced aerodynamic drag | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weight reduction | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced rolling resistance | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Light rail vehicles* | | | | | | | |
| Reduced aerodynamic drag | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weight reduction | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Local rail vehicles* | | | | | | | |
| Reduced aerodynamic drag | 000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weight reduction | 000 | 00 | 00 | 000 | 00 | 0 | 0 |
| Regenerative braking | 000 | 000 | 000 | 000 | – | 0 | 0 |
| *Intercity rail vehicles* | | | | | | | |
| Reduced aerodynamic drag | 00 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weight reduction | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aircraft* | | | | | | | |
| Reduced aerodynamic drag | 000 | 0 | 0 | 0 | 0 | 000 | 0 |
| Active laminar flow | 0 | 0 | 0 | 0 | 0 | 000 | 00 |
| Weight reduction | 000 | 0 | 0 | 0 | 0 | 000 | 00 |
| Supersonic stratospheric aircraft | – | X | X | X | 0 | 000 | 0 |
| *Shipping* | | | | | | | |
| Hull-form – low drag | 000 | 0 | 0 | 0 | 0 | 000 | 00 |
| Low skin friction | 000 | 0 | – | 0 | 0 | 0 | 0 |
| Wind-assisted ships | 0 | 0 | 00 | 00 | 00 | 000 | 000 |
| Efficient propellers | 000 | 0 | 0 | 0 | 0 | 000 | 00 |
| *CFC substitution* | | | | | | | |
| HFC-134a | – | 0 | – | – | X | 000 | 00 |
| Propane | 0 | 000 | – | 000 | 0 | 000 | 000 |

*Key to ratings on Tables I, II and III*:

Economics: 000 cost-effective in all; 00 some; 0 one; – none of the scenarios

Greenhouse gas reduction: 000 > 60 per cent; 00 30 to 60 per cent; 0 up to 30 per cent; – none; X up to 30 per cent worse; XX 30 to 60 per cent worse; XXX > 60 per cent worse

Local pollution reduction: 000 > 60 per cent; 00 30 to 60 per cent; 0 up to 30 per cent; – none; up to 30 per cent worse; XXX > 60 per cent worse

Security of supply improvement: 000 major; 00 useful; 00 moderate; – no change; X slightly worse; XX may be difficulties; XXX difficulties likely

Performance improvements: 000 major; 00 useful; 0 moderate; – no change; X slightly worse; XX may be difficulties; XXX difficulties likely

RTD needs: 000 R&D + demonstration + information dissemination; 00 demonstration + information dissemination; 0 information dissemination only

Strategy: 000 EC-led research; 00 industry-led research with EC involvement; 0 market forces + regulation transport. In other words, none of the actions undertaken should be detrimental to the environment whatever the outcome will be of the current scientific debate on the magnitude and extent of impacts such as global warming caused by transport.

## RTD priorities

There are four key areas for RTD support emerging from ETSU's work. First, there is a need for additional research into exhaust emissions from transport activities and into atmospheric chemistry processes in order to improve the understanding of greenhouse gas emissions and global pollution mechanisms. Second, a full in-depth evaluation of the merits of alternative fuels should be carried out, in order to ascertain whether a net environmental benefit can be derived from the use of these fuels. Of particular interest to freight transport are: compressed natural gas, biomethanol, bioethanol, vegetable oils and perhaps hydrogen. Third, there are some important technological developments which need to be supported by a combination of private and public-sector financing. These include:

- improving combustion systems in gasoline engines for road vehicles;
- improving combustion systems in conventional IDI and DI diesel engines;
- exploring the potential of unconventional internal combustion engines;
- improving conventional internal combustion engines in trains and shipping;
- developing suitable processes for nitrogen oxides reduction from aircraft engine exhausts including after-treatment.

Fourth, to take advantage of longer-term technological possibilities, it will be important to promote excellence at the European level (within existing structures) in the fields of materials research, heat exchanger design and development, and electrochemistry research.

## Conclusions

RTD policy is just one part of an overall approach to tackling the environmental problems of transport. Technology development can, in some respects at least, reduce the adverse impacts of transport on the environment. An understanding of the existing technology options, their development potentials and their likely effects on the relationship between transport and environment is a crucial element in any viable path towards sustainable mobility.

But technology in itself is certainly not enough. At the very least it will be necessary to consider a range of policies for restraining the amount of traffic if global environmental objectives are to be secured. Unless the adverse environmental impacts of transport are better internalized into the cost to users, technology developments may even be counter-productive. A technology strategy therefore needs to be integrated properly into transport policy more generally.

### Note

1. Besides SAST, MONITOR also includes the FAST activity (Forecasting and Assessment in Science and Technology) which carries out long-term prospective studies, and SPEAR (Activities in Support of the Evaluation of R&D programmes) which concentrates on methodologies for retrospective evaluation of Community RTD actions.

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# Economic instruments for sustainable mobility:
## the case of freight transport

*Gert Jan Koopman*

**Strengthening of existing EU actions and added innovative measures are needed to achieve sustainable mobility**

### Transport, the environment and the economy: the problem of externalities

In the period 1985-1990, road haulage grew at an average annual rate of roughly 7 per cent, far outstripping the growth in demand for rail and inland waterway transport, which expanded at a rate of approximately 1 per cent per annum. Road haulage growth was so strong that total transport grew at an even faster pace than GDP. As a result, road transport consolidated its position as the dominant inland transport mode in the EU: over 75 per cent of all goods transported in the EU use this mode. This implies that if this sector continues to expand at 1985-1990 rates, the total volume shipped by rail and inland waterways will equal only three years of *growth* in road haulage. The enormous expansion of road haulage in the run-up to the internal market is likely to have been propelled by strong GDP growth, increased concentration of production and distribution in industry in preparation for the internal market, alongside low transport costs, high real interest rates and technological developments facilitating new inventory techniques (see Koopman, 1993a). With regard to future developments, it can be stated that centralization tendencies in the goods producing sector aimed at exploiting economies of scale might especially fuel further growth, whereas falling real transport rates as a result of deregulation of transport markets would reinforce this tendency.

The strong growth of the transport sector, in turn, led to major concerns about the negative side-effects that this development entails. In fact, it is argued that, as transport users do not pay the full social costs of transport activities and, hence, do not take these into account, negative externalities occur. The main negative externalities linked to road transport are:

- Conventional air pollution. Emissions of $NO_x$ and $SO_2$ contribute to the acidification of the environment and can, under certain conditions, contribute to the generation of ozone, a characteristic they share with volatile organic compounds (VOCs). Some diesel particles are likely to have carcinogenic properties. Other conventional air pollution problems range from damage of buildings to lead poisoning and health problems caused by exposure to high levels of CO concentration. Although the precise dose-response relationships are not always known, these conventional forms of air pollution have been recognized for many years (see, for example, OECD, 1988).
- $CO_2$ emissions from transport contribute to the anthropogenic greenhouse effect. Global warming resulting from increased levels of greenhouse gas (GHG) emissions has only recently been recognized as a major threat. In spite of the large uncertainties, it seems that $CO_2$ emissions – irrespective of where they are generated – are the main contributor to this process that might cause significant damage.
- Some 50,000 people are killed in road accidents in EU and EFTA countries each year and a multiple of this number is wounded. There is strong evidence that, in addition to great human suffering, this creates significant costs for third parties which are not taken into account when transport decisions are made.
- It is well known that on congested roads the impact on traffic speeds of adding an extra car to the vehicle stream can be quite significant. Road users take only their own time losses into account and disregard those imposed on other traffic participants. In general this implies that traffic speeds and tolls are too low.

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- Road use leads to wear and tear on the infrastructure and thus implies maintenance costs. Empirical research demonstrates that the bulk of these costs are caused by heavy goods vehicles, which pay only part of the costs (the remainder are paid by private motorists). In addition, there is the issue of how road users should be made accountable for the capital costs of roads.
- Finally, transport is never environmentally neutral: noise, visual intrusion etc. of infrastructures and vehicles affect the quality of life. However, it is not yet clear how significant these costs are.

Thus there is a rather full set of negative externalities attached to road transport (for an extensive overview see Button, 1990). The share of road haulage in total road externalities varies per externality. Scarcity of available data and methodological problems prevent an exhaustive assessment per externality to be made. Nevertheless, it seems that as far as air emissions from road transport are concerned roughly half of the $NO_x$ emissions, less than one-fifth of VOC emissions, the bulk of $SO_2$ emissions and a significant share, likely to be in the order of one-third, of $CO_2$ emissions are caused by road haulage. Thus, it is clear that road haulage contributes significantly to total air pollution caused by road use.

With regard to safety, the available evidence seems to suggest that the share of road haulage in total accident externalities is rather small (perhaps less than 20 per cent); this is caused both by a relatively low risk per kilometre and a low share in total vehicle kilometres (Newbery, 1990). The latter element probably also explains why the share of goods vehicles in road congestion externalities seems rather small, roughly 15 per cent according to Newbery's calculations. However, it is well known that road wear and tear is almost exclusively caused by heavy goods vehicles and buses, which have a much higher damaging power than passenger cars owing to greater axle weights.

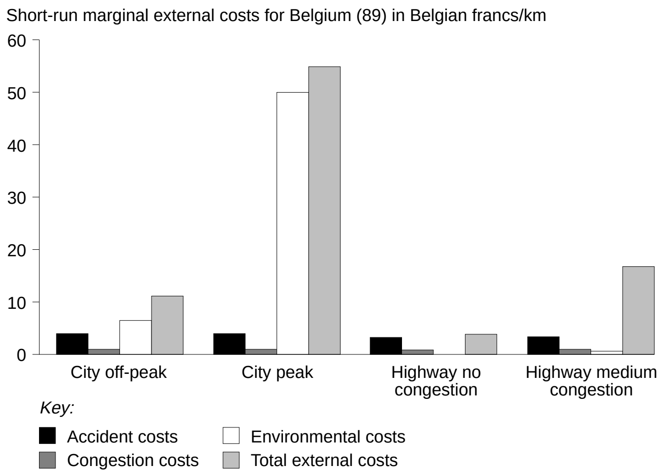
It is also often claimed that there are significant positive externalities attached to the transport function. By facilitating processes of specialization and economies of scale, transport contributes to economic prosperity. Empirical research on this issue has generally corroborated this. Similarly, a positive relation between infrastructure on the one hand and GDP and private sector productivity on the other has been found (for an overview, see Munnell, 1993). However, it has to be stated that the relationship found is not particularly stable and that there are still a number of methodological issues to be solved. Furthermore, even if there are large benefits from transport infrastructure, the question has to be addressed whether these benefits accrue to the transport users or to other agents. Only if the latter were confirmed could (part of) these benefits be labelled externalities. There is surprisingly little research on this topic. Nevertheless, a recent overview by Peca (1993) suggests that, under certain circumstances, such positive externalities might indeed accrue.

## Efficient policies for dealing with transport externalities

The design of efficient policies to internalize transport externalities is discussed in detail in Koopman (1993a) and will only be outlined here. First, the discussion focuses on a first-best world, in which there are no market failures and in which there is sufficient information to design optimal policies. Next, we turn to some obstacles which are encountered in reality and look for second best options. Basically, it appears that in a first-best world, after the identification of externalities, it is necessary to monetize the damage caused, and to internalize the externality by charging for pollution costs.

A first step in this process is the estimation of a damage function. This comprises the determination of the extra damage caused by an additional unit of traffic. Mayeres (1993), who carried out a case study for Belgium, demonstrates that there is a significant variation of monetary damage across vehicle type, road and time of day. Figure 1 illustrates this. Next, as shown in Figure 2, the "optimum" point of pollution should be gauged by equating the marginal damage costs of pollution with the marginal control costs. Abatement is efficient only until the concomitant costs equal the benefits of reduced pollution (i.e. a reduction in damage costs). The difference between the private costs faced by road users and total costs at that point should be internalized by adding a charge to the private costs. Such a policy will trigger a response which leads to a reduction in pollution and an increase in societal welfare. It is worth noting that the appropriate charges to be internalized are smaller than estimates of *current* externality costs, as these evaluate damages at uncontrolled, i.e. suboptimal levels. This is important as it is often thought that current cost estimates form a reliable guide to optimal charges[1].

