A Mileage Tax for European Road Freight Transport

Sub Report within the EU Research Project "External Costs of Transport and Internalisation"

August 31, 1995

ECOPLAN
Economic and Environmental Studies

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Abbreviations

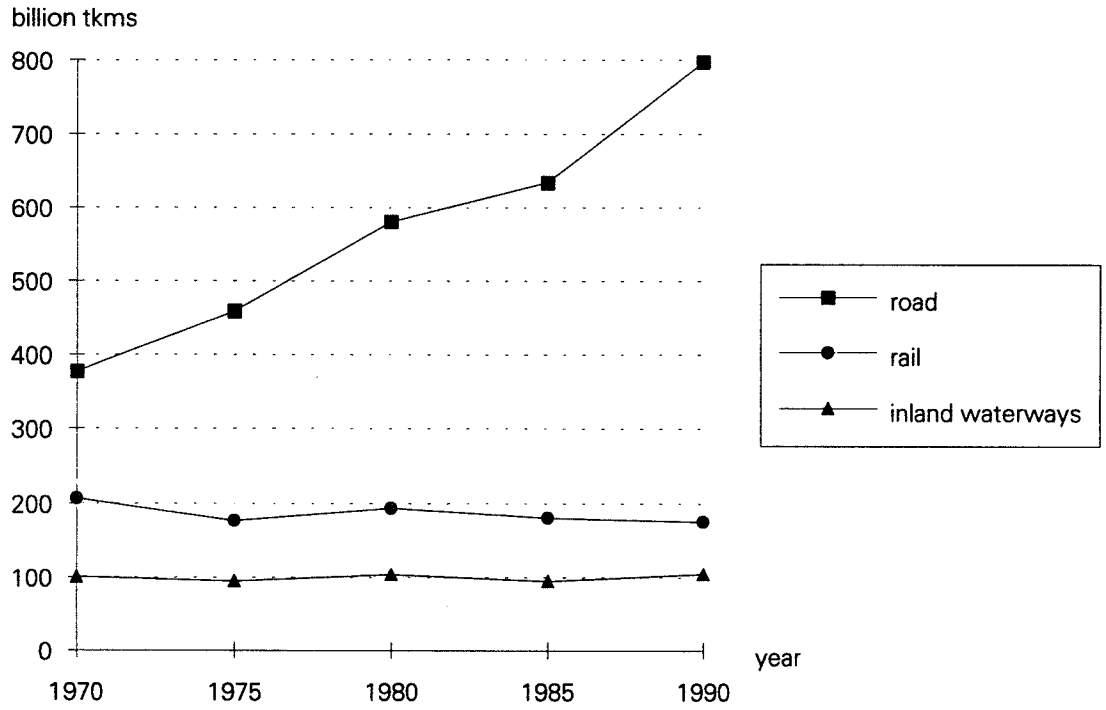
CHF	Swiss Franc
CO_2	Carbon dioxide
CTP	Common Transport Policy
DG	Directorate General
ECMT	European Conference of Ministers of Transport
ECU	European currency unit
ECU/$t_{tw,km}$	ECU per tonne of permissible total weight and kilometre driven
EU	European Union
EUR 12	Europe of the twelve
EUR 15	Europe of the fifteen
GDP	Gross domestic product
HGV	Heavy goods vehicle
LGV	Light goods vehicle
Mill.	Million
NFP	Nationales Forschungsprogramm (National Research Programme)
NO_x	Nitrogen oxides
OECD	Organisation for Economic Co-operation and Development
PM	Particulats
SO_2	Sulphur dioxide
t	tonne
T&E	European Federation for Transport & Environment
TEN	Trans European Network
tkm	tonne kilometre
vkm	vehicle kilometre
VOC	Volatile organic compounds

Summary

1 Introduction

In the last two decades freight transport has substantially grown: Between 1970 and 1990 the volume of tonne-kilometres (tkm) has increased by more than 50%. Figure S-1 shows that first of all road freight transport has profited from this growth .

Figure S-1: Freight transport in the EU, 1970 - 1990



Source: Commission of the European Community (1993), The future Development of the Common Transport Policy - A Global Approach to the Construction of a Community Framework for Sustainable Development (White Paper on Transport), Annex I.

The completion of the internal market will cause a further growth of freight transport. According to the White Book of the Commission an enormous increase is expected: "As to the future, forecasts of growth in transport demand show that in a "business as usual" scenario with a reasonably favourable economic climate the expansion of the road sector is likely to be buoyant: a near doubling of road transport demand for both passengers and freight seems likely." Without policy measures to reduce the harmful emissions most serious effects on the environment and on human health are to be expected. One such measure could be a mileage charge as described in the following sections.

2 Overview of the proposal

Table S-2: Summary of the main features of the proposed mileage tax

features of the tax	description	comments
basic idea	variable tax for heavy goods vehicles (HGV) to internalise external costs	based on the territorial principle
object of the tax	HGV, permissible total weight > 3.5 t	
field of application	whole road network of the Member States	
tax base	permissible total weight and kilometre driven	
tax rate: "basic version"	lower bound: 0.006 ECU/t_{tw}km upper bound: 0.012 ECU/t_{tw}km	based on estimates of external costs that are available at present, to be adjusted in the course of time
tax payer	owner of the HGV (haulage companies)	
differentiation of the tax rate	– "extended version": differentiation according to emissions of air pollutants and noise of vehicle type – "sophisticated version": taking account of spatially different levels of pollution and of congestion	Three emission classes for air pollutants: EURO I, II and III; based on avoidance costs or on external (damage) costs e.g. a doubling of the tax rate in urban areas and higher tax levels during rush hours and for bottlenecks in the transport system
metering system	– electronic road pricing system – two-way data communication between vehicle and a vehicle identification system	first best solution is based on a global positioning system or on an electronic impulse of the speedometer
implementation	– EU: defining main features and minimum requirements (lower bound tax rate) – Member State: introduction	new Directive of the Council in compliance with the Directive
introduction scheme	– gradual increase of the tax rate – transitional period for "first mover" initiatives of the Member States	starting tax rate: lower bound
use of the revenues	– stage 1: earmarking for less polluting transport modes, financing of rescue packages for the environment – stage 2: redistribution of the revenues to the economy	at EU level: only recommendations => national solutions stage 1: only as interim solution reduction of labour costs, probably in the frame of an ecological tax reform

Comment:

a) Tax base

Key parameter of every mileage tax will be the number of kilometres driven. Furthermore, the tax base takes into account the weight of the vehicles. Here it was decided to base on permissible total weight of the vehicles due to two reasons:

- The permissible total weight is given in the vehicle documents
- With this tax base it would be possible to integrate infrastructure costs of road freight transport in the mileage tax (user-pays-principle)

b) Tax rate

In the **"basic version"** the tax rate is only differentiated according to the permissible weight of the vehicles. The basic tax rate was calculated using existing conservative estimates of external damage costs for noise, air pollution and accidents (lower bound 20 ECU per 1'000 tkm, upper bound 40 ECU per 1'000 tkm). Not included are the external costs of CO_2-emissions (greenhouse effect). Assumptions on the payload and the average load per vehicle category had to be made to calculate the average mileage tax per tonne of permissible total weight and kilometre, which is

- Upper bound: 0.012 ECU/t_{tw}km
- Lower bound: 0.006 ECU/t_{tw}km

In the **"extended version"** the level of the mileage tax is differentiated according to emissions of air pollutants. As main criterion for this differentiation, future emission limits of the EU for diesel driven HGV were used. Based on these limits **three classes of HGV with different emission factors** were defined. The differentiated tax rate was then calculated with avoidance costs (estimated additional costs to introduce the cleaner technology) and with external damage costs (estimated reduction of the damages due to the cleaner technology). The results of both calculations are summarised in table S-3 and S-4, respectively:

Table S-3: Differentiated tax rate in ECU/t_{tw}km (per tonne of permissible total weight and kilometre driven)
With avoidance cost approach

Type of HGV	Upper bound in ECU	in %	Lower bound in ECU	in %
Class 1	0.0109	91%	0.0049	83%
Class 2	0.0116	97%	0.0056	94%
Class 3	0.012	100%	0.006	100%

Table S-4: Differentiated tax rate in ECU/t_{tw}km (per tonne of permissible total weight and kilometre driven) With damage cost approach

Type of HGV	Upper bound in ECU	in %	Lower bound in ECU	in %
Class 1	0.0088	74%	0.0044	74%
Class 2	0.0108	90%	0.0054	90%
Class 3	0.012	100%	0.006	100%

Air pollution, noise and congestion often concentrate in urban areas and at particular times and the same holds therefore for the external costs. Correspondingly, a mileage tax intending to internalise the external costs of HGV should vary between areas with different air qualities and noise levels. We call the version of the mileage tax meeting these requirements "**sophisticated version**". Although it would not make sense to fix a specific extra charge for all urban areas in Europe (the transport problems vary from town to town) existing studies show that external costs of air pollution, noise and congestion are at least doubled (this is a very conservative value) in urban areas compared to rural areas.

c) Metering systems

After discussing the requirements which a metering system designed to implement the mileage tax has to meet, the following conclusions could be drawn: To meet the demands of the proposed mileage tax (applicable on the whole road network, differentiation according to emission standards, space and time) only an **electronic road pricing system** is possible. Metering systems fulfilling all the requirements are not yet available. But there are large ongoing efforts to develop such systems at national and European level. It can be expected that in the next five years standards for such systems will be defined.
Already now, the choice of possible metering systems can be limited to **only a few**, even if the ideal metering system is not yet determinable:

- Basically, a two-way data communication between the vehicle and an electronic system unit outside of the car (beacons, global positioning system) is necessary. As kilometres driven must be registered on the whole road network this registration must be possible without expensive new infrastructure needs. This means in our view that **registration systems based on beacons are out of question** as the costs of building such beacons for the whole network would be enormous.
- There are at least two categories of registration systems that are not dependent on additional infrastructure investments and could therefore build the base for the implementation of the mileage tax:
  - Firstly, the kilometres driven could be registered on the base of an **electronic impulse of the speedometer**. Acceleration and rotation signals serve as a control and to prevent manipulation. With such a system beacons would only be necessary between areas with different tax levels and at national borders.
  - Secondly, the registration can be based on a receiver/transmitter unit receiving **signals of the global positioning system** (GPS). In this case the speedometer im-

pulse is used to control plausibility of GPS-signals. This solution has the advantage that no investments for new communication infrastructure are needed as the spatial identification of the vehicle is very precise. Therefore, it would also be possible to vary the tax level in different areas and for different times. Already now, the GPS-system is used by private hauliers to optimise the logistics of the fleet. This private use of GPS-systems will rise substantially in the next years.

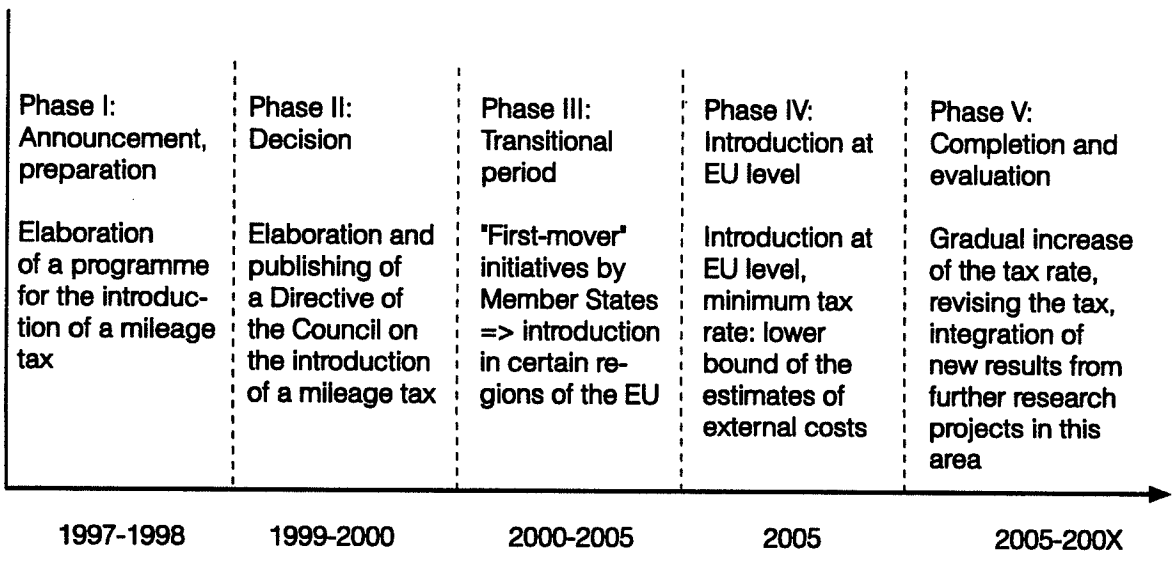
d) Implementation and Introduction

In many respects, the introduction of a mileage tax for road freight transport calls for policy measures at community level:

- **Distorting effect on competition**: A national mileage tax without an appropriate degree of co-ordination and harmonisation may influence the competitiveness of the economy in the respective country.
- **Global and/or transboundary character of environmental problems caused by road transport**: Especially in the case of air pollution the emissions of transport do not respect national boundaries. National action may not result in a substantial improvement of the air quality.
- **Compatibility of the metering system**: Community action will ensure the development of compatible systems and prevent the emergence of new barriers of trade at national borders. Furthermore, the development of such a system at EU level will cause less costs than uncoordinated national actions.

Therefore, a proposal for a gradual introduction at EU-level was developed. Figure S-5 summarises a conceivable introduction scheme for a mileage tax at EU level that distinguishes between five different phases. It has to be emphasised that in this proposal the introduction of the mileage tax itself is left to the Member States. The time schedule assigned to each phase is of course only one possibility among others.

Figure S-5: Proposal for an introduction scheme



e) Use of the revenues

Based on a review of different ways how to use the revenues of a mileage tax, a proposal was developed that takes into consideration criteria like political acceptance, revenue neutrality, administrative costs and the requirement that the use of the revenues does not weaken the incentive effect of the tax. The proposal is as follows:

- **Stage 1**: In a first stage which is clearly defined as an interim solution we suggest a mix of earmarking for investments in environmentally more compatible transport modes (e.g. TEN-projects for rail and inland waterways) and of rescue packages for the environment and/or of measures to reduce the negative impacts of road transport on human life. The first way to use the revenues is especially justified as long as the rate of the mileage tax hasn't reached its final level.
- **Stage 2**: In a second stage we propose to implement a refunding system. If, at that time, the Member States will still intend to introduce a harmonised CO_2/energy tax, the implementation of the two refunding systems will have to be closely co-ordinated. This could happen in the context of larger reorganisation of the existing taxation system, i.e. in the context of an ecological tax reform. The objective would be to reduce labour costs.

It is conceivable that at EU level it is only determined that the revenues must not be refunded to the transport sector. In addition, the EU would only make recommendations but would leave it to the Member States to define the use of the revenues in detail.

3 Assessment of the mileage tax

Regarding the main impacts of the mileage tax the analysis has to distinguish between the impacts on the transport sector, on the other sectors of the economy and on the environment. Additionally, a technical assessment including a comparison of the mileage and the diesel tax was carried out. At last, the political aspects of a mileage tax were assessed.

a) Impacts on the transport sector

- Given the various assumptions[1] the expected **increase of average road transport prices** is around 13% in the case of the lower bound tax rate and around 26% if the upper bound of the tax rate is applied.
- The proposed mileage tax will cause a rather **modest reduction of the road freight transport volume** of about 2-6%. Compared to the expected growth of road freight transport (see figure S-1), the mileage tax will only lead to a small decrease of the annual growth rate.

1 Some of these assumptions are of rather speculative character. Therefore, the results derived from the estimates should be considered as orders of magnitudes and not as exact figures.

- Approximately three-fourth of the reduction of road freight transport will be achieved by a **shift of freight transport to rail**. Due to differences in total capacity this shift would correspond to an increase of rail transport by about 7-17%.
- The **shift to inland shipping** is expected to be modest. Geographical reasons, transportation time and the rather different characteristics of the goods transported by ships (i.e. bulk goods) and HGV prevent a large shift from road transport to inland shipping.
- In the **road transport sector** itself probable impacts of the mileage tax are:
  - raise of average occupancy rate
  - adjustments in the vehicle fleet (cleaner and smaller HGV)
  - strengthening of the trend towards larger haulage companies
  - positive effect on combined transport
  - improving competitiveness of haulage firms with a modern vehicle fleet.

b) Impact on other sectors of the economy

The influence of the mileage tax on the cost structure and thereby on product prices of the other sectors was assessed on the base of the transport intensity of the sectors (the transport intensity being defined as the ratio between the sector specific road freight transport costs and the value of the gross production of the sector).
From the calculations of the direct and indirect effects[2] of the mileage tax on the production costs of the sectors with a high (road freight) transport intensity the following conclusions can be drawn:

- The proposed mileage tax will only have a **very moderate influence on the production costs of other sectors**. Compared to other influences (the exchange rates, the wage level or technical progress) the impact is nearly negligible.
- The calculations show that for the lower bound of the proposed mileage tax the **maximum increase of the production costs comes to 0.2 - 0.5% for almost every sector with a high transport intensity**. Only for two sectors (cement, lime, building materials and petroleum products, refineries) it is conceivable that the cost effect will be above 0.5%. For all other sectors, particularly the whole services sectors, the cost effect amounts to less than 0.3%. Taking the upper bound of the mileage tax, approximately doubled cost effects compared to the lower bound mileage tax have to be expected.
- On account of the above results the proposed mileage tax will **not have a noticeable impact on the competitiveness and on the growth rate of the European economy**. This is true all the more as the revenues of the mileage tax are not lost but would be refunded to the economy (e.g. through a reduction of the social security contributions or through a wage sum bonus).

2 The **direct effect** corresponds to the impacts of the mileage tax on the cost and price structure of all other sectors. The higher costs of road freight transport will partly be transferred to ancillary sectors and to customers of other sectors (**indirect effect**).

- At last, it must be remembered that the introduction of the mileage tax sets an incentive for adjustment processes towards a **more efficient and welfare optimising road freight transport system**.

c) Ecological impact

Two effects determine the ecological impact of the mileage tax:

- The **reduction of the transport volume** and therefore of the road performance of road freight transport reduces total emissions. Due to the low reduction of the transport volumes this effect is rather modest. This is also a consequence of the very low values of external costs that were used to define the basic tax rate.
- More important than the first effect is the **incentive set by the tax to improve the emission abatement technology** as the potential of improved technologies is considerable. The proposed differentiation of the tax rate will accelerate the use of less polluting trucks. If the differentiation is adjusted in the course of time a lasting incentive for truck manufacturers to develop emission abatement technologies beyond today's knowledge will be set.

d) Technical assessment

The technical assessment of the mileage tax shows that the development and running costs of an electronic metering system to implement the mileage tax can be justified by the positive effects of the mileage tax on the environment and human health.

- Although the "extended" and the "sophisticated" version of the mileage tax cause higher classification costs (the HGV have to be classified in different categories corresponding to their emission factors) the **welfare gains of a differentiation of the mileage tax are remarkable** and seem to justify these higher implementation costs.
- Out of the different electronic metering systems those based on the **global positioning system** are most suitable to realise this kind of differentiation at low additional costs. One can therefore conclude that the "sophisticated" and not only the "extended version" of the mileage tax should be the final objective of an introduction of this instrument.
- Automatic debiting systems are mainly developed and tested due to other reasons than the internalisation of external costs (charging for infrastructure costs, control of traffic flow, fleet navigation). As a consequence, the **additional costs to use such systems for the implementation of a mileage tax may be substantially lowered**. Therefore it is important, that the choice of a specific automatic debiting system is also based on criteria that are important from the point of view of an internalisation of external costs (e.g. the spatial differentiation).

e) Mileage or diesel tax?

