External Costs of Transport

The external costs of transport are large (estimated at about 8% of EU GDP (INFRAS, 2000)) but the estimates are uncertain. The most important categories of external cost are climate change, air pollution and accidents. Congestion is one of the highest components only in urban areas.

Road transport, which dominates overall mobility volumes, is responsible for more than 90% of total external costs. Road vehicles usually also show relatively higher average external costs per passenger-km and tonne-km than other modes - although the newest vehicles perform better from this point of view.

Figure 1 - Total External costs in EUR 17 by transport mode according to INFRAS-IWW (2000)

Figure 2  Average external costs 1995 (EUR 17) by means of transport and cost category: Passenger transport (without congestion costs)
Objective
Reduction of external costs of transport

Definitions
Total amount of external costs by transport mode (both freight and passenger); average external cost per passenger-km and tonne-km by transport mode.

Note: The external costs of transport are those that affect society, but are not directly born by the transport user who has caused them. They may consist of:

- environmental costs (e.g. damage due to air pollution, climate change, noise, electromagnetic fields, other upstream and downstream environmental effects)
- fragmentation of landscape, land take and ecological separation
- urban separation
- non-covered accident costs (such as grief and suffering)
- congestion (time loss inflicted to others)

The internal costs, sometimes called private costs, are those borne directly by the individual user of transport services – for example, for road transport, the costs of car purchase, fuel, maintenance, taxes, charges and premiums, and own time. The total social costs of transport are the sum of the internal and external costs.

As with any other kind of cost, external costs may be fixed or variable. Variable costs depend on output (i.e. km travelled), fixed costs do not. Variable external costs relate to the actual use of any means of transport. Fixed external costs usually arise within the upstream and downstream phases of the transport life cycle (e.g. environmental costs arising when producing the fuels, during production/dismantling of any kind of vehicle, or during rail/road/airplane/harbour infrastructure construction). A schematic overview of internal and external costs of transport, distinguished between fixed and variable costs, is given in the table below.
### Fixed taxes and charges

<table>
<thead>
<tr>
<th>Internal costs</th>
<th>Variable costs</th>
<th>Variable taxes and charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration tax</td>
<td>vehicle purchase</td>
<td>vehicle maintenance</td>
</tr>
<tr>
<td>VAT on insurance</td>
<td>vehicle insurance, own accident costs</td>
<td>fuel, lubricating oil, etc.</td>
</tr>
<tr>
<td>VAT on road tax, annual motorway vignette (ticket)</td>
<td>vehicle construction and dismantling; - infrastructure construction</td>
<td>Vehicle maintenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### External costs

- Fragmentation of landscape; environmental costs occurring during vehicle construction and dismantling, vehicle-related waste treatment, infrastructure construction
- Environmental costs (possible damages due to air pollution, climate change, noise, electromagnetic fields, depletion of resources)
- Ecological separation
- Socio-economic separation
- Accidents, as far as the costs are not covered by car insurance
- Free provision of parking space
- Uncovered infrastructure costs
- Congestion (time loss of others)

### Policy and targets

The reduction of external costs of transport is a main policy goal of EU environment and transport policies. There are two sets of policy tools that aim to reduce external costs:

- ‘command and control’ measures that directly reduce emissions, or other kinds of external impact (e.g. traffic bans in some urban neighbourhoods are a command and control measure to reduce congestion and air pollution)
- Pricing mechanisms (e.g. taxes, charges, subsidies) that give incentives to change users behaviour towards ‘cleaner’ transport. In most cases the internalisation of external costs refers to this set of policy tools.

Internalisation policies are dealt with more in depth within the fact sheet on "Internalisation of External Costs", which focuses in particular on pricing instruments.

The main principles for internalising (uncovered) environmental costs are set out in various international agreements (Vancouver, 1996; CEI, 1997; UN, 1997; LCTEH, 1999):
• **Pollution Prevention:** transport needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes.

• **Health and Safety Protection:** transport systems should be designed and operated in a way that protects the health (physical, mental and social well-being) and safety of all people, and enhances the quality of life in communities.