**Figure 1.** *Variation of the components of marginal external costs of car travel across different travel situations*




*Note:* P.M. Average private costs approx. 10 Belgium francs/car-kilometre

*Source:* Mayeres (1993)

**Figure 2.** *Internalization of externalities*

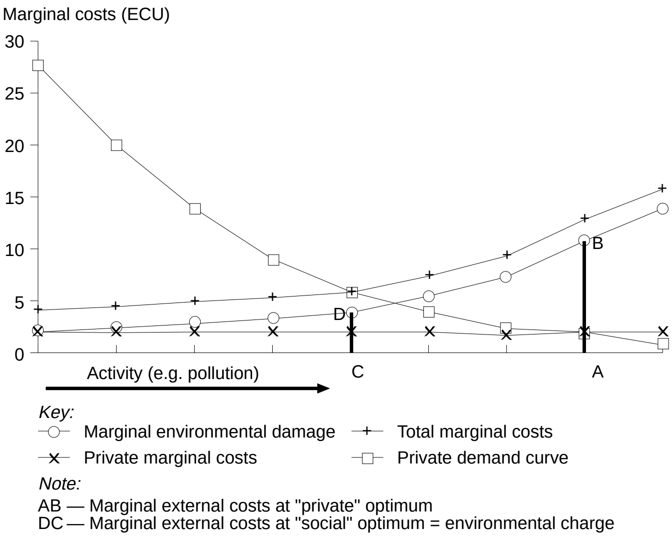
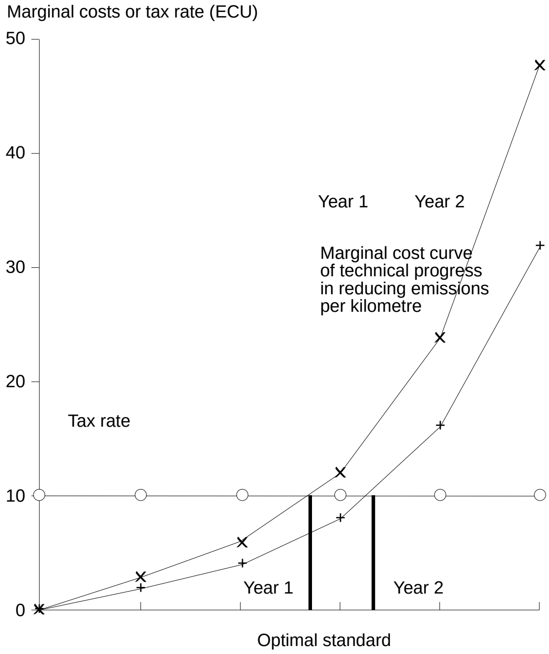



**Figure 3.** *Devising standards to mimic the effects of a tax*




The next step is to select the appropriate tax base. Here a crucial condition is that the charge is *closely tied to the polluting activity or to a proxy of it*. Only when economic agents can reduce the tax burden by adjusting their behaviour can the charge be considered to constitute an efficient instrument. If this condition is met then economic agents will exploit various response options to reduce pollution, until the marginal costs are equal across all dimensions. The charge – being an economic instrument – uses the market mechanism to exploit the decentralized information present at the level of individual decision makers who can decide on the least-cost mix of responses. If, for example, a charge on air pollution is introduced, economic agents will determine their response by switching to cleaner technologies, avoiding trips in high-pollution areas, reducing mobility, adjusting the modal split in such a manner that the overall costs are minimized. Furthermore, the charge gives a continuous signal which stimulates the development of clean technologies. The static and dynamic efficiency of a charge is difficult to approximate with regulation. This is the principal advantage of economic instruments: if they can be applied, they allow environmental objectives to be reached at least cost (Figure 3).

It has been argued (Koopman, 1993b) that in a world of perfect information and without market failure the following set of economic instruments would be the first-best response to the main negative externalities already listed:

- *Air pollution:* a direct emission tax, the level of which varies according to local circumstances (preferences and damages).
- *Accidents:* an insurance-like tax scheme that varies with distances driven and takes account of the driver-specific risks (similar to an extended version of third-party liability insurance schemes).
- *Congestion:* road pricing in which the price to be charged depends on the marginal time costs imposed on other drivers. Under certain conditions this will raise enough revenue to finance the capital costs of the road network.
- *Infrastructure maintenance:* an axle-weight-based kilometre charge exactly captures the (non-weather related) damage done to the road infrastructure. This user charge should be paid in the country where the damage occurs.

The current situation is that few of these policies aimed at efficiently internalizing transport externalities exist in reality: e.g. congestion is not taxed at all, in any member state of the EU. In other areas, the basic instruments are direct regulation (emission standards, safety norms for vehicles) and purchase/circulation taxes. Together with the much more important (as far as revenues are concerned) fuel tax, these charges are basically intended to cover infrastructure costs; although some might claim that, to the extent that they outstrip infrastructure costs, they also somewhat tax some of the externalities. However, most research available shows that if current externalities are monetized they represent a much larger sum than the balance between government revenues from transport and direct public expenditure (see Hansson and Markham, 1992).

Why then, have such policies not already been adopted in the real world? Basically, it seems that there are four factors which block the adoption of efficient policies. First, the technology with which to internalize certain externalities efficiently is not always available. Second, there are significant uncertainties as to a number of causal relations (e.g. dose-response) which hinder the identification of marginal cost curves. Third, socio-political factors often play an important role. Fourth, the running costs of these instruments are still uncertain and might be high in some cases (in particular in the short run).

As far as the congestion issue is concerned the main obstacles seem to be of a political nature although there are also still a number of important technologies to be solved: road users feel that it is unfair that they have to pay for a good that hitherto was free, and they mistrust the intentions of the government in introducing this instrument – many consider it as just another revenue-raising tax (Goodwin, 1989). Privacy issues also play a role in this respect as modern information technology would in principle make it possible to track vehicles. This suggests that a strong effort will have to be made to explain the policy goals, that intrusion of privacy should be avoided, that one must carefully reflect on the use of the revenues and that offsetting cuts in other transport taxes, where appropriate, should be made.

For maintenance costs the obstacles are of a different, albeit also political, nature. Here, many countries acknowledge the importance of axle-based taxes, but some hold on to the nationality principle, according to which countries exempt each other of the costs which national road hauliers cause to one another's infrastructure: road hauliers pay only in the country where they are registered. The desire to boost international competitiveness and internal-market considerations confound the adoption of efficient transport policies.

In the case of safety, it is probably a combination of the scientific uncertainty as to the exact relationship between the effect on the average accident rate of adding an extra car to the vehicle stream, the predominantly regulatory approach in this area (safety norms, obligatory devices such as seat belts) which has known significant successes (the number of persons killed per kilometre driven has declined in the past 15 years) and political problems similar to those in the case of congestion which has blocked progress in this area. Furthermore, the safety issue does not seem to be as high on the political agenda as it was a number of years ago. Nevertheless, when the marginal benefits of technical improvements to the vehicle and stricter traffic rules decline, a review of safety policies would seem likely.

Regarding air pollution, high costs of direct metering, scientific uncertainty with respect to dose-effect relationships and consequent problems in monetizing costs (which are furthermore affected by widely varying local circumstances and preferences) imply that economic instruments have not been the central element of policies in this field. Basically, the EU and the USA have relied on regulating tailpipe emissions per kilometre and other technical characteristics. Also in this area, the regulatory approach has brought forward significant improvements (see Table I). However, in areas where air quality is particularly bad and where compliance costs for stationary sources are likely to be particularly high – e.g. the Los Angeles area – means to introduce market-based mechanisms to achieve greater environmental improvements at lower costs are being looked at increasingly.

It appears that, owing to market failures, an additional role for direct regulation in certain areas is warranted. For example, high information costs concerning the safety performance of vehicles, certain safety devices and driving speeds, might constitute a good reason to continue regulating aspects like safety standards, life-saving devices (e.g. seat belts, airbags etc.) and speed limits. In addition, it would seem that in areas where regulation can significantly reduce externalities, and where solely introducing economic instruments would imply large running costs, a continued role for regulation is necessary. However, in such cases it should also be seen to what extent direct regulation schemes can be modified and combined with a partial use of economic instruments to limit the inefficiency inherent in pure regulation. An example is the case of air pollution. An important conclusion to keep in mind is that, on the whole, it seems at present that from a technical point of view, more efficient policies to deal with congestion, accidents and infrastructure maintenance costs are feasible[2].

## Fuel taxes as a second-best instrument?

As many environmental externalities are in some way or other related to fuel use, fuel taxes are often considered to be an attractive economic instrument with which externalities can be roughly internalized. Instead of designing the first-best set of instruments discussed above, it is argued that it is much easier simply to raise fuel

**Table I.** *Vehicle exhaust emission limits*

| | | CO | HC | $NO_x$ |
|---|---|---|---|---|
| *Passenger cars (grammes per kilometre)* | | | | |
| EC 1990 average fleet | | 17.5-37.6 | 4.1-5.9 | 2.3-3.4 |
| EC 1990 | limit | 14.3-27.1 | 3.0-6.9 | 1.7-3.1 |
| EC 1991-93 | limit | 6.2-11.1 | 1.6-3.7 | 0.9-1.5 |
| EC 1993 | limit | 2.7 | $HC+NO_x$ = 1.0 | |
| EC 1996 | limit | 2.2 | $HC+NO_x$ = 0.5 | |
| *Trucks (grammes per kWh)* | | | | |
| ECE Reg 49 1982 | | 14 | 3.5 | 18 |
| EC 1988 limit | | 11.2 | 2.4 | 14.4 |
| EC 1993 limit | | 4.5 | 1.1 | 8 |
| EC 1996 limit | | 4.0 | 1.1 | 7 |

costs. By raising this key parameter, the argument goes, the effects of the first-best set of instruments can be approximated, at a roughly comparable cost.

However, it can be argued that the overall effect of fuel taxes, in terms of economic costs and consumer satisfaction, is likely to be significantly worse than that of efficient policies. Basically, this is caused by the fact that the only channels which fuel taxation employs to reduce externalities are fuel use and, consequently, to a certain extent, lower private mobility. Other response options to reduce externalities are not tapped at all as no incentive is given to exploit them. This generally implies that the overall costs of reaching the same reduction in an externality are significantly higher when fuel taxation is used than in the case of the efficient economic instrument as the latter gives economic agents the possibility of finding the least-cost reduction using all possible means. This argument is not only of theoretical relevance as the case of congestion demonstrates. Here, fuel taxes have practically no effect as they only reduce *overall* mobility to a certain extent, while what is needed is a reduction at certain places and points in time. In this case, fuel taxes are thus practically ineffective from the transport policy point of view and, in addition, imply significant welfare costs as consumers are also induced to reduce mobility which is congestion-free. Another example is taxing for road wear and tear which (insofar as it is man-induced) is nearly exclusively caused by buses and freight transport. Major reductions in maintenance costs can be achieved by reducing the weight per axle which is achieved by adding more axles to a vehicle. As such a measure has a fuel penalty it is actually *discouraged* by fuel taxation. This demonstrates that in certain cases fuel taxation can even have perverse effects. Elsewhere I have argued that these welfare losses of fuel taxation are likely to be large in the case of nearly all externalities – with the notable exception of $CO_2$ emissions – and that it is thus worthwhile to develop more efficient options (Koopman, 1993b).

When analysing the impact which fuel taxation has on road haulage the following transmission channels are of importance:

- fuel efficiency;
- changes in modal split;
- total demand for freight transportation.

As fuel becomes more expensive road hauliers will attempt to reduce energy consumption per tonne-km transported. This might be achieved by various measures: larger trucks, fuller trucks (reduction of empties), driving behaviour and, especially in the long run allowing for an R&D lag, more fuel-efficient trucks. There is more research available for private transport than for road haulage, where the picture seems rather sketchy. However, well-documented long-term price elasticities of fuel *efficiency* in private transport of the order of –0.6 suggest that also in goods transport some effects are likely (see, for example, Goodwin, 1992).

In general it appears that at an aggregate level substitutability between transport modes is rather low. This is due to the large heterogeneity in the demand side and the supply side of transport. Modes differ significantly in terms of suitability, availability, reliability, frequency and speed. Generally road transport has far higher scores on these criteria than other modes and this is one of the driving forces of its growing share: in spite of the fact that it is two to five times more expensive per tonne-km than inland waterways and rail, it is the preferred choice in most transport markets. Furthermore, relative transport prices are not likely to be greatly affected as fuel costs comprise only roughly 10-15 per cent of total road haulage costs (the bulk consists of labour and capital costs). Thus, fuel taxation will have only a limited effect on the relative price competitiveness of road versus rail and inland waterways, even when fuel cost shares in these latter sectors are significantly lower than in rail[3]. Calculations with input-output models show, for example, that the effects of a $10 per barrel of oil equivalent $CO_2$/energy tax on prices of road haulage in Denmark, Germany, Spain, France and Italy would vary between only 1.5 and 2 per cent; a significant part of which is due to price rises in other branches of the economy (see Commission of the European Communities, 1992a).

The impact on the total demand for transport is likely to be very small in the short run as many production processes can be adjusted only at significant costs in this time frame and freight transport prices will be affected only moderately by fuel-price changes (see above). In the longer run, interactions between location, production (batch sizes, number of suppliers etc.) and inventory (high inventories/bulk transport versus low inventory/many small transport batches) decisions should allow greater flexibility. Aggregate price elasticities from transport models, however, are rather low (in the order of –0.1 to –0.2). These might underestimate the true long-term relationship as current transport models do not simulate the location, production and inventory decisions. Innovation in research in this area might produce more useful results to judge this issue (for a promising approach, see Ruijgrok, 1991). Analytical studies of industries where economies of scale are important (e.g. cement) show that transport prices can have an important effect on production and location decisions and hence on transport demand. It is therefore likely that, in the longer run, price elasticities of demand for freight transport could be significantly larger and might be in the order of –0.5. Where fuel taxation is concerned, it should, however, be repeated that owing to the small share of fuel costs in total costs, very significant price rises would be needed in order to have a noticeable effect on demand for freight transport.

For private transport the effects on fuel consumption and mobility are likely to be much larger. Transport demand elasticities with respect to fuel *prices* are in the order of –0.4 and fuel-demand elasticities might come close to 1.0 (see Dienst Verkeerskunde Rijkwaterstaat, 1989; Goodwin, 1992; Oum *et al*., 1992). This reflects the much higher share of fuel in total and certainly in perceived costs, a significant amount of price sensitive "leisure" travel and downscaling possibilities, which allow the same mobility to be realized at only slightly lower comfort levels.