In this sub report it was not possible to carry out a full scale cost-benefit analysis of the mileage and the diesel tax. But, based on a **qualitative comparison**, the following conclusions can be drawn:

- From the point of view of the **incentive** to reduce external effects of air pollution and noise the mileage tax has marked advantages compared to the diesel tax because only the mileage tax can be differentiated according to emission factors.
- It is not obvious which tax has the better **cost-benefit ratio**. Actually, the two instruments can hardly be compared because they pursue different objectives and have not the same incentive effects. In many respects they are rather complements than substitutes.
- A more useful comparison would have to base on **packages of instruments** to internalise external costs of road freight transport. The packages would consist of the mileage tax or the diesel tax plus useful accompanying policy measures. The core of the two packages could, for example, consist of the following instruments:
  - Core of package 1: CO_2/energy tax as global incentive charge and a differentiated mileage tax ("sophisticated version")
  - Core of package 2: Diesel tax, annual vehicle and/or sales taxes and urban road pricing schemes

  Both packages can take into account the most important external cost elements and influencing parameters (technology, spatial and temporal differences, way of driving). Again, it is not obvious which package is more cost-efficient.
- Compared to a general CO_2/energy tax, a diesel tax is only a second best solution because with a CO_2/energy tax there are no price distortions between different kinds of fuel and no corresponding negative incentive effects. Additionally, if diesel driven cars do not have to pay the diesel tax, different diesel pumps at the filling stations are necessary. As it may be difficult to introduce a diesel tax independently of the political discussion about a CO_2/energy tax it seems to be the advantageous strategy to promote first of all the introduction of a CO_2/energy tax.
- An argument in favour of a transport policy strategy basing on a differentiated mileage tax is the fact that such a strategy would fit the current Common Transport Policy (key words: user charges, tolls) and the development in road freight transport (key word in this context: telematics).

f) Political assessment

Based on an analysis of the major obstacles to introduce a mileage tax several policy measures are proposed to overcome potential opposition against the mileage tax.

The proposed measures are

- **to improve and harmonise the evaluation of external costs** in order to increase the comparability and robustness of the findings. The research work within the 4th Framework programme will probably contribute to this objective.

- **to improve the transparency of internalisation measures** in order to reduce misunderstandings of the objectives of an internalisation of external costs.
- **to develop a convincing concept for the use of revenues** because distributive effects often dominate in the political debate. Therefore, the way the revenues of the internalisation instruments are used can considerably contribute to an increase of political acceptance. Ways have been found to ensure revenue neutrality.
- **to implement a concise communication strategy** in order to include all major actors in the discussion on the objectives and introduction of the internalisation strategy.

4 Conclusions and recommendations

Based on the analysis of the mileage tax for European road freight transport in this sub report we come to the following general conclusions:

- The mileage tax corresponds to one of the main objectives of the environmental policy of the EU, the realisation of the **polluter-pays principle**. From a theoretical point of view, the mileage tax is a convincing approach to reduce the negative impacts of road transport on the environment and on human life.
- The tax is an efficient instrument for **one of the most important and most growing polluters** of the environment in Europe.
- The tax would be a useful **completion of the CO_2/energy** that is still planned to be introduced by the Member States.
- Even with conservative values for the external costs the internalisation leads to a **substantial rise in costs of road freight transport**.
- The tax **improves the efficiency of the whole transport system** and gives room for manoeuvre for alternative, less polluting transport modes.
- The tax will **not reduce competitiveness of the European economy**. On the contrary, "first-mover" advantages may result from innovations of European firms in the field of emission abatement technologies for HGV and of metering systems for electronic road pricing schemes.

Therefore, we recommend to set up a detailed programme for the introduction of a mileage tax to internalise external costs of road freight transport at EU level.

Ongoing and further research work will yield additional results that can be integrated in the programme. The results will allow to deepen and complete knowledge especially in the fields of the assessment of external costs and of the technical feasibility of metering systems and to overcome many of the difficulties connected with the introduction of a mileage tax. The fact that the tax will have to be introduced gradually is an additional reason to start as soon as possible with the introduction process.

1 Introduction

1.1 Setting the stage

Topic A of this project and many other studies have shown the serious impacts of road freight transport on the environment and on human life. The forecast of future growth of road freight transport is alarming: With the completion of the internal market and the development of the economies in Eastern European countries almost a doubling of road transport is expected.

There is growing consensus that changes in the general set-up for road transport are inevitable. In the view of the economists this change especially refers to prices in transport sector. As long as prices do not reflect all costs caused by transportation a substantial reduction of the negative impacts will hardly be attained. The internalisation of external costs has become an important key word in the discussion on future transport policy. In the White Paper on Transport the charging for externalities of transport in order to address environmental problems by the fundamental economic mechanism is mentioned as an medium term objective of the Common Transport Policy.

1.2 Objective of the report

The objective of each of the three sub reports carried out within topic B of this research project is to analyse one single instrument in a more detailed way. The three instruments to be discussed in sub reports were evaluated in a pre-selection based on different criteria.[1] The pre-selection was discussed on the first workshop within this research projcet on March 22, 1995, in Petten (NL).

The three sub reports deal with the following instruments:
- A mileage tax for European road freight transport
- A variable track charge for rail transport
- Differentiated sales and vehicle taxes

The sub reports do not intend to describe an optimal mix of different instruments.[2] Their objective is rather to provide a new input for the discussion on the use of certain economic instruments in the transport sector.

This sub report deals with a mileage tax for European road freight transport.

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1 See ECOPLAN, External Costs of Transport and Internalisation, Topic B: Internalisation, chapter 1 and 2: Theory of Internalisation and Pre-Selection of Possible Internalisation Instruments, draft of March 14, 1995.

2 For a concrete proposal of an optimal mix of instruments see Infras and IWW (1994), External Effects of Transport.

1.3 Structure of the report

The sub report is divided into 5 chapters. The content of the different chapters can be summarised as follows:

- In **chapter 2** we have put together some of the major **characteristics of road freight transport in Europe**. In the centre are figures about the transport volumes and their growth in the last two decades. Furthermore, we briefly analyse the structure of the road transport sector in the EU Member States.

- In **chapter 3** we have developed a concrete **proposal for a mileage tax** at European level to internalise external costs of road freight transport. The proposal bases on estimates of external costs that are available at present and would have to be adjusted as soon as research projects generate new results.

- A first **assessment** of the mileage tax proposed is given in **chapter 4**. We consider first of all the economic impacts of the tax. Furthermore we briefly discuss the ecological impacts, have a look at cost-benefit aspects between a mileage tax and a diesel tax and analyse ways to gain political acceptance for the introduction of this economic instrument.

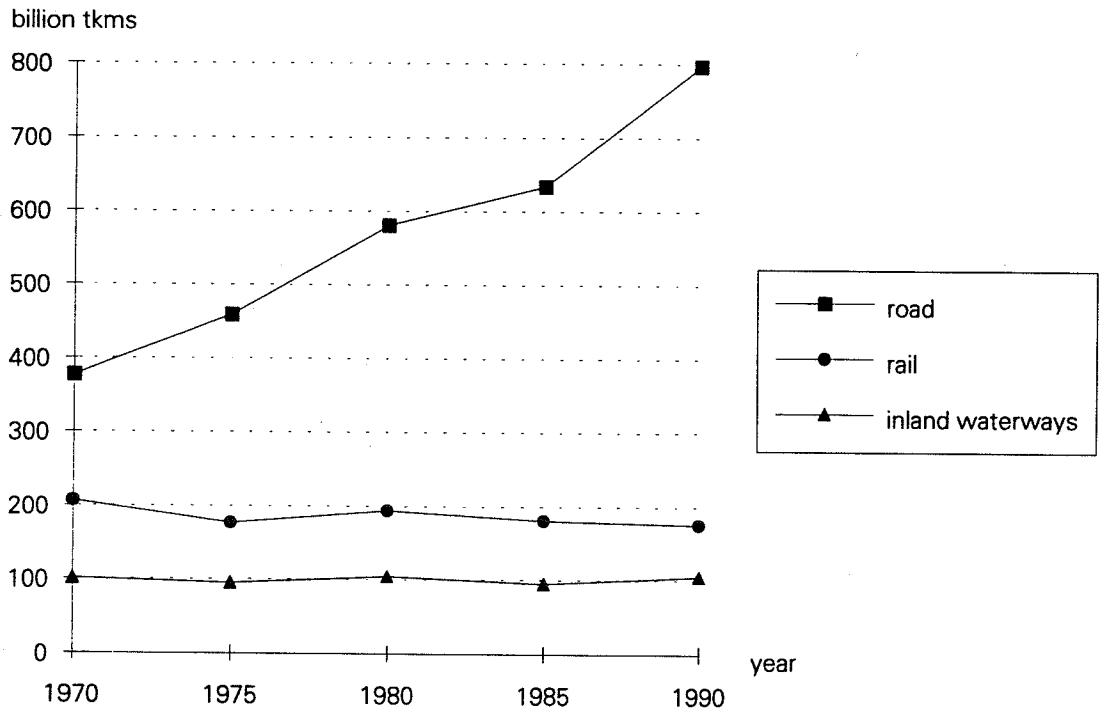
- In the **last chapter** the proposal is summarised and first conclusions and recommendations are drawn.

2 Freight transport in Europe

2.1 Freight transport volumes in the EU

In the last two decades freight transport has substantially grown: Between 1970 and 1990 the volume of tonne-kilometres (tkm) has increased by more than 50%. As figure 2-1 shows the different transport modes have profited in a very different way from this growth .

Figure 2-1: Freight transport in the EU, 1970 - 1990 (EUR 12)[1]



Comments:

- Almost all of the growth has been absorbed by **road freight transport**: Road transport more than doubled its transport volume. Its share on total transport volume has increased from about 50% to almost 70% (based on tonnes to around 90%!)
- **Rail transport** is still the second most important transport mode but its share on total transport volume has decreased, from 28% in 1970 to 15% in 1990. The transport volume too has decreased between 1970 and 1990.
- Transport on **inland waterways** has slightly increased, but this growth was below the growth rate of total freight transport. Accordingly, the share of inland navigation has decreased from about 13% to some 9%.[2]

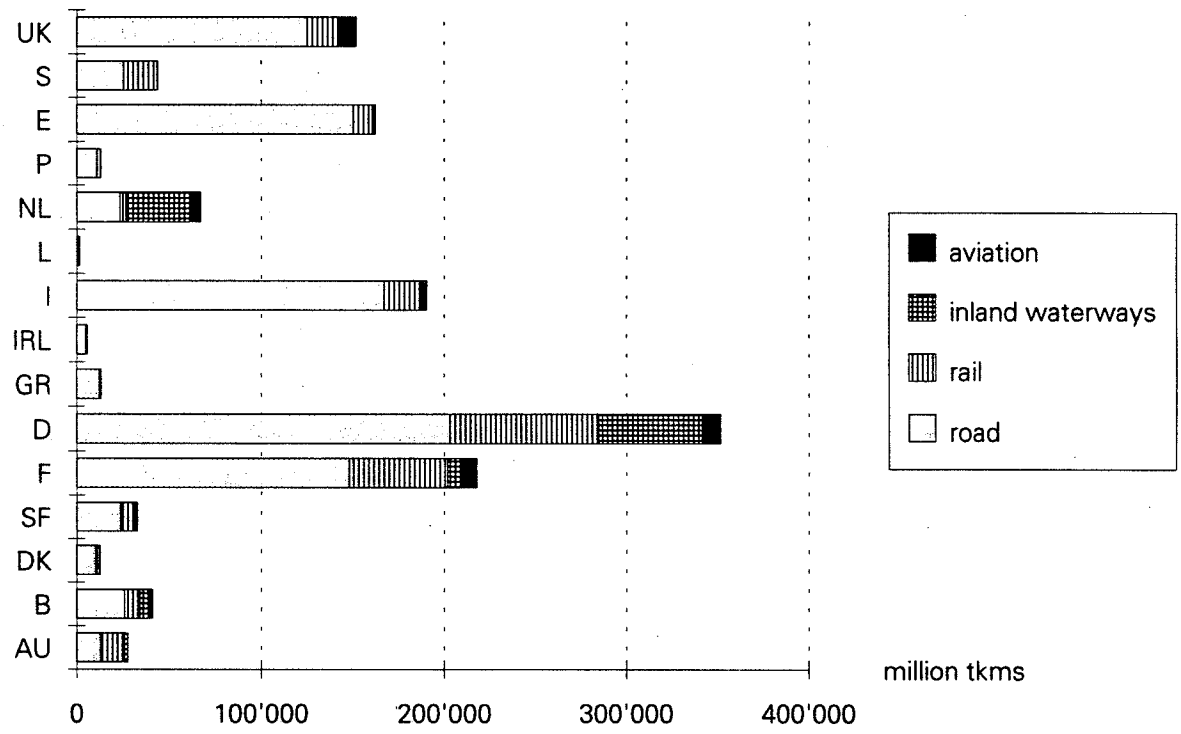
1 Source: Commission of the European Community (1993), The Future Development of the Common Transport Policy - A Global Approach to the Construction of a Community Framework for Sustainable Development (White Paper on Transport), Annex I. Data for aviation are not available.

The completion of the internal market will cause a further growth of freight transport. According to the White Book of the Commission an enormous increase is expected: "As to the future, forecasts of growth in transport demand show that in a "business as usual" scenario with a reasonably favourable economic climate the expansion of the road sector is likely to be buoyant. Under these conditions, a near doubling of road transport demand for both passengers and freight seems likely." Therefore, an annual growth rate between 2.7 and 4.7% seems plausible (total growth: 50-100% in 15 years).

2.2 Freight transport volumes in the Member States

The total freight transport volume shown in figure 2-1 is of course not evenly distributed between the Member States. Figure 2-2 summarises the volume of freight transport per transport mode in the Member States[3].

Figure 2-2: Freight transport volumes within the Member States, 1991 (EUR 15)[4]



2 The share of ocean shipping is not included in these figures. Especially in the trade between the Member States this transport mode is of major importance with a share of about 30%.

3 In figure 2-2 we have also included Austria, Sweden and Finland although these countries have joined the EU only in 1995. Figure 2-1 only refers to EUR 12.

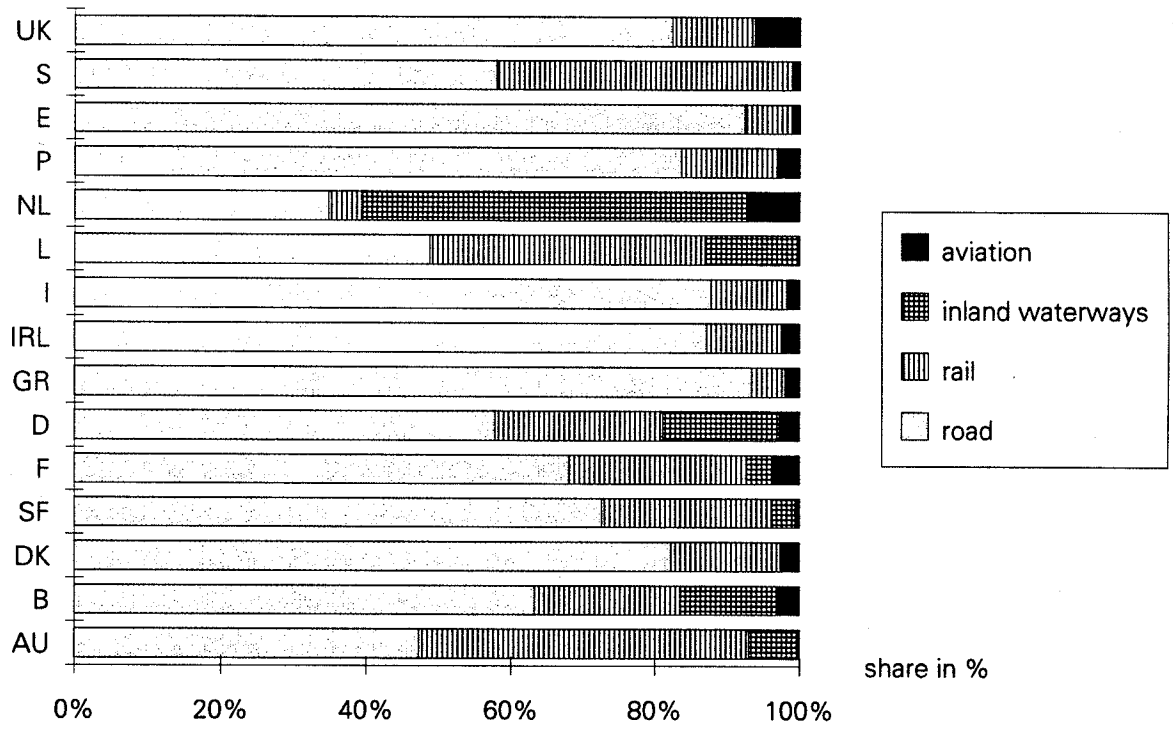
4 Sources: Committee of Enquiry (1994), Road Freight Transport in the Single European Market, Annex; different sources like ECMT Statistical Trends in Transport 1965-89, IRF World Road Statistics, UIC International Railway Statistics, Statistical Yearbook of the United Nations, national statistics, information from a questionnaire (see Infras / IWW (1994), External Effects of Transport, p. 80 ff.).

Comments:

- More than 80% of total freight transport volume fall to the five large Member States France, Germany, Italy, Spain and United Kingdom. In the case of road transport this share amounts to 84%.
- In only a very limited number of Member States inland waterways are of any importance: Belgium, France, Germany and the Netherlands cover more than 95% of total freight transport of this transport mode.

The growth of road transport given in figure 2-1 has not been uniform in the Member States. In some countries the transport volume more than doubled (e.g. D, B) in the last two decades and in Italy and Spain it even trebled, whereas in the United Kingdom it "only" increased by about 50% and in Portugal it even declined.
Figure 2-2 gives some first hints that there are considerable differences in the shares of the different transport modes between the Member States. In figure 2-3 the modal split in freight transport is shown for the 15 EU countries.

Figure 2-3: Share of transport modes on total freight transport (in tkm), 1991 (EUR 15)[5]



Comments:

- The differences between the EU countries in the infrastructure of the different transport modes are enormous. In the countries of Southern Europe, for example, freight transport by other transport modes than lorries is almost negligible. In these countries the potential of a modal shift away from trucks towards other modes is strongly limited in the short term.

5 Sources: see footnote 4.

- On the other hand, figure 2-3 shows that first of all rail can be a valuable alternative if the necessary infrastructure is provided.

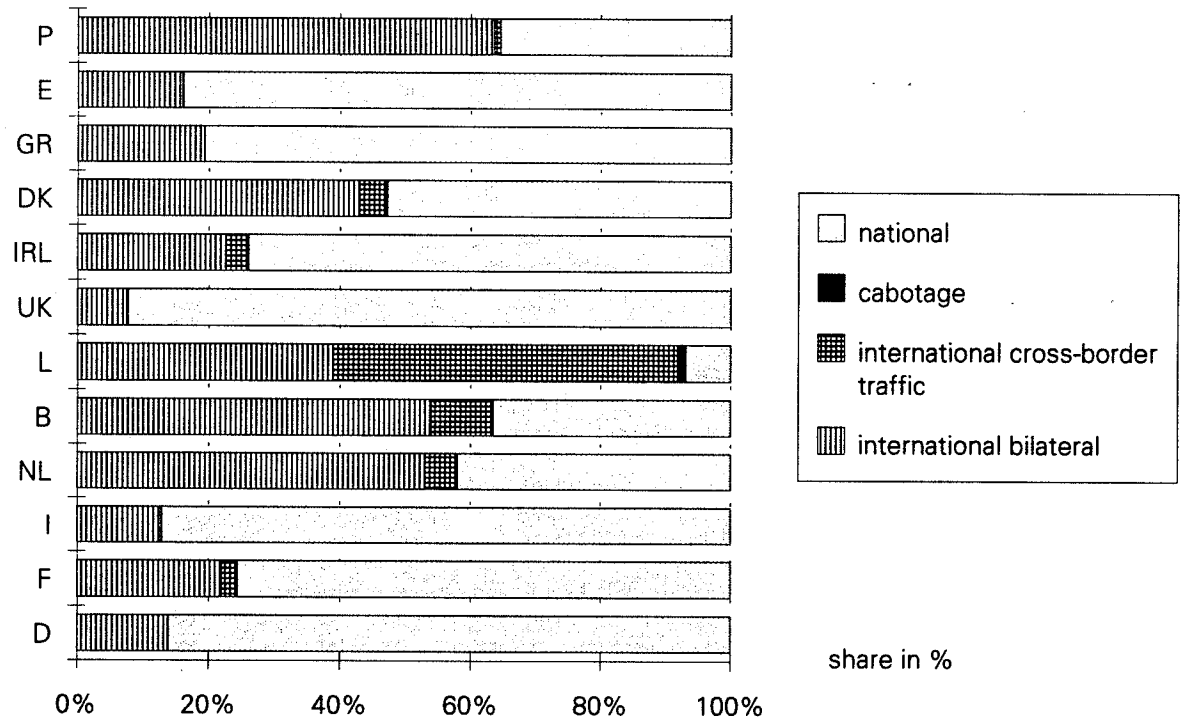
After this more general data on freight transport and in view of the impact assessment of a mileage tax, some characteristics of the road freight transport sector shall briefly be discussed in the following section.