• **Nature-saving Land and Resource Use:** transport systems must make efficient use of land and other natural resources while preserving vital habitats and maintaining biodiversity.

**Findings**

External costs must be evaluated if they are going to be used as a basis for calibrating transport taxes and charges. There is currently no unique, commonly accepted methodology for estimating external costs.

Many different studies during the past two decades have sought to evaluate the external costs of transport. The evaluations differ considerably in their scope, the specific transport modes considered, the kind of impacts evaluated, the hypotheses used and, correspondingly, the final quantitative results obtained. For instance, a study made by the International Organisation for Automobile Manufacturers (OICA, 1995) addresses the evaluation of total external costs of road transport in Western European countries, estimating the impacts related to air pollution, climate change and accidents, but not congestion. The study made within the ExternE program (Friedrich et al, 1997) addresses the energy-related external costs of transport, quantifying the marginal costs of air pollution and climate change for site- and time-specific trips, taking no account of congestion and accidents, which are not directly energy-related. The study made by INFRAS-IWW (INFRAS, 2000) addresses total, average and marginal costs of all transport modes in EU countries, taking account of all the main kinds of external impacts (environmental damages, accidents, congestion), but it does not quantify the costs of congestion related to non-road modes.

As the aims and the variables addressed are different, it is not easy to compare the results obtained by different studies and methodologies. However some rather consistent qualitative conclusions can be drawn:

- External costs of transport are large in absolute terms and represent a substantial problem for EU countries.

- The highest contributors to total external costs are air pollution, climate change and accidents. Congestion is less significant overall but represents the most important externality – in terms of total, average and marginal costs - within urban areas.

- Among the various atmospheric pollutants considered, fine particles (both emitted directly by tailpipes and generated by photochemical transformation of other pollutants) appear to be particularly damaging because of their threat to human health.

- Road transport – the largest share of both passenger and freight mobility volumes – is also the largest contributor to total external costs (see Fig. 1). Road transport modes also have relatively higher average costs per passenger-km and tonne-km than other modes (figures 2 and 3). However, some important improvements have been obtained through the newest technologies (e.g. Euro II vehicles, see box below), reducing the average environmental impact.

- The marginal cost of road transport (i.e. the cost related to the last additional km driven by any transport mode considered) varies considerably according to where and when the trip is taken (see Box below). Urban trips cause a much higher impact than rural trips, mainly because the higher population density in urban areas results in more people being exposed to the health effects of air pollution. The valuation can also vary considerably among different urban areas, depending on the population densities and climatic and geographic characteristics.

The graphs and numbers presented in this fact sheet draw mainly from the INFRAS-IWW (INFRAS, 2000) study. This has been chosen because it gives the most complete picture, measuring almost all the kinds of external impacts across modes in terms of total, average and marginal costs (although congestion costs from non-road transport modes were not considered as external, and therefore not
The results obviously rely on a set of hypotheses and assumptions. The methodology used and the range of sensitivities of the results are described in the metadata of this fact sheet.

The figures in this box illustrate importance for the external costs of transport of the location and the type of vehicle and fuel used.

The damage of PM$_{2.5}$ (particles with less than 2.5 µm diameter) is determined mainly by the population density in the area where the particles are emitted, and by the local climatic conditions that govern their dispersion. The more urbanised the area the higher the impact of PM$_{2.5}$. For secondary pollutants (sulphates, nitrates, ozone), which were looked at on the regional scale, the size of the impact is affected by the location (which determines the size of the overall population exposed), the regional climatic conditions (e.g. wind characteristics) and by the background concentrations of some pollutants (e.g. NH$_3$) that interact with the transformations processes of SO$_x$ and NO$_x$ pollutants into aerosols.