Thus, in summary, it appears that fuel taxation is, at best, only a second-best instrument to deal with the major transport externalities. First-best policies seem to have major advantages over using fuel taxes. If higher fuel taxes are nevertheless introduced, they should be accompanied by more efficient policies to tackle the main transport externalities. With regard to their effects, it seems that they will mainly affect private transport. In freight transport they are not likely to lead to a significant substitution in the direction of other modes and will, in the short run, have only very modest effects on transport demand. In the longer run, freight fuel consumption might be reduced further, on the one hand, by more fuel efficient trucks coming on the market, on the other hand, by somewhat reduced transport demand, following adjustments in production, inventory and transport patterns.

## Innovative economic instruments for limiting "conventional" air pollution from road transport

The introduction of the first-best policy instruments in the fields of congestion, infrastructure planning, pricing and maintenance and safety discussed above would imply a significant restructuring of existing approaches. In view of market failures such as information problems (e.g. with respect to safety) an additional role for direct regulation is warranted in certain cases (e.g. mandatory safety devices). However, on the whole, the important point is that in the case of these externalities significant progress can be achieved in the real world by moving towards the first-best set of policy instruments outlined above. The case of "conventional" air pollution seems somewhat different and is discussed in more depth in the following section.

### *Conventional air pollution*

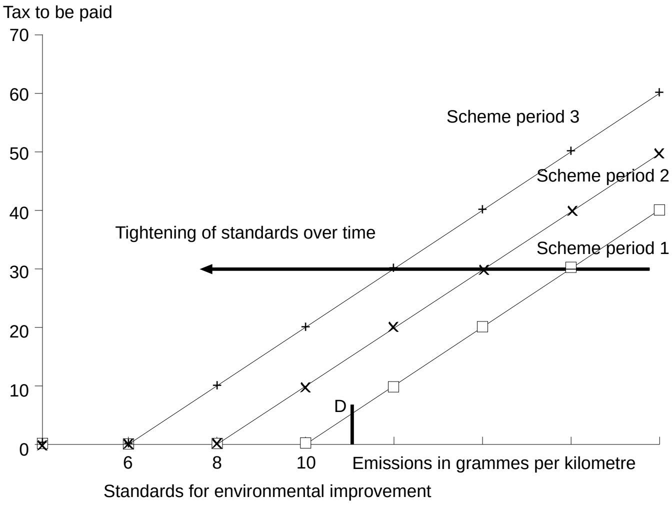
In the case of conventional emissions ($NO_x$, VOCs and CO) technical problems and uncertainty at present rule out the possibility of introducing the theoretically first-best instrument (direct emission charges). In finding an alternative instrument one should, as much as possible, try to approximate the first-best instrument. A reasonable approximation might be to introduce circulation taxes which are both vehicle-type and kilometre dependent. As emissions are, to a certain extent, determined by these two variables this option might be a practical way of taking on board some characteristics of the first-best instrument[4]. Strictly speaking this would suggest that there is no need for vehicle emissions standards. However, in reality, it seems that there might remain an important role for setting efficient standards. As the costs of technical changes to vehicles in reducing emissions significantly still seem to be relatively low compared with some other options it is reasonable to assume that in a world of perfect information a significant part of the response to the introduction of the first-best instrument would come from influencing the vehicle and technology choice. If information is not perfect and/or there are other market failures (i.e. imperfect discounting of future lifetime vehicle costs) – as seem to occur in reality – one might argue that well-defined vehicle emission standards could be an important *additional* element in designing a second-best policy instrument, as they guide consumers towards efficient solutions.

A two-stage procedure can be followed in this respect. The first step is to define a marginal cost curve of emission abatement measures (comprising the marginal costs of the least cost *package* of measures at each individual point on the curve) and determine optimal abatement as well as the marginal economy-wide cost (i.e. the implicit "optimal" tax) by equating this cost curve with the marginal benefit curve – as discussed above for Figure 2. Next, the "optimal" standard can be defined as the point where the marginal cost curve for technology improvements equals this implicit "optimal" tax. The second step of this procedure can also be followed when the environmental objective is given (e.g. because air quality standards are to be met) and one is, hence, confined to a cost-effectiveness analysis[5]. The second step of this procedure is illustrated in Figure 3. As technology progresses these standards should be tightened. Obviously, cars meeting the standards would pay significantly lower circulation taxes than old cars, which would provide an incentive to switch to new vehicles. As Figure 4 suggests, this latter channel would indeed have a major potential for bringing down economy-wide emissions as EC model year 1993 cars are approximately 70 per cent cleaner than cars from model year 1985.

Compared with existing policies the above-mentioned scheme differs particularly with respect to the emission-based circulation tax. At present, circulation taxes in the EU are largely a function of factors such as engine cylinder capacity, horsepower and vehicle weight, and do not directly take account of environmental considerations[6]. Furthermore, they are not related to kilometres driven. Standard-setting has been the dominant approach in OECD countries, but it is not clear to what extent these standards have been based on explicit cost-benefit and cost-effectiveness considerations.

Although the policy for air pollution outlined above has significant advantages, it might be wise to consider

**Figure 4.** *Standards and non-compliance fees*




supplementing it with elements which allow for a greater flexibility in ensuring the overall emission reduction. This is even more true if fuel taxation combined with emission standards remains the dominant approach. In this case the quest for instruments which imply a lower cost in achieving the emission reduction would be of great importance. The following options are of relevance in this context, but each of them needs to be carefully analysed.

### Other options for internalizing external costs of conventional air pollution

*Introducing trading possibilities between manufacturers for complying with standards*

The idea would be that credits could be earned for emission reduction beyond a standard which could be sold to producers unable to achieve the standard (see California Air Resources Board, 1992). This approach would guarantee compliance with the overall emission standard at low costs. More research is needed, especially into the possible strategic behaviour of car producers and the administrative and monitoring costs of such a scheme.

*Adding an environmental surcharge to the sales tax*

If standards are so tight as to force certain vehicle types off the market (because these cannot comply) and no trading possibilities across manufacturers exist then welfare losses will be incurred by potential owners of such vehicle types. If the utility of such vehicles to these economic agents is very high, then it is likely that, in the first-best scheme (direct emission charges) some of these vehicles would be operated while being appropriately taxed. Standards exclude this possibility and might therefore imply welfare losses. Some of these could be avoided by adding an environmental surcharge to the sales tax on those vehicles which would compensate the extra emissions above the standard (assuming that there is a bracket in the circulation tax scheme for such vehicles). Such a tax is illustrated in Figure 4. Careful analysis of this issue is needed.

*Environmental performance-related "fee-bate" system applicable at time of new vehicle sale*

It is sometimes argued that certain economic agents have very high discount rates and therefore, when deciding on which car type to purchase, attach a greater value to the purchase price than to operating costs which will have to be paid in the years to come. This would imply that taxing cars at the moment of purchase for environmental costs which they (will) cause is more efficient than taxing them during their operation. This has led some to propose a system in which an environmental yardstick is formulated which determines the tax at the moment of sale. Vehicles would be taxed as a function of the extent of non-compliance with the environmental standard; if vehicles have a better environmental performance they receive a rebate. Such a system seems particularly attractive if fuel taxation is the only means of internalizing environmental externalities – i.e. there are no environmentally adjusted circulation taxes. The system aims at changing the composition of the vehicle stock in an environmentally friendly direction.

An attractive feature of such a system is that it can be formulated in a revenue-neutral way. Such fee-bate systems have been proposed in various US states with respect to fuel consumption. In California a broader fee-bate system called DRIVE+ (Demand-based reductions in vehicle emissions plus improvements in fuel economy) was tabled in 1989 but was not accepted (Gordon and Levenson, 1990). In the state of Maryland a fee-bate system was adopted but the initiative was blocked by the federal government because it was perceived as an independent fuel efficiency policy in conflict with the federal approach (CAFE standards). Variants of this approach are *gas-guzzler taxes* and *gas-sipper rebates*. Careful analysis of the underlying assumptions is necessary because it is not clear that the high discount rates are a good reason for intervening at the moment of purchase (high discount rates need not imply market failures). Furthermore, in isolation, this system does not tax the marginal costs of polluting which implies that various sources of emission reduction are likely to remain untapped.

*Promoting "clean" fuels*

Environmental pollution not only depends on the characteristics of the vehicle, but also on the fuel used. Low-sulphur diesel fuel which is being marketed in California and in Sweden has a number of direct and indirect advantages (e.g. expanding the scope for the introduction of diesel catalytic converters). Reformulated gasoline has a great potential for bringing down VOC and CO emissions. In the long run bio-diesel and hydrogen/ fuel cells might have significant environmental benefits. Promoting "clean" fuels thus seems to be an attractive element in a policy strategy. Various instruments can be used in this respect, from standard-setting (e.g. reformulated gasoline in the USA) to differentiating excise taxes. The latter approach was followed in Europe with respect to unleaded/leaded gasoline and proved very successful.

*Direct taxation of emissions*
It is evident that in the long run direct taxation of emissions would be desirable. As discussed above this is not yet feasible. However, research into how this could be done is of great importance.

It is clear that many of these options need to be analysed carefully before far-reaching proposals are formulated in this area. Furthermore, the combination of policy instruments in an integrated strategy requires careful selection as not all options are easily compatible. For example, choices will have to be made with respect to dealing with air pollution via emission standards and fuel taxes (as is done at present) or approximating full internalization via environmentally adjusted and kilometre-based circulation taxes in conjunction with “optimal” standards, or alternatively via fuel taxation in combination with a fee-bate system. Furthermore, in the long run the direct emission tax scheme would have significant advantages, if the technological and informational problems could be solved at reasonable cost.

Finally, it is important to reflect on the optimal division of labour between the EU level and its member states: some measures should clearly be taken at the EU level (such as setting up the broad structure of the policies to be pursued, ensuring compatibility of systems), but in other cases member states should have a considerable degree of freedom to take account of specific national or even regional circumstances (e.g. congestion pricing).

## Some recent EC policy initiatives

It is not the aim of this article to give an exhaustive overview of recent EU policy initiatives in this area. Nevertheless it is useful, by citing some recent examples, to indicate that progress is being made on a number of important areas.

The transport-environment link has been clearly recognized by the European Commission in its Green Paper on transport and the environment (Commission of the European Communities, 1992b) and the White Paper on the future development of the common transport policy (Commission of the European Communities, 1992c). Internalizing the external (environmental) costs of transport is an important policy goal of the latter document. These documents provide a useful starting point for the formulation of efficient transport policies to achieve sustainable transport.

A number of important measures have already been introduced and/or proposed. Emission standards for cars (Directive 91/441/EEC) and trucks (Directive 91/542/EEC) were tightened and have brought the EU standards in line with those in the USA. Further tightening for passenger cars by 1996 has recently been adopted which in its first stage will reduce the limit value for petrol cars by 20 per cent for CO and by 50 per cent for hydrocarbons (HC) and $NO_x$. Moreover, the Commission is currently studying the cost-effectiveness of a wide range of measures both of a technical and a non-technical nature in order to prepare a strategy for the year 2000 and beyond, allowing European air quality standards to be met. Furthermore, a European Commission amendment to an earlier proposal for a council directive on the charging of transport infrastructure costs to heavy goods vehicles has been adopted which consists of an interim system comprising minimum vehicle tax rates (axle based) in conjunction with a limited introduction of user charges on some motorways and a minimum excise duty on diesel fuel. Pending definitive common rules, such a system is an important step forward in reaching an efficient transport policy in the field of infrastructure costs. Furthermore, it explicitly mentions the possibility of taking account of externalities in charging for road use.

Ongoing research and development work in the Commission’s R&D programmes (e.g. SAST and DRIVE) are likely to bring about solutions in areas where technical obstacles are still important.

It is clear that the European Community has already taken important first steps towards reaching a sustainable mobility which will be of great use in the future development of the Common transport policy.

## European renaissance: an illustrative scenario of sustainable mobility

An important question is whether the available instruments discussed above can be introduced at levels strong enough to reduce transport externalities in the future, even when transport activity is forecast to grow significantly in the baseline scenario. The answer to this question is essentially a political one. However, quantitative work suggests that a move in this direction would indeed result in a significant reduction in transport externalities. Within the framework of a study on long-term scenarios for the world economy in the year 1990 to 2015, an interdisciplinary working group was set up in The Netherlands which aimed to assess developments in three long-term scenarios for the Dutch transport sector (Centraal Planbureau, 1992a). State-of-the art economic, transport and energy modelling tools were used to derive results on key variables such as transport demand, environmental impact and congestion (Centraal Planbureau, 1992b).

In two scenarios a relatively strong environmental focus was introduced. The European Renaissance (ER) scenario is one and sketches a world for the period 1990-2015, which is characterized by a strong European integration implying a significant transfer of power to the EU level, a relatively strong economic growth (2.8 per cent per annum) and an activist European environment and energy policy (e.g. introduction of a European $CO_2$ tax).

Transport policy in this scenario uses both market-based and standard-setting approaches for reaching environmental targets. Strong increases in real fuel prices (in the order of 40 per cent) are combined with strict emission standards, a significant increase in (direct and indirect) parking costs and an expansion of public transport services in cities. EC support for combined transport and infrastructure expansion for all modes is of considerable importance.