2.3 Some characteristics of road freight transport in Europe[6]

a) Importance of international and national transport

In the last years, international intra-Union road freight transport has grown at a faster rate than national transport. Between 1986 and 1991, international transport grew by almost 50% whereas national transport "only" increased by about 22%. National transport is responsible for 97% of the total transported volume (in tonnes). In national transport the dominance of road freight transport is particularly marked: The market share is over 80%. In international transport, the share is about 60% but is rapidly growing.

Figure 2-4: Share of national and international transport by nationality of haulier, 1991 (EUR 12)

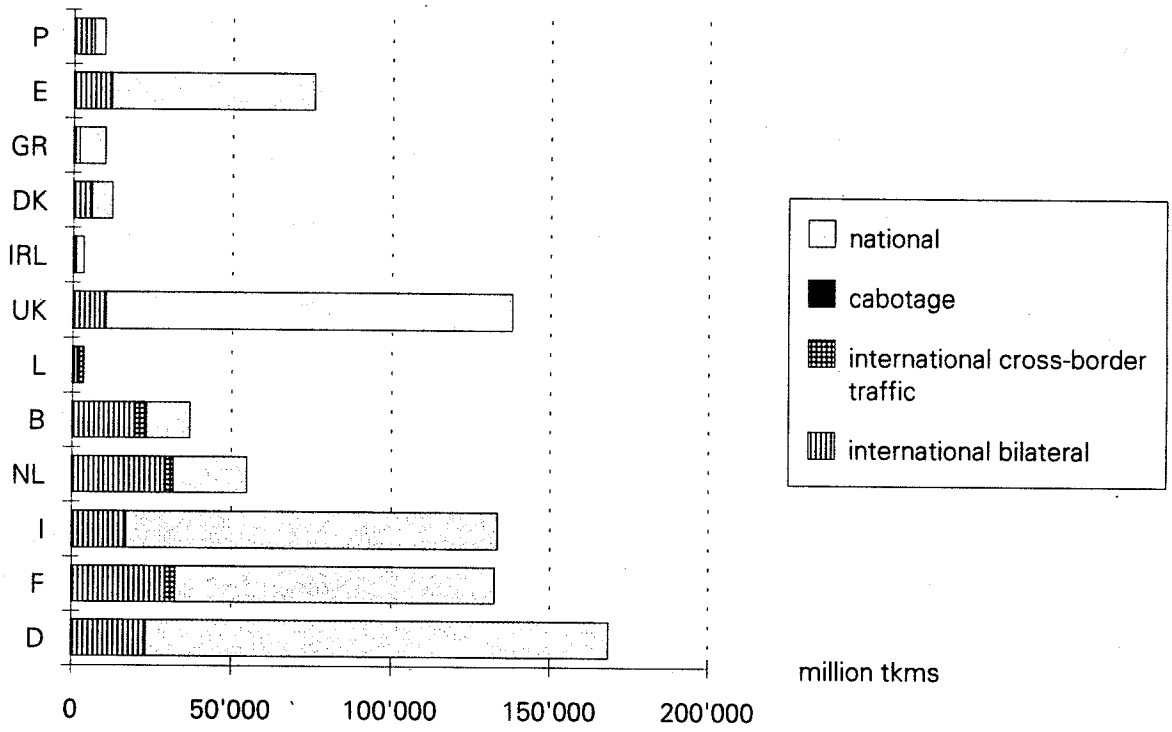


6 Sources of this section: Committee of Enquiry (1994), Road Freight Transport in the Single European Market, Commission of the European Community (1993), The Future Development of the Common Transport Policy and Eurostat (1994), Carriage of Goods 1991, Road.

The importance of international transport isn't the same for the different national freight transport sectors. Belgian, Dutch and Luxembourgian hauliers carry out more international intra-Union transports than national ones. The opposite is true for the hauliers of the other Member States (see figure 2-4).
The share of international intra-Union traffic held by hauliers in the state where the transport originates and ends also varies considerably. German hauliers, for example, are only responsible for about one-third of the international traffic loaded or off loaded in Germany. In the case of the Dutch hauliers this share is more than 60%.

Of course, there are not only differences in the relative shares of the different types of transport, but also in the absolute transport volumes (see figure 2-5). Again, the very large amount of international transports of the Dutch and to a minor extent of the Belgian hauliers is noticeable. Only French lorries have carried out more international transports than Dutch lorries.

Figure 2-5: Intra-Union road freight transport by nationality of haulier, 1991 (EUR 12)



b) Structure of the national road transport sector

The large differences between the road transport sector in the Member States also refers to the internal structure of this sector. In most countries small firms predominate. In Spain, for example, more than 90% of the hauliers have 5 vehicles or fewer. On the other hand, in the two countries with very high share in international freight transport, Belgium and the Netherlands, more than one-fifth have at least 11 vehicles (see table 2-6).

Table 2-6: Size of road haulage firms[7]

country	Number and Size of hauliers							
			of which					
	Total	Total	1 - 5 vehicles in %		6 - 10 vehicles in %		11 vehicl. and more	
	1985	1990	1985	1990	1985	1990	1985	1990
AU	6'970	...	67.6	60.1	23.3	25.8	9.1	14.1
B	7'812	8'72	73.5	68.3	10.9	11.6	15.4	20.1
DK	6'875	7'045	(a) 89.4	83.7	(a+b) 6.1	(b) 9.3	(a+c) 4.5	(c) 5.3
SF	(d) 13'639	14'339	(d) 94.7	95.8	(d) 2.4	2.1	(d) 0.9	1.1
F	28'895	37'037	(e) 80.0	(e) 81.6	(e) 7.5	(e) 5.6	(e) 12.5	(e) 12.8
D	(a) 44'572	(f) 41'325	(g) 88.7	(g) 83.1	(h) 7.7	(h) 9.7	3.6	7.2
I	204'119	...	95.0	...	3.1	...	1.8	...
L	260	(d) 289	...	...	...	...	...	...
NL	7'390	7'173	64.5	56.8	19.8	20.9	15.6	21.7
E	164'976	...	98.4	...	(i) 1.4	...	(k) 0.2	...
S	17'767	19'371	92.7	91.0	4.3	6.0	3.0	3.0
UK	96'000	86'300	87.0	83.0	7.0	8.0	6.0	9.0

(a) = 1984 figure
(b) = 6 - 9 vehicles
(c) = 10 vehicles and over
(d) = 1987 figure
(e) = estimate
(f) = 1988 figure
(g) = 1 - 6 vehicles
(h) = 7 - 10 vehicles
(i) = 6 - 20 vehicles
(k) = 21 vehicles and over

Between 1985 and 1990, the share of the small haulage companies (1 - 5 vehicles) has decreased in most of countries given in table 2-6. These small companies predominate on the local markets, whereas international transport is dominated by larger firms. The share of the local markets is considerably large if we look at the distances in freight transport (see next sub section). In most countries the number of comparatively large haulage companies has increased whereas the number of rather small hauliers has decreased. The consequence of this change in the structure of the road transport sector is a considerable increase in transport capacity resulting in a substantial over capacity in road transport .

c) Freight transport distances

In the EU, the vast majority of all goods is transported of relatively short distances. Table 2-7 shows that only in some 15% the transport distance is longer than 150 kms.

Table 2-7: Freight transport distances in the EU

Distance	Goods transported (%)
0 - 50 kms	64.2
50 - 150 kms	20.7
150 - 500 kms	11.9
500 - 1'000 kms	2.4
> 1'000 kms	0.9

7 Source: IRU based on different statistics, see Committee of Enquiry (1994), Road Freight Transport in the Single European Market, p. 44.

d) Main trends in European logistics[8]

- **Outsourcing**: Logistics have become one of the activities that are often outsourced to specialised companies because of the increasing complexity of logistic services and the growing need of specific knowledge. First of all large firms are capable to meet the demanding requirements.
- **Shift towards centralised European distribution centres**: The need to be present in many European countries has decreased with the liberalisation of the European transport sector. Many firms intend to switch to centralised European distribution and therefore demand a wide range of activities from logistic companies (so-called value added activities like packing, sorting, labelling, assembling and checking). Again, small firms will have difficulties to compete with large hauliers.

e) Traffic with Eastern Europe countries

Traffic with the former east bloc countries has rapidly increased since the end of the eighties but its share on total freight transport is still very low. The largest part of this traffic (i.e. approx. 80%) is either with Germany or passes through Germany. Especially on this transport axis there is a comparatively high potential of inland waterways to handle current and future traffic.

Operating costs of Eastern European hauliers are significantly lower than of Western European haulage companies. They are able to charge freight rates to customers that are 35-45% lower than the rates charged by their Western competitors and will therefore continue to push down rates of road freight transport. The relative differences in operating costs are given in the table below.

Table 2-8: Operating costs by nationality of haulier

Nationality	in % of average of 8 countries
Poland	77.5
Hungary	82.5
Spain	99.1
France	105.7
Belgium	106.6
The Netherlands	107.4
Germany	109.5
Italy	111.7

source: NEA

f) Combined transport

In the second half of the eighties, container and piggy-pack transport has expanded by about 50%. However, the share of these two forms of combined transport is still modest compared to total road freight transport in the Union alone: The 25 member countries of Intercontainer work some 11 billion tkms, and the 17 member countries of the Union Internationale des Sociétés de Transport Combiné Rail/Route work some 20 million tkms. It is assessed that about 3-4% of total European freight is carried by combined transport. Also in the case of inland waterways container traffic has rapidly grown in the last few years.

8 See Zonneveld G.J. and Halstead J.C. (1994), European Road Transport, p. 23 ff.

3 Main features of a mileage tax

3.1 Introduction

Objective of chapter 3 is to describe and discuss the most important features of a mileage tax for road freight transport at a European level. Before giving an overview of the structure of chapter 3 we start with a short description of the main characteristics of the mileage tax for road freight transport that will be discussed in the following sections:

The mileage tax for heavy goods vehicles is a **variable** tax. The parameters of variability chosen are distance, weight, emissions, space and time:

- **distance dependence** is the main variability that has to be achieved as external costs are closely connected with the distance driven; that's why the name "mileage tax" is used.
- the tax should be variable in the sense that it depends on the **weight** of the heavy goods vehicle as emissions (air pollutants, noise) are also a function of weight (we will show that we consider the permissible total weight the best parameter)
- because there are different technologies the tax should be differentiated according to the **emission factors** of the heavy goods vehicles.
- some of the external costs vary in **space** and **time**. Air pollution and noise (as well as congestion which is not treated here) often concentrate in urban areas and at particular times. Correspondingly, a mileage tax trying to internalise the external costs of heavy goods vehicles should vary between areas with different loads of pollutants and should be higher during rush hours.

Starting point of chapter 3 is the question on how to determine the general tax level of the mileage tax (**section 3.2**). Afterwards possible forms of differentiation of the mileage tax are discussed, namely a differentiation according to the emissions (**section 3.3**) and to space and time (**section 3.4**). This discussion will lead to a specific proposition on the level of the mileage tax.

In **section 3.5,** advantages and disadvantages of different possible metering systems to implement the mileage tax are treated. Thereby results of current research work about such systems are used. Stress does not lie on technical questions of different metering systems but on the practicability and interoperability of different systems.

In **section 3.6,** possible ways to implement the mileage tax are discussed to arrive finally at a proposal how to introduce the mileage tax.

Last but not least, **section 3.7** deals with the questions of revenue recycling. How should the revenues of the mileage tax be used? A discussion of advantages and disadvantages of different options will lead to a specific proposal on how to use the revenues.

3.2 Description and level of the mileage tax

To describe the mileage tax the following variables have to be defined:
- tax object
- tax base
- tax rate

3.2.1 Tax object

Object of the mileage tax are **HGV with a permissible total weight of more than 3.5 tons**. LGV (permissible total weight less than 3.5 tons) are excluded from the mileage tax. This makes sense for several reasons:

- For land transport, competition between modes exists especially between HGV and rail freight transport. Between rail and LGV there is almost no substitution potential within the freight sector, and correspondingly no competition.
- Compared to LGV, HGV cause higher external costs per vehicle-km but lower external costs per tkm.[1] On the other side, costs of the use of infrastructure are higher for HGV than for LGV.

3.2.2 Tax base

There are two basic questions to answer in the design process of a tax:
a) which **externalities** should be the base for the tax?
b) which **parameters** (kilometres, vehicle classes, weight etc.) are the appropriate tax bases?

a) Which external cost elements?

To determine which externalities should be integrated in the mileage tax the following differentiations and assumptions are made:[2]

- Topic A has shown that emissions of air pollutants are closely related to technological characteristics of the vehicle. Furthermore, there is also a rather close relationship be-

1 Infras / IWW (1994), External Effects of Transport, p. 187.

2 Of course, this choice depends first and foremost on other internalisation instruments that are or could possibly be used. Ideally, different options should be examined and ranked according to their overall cost-benefit-ratios (where costs include the administrative and implementation costs and the benefits include the environmental and economic gains from a tax structure that is more precisely polluter oriented). A full scale cost-benefit analysis of different internalisation instruments and tax options is far beyond the scope of this sub report. Therefore, we first describe a possible and useful version of a mileage tax basing on plausible assumptions. Cost-benefit aspects will be considered in the assessment of the tax, namely in section 4.4 (where the cost-benefit analysis is restricted to a comparison of different versions of the mileage and to a comparison between a mileage tax and a tax on diesel).

tween the kilometres driven and the exhausted air pollutants. Thus, a mileage tax seems a suitable instrument to internalise the external costs of **air pollution**.

- For this case study it is assumed that a dynamic **CO_2/energy** tax will be introduced at the European level (or even at the level of the OECD-countries). We assume that this CO_2/energy tax will include the expected costs of the emissions of CO_2, namely those of the greenhouse effect. The mileage tax will therefore exclude these costs.
- For **noise**, the reasoning can be based on the topic A of the project. One result was that noise reducing measures related to the vehicles are among the cost-efficient ones. Furthermore, an internalisation of noise will be much more cost-effective if a tax can be related to time and place of the damage. It is therefore reasonable to analyse a tax which is able to differentiate between different vehicle classes and account for local differences.
- The external costs of **accidents** could be, at least to a high degree, internalised by changes in the legal liability rules (higher reimbursements by the liability insurances) and (consequently) more risk specific insurance premiums. However, these changes are out of sight today. Therefore we assume that the external cost of the accidents are to be integrated in a tax.
- Furthermore, the **infrastructure costs** and the **congestion costs** are assumed to be considered within national tax and/or road pricing systems.
  However, it is possible that the technology to levy a mileage tax can, at low additional implementation cost, be used for a well differentiated infrastructure and congestion tax. In this case, it would be useful to integrate uncovered infrastructure costs in the mileage tax. Even if there is no deficit in the national road accounts, it would make sense to integrate infrastructure costs in the mileage tax in order to comply better with the user-pays-principle. As a consequence, the resulting surplus in national road accounts should be taken into account by lowering existing national taxes that do not meet the user-pays-principle.

Conclusions: We assume that the mileage tax **should include the external costs of air pollution, noise and accidents and exclude the CO_2 effects**. An integration of the congestion and infrastructure costs will only be mentioned in passing. Methodically, these assumptions should be seen as a **pragmatic and plausible choice**.

b) What parameters to base on?

To chose the most cost-effective tax base, it must be analysed what parameters influence the level of external costs. In an ideal world, an optimisation would be needed to chose the most effective option, taking into account the trade-off between implementation cost and additional precision in the incentive structure.[3]

3 To give an example: The best way to internalise the external costs of air pollution would be to base the tax on the amount of air pollutants actually emitted. On the other side, it would be very expensive to fit out all the trucks with the corresponding measuring instrument.

As in the last section, we will proceed in a rather pragmatic way and define one plausible design of the tax base. Again, cost-benefit aspects will be discussed in section 4.4 when the version of the mileage tax proposed in this chapter is assessed.

The most important parameters in the external cost function of the cost elements defined in sub section a) above are:

- the kilometres driven
- the weight of the vehicle
- the (emission abatement) technology of the vehicle (air pollutants, noise)
- the deterioration of the emission factors due to age and lack of inspection and maintenance
- the way of driving (e.g. the way of speeding up a vehicle)
- the place where and the time when the kilometres are driven.

For the **basic version** of the tax we propose the following tax base:

- Because we are discussing a mileage tax the "key parameter" is obviously the number of **kilometres driven**.
- Furthermore, the tax base should take into account the weight of the vehicles. We propose to use **permissible total weight.** This pragmatic choice can be justified by the following reasons:
  - The weight of the vehicle is - among others - an important factor influencing the emissions of air pollutants and noise.
  - The permissible total weight is given in the vehicle documents. Therefore, it can be expected that the assignment of the HGV to the different weight categories will cause rather low implementation costs.[4]
    Theoretically, the actual tonnage of the HGV would be the better tax base. But for implementation reasons it is impossible to use the actual tonnage as a tax base because a real time control mechanism for the actual tonnage would be very expensive.
  - Apart from the correlation between the weight of the HGV and its emissions, there is also a practical and political argument in favour of this tax base: The realisation of the "user-pays-principle" is one of the main objectives of the Common Transport Policy (see section 3.6.1). Thus, a mileage tax will most probably and first of all be introduced to charge road freight transport for its infrastructure costs. These costs depend strongly on the weight (or axle weight) of the vehicles. It can therefore be assumed that a mileage tax at the European level would anyway be differentiated according to the weight - as is, for example, the Swiss proposal for a mileage tax for HGV. In other words: the "environmental component" of the mileage tax could use this improved tax base without causing large additional implementation costs.

4 An alternative tax base could be the payload, but this would not cause considerable differences to the incentive effects of the permissible total weight. The only difference is that with permissible total weight there is an incentive to use HGV with a low net weight. Normally, the vehicle documents include both, payload and permissible total weight. Therefore, from an implementation point of view, there is no difference between these two bases.

To summarise, in our proposal the tax base for the **basic version** of the mileage tax is the **kilometres driven multiplied by the permissible total weight** of the HGV.

There are further parameters which will be treated under the title "differentiation of the mileage tax":

- A first step towards a more sophisticated tax must reflect the differences in **emission factors** and should therefore differentiate between vehicle classes. The tax has a good chance to prove cost-effective if it offers an economic incentive to promote the better vehicle technologies which are available at relatively low costs (see topic A of this research project). Such a tax, which we will call the **"extended version"**, will be examined and calculated in detail in section 3.3.
- As a further option, it should also be possible to distinguish between **different areas** and perhaps the **time of the day**. These options should be included in a more **"sophisticated version"** of the tax which will be discussed in section 3.4.