**Relative damage per tonne of PM$_{2.5}$ in different urban and rural locations**

![Relative damage per tonne of PM$_{2.5}$ in different urban and rural locations](chart)

Source: (Friedrich R. et al., 2000)

The next figure from (Friedrich R., et al., 2000) shows the variation of air pollution costs for various types of vehicles and modes. In Stuttgart, rail vehicles for passenger transport are operated only electrically, so there are no direct emissions from vehicle use. Of the remaining processes, most of the cost is from fuel (electricity) production. For vehicles with internal combustion engines, vehicle operation plays a very important role in the urban environment. The only exception is where petrol cars comply with EURO II, where the highest cost per passenger kilometre are from infrastructure use. Costs per passenger-km due to vehicle production, fuel production and infrastructure use are much lower for buses and coaches than for cars. In terms of total costs per passenger-km, electric rail vehicles have by far the smallest damage costs due to air pollution. Next comes coaches, but this is mainly due to high load factors, which cannot usually be achieved for inner-urban trips. The ranking in terms of increasing damage costs for modern road passenger vehicles is therefore: modern urban bus, EURO II petrol car and EURO II diesel car.
Average external costs of various modes of transport

Economic evaluation of the environmental impacts of transport is usually made in terms of the consumers’ willingness to pay to avoid a given expected damage due to some kinds of pollution or the willingness to accept a compensation for suffering a given damage (e.g. expected agricultural yield losses due to high ozone concentrations; health damage due to exposure to particulates).

The most recent and interesting of the many studies addressing external costs from transport are:

1. A recent study on external costs of transport by INFRAS/IWW (INFRAS, 2000). The main assumptions used in that study are presented in a table under Data.

2. The ExternE project series developed and applied a methodology for quantifying externalities called the impact pathway approach: the impacts of airborne pollutants are quantified by modelling their emission and dispersion (including chemical transformation processes), to calculate changes in ambient air concentrations from which physical impacts can be quantified using exposure-response functions. Damage costs are calculated using monetary values based on the willingness to pay approach. The impact pathway approach emphasises the ‘bottom-up’ valuation of marginal impacts related to specific trips rather than the overall damage caused by a given economic sector. Nevertheless, the approach can also be used to derive aggregated evaluations. (Friedrich, R. et al, 1997; Friedrich, R. et al., 2000).

3. The ECMT study “Efficient Transport for Europe, Policies for Internalisation of External Costs” (ECMT, 1998). This report summarises the theoretical and practical dimensions of internalisation, reviews recent estimates of external costs, explores the mix of regulations and economic instruments that might be used to promote internalisation successfully and estimates the size of incentives required in monetary terms.

The TRENEN II STRAN project (TRENEN, 1999) is not actually a study on the value of external costs. However it is an interesting and useful study, as it compares the marginal external costs of transport with the price paid by the transport user in the framework of the development of strategic models for the assessment of pricing reform in the
marginal external costs of transport. The ExternE methodology is used for air pollution. The estimation of noise damage is based on price information from the housing market. External accident costs are based on costs not covered by insurance.

The figures in the key message above are an estimate of the average external costs for passenger transport and freight transport and various modes of transport, excluding congestion costs (INFRAS, 2000). Based on average load factors per mode taken from national statistics (included in the metadata of this fact sheet), the main qualitative conclusion is that the external costs per passenger-km and tonne-km are higher for car/truck and airplane than for bus, rail and ship.

Three other figures show details per country and also an estimation of the congestion costs per country.

For 1995 the total external costs of transport (excluding congestion costs) are estimated on 530 billion Euro, or 7.8 % of the total GDP in EUR 17 (8.3 % including congestion costs). The most important contributor is road transport, causing 92 % of the total costs (INFRAS, 2000).

The average external costs of transport vary between countries. For road passenger transport, Germany is highest (28 % above average), Spain and Portugal are lowest (30 % below average). The explanations for these differences are the high share of diesel cars in Germany, the differences between average load factors (relatively high in Spain and Portugal), and the adjustments made to take Purchasing Power Parities into account (the PPP-adjusted value of statistical life lost for Spain and Portugal is lower than for most other EU countries).

For road freight transport, Switzerland is highest (81 % above average) and Austria is lowest (51 % below average). One explanatory factor is the lower weight limit for Switzerland and the relatively high population densities around roads.

For rail passenger transport, Denmark is highest (149 % above average) and Sweden and France are lowest (60 % below average).