The results of this scenario are presented in Table II. Although these results have been calculated using fairly pessimistic assumptions about available technologies, they show that significant reductions in externalities are feasible. The driving forces behind these results are a very significant (forced) technological progress and restrained demand growth in private transport (interaction of high prices and standards). In the freight sector demand is less responsive, but significant reductions in environmental stress are achieved via technological improvements.

This illustrative scenario shows that sustainable mobility and economic growth can go hand-in-hand, and that major reductions in environmental degradation can be achieved by using currently available instruments and technical options that are beginning to enter the market. Even better results are likely to be obtained in a scenario in which the efficient policies outlined earlier under the heading "Efficient policies for dealing with transport externalities" are fully introduced.

**Table II.** *European renaissance: a scenario for sustainable mobility 1990-2015 (calculations for the Dutch transport sector)*

| | Modal split 1990 (% shares) | Growth 1990-2015 (indices 1990=100) |
|---|---|---|
| Economic growth | | 200 |
| Employment | | 126 |
| Real fuel price | | 155 |
| Road infrastructure | | 115 |
| *Private transport* | | |
| Car[a] | 74.2 | 118[c] |
| Rail | 10.8 | 132 |
| Bus/metro | | 161 |
| Slow modes | 14.9 | 110 |
| Total | 100[b] | 119 |
| *Freight transport* | | |
| Road | 64.5 | 199 |
| Inland waterway | 32.9 | 149 |
| Rail | 2.5 | 206 |
| Total | 100[b] | 183 |
| *Externalities* | | |
| $CO_2$ | | 92 |
| $NO_x$ | | 23 |
| $SO_2$ | | 31 |
| Congestion | | 45–50 |

*Source*: Central Planbureau (1992b)
*Note*:
[a] Of which car passengers account for 33.3%
[b] Totals do not add up to 100 due to rounding
[c] Car mileage: 132; car passengers: 89

## Conclusions

Economic instruments have an important role to play in reducing transport externalities. Theoretically, these instruments are of a least-cost nature and select the most efficient options for diminishing externalities. It appears that, for most transport externalities, in real life there are economic instruments available which can reduce environmental degradation significantly and lead to an important improvement in societal welfare. Congestion pricing, environmentally adjusted circulation taxes and well-designed tailpipe emission standards, efficient – i.e. kilometre and axle based – wear taxes for goods vehicles, insurance schemes taking account of the external costs of accident risks and carbon-based fuel taxes are likely to constitute a powerful instrument kit with which to address the main externalities. R&D endeavours can play an important role in bringing direct emission taxation into the realm of the possible. In addition to these instruments a number of second-best schemes are available. In all cases a careful examination of the (administrative) costs of instruments is necessary before strong policy recommendations can be made.

The EU has already made a number of important first steps in recognizing the transport-environment link and in devising policies in this area. Simulation results show that major improvements can be reached if further progress is made along these lines.

### Notes

1. A second reason why this is often not correct is that such analyses often overlook current policy instruments that already internalize part of the externality. Only, the non-internalized marginal external costs (at the optimal point of pollution) should be internalized by adding a charge to existing transport costs. In practice this implies that knowledge on the demand reaction is necessary or that an iterative process will have to be followed.
2. Various countries, regions and cities have run experiments with forms of road pricing. Experiences in The Netherlands, Singapore, Oslo and Cambridge (UK) seem to indicate that technically road pricing need not pose major problems which could not be overcome. Furthermore, developments in information technology and research in the DRIVE programme will improve the technical prospects for road pricing even more.

3. However, it should be stated that in the few markets where competition does occur (because several modes are available, having roughly the same service characteristics) even small price changes could have a strong impact. In the aggregate these effects are barely visible because there are so many markets where effective competition does not occur.
4. However, it should be pointed out that there are two important differences between this option and direct emission charges. The first one is that emissions also depend heavily on the characteristics of the trip (e.g. congested, cold-start, urban driving versus uncongested trips over longer distances on highways) and the state of maintenance of the vehicle. This variation is not captured by a vehicle specific average volume of emissions per kilometre. Second, direct emission charges would also vary in relation with the damage caused, which varies across regions (e.g. densely populated versus countryside) and time of day (ozone formation requires sun light). The proposed circulation tax would have to be based on an *average* damage value (although some variation might be possible). Both factors are likely to be of significant importance.
5. This analysis assumes a simplified representative agent, representative vehicle economy. Furthermore, it is assumed that emission reduction does not change the characteristics of the vehicle to the consumer and is possible at increasing cost. In such a world an optimal standard can be derived easily along the lines discussed in the text. However, if there are various vehicle types and technical changes affect the (perceived) performance of the vehicles the analysis becomes more complicated. For example, if marginal cost curves differ significantly across vehicles, the selection of a single emission standard implies too little technical progress for some vehicle types and too much for others. This would imply an inefficiency which would have to be compared with the advantages of the proposed approach. More research on this issue is clearly needed.
6. In fact, circulation taxes largely function as a revenue raising device for financing infrastructure costs.

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# The European railways perspective

*John Markham*

**Railways in Europe may be at the dawning of a new age**

## Introduction

The publication of the European Commission's Green Paper (Commission of the European Communities 1992) on the impact of transport on the environment and the introduction of the concept of "sustainable mobility" marked an important turning point in the development of European Union policy both for transport and the environment. The initiative for the Green Paper came from the highest levels within the Commission, and it was subjected to a painstaking consultative process within the Commission's services. The outcome was a first-class document.

It is widely felt that the railways in Europe may be at the dawning of a new age. The emphasis given in the Maastricht Treaty to trans-European networks and the environment should lead to the modernization both of the European high-speed and the combined-transport networks, and place the railways in a position to make the maximum possible contribution to the future "sustainable mobility" of this continent.

In this article I will concentrate my remarks on combined transport and, in particular, on how the railways will contribute to the goals being set for it by policy makers.

A definition of combined transport is: The transport[1] of goods in which the: lorry; trailer (with or without tractor); semi-trailer (with or without trailer); swap body; container are carried by: rail or waterway for part of the journey; road for the initial or terminal haul. Right at the heart of this definition is rail, and this is why it is so important that the railway viewpoint be understood.

Taken at face value, the railway as a transport mode is the safest, cleanest, most environmentally friendly, and economical user of land in the world. Its contribution to sustainable mobility is unassailable and beyond doubt. However, the real world is never simple, and Figure 1 shows the key two-way relationships that exist.

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The development of the European combined-transport network will be a major component of a successful sustainable mobility policy. The goal of sustainable mobility should bring pressures to bear on the combined-transport network which, for its part, should be a major contributor to the realization of that goal. Similarly, the railway networks will be vital to the combined-transport network and vice versa. However, the railways' capacity to contribute will depend, not only on their own efforts, but also very much on the political, economic, and market framework within which they are allowed to operate.

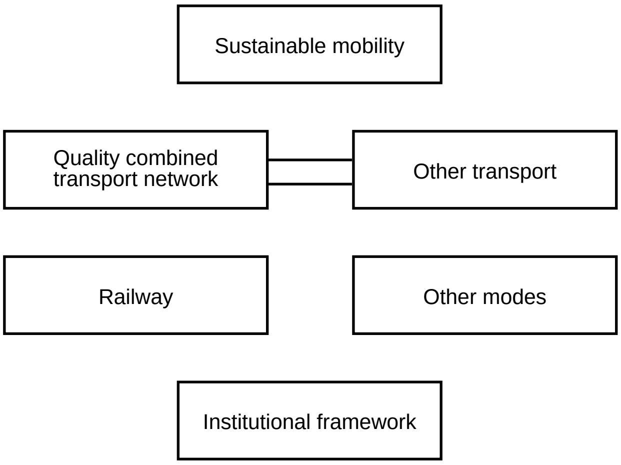
I will first highlight the areas needing critical attention at this time if we are to develop a combined-transport network which will satisfy the goals of both the customer and society. Second, I will provide some background statistics and sketch the vision which the policy makers have in mind for combined transport. Third, some of the difficulties will be outlined which the railways themselves have identified and the solutions which are already in progress will be mentioned. Not all of the solutions are within the railways' own powers to implement so I will identify policies which the national and international authorities need to amend before the railways can achieve their full potential.

## Background statistics

A quick review of some of the pertinent statistics over the past 20 years (Figure 2 and Table I) shows the extent of the difficulties in upholding the concept of sustainable mobility.

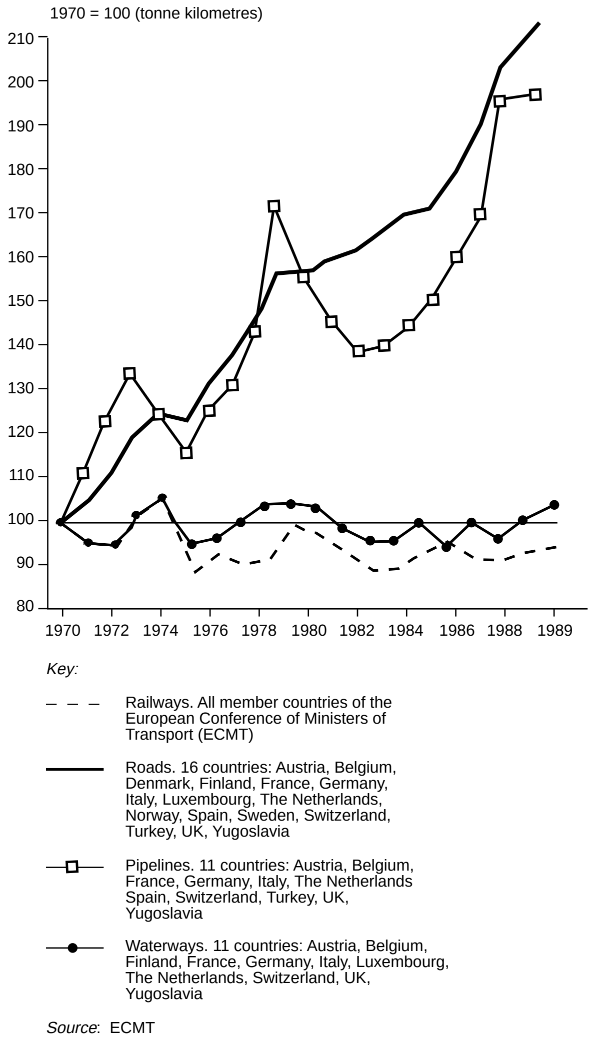
- Freight traffic by road and pipeline in the ECMT member countries has more than doubled in a consistent upward trend; carryings on the railways and waterways have remained more or less stagnant (Figure 3). In an expanding market the ECMT railways still broadly carry the same volumes of tonne-kilometres as they did 20 years ago.

**Figure 1.** *Combined transport and sustainable mobility*




- Within the EC or Community of European Railways (CER) railways, there are three large freight networks (DB and DR of the Federal Republic of Germany and SNCF, France). Together these haul 150 billion tonne-km per annum. Since 1971 the German networks have more or less held their own and SNCF has lost roughly one quarter of its traffic.
- FS (Italy) and BR (UK) both carry close to 20 billion tonne-km and have had mixed fortunes, with FS gaining 23 per cent and BR decreasing by 27 per cent.
- The networks in Spain (RENFE), Austria (OBB), Belgium (SNCB) and Switzerland (CFF) all carry around 10 billion tonne-km and all display growth ranging from 25 per cent to 47 per cent over the last 20 years.
- The Netherlands (NS), Danish (DSB) and Portuguese (CP) railways all haul two or three billion tonne-km and CP's performance has been spectacular since 1971.
- The three lowest carriers are Luxembourg (CFL), Greece (CH) and Ireland (CIE) all with approximately 0.6 billion tonne-km. Here CH shows a decrease.
- Of the three Nordic networks, SJ (Sweden) and VR (Finland) have shown very positive growth, with NSB (Norway) holding its own.
- The situation in Central and Eastern Europe is in such a state of flux that a comment on statistics may be unwise. The returns are shown in Table I.
- In seven of the CER networks, CFL, CFF, OBB, SNCB, NS, CH, and FS, the extent of international wagonload freight traffic exceeds 50 per cent.

**Figure 2.** *Freight traffic trends*




From both the European and the railway viewpoints there are trends here which must be improved. The reasons underlying the historic position are often, unfairly, placed at the feet of the railway undertakings. But the problem is not as simple as that and the institutional frameworks within which the railways are obliged to operate often leave a lot to be desired. Transport is vital to our society and it must be organized to enable it to fulfil its social and economic functions in such a way that customers' requirements are met, but fully taking into account the needs of the environment.