The two other parameters mentioned, the **deterioration of the emission abatement technology and the way of driving**, are beyond the scope of a mileage tax. Such a differentiation would require additional information and therefore probably increase implementation costs considerably. It is assumed that these parameters are better reflected by the CO_2/energy tax (way of driving) and regulatory measures (inspection and maintenance programmes, durability requirements).

Again these choices must be seen as preliminary. It is the aim to analyse the three versions of the tax which all have good chances to be cost-effective. As mentioned before, a more complete assessment would include a cost-benefit analysis of further options. Such an analysis would by far break the frame of this sub report.[5]

3.2.3 Tax rate

There are two approaches to assess the tax level, namely the internalisation approach and the standard-price-approach. In chapter 2 ("Theory of Internalisation") of the synthesis report of topic B of this research project both approaches were presented extensively. The main findings of chapter 2 will be applied to define the rate of the mileage tax.

a) Internalisation approach

According to the internalisation approach, uncovered infrastructure costs and external costs of road freight transport determine the level of the additional tax. There are different estimates of the external costs of road freight transport, depending - among other things - on the method used to calculate the external costs.

5 A large scale cost-effectiveness analysis of different policy measures is carried out within the Auto/Oil-Programme of the European Commission.

A number of methodological problems and the use of different valuation approaches (damage costs, avoidance costs) have been discussed in topic A of the study. In chapter 1 of topic A, an overview of existing studies on external costs was given. Some of these studies include estimates especially for road freight transport. Table 3-1 summarises the most valuable existing estimates (in our view) of the external costs of heavy goods vehicles:[6]

Table 3-1: Estimates of external costs of road freight transport (HGV), in ECU per 1'000 tkms

	reference year	Accidents	Air pollution	Noise	CO_2 /others	Total
Infras/IWW[7]	1991	22.2	13.0	12.7	10.6	58.5
Dienst GVF[8]	1993	7.1	20.3	17.0		44.4
Planco [9]	1991	8.7	11.6	1.6	2.3	24.2

As discussed in section 3.2.2, CO_2 emission costs will not be included in the tax rate.

Furthermore it must be discussed if the tax level should already account for future reductions in external costs due to other instruments: Because our version of the mileage tax cannot take into account in a cost-efficient way all parameters that determine the amount of external costs actually caused (see section 3.2.1 above), other transport policy instruments like e.g. speed limits, controls and technological measures remain important instruments to influence road freight transport. They could all lead to a reduction of external costs. Therefore, we assume that the external costs shown in table 3-1 are a useful pragmatic indicator for the external costs as long as no dramatic technological[10] or other changes take place. The possibility of such changes is a strong argument for a periodical revision of the mileage tax (see also section 3.6).

The authors of the estimates in table 3-1 emphasise that their results are on the "save" side because of lack of data for other fields of external costs and the specific methods used to calculate the external costs. Therefore, we propose to define a lower and an upper bound estimation of external costs that have to be internalised with the mileage tax

6 As expressed in the subreports of topic A, a direct use of the technical avoidance cost estimates for internalisation purposes is problematic and we therefore rely on the data base given here.

7 Infras / IWW (1994), External Effects of Transport, p. 188; the estimates correspond to the average of 17 European countries. The range is from 29.3 ECU per 1000 tkm (Finland) to 101.7 ECU per 1000 tkm (France).

8 Dienst GVF (1993), Grundlagen zur Kostenwahrheit im Verkehr. Updated with data of GVF for 1993 published in GVF-News (1995).
For air pollution only damages to buildings were considered. The estimates for accidents are based on the view of the transport user (contrary to the view of the transport mode) and can be found in ECOPLAN (1991), Soziale Kosten von Verkehrsunfällen in der Schweiz, p. 209.
To convert Swiss francs into ECU a exchange rate of 1.53 (1 ECU = 1.53 CHF) was used.

9 PLANCO - Consulting GmbH (1991), Externe Kosten des Verkehrs: Schiene, Strasse, Binnenschiffahrt; estimates for Germany. The original estimates are for 1985; they have been corrected for inflation up to the year 1991 by ECOPLAN.

10 The introduction of new technologies will be reflected by a tax differentiation discussed below.

according to the results for the external cost elements air pollution, noise and accidents as follows:

external costs to be considered in mileage tax, conservative estimates:
upper bound: 40 ECU per 1000 tkm
lower bound : 20 ECU per 1000 tkm

These values are average costs rather than marginal costs. As a damage cost function is missing, it is not possible to calculate *marginal* external costs.[11]

To define the tax rate per km, the values per tkm have to be converted. Therefore, an estimate of the average load of a HGV is needed. We have not been successful in finding official statistics about the average load of HGV in Europe. Several country studies indicate that this figure must be between 5 and 8 tonnes.[12] As an average 6.5 tonnes seem reasonable to us.
Of course, the average load depends on the permissible total weight of a HGV. Therefore, a differentiation according to categories of HGV has to be done. Table 3-2 contains the results of the estimates per vehicle category.[13]

Table 3-2: Payload and average load per vehicle category [14]

HGV - category (total weight)	payload (average) in t	load on average in % of payload	load on average in t	share on kilometres totally driven
3.5 - 12t	4t	40%	1.6t	10%
13 - 18t	7.5t	50%	3.8t	45%
19 - 28t	12t	55%	6.6t	25%
29 - 40t	21t	65%	13.7t	20%

Using the estimates in table 3-2, the tax rate (per tonne permissible total weight and per kilometre driven) can now be calculated. The results per vehicle category are shown in table 3-3.

11 There is evidence that marginal external costs would be at least as high as average external cost in the fields of external costs of air pollution and - to a less degree - of accidents. On the other side it is possible that marginal external costs of noise are lower than the average values.

12 For Germany average loadings are estimated around 7.5 tonnes, see DIW et. al (1994), Verminderung der Luft- und Lärmbelastungen im Güterfernverkehr 2010, p. 283.

For the Alpine corridors of Austria loadings in transit transport are between 8.6 and 15 tonnes on average, see Steierwald G. and Fusseis W. (1995), Alpenquerender Strassengüterverkehr 1994.

On average of 17 European countries Infras/IWW estimate an average loading of 6.4. tonnes for HGV. See Infras / IWW (1994), External Effects of Transport, p. 85.

13 The assumption of an average loading of 6.5t over all HGV is consistent with the data in table 3-2.

14 Estimates based on ECOPLAN - studies for the Swiss government. It should be noted that there may be large differences between the Member States, especially with regard to the figures in the last column.

Table 3-3: Tax rate per vehicle category ECU/t_{tw}km (per tonne of permissible total weight and kilometre driven)

HGV - category (total weight)	average weight per category	**upper bound** (in ECU)	**lower bound** (in ECU)
3.5 - 12t	9t	0.0071	0.0036
13 - 18t	15t	0.0100	0.0050
19 - 28t	24t	0.0110	0.0055
29 - 40t	36t	0.0152	0.0076

Obviously, the tax rate differs according to the vehicle category. This is the consequence of the assumption that the external costs per tkm are the same for every category (upper bound 40 ECU per 1000 tkm, lower bound 20 ECU per 1000 tkm). This assumption is implicitly used by existing studies on external costs of transport as these studies report average numbers of external costs per tkm. In reality, with rising permissible total weight external costs per tkm will rather be decreasing. For instance, neither the emissions of air pollutants nor those of noise of a HGV with permissible weight of 40 tons are 3 to 4 times higher than those of a HGV with permissible total weight of 12 tonnes.[15]
Therefore, we propose to use the same average tax rate for every vehicle category. This average tax rate corresponds to the sum of the individual tax rates per category weighted with their share of total tonne kilometres.[16] The result is as follows:

Tax rate per tonne of permissible total weight and kilometre:
- **Upper bound: 0.012 ECU/t_{tw}km**
- **Lower bound: 0.006 ECU/t_{tw}km**

b) Standard-price-approach

With the standard-price-approach the tax rate is defined according to what is necessary to reach an environmental standard that has to be met. Correspondingly, the (marginal) external costs are not required to determine the tax rate. As mentioned in the chapter "Theory of Internalisation" (see section 2.2.4 of the synthesis report on topic B) the tax rate is determined with a **step by step** rise of the tax or directly by using **avoidance cost estimates** representing shadow prices to reach an environmental standard.

Avoidance costs have been estimated in topic A of this project and - rarely - in the frame of other projects. Nevertheless, we propose not to use these assessments to determine the rate of the mileage tax because of the following reasons:

- At the moment we do not provide of **clearly defined reduction targets for totally allowed emissions at the European level** (as for example the reduction of tonnes of

15 See e.g. Infras (1991), Umwelt und Verkehr, spezifische Umweltkennziffern im Verkehr, Dienst GVF.

16 The effect is that the tax rate for rather heavy trucks is lowered, the one for rather light truck is increased. Thus, the distortion between these two categories is partly corrected.

NO_x emissions by 30% until the year 2005). Without such targets it is obviously impossible to determine the rate of a standard-price-tax at the European level.

- Even if overall emission reduction targets were available one had to define the **contribution of the different polluting sectors** (industry, households, transport) to the overall emission reduction. To do so, avoidance cost curves for a broad range of policy measures for the different sectors are indispensable but not available.[17]
- In topic A of this project the assessment of avoidance costs had to be restricted to **technical measures**. Possibly cheaper avoidance measures - as for example changes in the way of driving - could not have been taken into account. In the chapter on the theory of internalisation (see chapter 2 of the synthesis report of topic B) we have shown that under these conditions the rate of the standard-price-tax is probably too high.[18]

Parts of the information mentioned above will probably be provided within the frame of the EU-Auto/Oil-Programme. At this moment, no official results of this programme are available.

Therefore, we conclude that the rare estimates of the avoidance costs of road freight transport which do exist (including those developed within this project) cannot be used directly to define an adequate, socially efficient tax level. Nevertheless, in the following section 3.3 assumptions of the additional costs of environmental friendlier technologies for HGV will be used to propose a **differentiation** of the tax rate according to emission standards of HGV.

c) Conclusion: proposed tax level

Because of the lack of information in the field of the avoidance cost method, the proposed tax rate is based on existing estimates of the external costs (using the damage cost approach) of road freight transport.

The values per tonne of permissible total weight and kilometre driven are:

Upper bound: 0.012 ECU/t_{tw}km
Lower bound: 0.006 ECU/t_{tw}km

17 In the case of noise, for example, the avoidance cost curves constructed in topic A "only" refer to the costs of building insulation. It has not been possible to make a general ranking of avoidance measures with respect to their cost-effectiveness.

18 Regarding the very low and even negative avoidance costs of air pollution and climate assessed in topic A the possibility of a too high tax rate is rather limited in the cases of air pollution and climate change.

3.3 Differentiation according to emissions

Topic A of this research project has shown that the emissions of air pollutants and noise of HGV depend particularly on the technology used. Therefore, it is justified to differentiate the tax level according to the emissions of a HGV. The aim is of course to promote in an efficient way the use and the development of HGV with better emission abatement technologies. As mentioned above, this version of the tax will be called "**extended version**".

To introduce such a differentiation different problems have to be solved.

- It must be technically feasible to implement the differentiation under real world conditions. The differentiation of the mileage will probably make high demands on the metering system. This aspect of the differentiation will be discussed in section 3.5.
- The leverage point(s) for the differentiation have to be determined (air pollutants like NO_x, VOC, noise emissions).
- To differentiate the tax level, we propose to use (possible) future emission standards for HGV as a criterion. The monetary level of differentiation can be defined according to the additional costs to meet these standards or according to the reduction in external costs connected with the standards.

a) Leverage point(s) and emission standards

In a first step, we **restrict the differentiation to air pollutants** that are considered in specific emission standards of the EU for HGV. For HGV a tightening of the pollutant limits is decided respectively planned. The directive of the EU (91/542/EEC) prescribes a step by step reduction of the pollutant limits according to the 13 mode test cycle. Table 3-4 summarises the pollutant limits for HGV of the EU.

Table 3-4: Emission limits of the EU for diesel driven HGV (> 3.5t) in g/kWh[19]

	effective from a)	NOx	HC	CO	PM b)
Step 1 (EURO I)	1.7.92 / 1.10.93	8.0	1.1	4.5	0.36
Step 2 (EURO II)	1.10.95 / 1.10.96	7.0	1.1	4.0	0.15
Step 3 (EURO III) c)	after 1.10.99	5.0	0.6	2.0	0.10

remarks to table 3-4:

a) Pollutant limits valid in the EU: first date refers to new models, second date refers to all new registered HGV.

b) Particle limits for all HGV with more than 85 kW.

c) For step 3, only first proposals exist (German Government, Euro-Parliament) but until now no directive has passed. It can be expected that after 1999 the limits will be tightened. The limits used for step 3 are only of indicative character.

19 Values according to DIW et. al (1994), Verminderung der Luft- und Lärmbelastungen im Güterfernverkehr 2010, p. 340.

Table 3-5 shows the reduction of emissions aimed at with EURO II and EURO III limits in percent of today's EURO I limits.

Table 3-5: Reduction of emissions with EURO II and III compared to EURO I (in %)

	NOx	HC	CO	PM
EURO II	-13%	0%	-11%	-58%
EURO III	-38%	-45%	-56%	-72%

Conclusion: Following the EU-limits for air pollutants three classes of HGV should be defined to differentiate the mileage tax:

Class 1: HGV meeting the pollutant limits as they are indicated for EURO III
Class 2: HGV meeting the pollutant limits of EURO II
Class 3: HGV remaining above limits of EURO II

In a second step, a further **differentiation** could be made according to **noise emissions** of the vehicle. Four main reasons support this kind of differentiation:

- Topic A of this project has shown that HGV only account for 4% of the total mileage of road vehicles (in vkm) but a reduction of noise emissions of these vehicles would have almost the same effect as reducing the noise emissions from passenger cars that account for 80% of total mileage. Obviously, if a reduction of noise emissions from HGV can be achieved, a large impact on overall noise level can be expected.
- Accordingly, the assessment of the avoidance costs of noise in topic A resulted in the conclusion that it seems to be most cost-efficient to reduce noise from the heavy vehicles.
- Another result of the discussion in topic A was that vehicle related measures can lead to a noise reduction of about 5 dB(A) and that this kind of reduction is of a rather high quality because it reduces noise annoyance independent of location.
- Furthermore, the analysis in topic A has shown that in the case of noise most of the avoidance measures must be taken at the local level. Only for measures that are related to the noise emissions of the vehicle itself the international, i.e. the EU level seems to be the appropriate level for intervention.

Therefore, we conclude that an appropriate differentiation of the mileage tax would contribute in an efficient way to reduce the negative impacts of noise because a useful design of the tax will set incentives to use and to develop less noisy HGV.

Nevertheless, due to the limited data and the lack of official specific noise emission limits for HGV, the analysis in the section below considers first of all **air pollution** as a driver for the differentiation.

b) Differentiated tax level

To create an **incentive to switch** to HGV meeting the EURO II or even the EURO III norm the mileage tax should be differentiated according to these emission classes.
What should the level of differentiation be?

- In order to create an incentive to chose a better class HGV, the differentiation should make up for at least the cost difference (avoidance cost)
- In order to reflect the different environmental impact, the differentiation should correspond to the difference in external costs (damage cost)

Only with a differentiation according to the avoidance cost it can be ensured that the differentiation would set an incentive to switch to the better technology. However, without an environmental target it is very difficult to define a useful tax differentiation.[20]

On the other hand, a correct reflection of the emission reduction (and therefore the reduction in external costs) would require the damage (external) cost approach, otherwise the cleaner HGV classes are not rewarded adequately according to the polluter pays principle. From a theoretical point of view, this second approach is preferable.

In our opinion, both approaches can be considered. We will first present some evidence on the **avoidance costs**:

- HGVs not meeting the limits of EURO II pay the highest mileage tax. The difference to HGVs meeting EURO II corresponds to at least the additional costs of the cleaner technology of EURO II type HGVs. This additional costs have to be paid during the remaining average lifetime of the existing HGV-fleet. A first "guestimate" of this average lifetime would be around 5 years.
- The same principle has to be used for HGVs meeting EURO II but remaining above EURO III limits. During their remaining average lifetime (which we would estimate to around 10 years) the mileage tax should include at least the additional costs of EURO III limits.

Today, the limits of EURO II can be met technically. Already some motors of the model year 1992 remain under these limits.[21] We conclude that the EURO II norm will not cause substantial additional costs (guestimate: not more than 2'000 ECU).
But to meet the future EURO III norms several measures must be taken, where the additional costs are not known exactly. Several of the following measures seem to be necessary to reach EURO III norms:[22]

20 The differentiation of the mileage tax for road freight transport could for example be defined in a way that it pays to switch to the cleaner technology as soon as the yearly mileage of a vehicle is above 40'000 km a year. But it would also be possible to design the mileage tax in a way that this point is reached already at 30'000 km. So, an environmental target for road freight transport (e.g. reduction of NOx-emissions of 30%) is needed to determine at what yearly mileage the switch to better technologies should occur.

21 DIW et. al (1994), Verminderung der Luft- und Lärmbelastungen im Güterfernverkehr 2010, p. 341.

22 DIW et. al (1994), Verminderung der Luft- und Lärmbelastungen im Güterfernverkehr 2010, p. 333 ff.

- Very high pressure fuel injection
- Electronic engine control
- Optimised engine clearance volumes
- Controlled intercooling
- Turbocharging
- Multi-valve engine

Further possible measures would be the introduction of De-NO_x catalysts, oxidation catalysts and exhaust gas recirculation.

At the moment, only very speculative assumptions about these additional costs are possible. It can be expected that the Auto/Oil-Programme of the European Commission will provide valuable estimates of these additional costs. In this study, we assume additional costs to meet EURO III limits (as they were defined in table 3-4) of around 6'000 ECU per vehicle. This is a highly preliminary value that has to be corrected as soon as the Auto-/Oil estimates are available.

Before presenting the results of the calculations for a differentiated mileage tax we **summarise the assumptions used**:

Average remaining lifetime of the existing HGV-fleet remaining above EURO II limits:	4 years
Average lifetime of the (future) HGV-fleet meeting EURO II -but remaining above EURO III limits:	8 years
Average vehicle kilometres per year:	70'000 km[23]
Additional costs to meet EURO II limits:	2'000 ECU
Additional costs to meet EURO III limits (compared to EURO II)	6'000 ECU[24]
Interest rate i	5%

The differentiated mileage tax for HGV was calculated under above assumptions. The results are presented in table 3-6. For Class 3 HGVs the tax rates correspond to the estimated external costs in section 3.2.

23 As there is no environmental target available the differentiation of the mileage tax is designed in such a way that all HGV with a yearly mileage over the average of 70'000 km would have an incentive to switch to the environmentally better technology. For the average yearly mileage see DIW et. al (1994), Verminderung der Luft- und Lärmbelastungen im Güterfernverkehr 2010, p. 282.

24 It must be emphasized again that both values are very speculative and have to be corrected as soon as better data are available.

Table 3-6: Differentiated tax rate in ECU/t_{tw}km (per tonne of permissible total weight and kilometre driven) with avoidance cost approach

Type of HGV	Upper bound in ECU	in %	Lower bound in ECU	in %
Class 1	0.0109	91%	0.0049	83%
Class 2	0.0116	97%	0.0056	94%
Class 3	0.012	100%	0.006	100%

Class 1: HGV meeting the emission limits as they are indicated for EURO III
Class 2: HGV meeting the emission limits of EURO II
Class 3: HGV remaining above limits of EURO II

The "incentive structure" of this kind of differentiation is as follows: A switch to the cleaner technologies pays if the product of mileage and higher tax rate is bigger than the product of mileage and lower tax rate. As mentioned, under our assumption this point is reached if the yearly mileage of a vehicle is higher than the average road performance of 70'000 km. At first sight the incentive structure seems useful. However, without information about an environmental target or about the external (damage) costs it is not possible to judge whether this incentive is too strong or too weak.