For rail freight transport, Ireland is highest (105 % above average) and Sweden is lowest (67 % below average).

The electricity mix is an important factor when comparing rail transport between countries. For freight transport, Ireland uses only diesel traction, while Sweden uses electric trains, powered by green energy sources (like hydropower, biomass and waste), but also by nuclear power.

Uncovered infrastructure costs

Uncovered infrastructure costs are not taken into consideration. Such potential infrastructure deficits depend very much on the taxation system, the political conditions and the policies of the country regarding accessibility of more remote areas.

Average congestion costs

The average congestion costs are estimated by INFRAS/IWW (INFRAS, 2000) at an average of 0.5 % of GDP. See figure for variations between countries.

Average congestion costs are only a relatively small fraction of average total external costs. They arise mainly during peak periods in urban areas. In these periods and these areas, congestion contributes substantially to marginal external costs. It is referred to the fact sheet on internalisation.
External costs of transport

Average external costs 1995 for passenger transport (Euro/1000p-km)

Average external costs 1995 for freight transport (Euro/1000 t-km)

Figure 5.4.6. Average external congestion costs, 1995, Euro per 1000 p-km and t-km

Source: INFRAS, 2000

Future work

More has to be done to reach consensus – both from the scientific and the stakeholders’ point of view – on the methodology that should be used to evaluate external costs.

Source: ECMT, 1998; INFRAS, 2000
External costs of transport

Data

Distribution of external costs (1995)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Mio Euro/year</th>
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</thead>
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<td>Waterborne</td>
<td>2400</td>
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<tr>
<td>Aviation freight</td>
<td>2800</td>
</tr>
<tr>
<td>Rail freight</td>
<td>4300</td>
</tr>
<tr>
<td>Rail passengers</td>
<td>6000</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>13000</td>
</tr>
<tr>
<td>Bus</td>
<td>14000</td>
</tr>
<tr>
<td>Aviation passengers</td>
<td>29000</td>
</tr>
<tr>
<td>LDV</td>
<td>43000</td>
</tr>
<tr>
<td>HDV</td>
<td>113000</td>
</tr>
<tr>
<td>Car</td>
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</tr>
<tr>
<td>Total</td>
<td>529500</td>
</tr>
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</table>

Source: INFRAS, 2000

Average external cost 1995 for passenger transport (Euro/1000p-km)

<table>
<thead>
<tr>
<th>Country</th>
<th>Car</th>
<th>bus</th>
<th>Rail</th>
<th>aviation</th>
</tr>
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<td>47</td>
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<tr>
<td>Sweden</td>
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<td>51</td>
</tr>
<tr>
<td>Switzerland</td>
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<td>41</td>
<td>15</td>
<td>43</td>
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<td>UK</td>
<td>88</td>
<td>70</td>
<td>37</td>
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<tr>
<td>EUR 17</td>
<td>87</td>
<td>38</td>
<td>20</td>
<td>48</td>
</tr>
</tbody>
</table>

Source: INFRAS, 2000

Average external cost 1995 for freight transport (Euro/1000t-km)

<table>
<thead>
<tr>
<th>Country</th>
<th>road</th>
<th>rail</th>
<th>Aviation</th>
<th>waterborne</th>
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<td>France</td>
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<td>Germany</td>
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<td>Sweden</td>
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<td>UK</td>
<td>81</td>
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<td>211</td>
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<tr>
<td>EUR 17</td>
<td>88</td>
<td>19</td>
<td>205</td>
<td>17</td>
</tr>
</tbody>
</table>

Source: INFRAS, 2000

Average external congestion costs on roads, 1995, Euro per 1000 passenger-km and tonne-km, EUR 17

Version 20-08-2001
## External costs of transport

<table>
<thead>
<tr>
<th></th>
<th>passengers</th>
<th>freight</th>
</tr>
</thead>
<tbody>
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<td>Austria</td>
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<td>2.1</td>
</tr>
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<td>9.7</td>
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<td>France</td>
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<td>7.8</td>
</tr>
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<td>Germany</td>
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<td>12.6</td>
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<td>0.9</td>
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<td>1.2</td>
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Source: INFRAS, 2000