## The policy maker's vision for combined transport

The five broad principles which underlie the European Commission and Council approach to combined transport can be summarized as follows:

(1) freedom of choice of mode for the customer;

(2) intermodal competition on equal terms;

**Table I.** *Rail freight 1971-1990*

| | | 1991 billion tonne-km | 1971-1990 percentage change | 1989 percentage international |
|---|---|---|---|---|
| CER[a] | DB | 61 | – 4 | 43 |
| | DR | 40 | – 8 | 23 |
| | SNCF | 51 | – 24 | 34 |
| | FS | 21 | + 23 | 55 |
| | BR | 16 | – 27 | – |
| | RENFE | 13 | + 47 | 11 |
| | OBB | 13 | + 30 | 71 |
| | SNCB | 10 | + 29 | 68 |
| | CFF | 8 | + 25 | 72 |
| | NS | 3 | – 5 | 67 |
| | DSB | 2 | – 6 | – |
| | CP | 2 | +106 | 14 |
| | CFL | 0.7 | – 5 | 82 |
| | CH | 0.6 | – 14 | 56 |
| | CIE | 0.6 | + 2 | – |
| Nordic | SJ | 19 | + 30 | 43 |
| | VR | 8 | + 45 | 29 |
| | NSB | 3 | + 2 | 37 |
| Central | PKP | 82 | – 21 | 20 |
| | CSD | 59 | + 2 | 24 |
| | JZ | 23 | + 18 | 36 |
| | MAV | 16 | – 17 | 37 |
| East | BDZ | 14 | – 4 | – |
| | CFR | 49 | + 7 | – |
| | TCDD | 8 | + 38 | 14 |

*Note*:
[a] Community of European Railways

(3) overall socio-economic costs to be taken into account;

(4) the importance of the role of maritime and inland shipping; and

(5) the need for social and economic cohesion.

None of these principles poses difficulties for the railway companies. It is essential that freight transport should follow market rules. Manufacturers, industry, and businesses need high-quality transport services. Competition between operators, and between the transport modes, is one of the safeguards of quality of service and conducive to lower prices. There is a general acceptance that such competition must take place on equal terms in a wide range of areas. Differences presently exist in the way in which we evaluate, invest in, and manage infrastructure, in fiscal policy, and in regard to socio-economic costs (and benefits, should they exist).

Combined transport was originally conceived as a road/rail mode, but the important contribution of maritime and inland shipping in international traffic is now recognized more fully. The maritime mode is particularly important for the peripheral regions: e.g. Ireland, Portugal, Italy and Greece (Brindisi to/from Patras is a key link in the combined-transport network).

With these principles in mind, the Commission of the EC has defined a comprehensive network for an EU system for combined transport. This is shown in Figure 3.

## The railways' contribution to the combined-transport network

To some extent the railways' contribution began some years ago. A number of market-driven initiatives have existed for some time. Since 1986, about 100 locations in France and Belgium have been connected by Interdelta: 100 kph trains with customs formalities at the departure and arrival points; GONG trains between Germany and Austria owe their success to extremely short frontier stops; TRES trains connect France and Italy; and Trans-Euro-Fret (TEF) provides services between various countries.

Long-distance haulage offers the railways their best opportunities. The European Communities have fostered the development of trade, and this has led to rapidly expanding international transport markets. The single market, the breaking-down of the former East-West political divisions, the Maastricht Treaty, and the general desire to compete and progress economically, all point to the continuing expansion of international transport markets. There is, however, an acceptance that the market position of the railways in this international freight sector is still not strong enough:

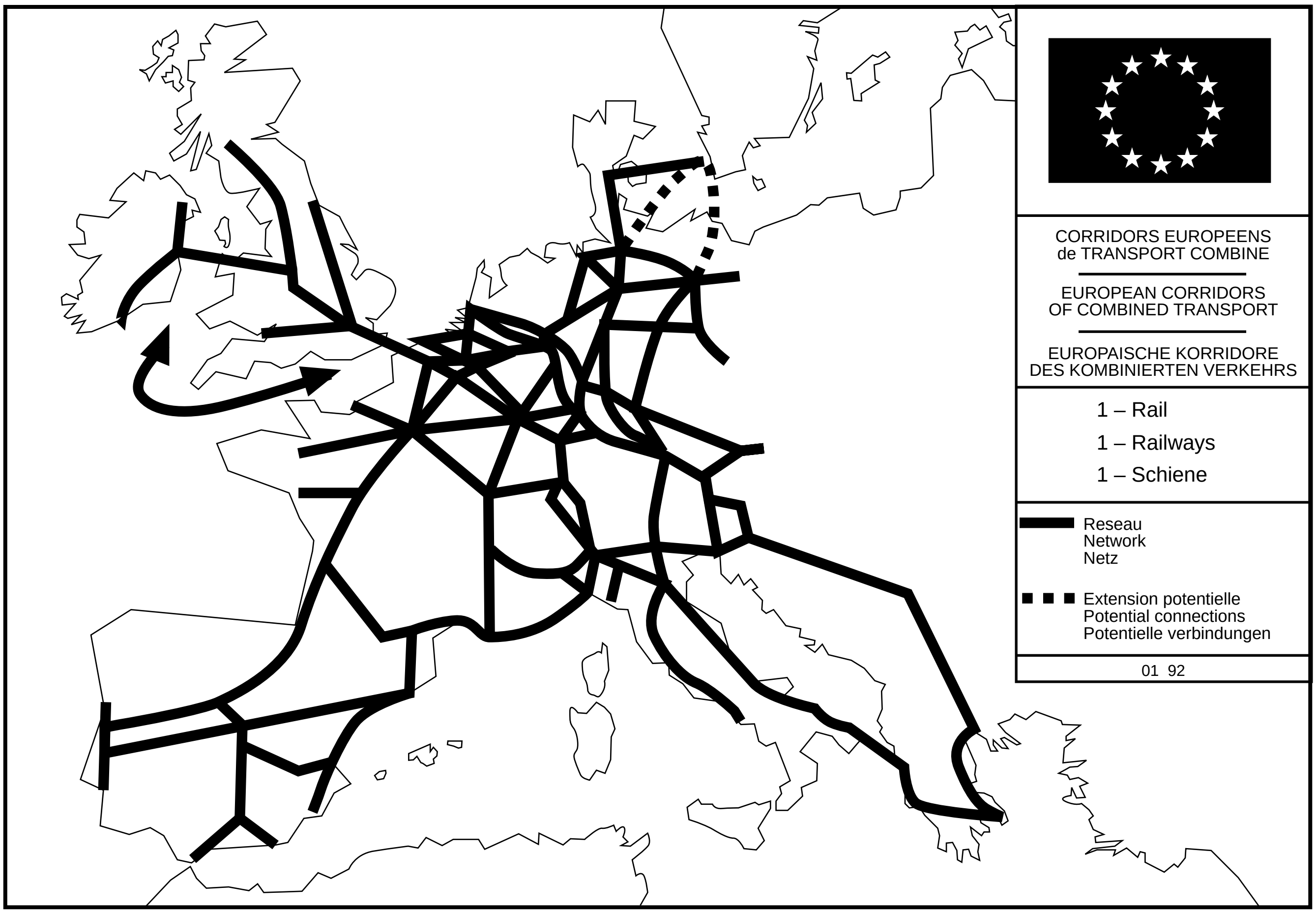
- the railways are not presenting themselves to customers as single carriers;
- traffic speeds are generally too slow;
- service quality is less than it should be; and
- frontier stops are excessive (customs, hygiene, and technical controls).

The railways are aware of the problems and have been working on the solutions. These include:

- thinking European (rather than nationally);
- raising service quality;
- international region-to-region trains; and
- concentrating traffic on highly efficient corridors.

It is also fair to say that the railways did respond to stimulation by the Commission and developed and presented the Kearney report (Kearney, 1989). This document was commissioned by the CER (Community of European Railways, Belgium) and consists of a major

**Figure 3.** *European network of combined transport*




review of existing combined-transport demand and the network needed to meet current and potential demand.

The Report contains firm recommendations for the future and has since been extensively used in the development of EC combined-transport policy.

In December 1991 the UIC (Union Internationale des Chemins de Fer) published its report *Rail without Frontiers: Freight Traffic*. The recommendations put forward in that report provide some insight into the considerable efforts being made by the railways to improve the quality of international rail freight services.

The technical and commercial recommendations are given in Tables II and III. These are being put into effect by the railways, and it must be said, with the aid of the EU. For example, a Commission working party has examined technical compatibility in all its many facets. The railways and manufacturers of transport equipment were important contributors to that work.

The railways have already played, are currently playing, and will continue to play a prominent part in the development of the combined transport network. However, the extent to which they can contribute is dependent on institutional factors; the problems to be overcome in this area are addressed in the following section.

**Table II.** *Traction/operating recommendations*

| Problems | Solutions |
|---|---|
| Locomotive changeover | Use inter-railway settlements<br>Acquire power-units suitable for bilateral/trilateral operations |
| Braking | Prepare information exchange in advance |
| Train crew | Harmonize technical conditions and operating regulations<br>Develop crew exchange rules and training |
| Technical inspection | Harmonize fleets<br>Bilateral/trilateral agreements |

*Source*: UIC (1991)

**Table III.** *Commercial/operating recommendations*

| Problems | Solutions |
|---|---|
| Dangerous goods | Develop line-of-route bilateral/ trilateral agreements |
| Data exchange | Better information technology (IT systems) |
| Train formation | International through trains<br>Upgrade means of transport |
| Labelling | Harmonize at international level |
| Tail-light | Common design/acceptance |
| Customs procedures | Extend simplified process<br>Deter customers demanding frontier clearance |
| Plant health, safety | Spot checks |
| Hygiene | Mutual recognition of certificates<br>Transfer checks to suitable stations |

*Source*: UIC (1991)

## Targets for the member states

In June 1991 the Transport Council approved a directive on railway development (91/440/EEC) and a regulation on public service contracts (1893/91/EEC). The national railway networks are in reality the "children" of the respective member states. The directive and regulation require that new ground rules shall be set for the networks:

- separation of financial responsibility for infrastructure and operations;
- putting in place a business-oriented financial structure, including debt restructuring; and
- multi-annual public service contracts between railways and the state.

Implementation dates are written into both instruments, which are aimed at improving state/railway relationships. The railways look forward to assisting the respective member states with their implementation.

The Commission's Green Paper on the impact of transport on the environment has highlighted the need for a global approach to environmental (and safety) effects often overlooked in the past. These include:

(1) regional planning policy;

(2) the land-use/transportation relationship;

(3) common cost/benefit evaluation procedures;

(4) the need to develop, implement, and enforce fiscal and economic instruments favouring both cleaner and safer technology and also the more environment-friendly modes;

(5) internalization of external costs; and

(6) planning for people, not vehicles.

These six points represent the key instruments for achieving sustainable mobility. There should have been more emphasis on regional, land-use, and safety issues in the Green Paper. However, all six are of critical importance. For example, a common cost/benefit evaluation would lead to much greater investment in networks; and of course the amount of such investment is fundamental to progress.

## Recent research: externalities and combined transport

The question of socio-economic costs, cost-benefit analysis, and externalities have now been researched for over 30 years. Within the UIC a working group exists with responsibility for the evaluation of the external costs of transport. It is necessary to point out of course that the internationalization of external costs is not a panacea for the railways. G*ood quality service is also an essential prerequisite.*

The most up-to-date research in relation to combined transport has been undertaken by an independent consultant for the European Commission. The results of that research confirm the high priority which must be given to the internalization of external costs if the goal of sustainable mobility is to be achieved:

- the external costs of *rail* are *very low*: between 0.46 and 0.50 ECU per 1,000 tonne-km (1985 prices);
- the external costs of *roads are excessive and variable*: motorways impose seven times the external costs imposed by rail; national roads are 19 times more costly than rail; and urban roads are some 22 times more costly.

Safety, congestion, air pollution, and noise externalities were analysed. A conservative approach was adopted and it is very likely that the external costs would be higher in practice than those assumed in this study.

The results of the study were input to an economic evaluation of the network proposed in the Kearney report (1989). This evaluation was also undertaken by a consultant and showed that:

- volumes in the year 2005 would be: 19-22m tonnes, without internalization of external costs, and 21-29m tonnes, with internalization of external costs;
- revenue results are sensitive to internalization and to rail infrastructure charging policy;
- levels of return vary over the network;
- if combined transport volumes triple, road haulage will still increase by 20 per cent; and
- the socio-economic evaluation gives good grounds for providing incentives for combined transport.

These results pose a serious challenge to the EU institutions and member states. A very strong case exists for the development of the combined-transport network; the internalization of external costs is a critical policy area from the investment, geographic, and commercial viewpoints, as well as for sustainable mobility.

## The future

The Kearney report (1989) envisaged an annual increase of 4 per cent in international traffic from 1987 to 2005, with combined-transport volume tripling to 43m tonnes by the year 2005. In addition, the Kearney report:

- projected that the combined transport proportion of international transport would increase from 4 per cent to 6 per cent;
- identified 15 major routes, and 15 further potential routes, in all catering for 75 per cent of traffic on the network;
- showed that the entire network was supported by cost-benefit analyses; and
- pointed to the need for dynamic marketing of the combined-transport product.

Independent work undertaken on behalf of the European Commission appears to support the Kearney work undertaken for the CER. The situation can be summarized as follows:

- the combined-transport network cannot develop on its own if current international freight transport market conditions remain;
- the benefits to society of today's combined-transport operations are not currently taken into account in the charging system; and
- the method of allocating social benefits to the network will radically affect the geographic form of the network.

## Conclusion

In conclusion, the railways fully support the need for sustainable and environmentally sound development as an essential component of transport policy in the EU. The development of the European combined-transport network will be a major component in a successful policy aiming towards sustainable mobility. The principles underlying combined-transport policy have the full support of the railways (customer choice, equal competition, the inclusion of socio-economic costs, shipping modes, cohesion). The railways' contribution to combined transport and the determined efforts to improve the product have been outlined.