For the "**damage cost approach**", we will present an **illustrative** calculation: According to table 3-1, about 50% of the external costs treated here are from air pollution. Based on table 3-5, the stricter standards represent on average a reduction of 20% (EURO II) and 53% (EURO III) compared to EURO I. The tax discounts would therefore be approximately 10% and 26% respectively.

Table 3-7: Differentiated tax rate in ECU/t_{tw}km (per tonne of permissible total weight and kilometre driven) with damage cost approach

Type of HGV	Upper bound in ECU	in %	Lower bound in ECU	in %
Class 1	0.0088	74%	0.0044	74%
Class 2	0.0108	90%	0.0054	90%
Class 3	0.012	100%	0.006	100%

Class 1: HGV meeting the emission limits as they are indicated for EURO III
Class 2: HGV meeting the emission limits of EURO II
Class 3: HGV remaining above limits of EURO II

This illustrative calculations shows that especially for class 1, the "tax discount" could be considerably higher with the damage cost approach. In general, the results indicate that the standards are socially efficient because the reduction in damage cost is higher than the avoidance cost required to meet the standards. However, as both calculations include a number of tentative assumptions, this conclusion should be treated with care.

If this differentiation is applied the incentive structure is as follows: If the product of yearly mileage and higher tax rate is higher than the product of yearly mileage and avoidance costs per vehicle kilometre of the cleaner technologies a switch to these technologies would pay. As mentioned above this kind of differentiation is preferable from a theoretical point of view.

In the case of **noise** a similar calculation can be carried out with the **avoidance cost** assessment of topic A. As mentioned before, the problem is that we do not provide of "official" emission limits like EURO I and II in the case of air pollution. Therefore, three classes are formed according to the figures stated in topic A:[25]

Class 3: HGV meeting the current EU emission limit of 84 dB(A)

Class 2: HGV meeting the emission limit of 80 dB(A)

Class 1: HGV meeting the emission limit of 78 dB(A)

The additional costs to meet the standards are:

- additional costs to meet the limit of 80 dB(A): 4% of vehicle production costs
- additional costs to meet the limit of 78 dB(A): 7% of vehicle production costs

With regard to the average lifetime of the future HGV fleet meeting the emission limits of class 1 and 2 and the average vkm per year we use the same assumptions as in the case of air pollution. The result of the calculation based on the assumptions made are given in table 3-8.

Table 3-8: Differentiated tax rate in ECU/t_{tw}km (per tonne of permissible total weight and kilometre driven) with avoidance cost approach

Type of HGV	Upper bound in ECU	in %	Lower bound in ECU	in %
Class 1	0.0111	93%	0.0051	86%
Class 2	0.0114	95%	0.0054	90%
Class 3	0.012	100%	0.006	100%

The differentiation is in the same order of magnitude as in the case of air pollution. Again, it should be kept in mind that several assumptions of the calculation are very preliminary and would have to be adjusted as soon as better figures are available. Furthermore, we'd like to emphasise that the three classes 1, 2 and 3 do not refer to existing "official" categories as in the case of air pollution. Thus, the results are of rather illustrative character. The following sections will refer first of all to the differentiation according to the emission abatement technology for air pollutants.

25 See chapter 7.2.1 of the synthesis report of topic A. Class 1 corresponds with the EU noise emission limits of 1990, class 2 with a proposal for a tightening in the year 1996, class 3 is only of indicative character.

3.4 Differentiation according to space and time

a) Introduction

Air pollution, noise and congestion[26] often concentrate in urban areas and at particular times and the same holds therefore for the external costs. Correspondingly, a mileage tax intending to internalise the external costs of HGV should vary between areas with different air qualities and noise levels. We call the version of the mileage tax meeting these requirements "**sophisticated version**".

If congestion is considered a good proxy for higher specific emissions, a differentiation according to congestion would also be sensible. Of course, this is true not only for HGV but also for passenger cars and light goods vehicles. Therefore, a general urban road pricing for all motorised road vehicles is often called for by economists.[27]

In principle, there are two possible ways how to introduce a differentiation of the mileage tax according to time and space:

- If the metering system for the mileage tax allows to differentiate the tax over time and space (see section 3.5 on metering systems) a spatial and temporal differentiation could be implemented even without a passenger car road pricing system
- If electronic urban road pricing systems were introduced in the next decade also HGV could be integrated in such a system and could be charged for the additional external costs in urban areas. The mileage tax would then only cover the "bottom line level" of the external costs, excluding the additional urban costs. It would of course be the best case if the metering systems were inter-operable or even the same for urban road pricing systems and for the mileage tax. However, on principle, the two tax systems could also work independently with two different systems.

To what extent should the mileage tax be differentiated according to time and space? To answer this question one needs estimates of the external costs of transport in urban areas. First estimates for Switzerland are discussed in the next subsection. Afterwards first conclusions for spatially differentiated mileage will be drawn.

b) Swiss studies of external costs of transport in urban areas

To make a proposal of a differentiated mileage tax for HGV according to space and time external cost estimates of urban areas must be used. In the frame of the Swiss National Research Programme 25 "City and Transport" external costs of transport were estimated for the Swiss towns Zurich and Berne.[28] The most important results of these studies are as follows:

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26 Congestion is not treated in this research project.

27 For an overview see e.g. N.C. Lewis (1993), Road Pricing - Theory and Practice.

28 ECOPLAN (1992), Internalisierung externer Kosten im Agglomerationsverkehr, INFRAS (1992), Internalisieren der externen Kosten des Verkehrs.

- In the case studies mentioned, external costs of local air pollution, noise and congestion are approximately doubled in towns compared to the external costs of transport in the suburbs.
- In section 3.2.3 the average external costs of road freight transport in Europe have been estimated between 20 (lower bound) and 40 (upper bound) ECU per 1000 tkm. The estimates for the whole area of Zurich and Berne (included the suburbs) are substantially higher. The estimates vary **between 100 and 140 ECU per 1000 tkm**.

c) Conclusions

It would not make sense to fix a specific extra charge for all urban areas in Europe as the transport problems and correspondingly the external costs of transport vary from town to town. However, some general guidelines can be set:

- Estimates for Swiss towns (which are relatively small and clean areas on a European scale) show that the mileage tax in urban areas should be at least twice as high as the mileage tax in rural areas.
- A differentiation over time depends crucially on the specific traffic situation in urban areas. If the traffic flows correspond to a typical daily pattern, e.g. congestion problems occurring mainly during rush hours, it would be sensible to introduce some kind of congestion pricing also for the mileage tax.[29] Such a differentiation may not only be efficient in urban areas but also for other bottlenecks in the transport system, as for example transalpine transport corridors.
- The tax rates derived in sections 3.2 and 3.3 are average values over space. If for urban areas the rate of the mileage tax will be increased they should be lowered in rural areas.[30]

3.5 Metering systems

a) Introduction and overview

The "sine qua non" of the mileage tax is a metering system that allows to charge the tax rates derived in the above sections. In Europe, several research programmes and projects deal with the question of automatic debiting systems. To mention only the most important ones:[31]

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29 For an overview of congestion pricing see e.g. N.C. Lewis (1993), Road Pricing - Theory and Practice, chapter 2.

30 The extent of this reduction could simply be calculated in such a way that the sum of the revenue of the mileage tax and of the local additional charges (introduced step by step) should remain at the level resulting from our proposed average tax levels.

31 We renounce to mention all the official and informal literature on this topic. Research within the EU is documented by DG XIII, Directorate C-6.

- Within the EU - DRIVE I and II programme there were several research projects (e.g. ADEPT, ADS, CASH, GAUDI) treating possibilities, standards and the development of electronic systems for road transport (advanced transport telematics). Follow up programmes (ADEPT II, GAUDI II) are in work or planned.
- In Germany, there is an ongoing field study with ten different electronic metering systems on the motor way A555 between Bonn and Cologne.
- In Switzerland the national government evaluates four different metering systems for a national mileage tax for HGV. First results can be expected towards the end of 1995.
- In the 4th Framework Programme new research projects will be launched. It can be expected that in the telematics application programme there will be also projects about metering systems for road pricing as for instance projects about international interoperability of electronic fee collection systems.
- The Commission services of DG VII and XIII have initiated the CARDME initiative. CARDME addresses interoperability issues between Member States related to the introduction of electronic fee collection systems.

From the existing and ongoing research efforts in the area of metering systems for electronic road pricing the following conclusions are important in the context of this case study:

- There are different competing metering systems in development and partly in use. Until now, there is no system that can claim to be the future European Standard. The problem of interoperability has to be solved yet.
- The requirements for the proposed mileage tax ("truck pricing") may differ substantially from those for a general road pricing for all motorised vehicles. It may be less difficult to establish a road pricing for lorries only, compared to a road pricing for all vehicles (less problems with privacy, less different types of vehicles, smaller total number of vehicles, smaller total number of owners, firms and not households as owners). Therefore, it could be efficient **not** to use the same metering system for all vehicles, but a special one for the introduction of a mileage tax for HGV at the European level.
- At this moment it is not possible to determine the ideal metering system for the introduction of a mileage tax for HGV. We have to wait for the results of the many ongoing research projects all over Europe.

In the following sub-section concentration lies therefore on some general requirements that a metering system has to meet. Afterwards first conclusions are drawn in respect of the most discussed metering systems.

b) Requirements

The metering system used to implement the mileage tax for HGV has to meet a large number of requirements. Some of the most important ones will be discussed in this subsection.

- **Registration** of the distance covered: The system to register the kilometres driven must meet the following standards:

- capable to register the kilometres driven precisely (independently from the velocity of the HGV, in rainy or foggy conditions equally well as in storm or snow)
- technically feasible and reliable
- the free flow of traffic may not be affected
- impossible to manipulate (secure from theft and fraud)
- practicable for all types of HGV and able to register also trailers
- capable to register areas with different tax levels (urban areas, transit corridors) and national borders (to implement the principle of territoriality)
- applicable to all kinds of roads (and not only on motor ways as external costs of freight transport occur independently of the type of roads)

❑ **Accounting and transfer of data:**

- From the HGV the data of the registration device must be transferred to the authority imposing the mileage tax. This transfer must be secure from manipulation, technically feasible and compatible with data protection requirements. There are different systems existing that after the transfer of data could be used to charge automatically for the kilometres driven.
- As an alternative the kilometre registration device could be linked with an in-vehicle smart card system which debits the taxes automatically during the journey and which registers electronic receipts showing the time and place of payment. Such a system would guarantee data protection as the HGV remain anonymous.

❑ **Technical interoperability:** The European countries try to reach an agreement about specifications and norms of the future metering system to be used. Even if more than one system will finally be used, different metering systems should have technical interoperability. Although the notion of interoperability is not yet defined clearly, in practice this would for instance mean that only one device to register the kilometres driven is necessary.

❑ **Procedural interoperability:** The same is true for the procedure to impose the tax. For the haulier this procedure should be as easy as possible. This means for instance that the transfer of data to the national authority should be the same for all HGVs and for all countries. This procedure could be organised in the following ways:

- The tax could be imposed by every country independently of the nationality of the haulier. Then the transfer of data must be done separately for every country. For international transports, therefore either an automatic device transmitting this data to the national authority would be needed (e.g. via satellite) or at national borders HGVs would have to stop to enable the authorities to check the kilometre registration device. However, the second version would be contradictory to the aim of free border crossing within the Common Market.
- Every country imposes the mileage tax to their national hauliers, independently from the country in which the kilometres were driven. With the help of the kilometre registration device the countries in which the kilometres were driven and the corresponding tax rates could be identified. An international clearing authority would then be responsible to organise the distribution of the revenues according to the territoriality principle.

- A smart card solution seems to us the most efficient system. To secure the territoriality principle every country would have his own type of smart card. The only thing the driver would have to do would be to change the smart card when he crosses national borders.

- **Enforcement:** First of all and as mentioned earlier, the kilometre registration device must be secure from manipulation. Nevertheless, it is necessary to prevent that HGVs with a device out of order or with invalid smart cards may drive. Therefore there must be controls to detect such cases. Similar to speed controls this could be achieved with mobile control units. Photo-logging and video-imaging of vehicles are systems in rapid development that could be used for such controls.
- **Cost effectiveness:** Infrastructure and operating costs of the metering system should be as low as possible. For instance, the ongoing Swiss evaluation of a metering system for a mileage tax for HGV set an upper limit of in-vehicle costs of 500 CHF (330 ECU) for the kilometre registration device.

c) Metering systems meeting basic requirements

To meet the demands of the proposed mileage tax (applicable on the whole road network, differentiation according to emission standards, space and time) only an **electronic road pricing system** is possible.

Metering systems meeting all the requirements are not yet available. But there are large ongoing efforts to develop such systems at national and European level. It can be expected that in the next five years European wide standards for such systems will be defined.

Already now, the choice of possible metering systems can be limited to **only a few**, even if the ideal metering system is not yet determinable:

- Basically, a two-way data communication between the vehicle and an electronic system unit outside of the car (beacons, global positioning system) is necessary. As kilometres driven must be registered on the whole road network this registration must be possible without expensive new infrastructure needs. This means in our view that **registration systems based on beacons are out of question** as the costs of building such beacons for the whole network would be enormous.[32]
- There are at least two categories of registration systems that are not dependent on additional infrastructure investments and could therefore build the base for the implementation of the mileage tax:
  - Firstly, the kilometres driven could be registered on the base of an **electronic impulse of the speedometer**. Additionally, acceleration and rotation signals serve as a control and to prevent manipulation. With such a system beacons would only be necessary between areas with different tax levels and at national borders.

32 Beacon based solutions as they are tested for instance by the ongoing field study in Germany may be interesting for an automatic debiting system for motorways.

- Secondly, the registration can be based on a receiver/transmitter unit receiving **signals of the global positioning system** (GPS). In this case the speedometer impulse is used to control plausibility of GPS-signals. This solution has the advantage that no investments for new communication infrastructure are needed as the spatial identification of the vehicle is very precise. Therefore, it would also be possible to vary the tax level in different areas and for different times.
  Already now, the GPS-system is used by private hauliers to optimise the logistics of fleet. It can be expected that the private use of GPS-systems will rise substantially in the next years.

d) Conclusions

Many problems still have to be solved until a reliable metering system will be available at a reasonable price. Basically, the metering technique is available but in many respects European wide standards have still to be defined.

Probability is high that the ongoing projects and programmes will provide specific solutions to the open questions. But of course, it is a political question if these systems will also be used for an environmentally oriented mileage tax as it is proposed in this case study.

3.6 Implementation of the mileage tax

This chapter gives first answers to two questions concerning the introduction of a mileage tax for road freight transport:

- In section 3.6.1 we discuss a possible distribution of tasks between the Member States and the Community. In other words, we ask whether there is a need for Community action and in what sense?
- Section 3.6.2 focuses on useful ways to implement a mileage tax for road freight transport.

3.6.1 Need for Community action

As in other areas the principle of subsidiarity is also the guideline for the development and application of transport policy instruments at Community level, i.e. policy measures should be taken at Community level if action at national or local level will not yield satisfactory results.
As shown in the pre-selection of possible internalisation instruments, in the case of a mileage tax for road freight transport several reasons speak in favour of a proceeding at Community level:

- **Distorting effect on competition**: A national mileage tax without an appropriate degree of co-ordination and harmonisation may influence the competitiveness of the economy in the respective country.
- **Global and/or transboundary character of environmental problems caused by road transport**: Especially in the case of air pollution the emissions of transport do not respect national boundaries. National action may not result in a substantial improvement of the air quality.
- **Compatibility of the metering system**: Community action will ensure the development of compatible systems and prevent the emergence of new barriers of trade at national borders. Furthermore, the development of such a system at EU level will cause less costs than uncoordinated national actions.[33]

The development and introduction of a mileage tax at Community level would correspond to the objectives of the Common Transport Policy (CTP) and to the policy measures and decisions taken so far at EU level:

- In Article 99 of the **Treaty on European Union** of Maastricht the harmonisation of charges and indirect taxes to level out differences in the conditions of competition is mentioned as a task of the Commission and the Council.

  Furthermore, Article 75 of the Treaty lays down the competence of the Council of the European Union to set up rules for international transport. The Council acts on the

33 In June 1995, the Council of the European Union Transport Ministers adopted a Resolution urging the Commission to table a proposal to ensure the interoperability of the different telematic systems being established in Europe (see European Information Service "transport europe", June 1995, II transport policy, p. 11).

proposal of the Commission and has to proceed according to the co-operation procedure defined in Article 189c of the Treaty or - in special cases - according to the consultation procedure described in Article 75(3).

- In the **White Paper on Transport**[34] the Commission described its global approach and its priorities in the future transport policy. In the White Paper, one emphasis is placed on the development of a Community framework for the charging of infrastructure and other costs to users. The internalisation of external costs of transport is explicitly mentioned as medium term objective of the CTP.
- In **June 1993** the Council of Transport Ministers took a decision with major impacts on the taxation of heavy goods vehicles.[35] The **Council decision** authorised Member States to introduce tolls (distance related charges) and charges (time related charges) for the use of trunk roads. According to the Commission the decision sets out the internal structure needed to take account of all infrastructure costs and, at a later stage of all external costs of road transport.[36] By December 1997 at the latest the Commission will have to report to the Council on the experiences made so far. This review will make it possible for the Commission to make proposals concerning the introduction of electronic road pricing systems and the extension of the system of tolls and user charges to comply with the objective of a variable and territorially based cost allocation. Furthermore, first adjustments of the level of the tolls and user charges may be realised, probably taking account of ecological considerations. Therefore, the review gives the Commission the opportunity to make a first step in the direction of an internalisation of external costs of transport.

Such a first step could consist of the development of a proposal for the introduction of a mileage tax as described in the sections above. A possible procedure could consist of the following cornerstones

- A first step could consist of a **survey of the results of transport research projects** within the Framework programme IV and within DG VII. The specific programmes "Information and Communication Technologies" (especially "Telematics") and "Transport" will yield useful information for the development and introduction of a mileage tax at EU level because the assessment of external costs of transport as well as the evaluation of electronic charging systems for road transport are important topics in these research programmes. The Framework programme IV will end in 1998.

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34 See Commission of the European Community (1992), The future development of the common transport policy.

35 See Directive 93/89 EEC of the Council on the taxation of heavy goods vehicles and the introduction of tolls and user charges on certain infrastructure by the Member States, October 25, 1993. This Directive has been declared null and void by the Court of Justice of the European Union on July 5, 1995 because the Directive reflects too little the former proposal of the Commission and of the European Parliament and because there was no new consultation of the Parliament after the Council changed the content of the proposal. Nevertheless, the content of the Directive remains valid until a new legal base for the introduction of tolls and user charges will be worked out. The Commission will present a new proposal within the next months. In this new proposal, the Commission could announce that the internalisation of external costs of road freight transport will be the next step after the introduction of user charges and tolls to cover infrastructure costs.

36 See van Vreckem D. (1994), European Union Policy on Taxes and Charges in the Road Transport Sector, p. 180.

- The survey should also contain an **evaluation** of the experiences made with the **"Euro Vignette"** introduced in Belgium, Denmark, Germany, Luxembourg and the Netherlands in January 1995.
- Based on these information the Commission could work out in the frame of a communication strategy (see section 4.5.2) a **detailed programme for the introduction of a mileage tax** containing a schedule of the further proceeding. We can imagine the following steps:
  - deepening and completion of the existing studies with results from the fourth Framework programme on the assessment of external costs
  - based on this, clarifying the methods to be used for assessment
  - generating "official" minimum and maximum values for the external costs[37]
  - taking decisions on the technology of the metering systems to ensure interoperability
  - defining the range of the tax rate for the different types of vehicles that is to be reviewed after a certain time
  - defining the area of applicability
  - defining rules concerning the use of the revenues
  - defining the time schedule for the introduction
- The formal introduction of a mileage tax would require **a decision of the Council** in form of a Directive. The Directive would have to define the main features of the tax. It would base on the detailed programme for the introduction of a mileage tax.
- The **implementation** of the tax itself would be the task of the **Member States**. After the large difficulties to introduce a CO_2/energy tax at Community level (i.e. in all Member States at the same time) it could be necessary - as in the case of the CO_2/energy tax - to define a transitional period in which the Member States can introduce the mileage tax individually. Of course, the national solutions would have to comply with the regulations of the Directive.