### Metadata

#### Technical information

**Data sources**

- Efficient Transport for Europe, Policies for Internalisation of External Costs, ECMT, 1998

**Description of data**

- Average external costs of passenger transport
- Average external costs of freight transport
- Average congestion costs

**Original measure units**

- **Original purpose**

**Geographical coverage**

EU 15

**Temporal coverage**

- **Methodology and frequency of data collection**
Overview of the most important methodological assumptions for the estimation of external costs as used in the INFRAS/IWW study “External Costs of Transport”, March 2000

<table>
<thead>
<tr>
<th>Type of effect</th>
<th>Cost components</th>
<th>Most important assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents</td>
<td>Additional costs of - medical care - opportunity costs of society - suffer and grief.</td>
<td>• A value of human life of 1.5 million Euro is considered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Average costs are equal to marginal costs. There is no specific relation between vehicle-km and accident rates assumed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Insurance payments are considered in order to estimate external cost components.</td>
</tr>
<tr>
<td>Noise</td>
<td>Damages (opportunity costs of land value) and human health.</td>
<td>• The valuation approach is based on a willingness to pay for silent space above 55 dB(A).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Average costs are estimated by a top-down approach based on ECMT data.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Marginal costs are estimated by a modelling approach.</td>
</tr>
<tr>
<td>Air pollution</td>
<td>Damages (opportunity costs of - human health - material - biosphere.</td>
<td>• The results are based on a new and consistent data basis for emissions for all countries (TRENDS’ Eurostat).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Health costs are based on a WHO study estimating health costs for France, Austria and Switzerland.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Building damages, crop losses and forest damages are based on results of Swiss expert studies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Marginal costs are computed by the ExternE model. In order to be compatible with the top-down approach for total and average costs, building damages are adjusted.</td>
</tr>
<tr>
<td>Climate change</td>
<td>Damages (opportunity costs) of global warming.</td>
<td>• The data basis is TRENDS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A unit cost value of 135 Euro per tonne of CO2 is considered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Marginal costs are assumed to be equal to average variable costs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The unit costs of air transport are doubled in order to consider the specific risks of emissions in higher altitudes.</td>
</tr>
<tr>
<td>Nature and landscape</td>
<td>Additional costs to repair damages, compensation costs.</td>
<td>• A repair cost is used, estimating the restoration costs for different types of infrastructure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A reference level (unspoilt nature) of 1950 is assumed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The effects are not relevant for social marginal costs, since these costs are infrastructure-related.</td>
</tr>
<tr>
<td>Separation in urban areas</td>
<td>Time losses of pedestrians.</td>
<td>• According to the methodology used in Germany (EWS), time losses are estimated based on random samples of different type of cities.</td>
</tr>
<tr>
<td>Space scarcity in urban areas</td>
<td>Space compensation for bicycles.</td>
<td>• The effects are not relevant for social marginal costs, since these costs are infrastructure-related.</td>
</tr>
<tr>
<td>Additional costs from upstream and downstream processes</td>
<td>Additional environmental costs (air pollution, climate change and risks)</td>
<td>• Based on the energy consumption, additional costs for precombustion, production and maintenance of rolling stock and infrastructure is estimated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For nuclear risks, a shadow price of 0.035 Euro per kWh of nuclear energy is assumed, based on willingness-to-pay studies for risk aversion.</td>
</tr>
<tr>
<td>Congestion</td>
<td>External additional time and operating costs.</td>
<td>• Use of a traffic model to compute marginal and average costs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Time values are derived from EU research projects (PETS).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three approaches:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Net welfare loss for road transport facing an optimal congestion tax,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Revenues of an optimal tax,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Time losses relative to a better level of service.</td>
</tr>
</tbody>
</table>