The freight market in the countries of the ECMT has expanded over the past 20 years but, with some exceptions, rail freight carryings have remained static. The state/railway relationships must be improved. Six key issues relating to the Green Paper were identified. An examination of recent research confirmed a strong case for the development of the combined-transport network. The internalization of external costs is critical to the development of the network. The level of future investment, the geographic spread of the network, commercial returns, and sustainable mobility, all depend on the extent to which externalities are introduced into the charging system.

The key to the railway perspective on sustainable mobility and the European combined transport network is quality. This applies to two facets of rail freight business: *quality of service to customers,* and *quality of life to society* (which is summarized below).

(1) For the customer:

- competitive performance level;
- competitive price;
- reliable;
- capable of optimal integration with customer's internal logistics.

(2) For society:

- safer;
- less pollution;
- less noise;
- less congestion.

### Note

1. Council Directive 75/130/33C; maritime may be included in the future; road hauls must be to the nearest rail depot and cannot exceed 150km when combined with waterways.

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# Potential forms of regional economic co-operation to reduce goods transport

*Helmut Holzapfel*

**Substantial transport savings can be made by using regional supply structures**

The traffic growth in goods transport is largely due not to increases in quantities transported but to the growth of transport distances. This is clearly brought out by – *inter alia* – the disproportionate growth in the volume of border-crossing transport. At the root of these increasing distances ultimately lies a process of international division of labour which, in Europe, is indisputably being promoted by a policy of cheap freight transport prices, owing to the so-called "liberalization" of road haulage.

There is a contrary trend, however, which is the basis for the considerations on transport savings in this article: a reconsideration, also by European policy makers, of regions as economic units and units for internal co-operation. In the following, it will be analysed how far regional co-operation can avoid the transport of goods, what measures can support such a trend and what circumstances, not necessarily related to transport, advocate a greater consideration of the region.

## The region: source and target

Despite the trend towards greater distances mentioned above, the region is still the spatial unit within which the majority of goods transport takes place today. If traffic loads are high along long stretches of routes in the densest areas of Europe (for instance, along the Ruhr and on as far as Amsterdam), this has to do not only with long-distance transport passing through these areas but also, overwhelmingly, with short-distance transport arising within the areas. On one of the central autobahns in the Ruhr area between Duisburg and Dortmund, more than half the transport is driving no more than 10km on the network. In conurbation areas, regional forms of co-operation are still highly developed: for instance, in the Ruhr area 80 per cent of goods transport by rail is for distances of less than 50km.

For goods transport in general much the same is true, especially if international maritime transport, in any case not immediately comparable for physical reasons, is kept out: in the case of road transport in Germany (the prevailing mode), 85 per cent of traffic is short-distance (up to 50km), and only 8 per cent is border-crossing (reception, consignment and transit), of which only one-tenth is through traffic.

From the overall analysis of border-crossing European road traffic, by Prognos AG for the International Road Transport Union (IRTU), it can be deduced that border-crossing road traffic in Europe chiefly serves trade in goods between neighbouring countries. The ten most important connections, already constituting over half the total traffic, come from the five possible neighbouring-country links between Germany, The Netherlands, Belgium and France, each in both directions.

Accordingly, even goods transport is far more oriented to *intra-regional* relationships than many people wish to accept. At present, however, for the reasons set forth, there is a trend towards increasing distances and thus to a replacement of regional by *supra-regional* co-operation. The question should then be asked, what conditions might lead to a reconsideration and higher valuation of regional co-operation. In other words, how can the trend towards a more supra-regional orientation of trade be avoided?

## The region in the EU context: a factor of increasing economic significance

A transport policy for the regions could be built on the basis of a restored attractiveness of neighbouring areas.

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The concept of "region" in Europe is certainly still unclear (see Scholle, 1993); all that is broadly manifest is that in general terms it is a third tier in the EU lying below member states. In the German Federal Republic, it is normally taken that this level also lies below the usual size of the *Länder*.

## Areas have a major economic and administrative centre

Existing areas which define themselves as a region have a size of around 250km$^2$. Often, such areas have a major economic and administrative centre in which many jobs are concentrated. Traffic within such regions consists very largely of short-distance traffic, up to 50km. As a rule, 80-90 per cent of journeys start and finish within those regions: only the residue has a source or target outside, or is in transit. That makes this tier really ideal for planning and organizing transport. Indeed, the local and regional public transport authorities are among the foremost explicitly *regional* institutions. It is essential and typical for the success of these transport authorities that they arise from individual municipalities' interests in overall co-operation, and have not been brought in "from above".

Also in other cases, similar promise might come from greater powers for the regions: forms of co-operation between firms to co-ordinate transport at this level will be discussed below. Regulatory intervention at this level (say, joint planning of goods traffic flows and centres) in the joint interest of all concerned could, for instance, be successful. Regional labelling of products is proposed and deliberately applied by many producers in the new *Länder* (the territory of the ex-GDR). If products are largely produced within a region and this is taken as a criterion of quality and marketability, transport relations will consequently also become more favourable.

At present, it seems as if the ideas which exist in the EU of the region as a unit of action are acquiring increasing relevance. The Maastricht Treaty for the first time recognizes the regions, in the form of a regional committee. To date, however, power has only rarely been devolved "from above" by the EU. The regions would, however, be a questionable unit were they to serve only to take away from municipalities matters which these had hitherto run well. This would only be in line with the existing trend of continued shifting of decisions to higher levels.

More regional links have to go hand in hand with more regional powers and corresponding changes in funding provisions. The current debates on regionalization of railways in Europe, specifically in Germany, show, however, that the funds which are decisive for decentralized institutions are not made available, or only after heavy debate.

Lately, industry itself has shown increased interest in regional co-operation strategies. The economic strength and development of a region undoubtedly influences the market opportunities of local businesses, so that regional co-operation always implies the promotion of the interests of local producers and manufacturers. (On the general questions of the relevance of industrial relations, see von Gleich *et al*., 1993.)

### Economic supply strategies based on regional co-operation

Early steps towards forms of regional co-operation have always existed, as the example of the emergence of transport authorities shows. Similarly, in the past, there have also been (by no means always positive) forms of preference for products produced in the region or in one's own country ("Buy British").

The key idea of the proposals discussed below is that models of regional co-operation make sense only if they offer real advantages for the quality of life of those living in the region, taking ecological factors into account. The advantages must also be made evident. Regional co-operation must, in short, lead to a qualitative improvement for those concerned, not a loss or a sacrifice in the interest of some sort of abstract "regional identity". The latter would not lead to success and could result in dubious xenophobic and aggressive justificatory theories.

A first attempt to construct a new model as the basis for a regional approach takes the exchange of information between regional institutions and firms as a starting point. Firms often do not even know that a product which they obtain expensively from elsewhere is also available regionally. Regional information systems which provide a comprehensive listing of product ranges and are easily accessible might help here.

The effect of such information systems in terms of the enhancement of market transparency is of course particularly favourable for small regional suppliers which are not well enough known or publicized to be perceived as regional alternatives to the existing providers outside the region. The estimates below, however, must be regarded with caution: obviously, one cannot expect a regional producer to be preferred if the present more distant supplier offers better quality and more favourable prices. Still, besides shorter distances and the ensuing security of delivery, there is a whole range of positive side-effects associated with choosing a regional supplier: giving out orders within a region increases the regional economic potential, which is a decisive factor for many of the secondary qualities of a region and therefore a precondition for the development of one's own business.

Regional systems to improve market transparency can be supported and promoted by public policy measures. Since they will not necessarily be self-financing from the outset, participation should be made financially attractive in order to make sure that the important smaller businesses are included. A state-financed participation scheme might be an essential condition for them to be set up quickly.

The potential of improved regional information can be enhanced decisively by actual regional forms of co-operation. Such co-operation should be applied, first, to traffic problems and the various problems associated with traffic, particularly urban development policy. The growing problems with traffic congestion in conurbations ask for immediate action. Here, regional and decentralized measures are best able to develop into a problem-oriented strategy of which the following measures could be part (see Hesse, 1992):

- Strategies to shift transport to rail and in particular the development of interchanges between road and rail, i.e. combined transport. Regional business co-operation should take into account passenger transport as well, since shifting passengers to rail during rush hours is sometimes a better guarantee for the transport of goods than road-building measures. (For this reason, the Japanese car industry is inducing its workers to take public transport to work.)
- Better organization of goods transport movements (development of "city logistics" strategies).
- Development of regional goods-transport schemes, similar to the scheme developed by the city of Zürich, which includes the regulation of regional building-site traffic (see Stadtplanungsamt Zürich, 1992).
- Development of regional and municipal "lorry guidance schemes" to bring about the guidance and control of goods-transport routes and times (a similar scheme was developed by the city of Köln).

All such measures will be successful only if firms located in the region are brought together with their objectives and future perspectives. In particular, the involvement of industry has the positive side-effect of providing mutual knowledge of transport needs which will bring out opportunities for co-operation that may go well beyond the area of transport as such. Municipal and regional planners should accordingly have a large interest in setting up regional working groups to discuss the whole range of goods-transport issues, and offer these groups a considerable chance to participate in regulatory decision-making. This will in any case work only if regions and municipalities themselves have adequate regulatory powers. At present, these powers (night traffic bans, technical requirements for lorries, organization of road-rail interchanges) lie at best with the *Länder* authorities, but mostly at the federal level. A condition for enhanced regional co-operation, leading to traffic control and transport avoidance, is thus *a shift of regulatory powers* to the municipalities and the regions.

## Railway regionalization offers the oppportunity to organize transport better

The third set of measures for greater regional co-operation lies in orienting traffic infrastructures more towards regional traffic interests. While in recent years public attention was directed largely towards the development of long-distance links, it was often overlooked that the real bottlenecks arise in links within regions and conurbations. In particular, in Germany, the so-called railway regionalization now offers the opportunity to organize and co-ordinate better the short-distance transport of passengers and of goods at the regional level.

Admittedly, the prerequisite for regionalization is that the *Länder* and the municipalities are equipped not only with the power to run public transport but also with the appropriate financial resources. It is worrisome in this connection that the interests and costs of regionalizing goods transport have most recently taken, at best, a subordinate place in political debate. Yet it might be of great interest for the co-operation between two firms in a region to have a rail connection between them, securing punctual delivery independent of the road network and the risks of traffic jams. In the Ruhr area, for instance, there is a large network of company and municipal railways that could serve such interests (a regional goods railway was also discussed in connection with the International Building Exhibition, but met with little interest, particularly from the Bundesbahn).

All three sets of measures (regional information systems to improve market transparency, installation of multiple forms of regional co-operation with appropriate devolution of powers, and greater orientation of traffic infrastructures towards interests of regional transport) could, taken together, support a more regional orientation in goods supply. One should not overlook the evident trend by customers and consumer organizations to prefer products from their own region, for environmental and other reasons. These consumer trends could be supported by the regional labelling of products as proposed Böge (1992; 1993).

The potential of the measures must, however, be assessed in the context of the overall strategy that is proposed. A positive influence would certainly come from a general increase in freight rates, while a continuation of the present trend to cut prices would obviously have a negative effect. These factors add an element of uncertainty to the following assessment of the potential for transport saving, already complicated by a lack of data on transport chains.

## Transport saving and other advantages of co-ordinated regional supply

The potential savings from the measures described above can be calculated in the following way. As a starting point for considering to what extent the products conveyed might also be the object of regional procurement, one could take the total aggregate kilometres of long-distance goods transport. This exercise demonstrates that we are not only dealing with quantitative questions but also with questions of a qualitative nature. For instance, the delivery chain from producer to consumer can be impressive, say in the case of orange juice, particularly because the trees grow in Brazil. To move to regional products here, a different product would have to replace the original one, like apple juice, grape juice or pear juice. This seems difficult after years of advertising for the foreign product (e.g. high vitamin C) that make orange juice sound healthy. However, in the case of orange juice the considerable processing (concentrate) affects the quality significantly in comparison with freshly pressed juice. The content of vitamins in other juices is quite comparable if not indeed higher. The industry knows that too, as the advertising shows: “that freshly pressed taste” – the advertisement emphasizes this only because it is not true.

In order to make the approach more understandable and to clarify the assumptions, the potential of possible regionalization will be exemplified below on the basis of a specific product (yogurt), before going on to assess the overall potential for savings. (We are extremely grateful to Ms S. Böge (1992) for the data and relevant calculations.) Table I shows present procurement locations of raw materials for yogurt production in Stuttgart. Only direct deliveries to the final manufacturer are included. Table II shows the pattern of distances when nearer manufacturers of approximately equivalent products are chosen.

**Table I.** *Existing supply structure*

| Component | Place of production | Delivery distance in km CT | CR | FM | Total |
|---|---|---|---|---|---|
| Milk | Regional | 10 | 16 | 10 | 36 |
| Yogurt cultures | Niebüll | 12 | 36 | 862 | 910 |
| Fruit added | Aachen | 11 | 0 | 435 | 446 |
| Sugar | Offenau | 9 | 10 | 53 | 72 |
| Glass | Neuburg | 21 | 89 | 150 | 260 |
| Aluminium lid | Weiden | 10 | 52 | 242 | 304 |
| Label | Kulmbach | 11 | 19 | 284 | 314 |
| Container | Bad Rappenau | 7 | 6 | 42 | 55 |
| Divider | Ludwigsburg | 13 | 0 | 0 | 13 |
| Clingwrap | Stuttgart | 6 | 0 | 0 | 6 |
| Glue (labels) | Düsseldorf | 21 | 0 | 398 | 419 |
| Glue (containers) | Lüneburg | 12 | 50 | 597 | 659 |
| *Total* | | | | | |
| (Including yogurt cultures)[a] | | 143 | 278 | 3,073 | 3,494 |
| (Without yogurt cultures) | | 131 | 242 | 2,211 | 2,584 |

*Key*: CT = City route; CR = Country route; FM = Federal motorway

*Note*:
[a]See foot of Table II

The savings shown in Table III relate to average distance reductions from choosing the closer regional manufacturer.