3.6.2 Introduction scheme: Forms of gradualism

By changing the transport prices a mileage tax for road freight transport affects processes and structures that have grown over time and that cannot be changed in the short run (e.g. international trade and division of labour, settlement patterns and location of firms, transport infrastructure). Any unexpected and abrupt change of transport policy would cause avoidable adaptation costs to the economies and societies of the Member States. In order to reduce the cost effects to industry and consumers, an **early and reliable announcement** of the procedure and a **gradual introduction** of the mileage tax would be essential.

37 This would of course mean that the tax rate given in chapter 3 would have to be adjusted to the new results.

In the case of the mileage tax, a step by step introduction scheme can refer to different aspects:

- **Tax rate**:

  In the former proposal for a CO_2/energy tax the Commission suggested a step by step increase of the tax starting from 3$ per barrel in 1993 with an additional $1 per barrel in the successive years until 2000.[38]

  In the case of the mileage tax a similar procedure could be chosen. Starting point could be the lower level of the tax rate described in section 3.2.3. The tax rate would then be put up every year in order to reach the upper bound of the tax rate ten years after the introduction of the mileage tax. The upper bound of the tax rate should be revised regularly because new and better assessments of the external costs of road transport may be available in the course of time.

  The procedure set out above is one possibility among many others. One could also consider a yearly increase (e.g. 5%) of the charges and tolls that are to be introduced according to Directive 93/89 EEC to cover infrastructure costs until the upper bound of the tax rate is reached. Of course, this procedure is only possible if infrastructure charges will be levied with a metering system that meets the requirements set out in section 3.5.

  It should be noted that from an economic point of view it is extremely difficult to determine the "optimum tax rise path". As far as possible the tax rise path should take into account investment cycles in the transport sector.

- **Different types of roads**:

  Another form of gradual introduction would consist in extending step by step the field of application of the mileage tax, i.e. the type of roads that are included in the system. Depending on the metering system chosen more or less technical installations are necessary. In a first step these installations could be set up along motorways and similar trunk roads.

  From the point of view of internalisation this form of gradual introduction is not justified because external effects of HGV are not limited to certain types of roads. Furthermore, undesirable circumventing traffic and, in the long run, distortions in land use patterns may result (i.e. distortions in location decisions of private firms) from this kind of pricing. Therefore, this kind of gradual introduction has to be rejected.

- **Different regions**:

  A third type of gradual introduction could refer to the geographical field of application. As mentioned before, the external costs of transport are not evenly distributed over space. In some regions of Europe the environmental damages caused by road transport are much more serious than in others. Accordingly, the need for action differs too. One can expect that the political acceptance of a mileage tax increases the more people and environment suffer from the emissions of road freight transport.

38 See Commission of the European Communities (1991), A Community Strategy to limit Carbon Dioxide emissions and to improve energy efficiency, p. 9.

As mentioned above a transitional time period could be foreseen to enable "first-mover" initiatives of single Member States or of a group of them. But there is no reason to exclude certain regions in the long term. On the one hand, desirable adaptation processes would not take place, on the other hand, a reduced tax rate can take into account the less harmful effects of road freight transport in these regions (see section 3.4).

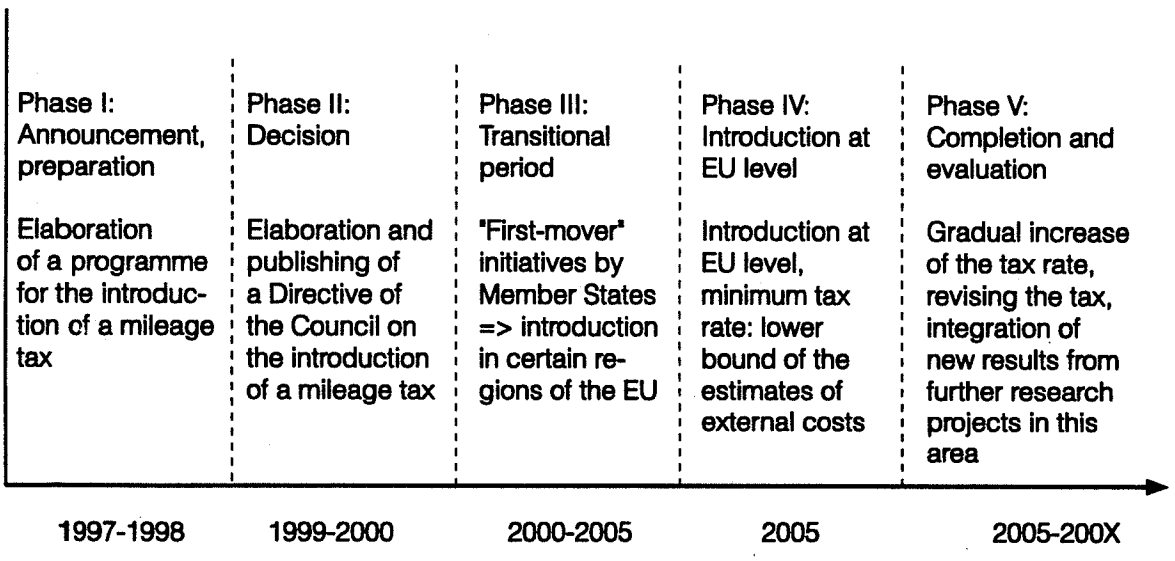
Another reason for a gradual introduction that may be put forward in the political discussion are differences in the quality of the infrastructure for alternative, less polluting transport modes. Figure 2-3 is a strong indicator for considerable differences in the potential of less polluting transport modes between the Member States. In some regions the provision of a valuable alternative to satisfy transport demand will take more time than in other regions. From the point of view of internalisation theory this argument doesn't hold water. Road freight transport should pay its full costs independently of the service quality of alternative transport modes.

We conclude that the first type of a stepwise introduction scheme is the most important one and should be followed. The third form of gradual introduction is probably useful due to political reasons (see section 4.5). However, we do not recommend the second form of a stepwise introduction scheme because of wrong price signals and incentives set by this solution.

3.6.3 Conclusion

From the discussion in the two last sub sections a proposal for a gradual introduction scheme can be derived. In figure 3-9 we have summarised a conceivable introduction scheme for a mileage tax at EU level that distinguishes between five different phases. The time schedule assigned to each phase is of course only one possibility among others.

Figure 3-9: Proposal for an introduction scheme



3.7 Use of the revenues

3.7.1 Introduction

As mentioned in the chapter "Theory of Internalisation"[39] the objective of an internalisation tax like the mileage tax is to change price signals in order to ensure a more efficient allocation of scarce resources, i.e. to improve the efficiency of the transport system. The internalisation theory doesn't answer the question how the revenues of an internalisation tax are to be used but supports a solution that minimises additional distortions. In contrast to the internalisation process the use of the revenues is not only an efficiency but also a distributive question. In the political discussion efficiency aspects often take a back seat and distributive effects become much more important. Therefore, the following sections also deal with proposals that don't meet the requirement of minimum additional distortions.

3.7.2 Earmarking for transport infrastructure

a) Road infrastructure

As already mentioned before, the realisation of the "user-pays-principle" is one of the main objectives of the Common Transport Policy (CTP) for road transport. The charging for the use of the road infrastructure can be considered as the first step, the charging for external costs, i.e. the realisation of the polluter-pays-regulation as the second step towards a transport system that pays its full costs.[40]

If the infrastructure costs caused by HGV are covered any earmarking of the revenues from an internalisation tax (i.e. from the mileage tax) would result in an extension of road infrastructure beyond a socially desirable level. Due to the earmarking mechanism even infrastructure projects with a low priority would be realised simply because the funds for financing are available.
If the mileage tax is introduced in a situation where road freight transport covers its full share on road infrastructure costs - and these costs will be considerable if all of the road infrastructure projects planned within the Transeuropean Network (TEN)[41] shall be realised - , some of the revenues could be used for this purposes.

From an environmental point of view, the consequences of this kind of earmarking are unwelcome as the improvement in the road infrastructure would the partly offset the reduction effect of the tax on traffic volume. The major argument in favour of this kind of

39 See chapter 2 of the synthesis report of topic B of this project. The theoretical aspects of different ways to use the revenues from an internalisation strategy are discussed in section 2.3.5.

40 See Van Vreckem D. (1994), European Union Policy on Taxes and Charges in the Road Transport Sector, p. 180.

41 See Kommission der Europäischen Gemeinschaften (1993), Wachstum, Wettbewerbsfähigkeit, Beschäftigung: Herausforderungen der Gegenwart und Wege ins 21. Jahrhundert, p. 90/91.

earmarking is the acceptance of an internalisation strategy. Experiences made so far have shown that public opposition to any kind of road pricing can be reduced if the revenues are used to finance improvements in the road infrastructure. In this case the society will not only identify the effects of paying higher taxes for road transport but also apparent benefits of the internalisation strategy.

Conclusion: Regarding the objectives of the CTP it is hard to imagine that a mileage tax to internalise external costs will be introduced in a situation where road freight transport doesn't already pay its full infrastructure costs. Under this assumption there should be no earmarking for road infrastructure purposes.

b) Infrastructure of environmentally more compatible transport modes

In general, the same arguments as stated above can be advanced against the use of some of the revenues from the mileage tax for improvements in the infrastructure for rail transport or inland waterways, namely

- the problem of too large investments due to the earmarking mechanism and
- the increase of the political acceptance of an internalisation strategy.

Nevertheless, there are arguments that justify this kind of earmarking: As long as the external costs of road transport are not fully internalised, subsidies for environmentally more compatible transport modes may be efficient because they reduce the imbalance between road transport and the other transport modes and therefore existing distortions in the transport sector.[42] Due to the arguments stated in topic A of this project it can be assumed that a mileage tax basing on the existing estimates of external costs will not result in a full internalisation because the estimates usually represent lower limits of the "true" external costs.
However, one should not forget the fact that the distortions between the transport sector and other sectors of the economy are not redressed with this "second best solution" (see figure 3-10). Therefore, this kind of earmarking should only be introduced for a limited period and be revised periodically.

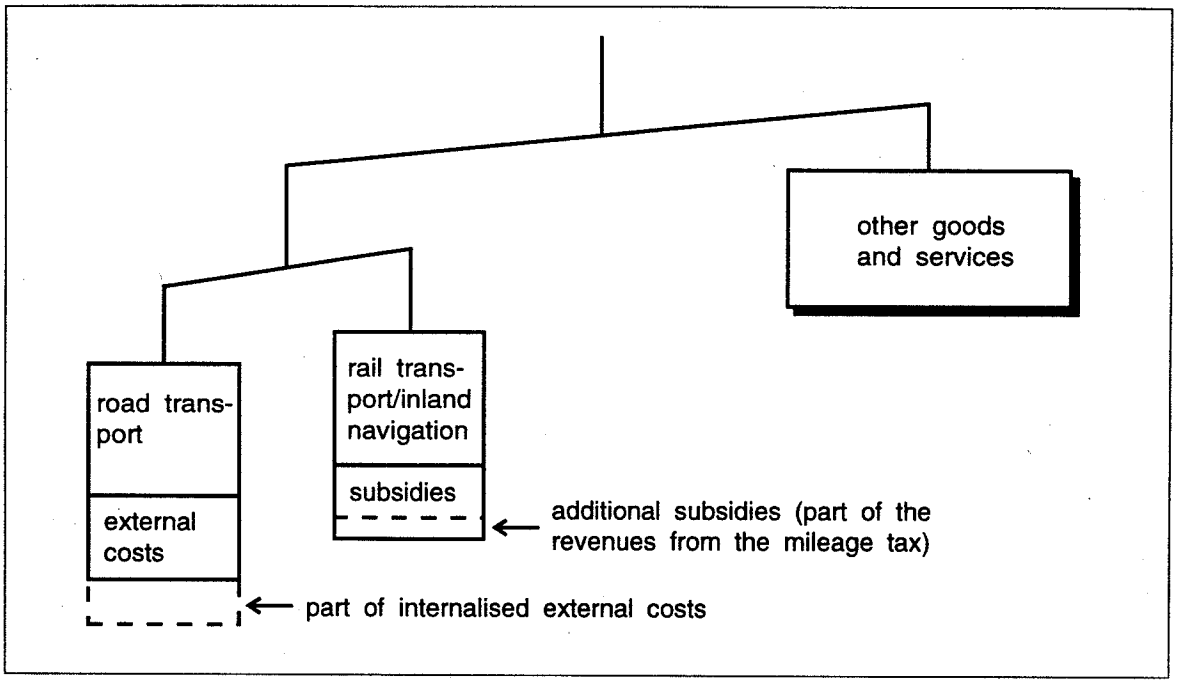
From the chapter "Theory of Internalisation" we know that the efficient amount of the subsidies depends on the cross-price-elacticities between more and less polluting transport modes (i.e. the higher the elasticity the higher subsidies are justified). The elasticity itself is largely determined by the service quality of alternative transport modes in comparison with road freight transport:

- In the case of **rail transport** the service quality can substantially be increased if the interoperability between the different rail networks and combined transport systems is improved and potential economies of scale are exploited. Such economies of scale occur if additional links or terminals are added to an existing network provided the capacity of the network is not exceeded.

42 The extent of these distortions may differ considerably between the Member States. It depends on the amount of current subsidies for the less polluting transport modes and of course of the external costs caused by these transport modes (energy production for rail!).

- Compared to rail transport the possibilities of **inland waterway transport** to offer valuable alternatives to road freight transport are rather limited. Due to geographical reasons such alternatives exist only for certain regions of Europe (see also figure 2-2 and 2-3) and only for a limited range of goods, especially mass goods.

Figure 3-10: Imbalances in the transport sector



From this point of view, investments in rail infrastructure to increase the interoperability of and the access to rail networks should be considered as first option if the revenues of a mileage tax are to be used for improvements in transport infrastructure.
Beside the reason stated above, this way of using the revenues can be justified by another two arguments:

- In contrast to an earmarking for road infrastructure, improvements of rail infrastructure support the switch of road freight transport to an environmentally more compatible transport mode. The incentives set by the tax are rather strengthened than weakened. But chapter 2 has shown that in many EU countries it would be almost impossible to shift even a small part of road transport to alternative transport modes without substantial improvements in their infrastructure.
- In comparison to other ways of using the revenues the administrative costs should be quite low.

Possible infrastructure projects that could profit from this kind of earmarking are given in the White Book on Growth, Competitiveness and Employment: The Commission has drawn up a provisional overview of transport infrastructure projects within the TEN.

Some of them refer to important improvements of the infrastructure for rail and inland waterways (e.g. the Betuwe-Line).[43]

Conclusion: In the sense of an interim solution an earmarking of the revenues for infrastructure projects of less polluting transport modes can be justified.

3.7.3 Use of the revenues to cover external costs

In our theoretical discussion[44] we have argued that a compensation of the "victims" of external costs could result in further distortions. Persons living along a noisy street, for example, already profit from lower rents. In this case a compensation would only set wrong incentives.

Nevertheless, there are also situations that do not cause further distortions. For example, burdens of the past caused - at least partly - by road transport could be redressed by using some of the revenues to finance rescue packages for the environment (e.g. reforestation projects in alpine regions) or investments in favour of the public (e.g. noise barriers or sound insulation of buildings).
As in the case of an earmarking of the revenues one can critically ask why these policy measures are not taken independently of the introduction of an internalisation tax if their social priority is that high. From political science we know that it is more difficult to establish an effective lobby fighting for policy measures whose benefits are distributed quite evenly within the population than for policy measures in favour of a rather small group of the society. It can be assumed that compared to the preferences in the public too little funds are used for environmental protection purposes.[45] As the financing of the rescue packages proposed would correspond to the "polluter-pays-principle" a rather high political acceptance of this way to use a part of the revenues from a mileage tax can be expected.[46]

Conclusion: A part of the revenues from the mileage tax could be used to finance the redressal of environmental damages and disturbances to the public caused by road transport.

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43 See Kommission der Europäischen Gemeinschaften (1993), Wachstum, Wettbewerbsfähigkeit, Beschäftigung: Herausforderungen der Gegenwart und Wege ins 21. Jahrhundert, p. 90/91.

44 See draft of March 14, 1995.

45 In the case of noise the fact that too little private investments in noise barriers, sound insulation of buildings etc. are undertaken, can be contributed to imperfections in the functioning of the housing market, to considerable information and transaction costs and to the free-rider problem when it comes to the financing of the measures (see ECOPLAN (1992), Internalisierung externer Kosten im Agglomerationsverkehr, p. 36 ff.)

46 In Switzerland, this way of using the revenues from internalisation taxes in the transport sector shows a high degree of consent in different groups of the society (see Dienst für Gesamtverkehrsfragen (1993), Politische Umsetzung, Soziale Kosten und Nutzen des Verkehrs, p. 47).

3.7.4 Source of revenues for the national budgets of the Member States

Little evidence is given for this kind of using the revenues from a mileage tax:

- With the exception of the arguments stated in the last section the internalisation of external costs does not enlarge the range of tasks of the public authorities. Accordingly, no need for further revenues can be derived from the introduction of a mileage tax.
- Considering the political acceptance of an internalisation scheme it is of major importance to prevent the impression that the mileage tax will simply be another source of revenues for the treasuries of the Member States. Revenue neutrality will be an important argument in the political discussion because otherwise it would become very difficult to "sell" the main point of the mileage tax to the population, i.e. the changing of the price signals in favour of the environment.

  Also in the case of the proposal for a CO_2/energy tax revenue neutrality was underlined as a key characteristics of the new tax.

Conclusion: Revenue neutrality - with the exception stated in section 3.7.3 - should be a main characteristics of the mileage tax.

3.7.5 Redistribution of the revenues

From a theoretical point of view the redistribution of the revenues is the most favourite solution especially if a double-dividend situation can be attained (i.e. using the revenues from the mileage tax to reduce the tax rate of a distortionary tax).

Below we briefly discuss the main possibilities to refund the revenues from a mileage tax for road freight transport. Because the tax does not directly affect the household side we concentrate on refunding systems for firms.

- **Reductions in social security contributions and/or in the income taxes**

  In most of the Member States the social charges (unemployment insurance, and the income taxes lead to a substantial rise in labour costs. Table 3-10 shows that these costs amount to 23.5% of gross domestic product (GDP) on average in the Member States in 1991.

  The high labour costs set strong incentives to reduce the input of labour and contribute to a replacement of the input factor labour by the factor capital. In order to fight unemployment and the increasing share of black economy the Commission suggests in its White Book on Growth, Competitiveness and Employment to reduce this costs by 1 to 2% of GDP and to compensate the resulting shortfall in receipts by raising other kind of taxes, for example eco taxes. Thus, the revenues of the mileage tax could be used to finance reductions in the social security contributions and in income taxes.

Table 3-10: Social security contributions and income taxes in % of GDP, 1970 and 1991 (EUR 12)[47]

Country	1970 in % of GDP	1991 in % of GDP	Difference 1991/1970
B	19.6	29.5	9.9
DK	21.2	27.3	6.1
D	18.8	25.9	7.1
GR	10.1	16.5	6.4
E	8.2	20.4	12.2
F	16.9	25.4	8.5
IRL	8.3	17.8	9.5
I	12.7	23.6	10.9
L	16.2	25	8.8
NL	22.7	29.7	7.0
P	–	16.0	–
UK	16.7	16.7	0.0
Community	16.6	23.5	6.9
USA	15.9	19.4	3.5
JAP	8.6	16.6	9

Regarding the feasibility, reductions in social security contributions seem much easier to implement than reductions in the income taxes.[48] If social security contributions are to be reduced, the reimbursement would have to base on the obligatory social charges which may differ from Member State to Member State.