Source: INFRAS, 2000

Load factors per country used in the INFRAS/IWW study

<table>
<thead>
<tr>
<th>Load factors (road)</th>
<th>Car (pass/veh)</th>
<th>Bus (pass/veh)</th>
<th>LDV (t/veh)</th>
<th>HDV (t/veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1.48</td>
<td>30.0</td>
<td>0.30</td>
<td>9.8</td>
</tr>
<tr>
<td>Belgium</td>
<td>1.46</td>
<td>11.6</td>
<td>0.30</td>
<td>5.0</td>
</tr>
<tr>
<td>Denmark</td>
<td>1.86</td>
<td>20.0</td>
<td>0.30</td>
<td>8.9</td>
</tr>
<tr>
<td>Finland</td>
<td>1.40</td>
<td>12.9</td>
<td>0.30</td>
<td>6.2</td>
</tr>
<tr>
<td>France</td>
<td>1.86</td>
<td>18.5</td>
<td>0.30</td>
<td>4.6</td>
</tr>
<tr>
<td>Germany</td>
<td>1.44</td>
<td>18.5</td>
<td>0.30</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Version 20-08-2001
### External costs of transport

<table>
<thead>
<tr>
<th>Country</th>
<th>Accident</th>
<th>Noise</th>
<th>Air pollution</th>
<th>Climate change</th>
<th>Nature and landscape</th>
<th>Urban effects</th>
<th>Upstream effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greece</td>
<td>1.98</td>
<td>10.7</td>
<td>0.30</td>
<td>7.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>1.71</td>
<td>8.5</td>
<td>0.30</td>
<td>7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>1.88</td>
<td>16.9</td>
<td>0.30</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1.60</td>
<td>17.7</td>
<td>0.30</td>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>1.63</td>
<td>22.2</td>
<td>0.30</td>
<td>7.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>1.81</td>
<td>11.3</td>
<td>0.30</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>2.46</td>
<td>27.7</td>
<td>0.30</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>2.02</td>
<td>25.2</td>
<td>0.30</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>1.64</td>
<td>13.2</td>
<td>0.30</td>
<td>4.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>1.67</td>
<td>18.7</td>
<td>0.30</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>1.66</td>
<td>8.9</td>
<td>0.30</td>
<td>6.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.74</td>
<td>17.2</td>
<td>0.30</td>
<td>5.62</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** INFRAS, 2000

### Sensitivity analysis of the INFRAS/IWW study: overview of the most important results per external cost category

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Share of total external costs</th>
<th>Sensitivities considered</th>
<th>Range of sensitivities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident</td>
<td>29%</td>
<td>Risk value</td>
<td>-60% to +92%</td>
</tr>
<tr>
<td>Noise</td>
<td>7%</td>
<td>Risk value, Lower bound 50 dB(A)</td>
<td>-27% to +41% +58%</td>
</tr>
<tr>
<td>Air pollution</td>
<td>25%</td>
<td>Risk value, Consideration of forest damages</td>
<td>-40% to +59% +19%</td>
</tr>
<tr>
<td>Climate change</td>
<td>23%</td>
<td>Upper and lower bound for scientific shadow rate CO2, Alternative (political) reduction aims</td>
<td>-48% to +48% -73% to -93%</td>
</tr>
<tr>
<td>Nature and landscape</td>
<td>3%</td>
<td>Prevention cost approach</td>
<td>-55% (road) +210% (rail)</td>
</tr>
<tr>
<td>Urban effects</td>
<td>2%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Upstream effects</td>
<td>11%</td>
<td>According to air pollution and climate change</td>
<td>According to air pollution and climate change</td>
</tr>
</tbody>
</table>

**Source:** INFRAS, 2000

### Qualitative information

**Strength and weakness**

Reliability, accuracy, robustness, uncertainty (at data level)

Further work required (for data level and indicator level)

### References

CEI, 1997: *CEI Environment Ministers’ Declaration “Towards Sustainable Transport in the CEI Countries”.*


Proost, S., Van Dender, K. Centre for Economic Studies, Katholieke Universiteit Leuven, Belgium, Project funded by the European Commission under the Transport RTD programme of the 4th Framework Programme.

UN, 1997: UN/ECE Vienna Declaration.