At first sight, these figures seem dramatic. It is also striking that the kilometres saved are mainly on motorways, that is, on long-distance transport.

On further consideration, the values are by no means so surprising: in practice, they amount to re-regionalization. A development that has accepted increasing distances without any consideration of the associated problems is here being theoretically reversed. The changes in distance which have occurred were mostly very large. Manufacturers around 30km away have been replaced by manufacturers 300km away. Additionally, there has been a development of intensified division of labour, that is, additional dispersal of manufacturing sites, which has generated considerable new traffic (Holzapfel and Vahrenkamp, 1993). The value of the findings is reduced somewhat by the limitations of the foodstuffs manufacturing example, and the assumption that changes in manufacturers’ distances take place independently of weight or value – a theory which could not be checked for cost reasons.

**Table II.** *Supply structure using regional suppliers*

| Component | Place of production | CT | CR | FM | Total |
|---|---|---|---|---|---|
| | | Delivery distance in km | | | |
| Milk | Regional | 10 | 16 | 10 | 36 |
| Yogurt cultures | Niebüll | 12 | 36 | 862 | 910 |
| Fruit added | Heidelberg | 14 | 0 | 107 | 121 |
| Sugar | Offenau | 9 | 10 | 53 | 72 |
| Glass | Neuburg | 21 | 89 | 150 | 260 |
| Aluminium lid | Rastatt | 11 | 0 | 86 | 97 |
| Label | Stuttgart | 6 | 0 | 0 | 6 |
| Container | Backnang | 15 | 16 | 0 | 31 |
| Divider | Pforzheim | 10 | 3 | 33 | 46 |
| Clingwrap | Stuttgart | 6 | 0 | 0 | 6 |
| Glue (labels) | Schwäbisch Hall | 14 | 44 | 37 | 95 |
| Glue (containers) | Weingarten | 12 | 6 | 65 | 83 |
| *Total* | | | | | |
| (Including yogurt cultures)[a] | | 140 | 220 | 1,403 | 1,763 |
| (Without yogurt cultures) | | 128 | 184 | 541 | 853 |

*Key*: CT = City route; CR = Country route; FM = Federal motorway

*Note*:
[a]The yogurt cultures are at present transported from Niebüll to Stuttgart by private car. This is an exceptional situation which we shall not take into account in estimating possible reductions of distances between supplier and final manufacturer

**Table III.** *Lorry km saved by using regional supply structures (per cent)*

| | |
|---|---|
| City route | 2 |
| Country route | 24 |
| Federal motorway | 75 |
| Total | 67 |

Compared with the potential savings in the yogurt example, the potential savings in industrial sectors with a more complex supply structure, such as the car industry, are certainly much greater. A theoretical analysis shows that the number of transport links grows with low integration of the production process and with high numbers of suppliers (Holzapfel and Vahrenkamp, 1993). The figures which were taken in the case of our yogurt example (as for foodstuffs in general) to calculate the related potential savings were chosen in such a way as to lead to an underestimate of feasible potential savings.

Interviews with car manufacturers have led to crude estimates that the dispersal of pre-producers and the choice of remote suppliers caused an increase in transport of around 50 per cent, which would also be the theoretical potential saving. For the reasons mentioned, the author tends to regard this as an underestimate. It must, however, be stated that in general there is a high degree of uncertainty here, especially with regard to the potential suitability of regional suppliers. On the other hand, particularly in the car industry, there are moves under way to increase supplier quality, and these could also come about in the regional sphere. In addition, this research has led to the finding that at least a kind of bundling of suppliers is being aimed at by the car industry (larger quantities bought from fewer producers). This would mean a greater bundling of transport, and perhaps a greater efficiency.

These considerations do not apply in any way to transport to sales points for final consumers. Here, the theoretical potential is certainly lower. At any rate, even theoretically it is scarcely possible to determine the organizational potential for possible regionalization (deliveries of petrol to filling stations etc.). In the case of deliveries of some foodstuffs (cola drinks), the delivery of concentrate to regional diluters saves transport. As pointed out above, still more can be saved, particularly in the case of fruit juice, by using regionally produced juices without previous conversion to concentrate, the manufacture of which takes further energy.

The potential saving from labelling of products produced within a region is difficult to estimate. Would honey imported from Canada, which is after all clearly marked as coming from remote regions, then be less demanded? The effect here depends definitely on propaganda work by consumer associations, but is ultimately difficult to define. In general terms, it also depends on further developments in our lifestyle and on the question whether products which come from far away continue to enjoy an "image" bonus. Anyway, the transport delivery effect correlates strongly with the effect of increasing freight rates, and can hardly be separated from it.

If, despite the facts that:

- the theoretical potentials in the area of manufacture and pre-production show upper limits which would, in practice, be only partly attained as a consequence of the measures described; and
- the potential is smaller for deliveries to final consumers, and there is a close correlation with pricing;

a major overall potential is seen for regionalization measures, this also has to take into account that the degree of attainment of theoretically conceivable potential (certainly small under present conditions) certainly depends very much on developments in transport prices. Estimates of precise magnitudes of possible $CO_2$ emission reductions would require extension of the analyses done in this article to existing data, by tracing product chains, for instance in the car industry. Further research might bring a more exact estimate of the potential, and therefore a better basis for action.

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# Fiscal measures as part of a European policy on freight transport

*Arie N. Bleijenberg*

**The most insidious fact about road transport is its seemingly inexorable trend to grow**

## Forecasts on transport growth

From an environmental point of view, the most insidious fact about road transport is its seemingly inexorable trend to grow. More trucks on the road, in turn, mean more noise, more vibration, more air pollution and more risks to safety. Figure 1 presents two recent forecasts of the growth in road freight transport. The first one, by the Commission of the European Communities, foresees an increase in transported tonne-kilometres by 58 per cent in the period 1990-2010 (Dumort and Guilmot, 1990). The second forecast was done by NEA, for the International Road Transport Union. They estimate a growth of 92 per cent in the same 20 years. This forecast only applies to the so-called interregional transport (NEA, 1992). The trend in both scenarios is clear: road freight transport will continue to grow in the future, as it has in recent decades. The growth rate is nearly the same as the realized and expected growth in gross domestic product (GDP).

A particular area of environmental concern with regard to traffic growth is the fuel consumption of motor vehicles and the related emissions of carbon dioxide ($CO_2$). Enhanced $CO_2$ concentrations in the atmosphere contribute to global warming. Figure 1 therefore shows the projected increase in fuel consumption. Although both forecasts foresee an improvement in the energy efficiency of trucks, i.e. a decrease in fuel consumption per tonne-kilometre, fuel consumption is expected to grow by, respectively, 23 and 57 per cent during the years 1990-2010. In this context, it is noteworthy, however, that energy efficiency in The Netherlands has actually decreased by 7 per cent in the period 1982-1989. Hence, the expected *increase* in fuel efficiency might be an optimistic assumption.

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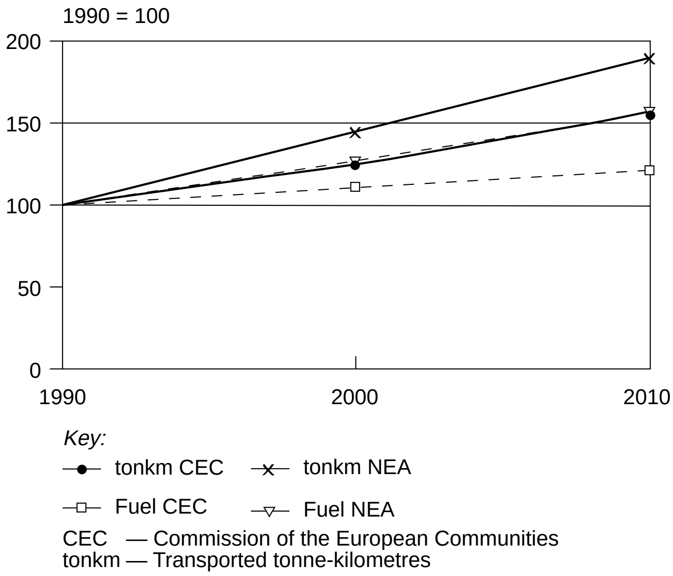
## Transport and the environment

Generally speaking, the growth trends in vehicle mileages are strongly at odds with emission control objectives. Figure 2 compares the expected rise of $CO_2$ emissions with the official target of the European Communities, set in October 1990, to stabilize $CO_2$ emissions by 2000 at the level of 1990, as well as with the corresponding Dutch target. It is assumed here that the increase in $CO_2$ emissions equals the expected growth in fuel consumption. This will most probably be the case if the current policy on vehicle emissions and fuels is not changed.

More importantly, however, it is assumed that road traffic has to make an average contribution to achieving the stabilization goal. Of course, some will argue that transport should contribute less and others that it should contribute more. It is not surprising that each sector has good reasons to argue that other sectors can and should make a more than average contribution. I consider it, however, a good starting point to suggest that transportation should contribute to a $CO_2$ control policy on equal footing with other sectors. This is the line taken in The Netherlands where $CO_2$ emissions from trucks have to decrease by 10 per cent in the period 1986-2010 (Dutch Ministry, 1991).

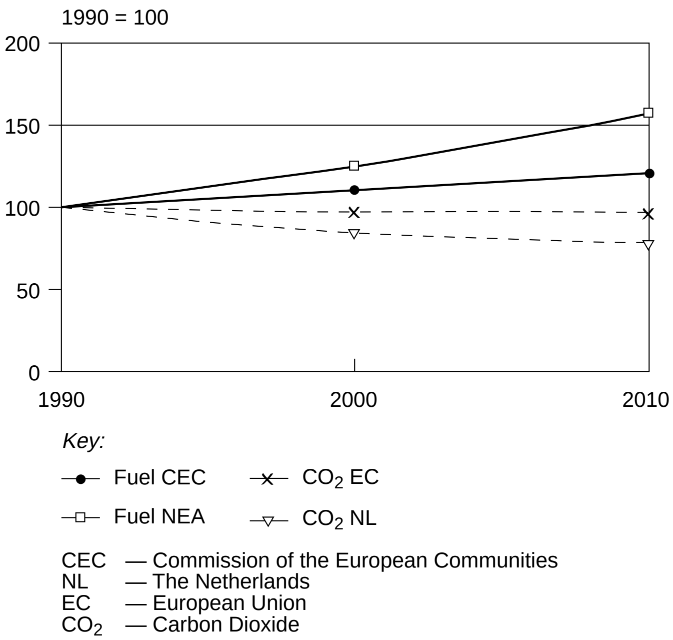
Because the EU has not yet set targets for reducing nitrogen oxide ($NO_x$) and hydrocarbon (HC) emissions, the projected emissions for these two pollutants can only be compared with the corresponding Dutch reduction targets for road traffic (Figures 3 and 4) (Dutch Ministry, 1990). These are based on the critical loads for the respective emissions; in other words, the level of the targets is set in relation to the carrying capacity of the ecosystem. The comparison shows that the emissions calculated by NEA are two to four times higher than the Dutch targets for the year 2010. This means that the expected growth in transport-related emissions is likely to cause irreparable damage to the Earth's ecosphere.