- **Bonus on the wage sum**

  The compensation refunded is defined as a certain percentage of the whole wage sum of the respective firm. Especially firms with a large share of payroll costs (e.g. firms of the services sector) benefit from this solution.

  It is essential that the firms have to show "official" figures of their wage sum (e.g. the wage sum that defines social security contributions of the employer) independently of a possible refunding system of the mileage tax. Otherwise, this kind of redistribution would cause too high administrative costs.

- **Bonus per workplace**

  Another possible way to redistribute the revenues consists in a lump sum reimbursement per workplace. In comparison to their costs, firms with a large number of em-

47 Kommission der Europäischen Gemeinschaften (1993), Wachstum, Wettbewerbsfähigkeit, Beschäftigung: Herausforderungen der Gegenwart und Wege ins 21. Jahrhundert, p. 152.

48 See Deutsches Institut für Wirtschaftsforschung (1994), Ökosteuer - Sackgasse oder Königsweg, p. 72 ff.

ployees with a rather low salary benefit the most from this way of reimbursement. This effect would correspond with the objective set out in the White Book to improve first of all the situation of low qualified and unskilled workers.

Regarding the feasibility and the administrative costs the implementation of this reimbursement system causes large problems. Normally, the number of persons employed is not shown officially and varies in the course of an year. It would be difficult to define an official base to determine the compensation of each single firm. Further problems arise because the system should distinguish between full-time and part-time employment. Frequent controls would be necessary to prevent improper use of the system.

We conclude that **the refunding system should either consist of a reduction of the social security contributions or of a wage sum bonus**. The choice between the one or the other should depend on the administrative costs of the two possibilities and may therefore differ from Member State to Member State.

Independent of this choice of the specific refunding system some distributive effects of a reimbursement should be considered:

- It must be decided **what firms get the benefit** of the reimbursement of the revenues. Should the revenues of the mileage tax remain in the transport sector or should also firms of all the other sectors profit from the system? Due to the following reasons only the first option is out of question:
  - The incentive effect of the mileage tax would be reduced if only the firms of transport sector profit from the redistribution.
  - The refunding system sets an incentive to increase employment in order to get to get higher repayments. In the case of the transport sector the consequences of this incentive are unwelcome because road freight transport is more labour-intensive than rail transport and transports on inland waterways. Therefore, the refunding system should not support a more labour-intensive production in the transport sector.
  - The refunding system should not cause additional distortions between the different sectors of an economy. All the sectors should be treated similarly.
  - If only transport companies are to be included in the refunding system, an unambiguous definition of the respective firms would be necessary. This definition would cause considerable problems (e.g. what to do with firms with internal transport departments?). Frequent controls by the public authorities were indispensable because the refunding systems would set incentives to "overestimate" the personnel or its wage sum of the transport department. Thus, the implementation of this solution would cause large administrative costs.
- The second point refers to **differences in the amount that can be refunded between the Member States**. As a consequence of the territoriality principle of the mileage tax, the amount of national revenues from the mileage tax depends on the road performance of road freight transport within the Member States. In other words, the more trucks drive through a country the higher is the compensation in favour of the domestic economy. There are considerable differences between the Member

States if one compares the transport volume of road transport with the number of employed within the different countries. Accordingly, the refund to per person employed will also differ strongly between the Member States.

This means that for example that geographical reasons (i.e. being a transit country) or the promoting of road transport instead of other transport modes in the past increase the level of the amount that can be refunded to the firms within a Member State. These differences could be reduced if a part of the revenues from the mileage tax flows into an "equalisation fund". The drawback of this proposal is evident: An additional administrative machinery would have to be installed leading to an increase of the transaction costs. Furthermore, one can argue that the economies with a large share of road transport also face more negative impacts, (i.e. more external costs) and a higher financial burden because of the mileage tax.[49] Therefore, we suggest to renounce on the setting up of an equalisation fund and to accept the differences between the Member States.

In the last decade, the introduction of internalisation taxes or incentive charges connected with a reimbursement of the revenues to the households and firms has broadly been discussed under the key word "Ecological Tax Reform". The main idea of this concept can also be found in the new development model outlined in the Commission's White Book on Growth, Competitiveness and Employment. It suggests an internalisation of external costs in a broad scale combined with a reduction of the taxation of labour.

Due to this objective for the future development and regarding the administrative challenge and the distributive effects of all of the three refunding systems described above it could be a useful strategy to introduce this kind of "revenue recycling" only in the context of larger reorganisation of the existing taxation system. The planned resumption of the discussion on the introduction of a CO_2/energy tax by the end of this century could mark the starting point of such a reorganisation process.

3.7.6 Conclusion and recommendation

Obviously, it is not easy to find the "best" way to use the revenues from a mileage tax. Each of the possibilities has its advantages and drawbacks. If we base our recommendation on criteria like the political acceptance, the administrative costs and the requirement that the use of the revenues does not weaken the incentive effect of the tax, our proposal is as follows:

- **Stage 1**: In a first stage which is clearly defined as an interim solution we suggest a mix of earmarking for investments in environmentally more compatible transport modes (e.g. TEN-projects for rail and inland waterways) and of rescue packages for the environment and/or of measures to reduce the negative impacts of road transport on human life. The first way to use the revenues is especially justified as long as the rate of the mileage tax hasn't reached its final level (see section 3.6.2).

49 This argument is weakened if the share of transit transport carried out by foreign hauliers is outstandingly high. In this case foreign companies "finance" more than average of the cost reduction in favour of the domestic firms.

- **Stage 2**: In a second stage we propose to implement a refunding system. If, at that point in time, the Member States will still intend to introduce a harmonised CO_2/energy tax, the implementation of the two refunding systems will have to be closely co-ordinated. This could happen in the context of larger reorganisation of the existing taxation system, i.e. in the context of an ecological tax reform. The objective would be to reduce labour costs.

We can imagine that at EU level it is only determined that the revenues must not be refunded to the transport sector. In addition, the new Directive of the Council would only make recommendations but would leave it to the Member States to define the use of the revenues in detail.

4 Assessment of the mileage tax

4.1 Introduction

In chapter 3 a possible design of a mileage tax for road freight transport has been described. In this chapter we will critically review the possibilities and limits of the mileage tax proposed and we will carry out impact assessments.

- In section 4.2 we will look at the **economic impacts** of the tax. The section also contains an estimate of the changes of the transport volumes of the different transport modes.
- Section 4.3 will deal with the **ecological impacts** of the mileage tax. Both, the impact of technology improvements and of traffic volume reductions will have to be considered.
- Section 4.4 comes back to **cost-benefit aspects** of the different versions of the tax. Potential welfare gains will be compared - as far as possible within this sub report - with additional costs of a more or less extensive differentiation of the mileage tax. Furthermore, the results will be used to assess the advantages and disadvantages of the tax in **comparison to a diesel tax**.
- At last, in section 4.5 **political questions** in the context of an introduction of a mileage tax are analysed.

4.2 Economic assessment of the mileage tax

4.2.1 Introduction

The economic impacts of the mileage tax should be assessed in a quantitative way. If ever possible, this should be done with a multi-sectoral model incorporating all Member States and placing emphasis on the transport sector which has to be differentiated according to modes. General equilibrium models would fit these requirements in a perfect way.
As such a model cannot be built up in the framework of this case study,[1] the economic impacts are assessed in a qualitative way on the one hand, and, on the other, using results of existing studies by analogy.

1 Within the 4th framework programme ECOPLAN is partner of the Research Proposal EICAT (Economic Impacts of Carbon Tax Policies, PL 950158) in which the development of such a general equilibrium model for Europe is proposed.

The chapter is structured as follows:

- To assess the possible economic impacts of the proposed mileage tax a working model showing the different kinds of impacts is needed. In section 4.2.2 such a model is presented.
- In section 4.2.3 possible impacts on the transport sector are worked out in more detail.
- Section 4.2.4 takes a closer look at all other sectors.
- In Section 4.2.5 the results are summarised and first conclusions are drawn.

In this chapter we restrict ourselves to an analysis of the impacts in the different sectors of the economy. An analysis of the overall welfare effects should incorporate also the benefits from the reduced external effects of road freight transport. Possible negative effects on the transport sector and on all other sectors therefore should be compared with the reduction of external costs of road freight transport. The fact that these benefits are left out must always kept in mind when first results on the impacts of the economy are presented on the next pages.

4.2.2 Working model

Figure 4-1 shows the context of the most important impacts of a mileage tax which will be commented on the next pages. But, as mentioned, it will not be possible in this case study to work out all the single steps in a quantified manner.

a) General set-up

As a starting point for the assessment of the economic impacts of the mileage tax following figures should be made available:

a1) Supply in goods transportation: Three modes have to be looked at, namely freight transport by road, by rail and by inland waterways. For these modes the supply can be described with the help of the following data:

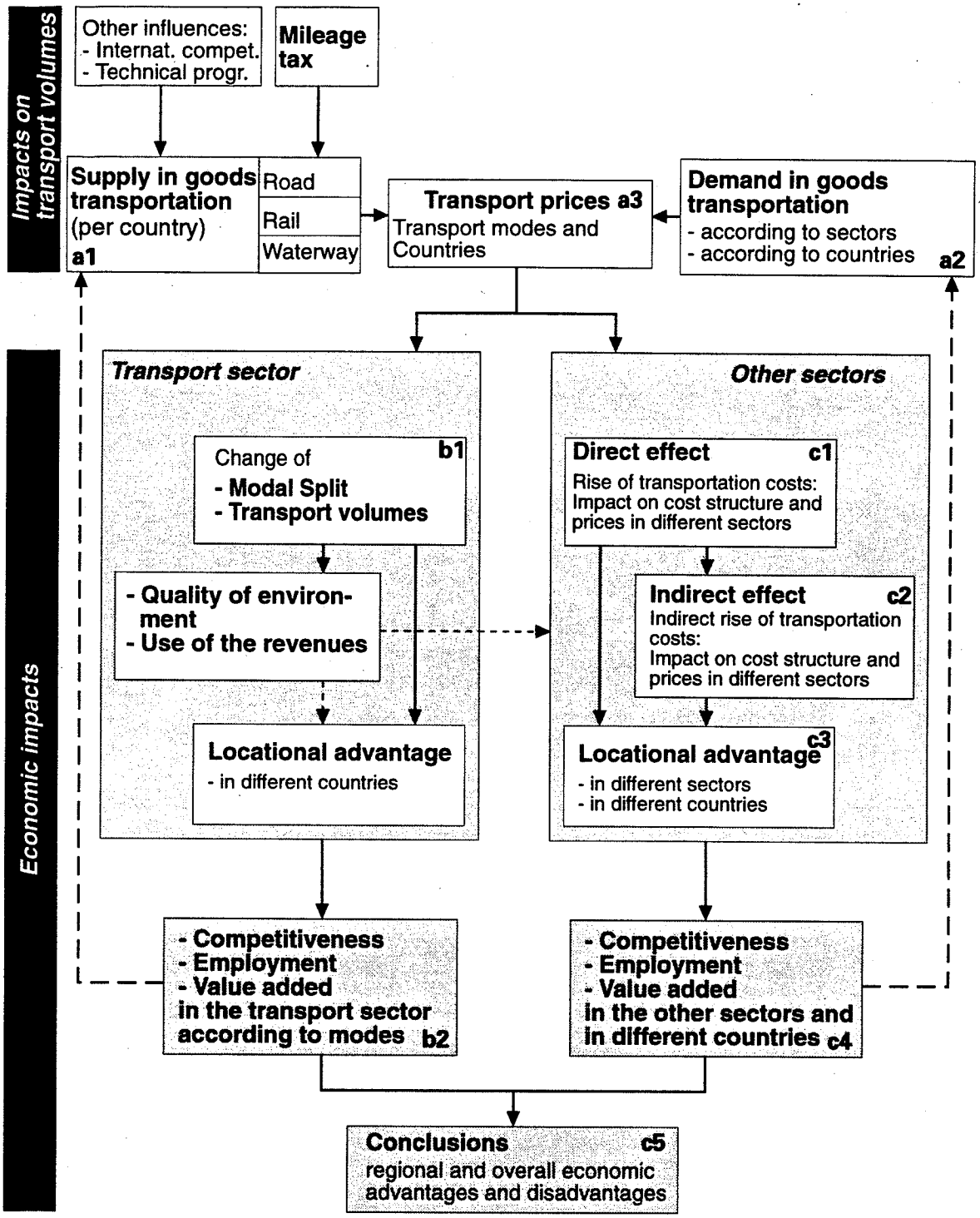
- Per mode: vehicle-kilometres per year and per country
- Per mode: taxes, charges, subsidies (including the mileage tax) per country

a2) Demand in goods transportation: To analyse the changes in demand for goods transportation following data should be known:

- Per mode: Freight traffic volume, transported tonnes
- Per mode: Freight traffic movements, transported tonne-kilometres (tkm)

These data should be differentiated according to sectors and countries. Within sectors those with a high transportation intensity are of most interest, as the impacts of the mileage tax will probably be most marked in these sectors. Between countries a differentiation according to their transportation intensity (vehicle-kilometres per capita or per working place) will be useful.

Figure 4-1: Working model "Economic impacts of the Mileage tax"



a3) Transport prices: Transport prices are a result of supply and demand. They may vary between countries and different modes. The mileage tax will rise the prices of road goods transportation. This price rise depends to what extent the hauliers can pass through the mileage tax to the demand side. Only if the whole mileage tax will

be paid by the demand side the price rise corresponds to the mileage tax. In every other case it is lower.

b) Impacts on the transport sector

b1) Modal split and transport volumes:

- What will be the **shift** of demand from road goods transportation to the other competing modes (rail, inland waterways)? To answer this question differentiated data are needed about the quality of transport modes per country as well as about the capacity of transport modes per country. This will lead to spatial differentiated cross-price-elasticities between the three modes.
- On the other side the increase of prices in road goods transportation will directly **reduce** the whole volume of transported goods. This effect can be estimated with the direct price elasticity of roads freight transport.

b2) Competitiveness, employment and value added in the transport sector: Impacts on employment and value added can be estimated with the help of economic indices (employees per tkm, employees per vehicle-kilometre). The magnitude of the shift between modes may serve as an indicator for the competitiveness. But also a potential increase of productivity provoked by the mileage tax has to be considered at (e.g. raise of occupancy rates, better logistics).

c) Impacts on other sectors

c1) Direct effect: The direct effect corresponds to the impacts of the mileage tax on the cost and price structure of all other sectors. These impacts vary between different sectors and countries. Sectors with a transport intensity above average will be of main interest.

c2) Indirect effect: The higher costs of road freight transport will partly be passed through to ancillary sectors and to customers of other sectors. To estimate the magnitude of this indirect effect input-output calculations are necessary.

c3) Influence on locational advantages: There are two main effects that influence the locational advantage. Firstly, there is the influence of regionally varying higher costs of road freight transport. Secondly, the use of the revenues of the mileage tax may cause positive effects on the locational advantages.

c4) Competitiveness, employment and value added: The effects mentioned above may influence the competitiveness, the employment and the value added produced of the different sectors. The assessment of the impact on these variables asks for a multi-sectoral model.

c5) Conclusions: At the end, all the effects have to be summarised in an overall economic assessment of the impacts of the mileage tax.

4.2.3 Impacts on the transport sector

a) Setting the stage

It is not possible to carry out a sound assessment of the impacts of the mileage tax for the different Member States and for the EU as a whole. Large differences in the characteristics of the freight transport sector (e.g. modal split, size of the firms, transport prices, infrastructure for the different transport modes) call for a more detailed analysis for each of the Member States. Therefore, the objective of this chapter is to estimate the order of magnitudes of the impacts on the transport sector. It will be inevitable to make rough assumptions in order to generate "European average figures".
Figure 4-1 shows that the main input for the assessment of the impacts is the effect of the mileage tax on prices of road freight transport. In a first step, we have to estimate therefore the impact of the mileage tax on transport prices in road freight transport.[2] Our assumptions for this assessment are given in table 4-2.

Table 4-2: Main assumptions for the assessment of the impact on transport prices

Parameter, assumption			Comments
average costs in **ECU/vkm**:			Estimate for Germany (lowest value of different German and Swiss estimates of costs in the transport sector[3]). Swiss estimates are 20-35% higher (reasons: 28t-limit, lower average road performance per HGV and year) lower cost rate: 10% below German estimate upper cost rate: 10% above German estimate
veh. cat.:	lower cost rate:	upper cost rate:	
3.5 - 12t	1.00	1.22	
13 - 18t	1.06	1.29	
19 - 28t	1.10	1.34	
29 - 40t	1.19	1.46	
market price: 80% of costs			reduction due to over capacities and to the cost level above average in Germany (see table 2-8 in chapter 2)
share of the different categories on total vehicle kilometres:			see chapter 3, table 3-3
veh. cat.:	% of total vkms		
3.5 - 12t	10%		
13 - 18t	45%		
19 - 28t	25%		
29 - 40t	20%		

The assumptions taken above are on the save side: The cost rate and the market price assumed are lower limits of the actual transport prices in European road freight transport.

2 We renounce on a discussion of the supply and demand figures in the freight transport sector. Some of the relevant figures are given in chapter 2 of this sub report.

3 See Kaus P., Bund Deutscher Fernfahrer (1994), Kosteninformationssystem im Strassengüterverkehr, p. 272, Ernst Basler & Partner (1995), Auswirkungen des EWR-Neins auf den Strassengüterverkehr, p. 39 und ASTAG (1990), Die Selbstkosten im Werkverkehr.

Consequently, **there is a tendency towards an overestimation of the price increase respectively the impacts caused by the mileage tax.**
With the assumptions in table 4-2 the impact of the mileage tax on the price of an average vehicle kilometre can be estimated for the different vehicle categories. The results of these calculations are given in table 4-3.

Table 4-3: Price increase caused by the mileage tax (in % of average price per vkm)

Vehicle category	lower bound of the mileage tax		upper bound of the mileage tax	
	lower cost rate	upper cost rate	lower cost rate	upper cost rate
3.5 - 12t	4.0 %	3.3 %	8.0 %	6.6 %
13 - 18t	8.9 %	7.3 %	17.7 %	14.5 %
19 - 28t	15.1 %	12.3 %	30.1 %	24.6 %
29 - 40t	28.6 %	23.4 %	57.3 %	46.8 %
weighted average of all cat.	14.3 %	11.7 %	28.6 %	23.4 %

Table 4-3 shows that the relative price increase is higher for heavy trucks than for rather light trucks. Two reasons are responsible for this effect:
- the design of the mileage tax (tax rate bases on permissible total weight of the HGV)
- costs per vehicle kilometre increase less than proportional with growing permissible total weight.

Granting the assumptions given in table 4-2, the mileage tax would **raise the price of an average vehicle kilometre** in road freight transport by **12-14%** in the case of the lower bound of the tax rate and by **23-29%** in the case of the upper bound.

b) Potential shift to other transport modes

In this section we deal with the question what shifts to other transport modes can be expected from the price increase shown in table 4-3? We distinguish between potential shifts to rail transport and to inland shipping.[4] Furthermore, we briefly discuss the potential reduction of road transport.

❑ **Potential shift to rail transport**
Several reasons limit potential shifts from road to rail transport:
- **Transport distances**: Due to the time and money used to load and unload goods on/off the trains, rail transport (incl. combined transport) is only competitive for longer transport distances: According to studies and opinions of experts the "minimum distance" is somewhere between 250 and 500 kms. Table 2-7 shows that more than 85% of all goods are transported over a shorter distance.

4 Main Sources: Zonneveld G.J. and Halstead J.C. (1994), European Road Transport; Committee of Enquiry (1994), Road Freight Transport in the Single European Market.