**Figure 1.** *Projected growth in road freight transport and fuel consumption*




*Sources:* Dumort and Guilmot (1990); NEA (1992)

**Figure 2.** *Comparison of the project growth in $CO_2$-emissions, with the EC stabilization goal and reduction targets for road haulage in The Netherlands*

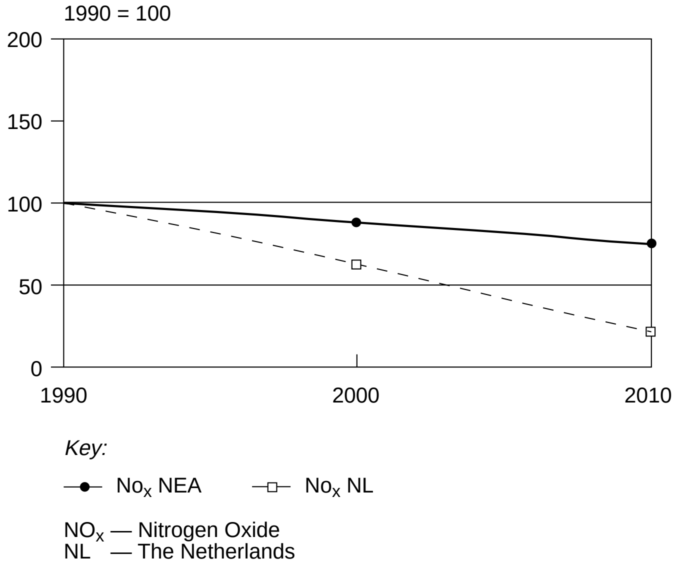



*Sources:* Dumort and Guilmot (1990); Dutch Ministry for Housing (1990) and NEA (1992)

## Transport and the economy

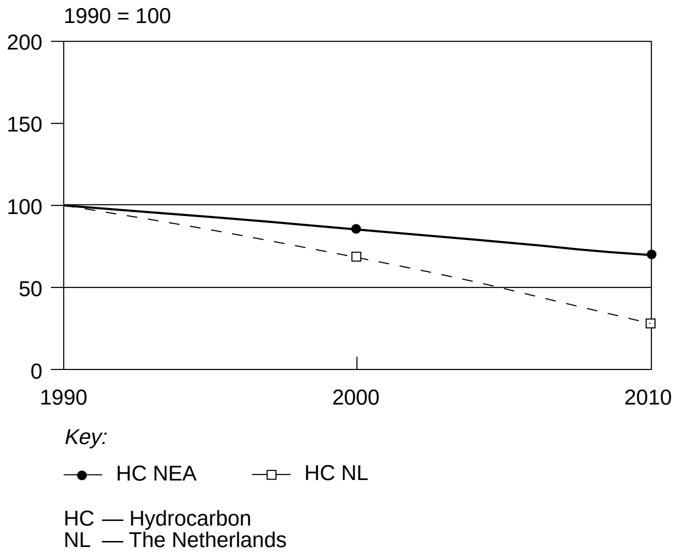
It is often argued that the increase in freight transport must equal GDP growth, as was the case in the past (CEC, 1992; NEA, 1992). From this it is concluded that curbing the growth in transport will reduce economic growth. Or,

**Figure 3.** *Comparison of the project $NO_x$-emissions with reduction targets in The Netherlands*




*Sources:* Dutch Ministry for Housing (1990); NEA (1992)

**Figure 4.** *Comparison of projected HC-emissions with reduction targets in The Netherlands*




*Sources:* Dutch Ministry for Housing (1990); NEA (1992)

the other way around, more transport will lead to additional economic growth.

In my opinion, these arguments are based on a misconception of the complex relation between transport and the economy. According to an old Dutch saying “the chimneys have to smoke”: when the factories are running, people have jobs and earn money. Thus everyone used to be happy when the “chimneys smoked”. This expression, however, is outdated now. People still like economic welfare, but without smoking chimneys. This in fact is the challenge of sustainable development: continued economic growth with a sharp reduction in pollution. The EC Commission's Task Force on the environment and the internal market has called this "breaking the link between growth and pollution" (Task Force Report, 1992).

## Transport does not directly contribute to economic prosperity

The same objective should be set for the relation between transport and economic growth: to achieve continued economic growth without a further increase in traffic. In fact, transport does not directly contribute to economic prosperity. According to the system of national accounts, it is a so-called intermediate service. This means that transport is used to produce final goods and services for consumption and investments. Indeed, transport can be regarded as a production factor, like labour and capital, needed in the economic process. This implies that freight transport is a cost in the economic process which economic factors will be willing to pay only if the benefits of transportation are higher. In other words: if we could produce the same volume and deliver the same goods and services to the same places, with less transportation than currently needed, this would be preferable from an economic point of view. Consequently, in theory, it is possible that less transport would lead to a higher level of prosperity.

The answer to the question of when more transport is required to achieve a higher level of material welfare must be sought in two areas. First, economies of scale are important. This implies that production in large factories is often cheaper than in small ones. However, centralized production requires transport over longer distances. The economic optimum is achieved when the marginal costs of transport equal the marginal economies of scale. The price of transportation is one of the main factors which determine the economically optimal level of concentration and distribution of production facilities. By getting transport prices right, a financial counterweight is created to economies of scale which should lead to a greater decentralization of production facilities and, consequently, less transport demand.

The second category of factors justifying transport from the economist's point of view are comparative advantages. Clearly, it is cheaper to grow grapes in France or Italy and to transport them to The Netherlands, than it would be to grow them there. Again, the price of transport and the level of comparative advantages together determine the economically optimal distance. Generally speaking, physical (e.g. climate, infrastructure), social (e.g. level of education, political stability) and administrative conditions can lead to comparative advantages. The first two are "natural" causes of transport demand, and would not be problematic if transport prices were right. Administrative advantages, by contrast, have to do with differences in national government regulations, such as different tax rates and environmental standards. These administrative differences can lead to an "artificial" transport demand. It is simply cheaper to produce in a low-standard, low-tax country than at home, even if the costs for the shipping of goods to and from this foreign location are taken into account. Harmonizing the relevant government regulations would avoid such artificial transport demand. I propose that the EC Commission investigates the level of artificial freight traffic and initiate proceedings to harmonize the relevant government regulations in order to avoid this uneconomic transport demand.

The next section will deal with transport prices. As I have argued above prices have to be set at a level where they do not artificially generate transport demand. If the current prices do not reflect the full costs, the conclusion must be that the volume of current transport is not economically optimal.

### Making transport pay its full costs

Presently, a part of goods transport is caused by artificially low transport prices. Low transport prices mean that even relatively small marginal economies of scale and comparative advantages are exploited, which increases transport demand. As the European Conference of Ministers of Transport stated in 1989, the current prices in transportation do not reflect its full costs[1].

> Since many users do not pay their full costs, it is necessary, in accordance with the Polluter Pays Principles, to introduce systems of supplementary charging for environmental damage caused. In principle each transport mode should pay the full costs caused.

In Table I, a rough estimate of the full costs of road transport is presented. The costs are calculated in relation to the fuel price, as they are probably more closely related to fuel consumption than to mileage or vehicle ownership. Fuel consumption reflects the mileage driven, the weight carried and the efficiency of the engine, and these parameters influence emissions, noise, damages to road infrastructure, etc. in different ways. It should be noted that the figures given are nothing more than a preliminary indication. Scientific research on the costing of transport is only partly available and a close analysis goes beyond the scope of this article. Nevertheless, these

**Table I.** *Rough estimate of the full costs of road transport in ECU/l fuel*

| | ECU/l |
|---|---|
| Fuel costs, excluding VAT and excise duty | 0.20 |
| Government expenditure[a] on roads, traffic police, courts and administration | 0.40 to 0.60 |
| External costs[b] related to air pollution, noise, road safety, land use and other environmental effects | 0.20 to 0.60 |
| Total[c] | 0.80 to 1.40 |

*Notes*:

[a] A Dutch survey put total government expenditure related to road traffic at at least 10.4 to 12.4 billion Dutch guilders (IOO, 1989). This corresponds to 0.52 to 0.62 ECU/l motor fuel. To take into account the possibility that in other countries corresponding government expenditure does not have the same volume, a bracket of 0.40 to 0.60 ECU/l is used. In this figure it is assumed that all government expenditure is covered by the excise duty on motor fuels and not by the annual vehicle tax or the purchase tax. This reflects the proposed so-called variabilization of motoring costs (Bleijenberg, 1989)

[b] This figure is based on three international literature reviews (Bleijenberg, 1988; Dogs and Platz, 1991; Quinet, 1989). The Dutch review concludes that external costs amount to 0.21 to 0.31 ECU/l. The study commissioned by the OECD estimates the external costs to be twice as high. The German study estimates the external costs at 0.26 to 0.54 ECU/l

[c] Not included in this estimate is the financial advantage of road haulage owing to the violation of government regulations on driving hours, speed limits and others. A British expert estimates this cost advantage at around 25 per cent (Whitelegg, 1990)

cost figures give an impression of the possible level of the full costs of road traffic[2].

In total, Table I indicates that, in order for transport to cover all its costs, the excise duty on motor fuel should be 600 to 1,200 ECU/1,000 l. This is substantially higher than the latest proposal from the European Commission which sets the minimum level for diesel at 245 ECU/1,000 l and the maximum at 270 ECU/1,000 l. It should be noted, however, that the figures in Table I assume that present vehicle registration taxes are abolished.

## The impact of higher fuel prices

A substantial rise in fuel prices is expected to have a number of positive effects on freight transport, not only in relation to environmental concerns. In particular, it would stimulate the use of more energy-efficient vehicles as well as driving behaviour geared towards fuel saving; the number of empty and partly loaded trips would decrease; a shift would take place towards more energy-efficient modes of transport, such as rail and waterways, including combined transport; and economies of scale and comparative advantages would be balanced thus leading to a reduction in the overall transport volume (see above). These effects would result both in a reduction in emissions and noise, and a more economically efficient transport system.

Besides the question how high fuel prices should be to cover the full costs of road transport, the question may be asked what increase in fuel prices is needed to achieve a certain amount of emission reduction. Based on three studies, The Netherlands Economic Institute concludes that the long-term price elasticity for fuel consumption in road haulage is around – 0.6 (Pronk and Blok, 1991). This means that a 100 per cent increase in the fuel price will, in the long run, reduce energy consumption of road haulage by around 30 per cent. Half of this reduction will be achieved by less fuel consumption per vehicle kilometre (the first two effects mentioned above). The other half will be realized by a better use of the loading capacity, a modal shift and a reduction in transport volume (the last three effects mentioned above). The modal shift towards rail and waterway transport amounts probably only to a few per cent. For rail, however, this could mean an increase in tonne-kilometres by 10 to 20 per cent. More particularly, in order to stabilize the $CO_2$ emissions from road transport in the coming decade, a rise in excise duty on motor fuels to 500 or 600 ECU/1,000 l is needed. This will, however, not be sufficient to real "sustainable mobility" (see earlier).

An increase in fuel tax rates as suggested above would generate considerable new government revenue. This revenue should be used to reduce other taxes. First, the vehicle tax can then be abolished. And, second, the income tax should be lowered. Thus, the source of taxation is changed but no additional tax burden is imposed on business and consumers (Bakker and Bleijenberg, 1991, 1992). The macro-economic effects of such a shift in taxation are relatively small, according to calculations with a macro-economic model for The Netherlands (Bleijenberg *et al.*, 1990). Table II summarizes the main results of that study which started from the assumption that the taxes on all motor fuels were increased to 640 ECU/1,000 l. The total additional tax revenue was used to lower the rates of other taxes as described above.

Although the macro-economic effects of a substantial rise in fuel prices are relatively small, there are major concerns about the distributive effects of such a measure, particularly in relation to the position of the peripheral

**Table II.** *Macro-economic effects for the year 2000 of an increase in taxes on all motor fuels to 640 ECU/1,000 l, in combination with abolishment of the vehicle tax and a reduction in the income tax*

| | Changes relative to current policy |
|---|---|
| Budget deficit | 0.0[c] |
| Tax burden | –1.5[c] |
| Employment | 0.5[a] |
| Private consumption (volume) | 0.0[a] |
| Production (volume) | –0.4[a] |
| Inflation | 1.8[b] |
| Labour costs per employed person | –1.9[a] |
| Balance of payments | 0.5[c] |

*Notes*:
[a] In %
[b] In % points
[c] In % points of net national income

regions in the Community, such as Scotland, Ireland, Greece and the Iberian Peninsula. It could be argued that their geographical location, far away from the economic core areas of the EC puts them at a competitive disadvantage if transport prices are high. This argument runs counter to the demand for a substantial increase in transport prices, as this increase would contribute to freezing existing lags in prosperity. In my opinion, however, subsidizing road transport – instead of making it pay its full costs – is not a good policy instrument to achieve social and economic development goals. First of all, a general low-cost transport policy is not specific enough, because it stimulates all transport, and not only transport to and from the peripheral regions. Second, the environmental disadvantages of road transport, also in the periphery, are too large to be simply ignored. Last, but not least, I am not sure whether subsidized transport will give an economic advantage to the peripheral regions. It might instead favour the economic development in the central regions with their existing economies of scale and economic infrastructure. Indeed, better transport links to the peripheral zones of the Community do not only serve the export of products from the periphery to the centre, but also the import of products from the centre to the periphery.

## Conclusion

The analysis in this article leads to a number of conclusions about the present state of affairs at the interface between road freight transport, the environment and the economic system. It supports a number of proposals for action. Summarizing, four main points emerged. First, current growth trends in road haulage lead further away from the aim to stabilize and reduce $CO_2$ emissions. They also prevent a reduction in the emissions of $NO_x$ and HC to an ecologically sustainable level based on the concept of critical loads.

Second, part of the current volume of road haulage is justified by artificially low transport prices. This is partly due to the fact that transport prices do not cover the full transport costs, and partly because there are artificial (i.e. administrative) comparative advantages. I propose that a major aim of EC transport policy be to avoid artificial transport demand.

Third, a substantial rise in the level of excise duty on motor fuels is an effective measure to reduce the environmental impact of transportation. Fourth, the harmonization within the European Union of excise duties on motor fuels at a high level is fully compatible with the completion of the internal market. The completion of the internal market and the related deregulation of freight transport markets need to be supplemented with fiscal measures, which make each transport mode pay its full costs.

### Notes

1. European Conference of Ministers of Transport, Council of Ministers (1989). Resolution on Transport and the Environment, Paris.
2. The European Federation for Transport and Environment (EFTE) carried out a large project on internalizing social costs of transportation which looked, among other things, at the full costs of road transport. The report of the study was not yet available when the present article was finished: EFTE (1993). *Getting the Prices Right. A European Scheme*, Stockholm/Brussels; see also Kageson, P. (1992), *Internalizing Social Costs of Transport* (preliminary study), EFTE.

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