- **Service quality of rail transport**: In many countries the service quality (namely flexibility and reliability) of freight transport is not always satisfactory. However, studies have shown that flexibility is regarded as the most important factor in selecting a transport mode, followed by speed and price.
- **Extension and interoperability of rail networks**: Total length of the road network is substantially larger than total length of railways. Different electrification voltages, bridge heights, container width, signalling systems etc. make cross-border rail transports more difficult.
- **Rates in road freight transport**: Due to over capacities and due to the Eastern European competitors rates in road freight transport will rather decrease than increase. Therefore, a part of the price increase caused by the mileage tax (and other tolls and charges) will probably be offset.

However, one can expect that the efforts of the EU and the Member States to increase competitiveness of rail will improve the competitiveness of rail transport in the long term.

❑ **Potential shift to inland shipping**

Similar to rail transport different characteristics of inland shipping restrict the potential shift from road to this transport mode:

- **Transportation of bulk goods**: Inland shipping is mainly used for the transportation of bulk goods (e.g. sand, oil, coal etc.). The importance of these products has decreased compared to technologically advanced products.
- **Geographical restriction**: Potential shifts are of course limited to transport flows through areas that have available a canal system.
- **Speed**: Inland shipping is relatively time-consuming (loading/off loading, speed of vessels).

On the other hand increasing container shipping will improve the competitiveness of inland shipping because the variety of goods suitable for such transports is increased substantially, i.e. more goods become transportable by ships.

❑ **Reduction of road freight transport**

In table 4-3 we have assessed the raise of transport prices caused by the mileage tax. The effect of this increase on road transport volume can be approximated by applying price elasticities of road freight transport. Price elasticities are a measure for the reaction of demand to price changes. The reaction patterns included reach from reducing the amount of goods transported, an increase of efficiency in logistics to shifts in modal split.

The assessment of price elasticities in transport is difficult because they are influenced by a bundle of factors like:

- the class of goods that are transported
- short or long term perspective
- service quality of alternative transport modes
- freight transport distances
- extent of price increase.

In this sub report we rely on estimates for the price elasticities of road transport shown in the literature. Based on a short literature survey[5] we assume that the average price elasticity in road freight transport amounts to -0.2. With this rather low "guestimate" we try to take into account:

- the large share of goods that are transported over a short distance (see table 2-7)
- the limited capacities of the alternative transport modes in the Member States
- the pressure on the freight rates in road transport.

On the assumption that the average price elasticity of road transport amounts to -0.2 the mileage tax would lead to a **total reduction of the volume of road transport of 2-6%**. If we "distribute" this potential reduction linearly over a time period of 15 years, the reduction per year amounts to 0.13 - 0.4%. It should be kept in mind that the average annual growth rate of road transport is expected to be around 2.7 - 4.7% in this period (see chapter 2). Thus, the introduction of the mileage tax would only result in a small reduction of the annual growth of road transport.

If we assume that the price elasticity is substantially higher, for example -0.4, the annual reduction of road freight transport amounts to 0.3 - 0.8%.

❑ **Influence on modal split in the transport sector**

As mentioned above, the reduction of road transport volume can partly be explained by a shift from road transport to other transport modes. The extent of this shift can be approximated by the cross price elasticity. According to the literature survey mentioned[6] 0.6 can be considered as a plausible average value for the cross price elasticity between road and rail transport. If we base our assessment on this assumptions an **increase of rail transport of 7-17%** can be expected. This increase would correspond to an additional transport volume of 12-30 billion tkm. Thus, some 1.5-4% of road transport volume would shift from road to rail transport. Regarding the total reduction of the road transport volume of 2-6% it seems that a shift to rail transport is the dominant response of the transport sector to the mileage tax.

In the long term, this share will probably be higher because the improvements of rail infrastructure will increase the cross price elasticity.

c) Impacts of the mileage tax on trends in the transport sector

In chapter 2 and in the last section we have discussed different trends in the transport sector. In the following, we briefly analyse what impacts on these trends can be expected from the introduction of a mileage tax.

❑ **Raise of average occupancy rate**: Because we have chosen the permissible total weight as tax base, transport costs per tkm decrease with an increasing occupancy rate. Thus, the mileage tax sets an additional incentive to improve the occupancy rate.

5 ECOPLAN (1995), Arbeitspapier Elastizitäten im Güterverkehr.

6 ECOPLAN (1995), Arbeitspapier Elastizitäten im Güterverkehr.

- **Adjustments in the vehicle fleet**: The design of the mileage tax also affects the vehicle fleet of the haulage companies. Increasing investments in new HGV can be expected because of the differentiation of the tax rate according to the emission reduction technology of the vehicles. Furthermore, a certain trend towards lighter trucks is possible because the raise of transport costs is larger for heavy vehicles than for light ones.

- **Changing of the structure of the road transport sector**: For companies with efficient logistics it will be easier to increase the occupancy rate. The increasing importance of convincing logistic concepts (see chapter 2) would be strengthened with the introduction of a mileage tax. Small firms will have difficulties to offer competitive logistic services because the transport firms are more and more forced to provide an extensive European-wide distribution network. Accordingly, the introduction of a mileage tax would accelerate the structural change in the transport sector, especially the trend of increasing size of haulage companies (see table 2-6).

- **Effect on combined transport**: There is a slightly positive effect on combined transport because of the increase of road transport prices. The effect is lowered by the fact that over capacities and sharp competition in the road transport sector tend to reduce transport prices. On the other hand, the positive effect for combined transport could be strengthened if our proposal for the use of the revenues (see chapter 3.8) would be realised.

- **Impact on the international competitiveness of haulage companies**: Because the mileage tax bases on the territorial principle there are no additional distortions between the competition of the hauliers of different nationalities. However, the mileage tax will improve the competitiveness of haulage firms with a modern vehicle fleet because of the differentiation of the tax rate according to the emissions of the HGV.

4.2.4 Impacts on other sectors

a) Transport intensity of the sectors

To assess the influence of the mileage tax on the cost structure and thereby on product prices of the different sectors the transport intensity of the sectors must be known. The **transport intensity** can be **defined** as follows: The transport intensity corresponds to the **ratio between the sector specific road freight transport costs and the value of the gross production of the sector** (this last value equals the sum of intermediate consumption and value added). As the transport intensities are not available for every Member State, estimates from existing studies for single countries are being used.

The estimates in table 4-4 are based on input-output-tables for Germany and Switzerland.[7] They only show the sectors with a high transport intensity. The direct transport intensity corresponds to the intermediate consumption of road freight transports for every sector. The indirect transport intensity can be derived by calculating the famous Leontief Inverse from the input-output-tables.[8] This was done for Germany and Switzerland.

Of course, the production process in the sectors may vary substantially between different Member States. Therefore, table 4-4 has to be understood as a very raw estimate of the magnitude of the transport intensity.

Table 4-4: Estimate of the average direct and indirect transport intensity in road freight transport in transport intensive sectors for Germany and Switzerland (1990)

	Direct transport intensity	Direct and indirect transport intensity
Cement, lime, building materials	4%	7%
Petroleum products, refineries	3%	5%
Wholesale trade	2.5%	3.5%
Fine paper, paper and pulp products	2%	3.5%
Food products, beverage, fodder	2%	3.5%
Printing and publishing	2%	3.5%
Metallurgy, ores	1.5%	3.5%
Forestry, saw mills, furniture	1.5%	3.%
Construction	1.5%	3.%
Rubber and plastic products	1.5%	3%
Hotels and restaurants	1.5%	2.5%
Chemicals	1%	2.5%
Glass, ceramic products	1%	2.5%
Machinery, motor vehicles	1%	2.5%

For the remaining sectors the direct transport intensity (regarding road freight transport only) can be estimated below 1%. These sectors have a low transport intensity and will hardly be affected by the mileage tax. Particularly almost the whole services sector belongs to this category.

It is an open question if the transport intensities will be the same in other Member States of the EU. As the structure of the economy changes, transport intensities may also change.
For instance, in Germany and Switzerland the share of other transport modes in freight transportation is above the average compared to the EU. This could indicate that trans-

7 See DIW et al. (1994), Verminderung der Luft- und Lärmbelastungen im Güterfernverkehr 2010 and internal calculations.

8 The Leontief Inverse considers additionally the road freight transport costs that are incorporated in the costs of all other intermediate goods.

port intensities in the EU (regarding road freight transport only) are higher than the results in table 4-4.
On the other hand, Germany and Switzerland are countries with a very high division of labour, which may cause transportation needs above the average.

b) Direct and indirect effects of the mileage tax

The transport intensities estimated above are used to assess the impacts of the mileage tax on the cost structure and the prices of the single sectors. It is possible to estimate an upper bound for these effects regarding the following assumptions:

- The mileage tax is fully passed through to the transport demand
- Potential shifts to other transport modes (and therefore a smaller increase of transport prices) are ignored.

Under these assumptions the maximum potential rise of the production costs in the transport intensive sectors will be calculated. The results are summarised in table 4-5.

Table 4-5: Maximum direct increase of production costs caused by the mileage tax in transport intensive sectors on the average for Germany and Switzerland (1990)

	Lower bound tax rate,[9] estimated increase of road freight prices on average[10]	Upper bound tax rate, estimated increase of road freight prices on average
Cement, lime, building materials	0.52%	1.04%
Petroleum products, refineries	0.39%	0.78%
Wholesale trade	0.36%	0.65%
Fine paper, paper and pulp products	0.26%	0.52%
Food products, beverage, fodder	0.26%	0.52%
Printing and publishing	0.26%	0.52%
Metallurgy, ores	0.2%	0.39%
Forestry, saw mills, furniture	0.2%	0.39%
Construction	0.2%	0.39%
Rubber and plastic products	0.2%	0.39%
Hotels and restaurants	0.2%	0.39%
Chemicals	0.13%	0.26%
Glass, ceramic products	0.13%	0.26%
Machinery, motor vehicles	0.13%	0.26%

9 The lower bound tax rate is 0.006 ECU/$t_{tw,km}$, the upper bound tax rate is 0.012 ECU/$t_{tw,km}$ (see section 3.2.3).

10 The average estimated increase of prices in road freight transport is 13% for the lower bound of the tax rate and 26% for the upper bound of the tax rate; see section 4.2.3, table 4-3.

Comment:

- The maximum direct rise of the production costs caused by the mileage tax lies around the 1% - level. For the lower bound tax rate, in six sectors a cost increase above 0.2% will occur, respectively above 0.4% for the upper bound tax rate.
- It can be expected that the mileage tax will only partially be passed through from the road freight transport sector to the road freight transport demand. Therefore, the estimates in table 4-5 overestimate the actual direct increases of the production costs.
- As permissible total weight is the tax base of the mileage tax the proposed mileage tax will lead to rising price increases with higher total weight of a heavy goods vehicle. Therefore, sectors using heavy goods vehicles with a permissible total weight over the average (e.g. many 40-tonne HGVs) will have a slightly higher maximum cost increase than estimated in table 4-5.

The direct impacts of the mileage tax on production costs were reported on table 4-5. But as the intermediate goods used in the production process include also transportation costs, this indirect effect has to be taken into account additionally.
In table 4-6 the maximum effect on production costs is shown including the direct and indirect effects of the mileage tax.

Table 4-6: Maximum direct and indirect increase of production costs caused by the mileage tax in transport intensive sectors on the average for Germany and Switzerland (1990)

	Lower bound tax rate,[11] estimated increase of road freight prices on average[12]	Upper bound tax rate, estimated increase of road freight prices on average
Cement, lime, building materials	0.91%	1.82%
Petroleum products, refineries	0.65%	1.3%
Wholesale trade	0.46%	0.91%
Fine paper, paper and pulp products	0.46%	0.91%
Food products, beverage, fodder	0.46%	0.91%
Printing and publishing	0.46%	0.91%
Metallurgy, ores	0.46%	0.91%
Forestry, saw mills, furniture	0.39%	0.78%
Construction	0.39%	0.78%
Rubber and plastic products	0.39%	0.78%
Hotels and restaurants	0.33%	0.65%
Chemicals	0.33%	0.65%
Glass, ceramic products	0.33%	0.65%
Machinery, motor vehicles	0.33%	0.65%

11 The lower bound tax rate is 0.006 ECU/$t_{tw,km}$, the upper bound tax rate is 0.012 ECU/$t_{tw,km}$ (see section 3.2.3).

12 The average estimated increase of prices in road freight transport is 13% for the lower bound of the tax rate and 26% for the upper bound of the tax rate; see section 4.2.3, table 4-3.

Comment:

- Table 4-6 shows the maximum total increase of production costs in the sectors with a high transport intensity (taking into account the direct and the indirect effect). Base of the results in table 4-6 are input-output-tables for Germany and Switzerland. Therefore, the results are only of indicative character for other Member States of the EU.
- Again the fact should be stressed that actual increases of production costs will be substantially smaller than in table 4-6 because
  - the road freight transport sector will not pass through the whole mileage tax to transport demand
  - not all transportation cost included in intermediate goods will be passed through to the sectors demanding these intermediate goods.

  Correspondingly, the values in table 4-6 clearly are upper values of the possible cost effect of the mileage tax.
- Keeping this in mind table 4-6 shows that
  - the maximum effect of the lower bound mileage tax on the production costs would be below 1% of total production costs. In almost every sector the cost increase is less than 0.5%.
  - also in the case of the upper bound mileage tax only a very few sectors may experience an increase of production costs above 1% (Cement, lime, building materials and petroleum products, refineries).

c) Conclusions

The calculations of the direct and indirect effects of the mileage tax on the production costs of the sectors with a high (road freight) transport intensity could only be done for the example of German and Swiss input-output-tables. Although other Member States of the EU may have quite a different economic structure first, more general conclusions from these calculations can be drawn:

- The proposed mileage tax will only have a **very moderate influence on the production costs of other sectors**. Compared to other influences (the exchange rates, the wage level or technical progress) the impact is nearly negligible.
- The calculations for Germany and Switzerland show that for the lower bound of the proposed mileage tax the **maximum** increase of the production costs comes to 0.2 - 0.5% for almost every sector with a high transport intensity. Only for two sectors (cement, lime, building materials and petroleum products, refineries) it is conceivable that the cost effect will be above 0.5%. For all other sectors, particularly the whole services sectors, the cost effect amounts to about 0.3%. Taking the upper bound of the mileage tax we expect approximately doubled cost effects compared to the lower bound mileage tax.

  It seems very plausible that in the other Member States the maximum effects on production costs will be of the same magnitude.
- On account of the above results the proposed mileage tax **will not have a noticeable impact on the competitiveness and on the growth rate of the European economy**. This is true all the more as **the revenues of the mileage tax are not lost but**

would be refunded to the economy either through a reduction of the social security contributions or through a wage sum bonus (see chapter 3.8).

- At last, it must be remembered that the main objective of the mileage tax is to redress an economic market failure. Today, road freight transport is too cheap. It causes external costs (air pollution, noise, accidents) that affect public welfare. With the introduction of the mileage tax the road freight transport sector will at least partly pay for these external costs. Therefore, the mileage tax creates an incentive for adjustment processes towards a more efficient and welfare optimising road freight transport system.

4.3 Ecological assessment

On principle, the ecological impact of the mileage tax has two sources:

- reduction of the transport volume and the performance of road freight transport
- improved emission abatement technology of the lorries

In the centre of our discussion is the **air pollution** caused by road freight transport because of the differentiation of the mileage tax according to the emissions of air pollutants. Furthermore, the contribution to air pollution is the most serious impact of road freight transport on the environment and human life.
The contributions of road transport to total emissions of air pollutants are the following:[13]

- NO_x: 61%
- VOC: 49%
- CO_2: 26%

The share of road freight transport on total emissions of mobile sources differs from Member State to Member State. The figures for the EU are given in the table below:

Table 4-7: Estimate of total emissions of road freight transport, 1991 (EUR 15)[14]

Pollutant	1'000t/a	share of road freight transport on total emission of mobile sources
NO_x	2'053	42%
VOC	436	14%
CO_2	179'541	32%

13 See OECD (1993), OECD environmental data stated in Infras/IWW (1994), External effects of transport, p. 112.

14 Infras/IWW (1994), External effects of transport, p. 122.

From topic A we know that HGV considerably contribute to the overall **noise emissions** of road transport. Though the amount of kilometres driven of passenger cars is 20 times higher than the mileage of HGV, reducing the noise of HGV will have almost the same effect as reducing the noise emissions of passenger cars.

4.3.1 Impact of the road performance

From section 4.2 we know that the reduction of road transport volume would probably be very modest compared to the expected growth in the next 15 years. Accordingly, the impact on the emissions of **air pollutants** is relatively small.
If we neglect the change in emission abatement technology, we can conclude that the mileage tax reduces total emission (all sources) by the following orders of magnitude

- NO_x: 0.5 - 1.5%
- VOC: 0.14 - 0.4%
- CO_2: 0.17 - 0.5%

In the case of **noise**, the effect will also be very limited because of the characteristics of noise emissions. Only a large decrease of traffic volume results in a substantial reduction of noise emissions. From this point of view it would be useful to differentiate the mileage tax according to space. A relatively high tax rate in urban areas could contribute to an improvement of the situation.

But it is quite clear that the tax "would not do the job". Other transport policy measures like local speed limits, access restraints etc. will certainly be needed.

4.3.2 Impact of the improved technology

Regarding the contribution to the reduction of emissions the incentive set by the tax to improve the emission abatement technology of the trucks is more important than the reduced road performance of road freight transport:

- In the case of **air pollutants** table 3-5 has shown that the potential of improved technologies is considerable. Remembering the assessments of topic A that resulted in low and even negative marginal avoidance costs of technological measures to reduce the emissions of air pollutants the mileage tax would contribute considerably to a switch from heavy polluting to "cleaner" trucks.
- In comparison to the effect of the reduced traffic volume the technology effect would be even more important in the case of **noise emissions** from HGV. From topic A we know that reducing noise at the source has the advantage that the reduction of the noise annoyance is independent of the location, i.e. indoor and outdoor noise will be reduced.

If the differentiation is adjusted in the course of time the tax will furthermore set an incentive for truck manufacturers to develop emission abatement technologies beyond today's knowledge. This **dynamic effect of the differentiated mileage tax** has not only an important ecological component. It is also possible that European truck manufacturers gain shares of market if they can offer cleaner HGVs than the competitors outside the Common Market.

An assessment to what extent the differentiated mileage tax would promote the use and the development of cleaner and less noisy trucks is not possible within this sub report. Further information about the additional costs caused by different technologies and about the distribution of the different vehicle types would be necessary.

4.3.3 Conclusion

The main ecological impact of the mileage tax will result from the incentives set by the differentiation of the tax to use and develop less polluting HGV. On the other hand, the effect of the tax on the kilometres driven must not be overestimated because the expected growth of road freight transport will more than compensate the reduction effect of the price increase.

However, one should keep in mind the following points:

- We have always understood **the mileage tax as one possible instrument** of a bundle of policy measures to reduce the emissions of road transport.
- Due to different difficulties in the assessment of external costs (see topic A of this research project) it can be assumed that the existing estimates represent only the **very lower limit of the "true" external costs**. Accordingly, the tax rate is also "too low".
- Our description of the **mileage tax bases on today's knowledge**. As soon as new results will be generated by research projects they should be taken into account in the design of the tax. This also refers to technological improvements: Once the standards set out in section 3.3 will be attained by most of the trucks in use the tax can set incentives for further innovations in emission abatement technologies.
- And last but not least: In this sub report we often had to make speculative assumptions. We have always tried to be on the "save side", i.e. our assessment bases on rather **conservative assumptions**. With this procedure we risk to systematically underestimate the potential of a mileage tax.

4.4 Technical assessment and cost-benefit aspects

4.4.1 Introduction

In section 3.5 we have described the technical requirements that must be met by the metering system used to implement the mileage tax. In this section we come back to the important question of **cost-benefit aspects** of the mileage tax described in this sub report. The core question is whether the development and running costs of such an electronic pricing system can be justified by its effect on the negative impacts of road freight transport on the environment and human health.

As mentioned in section 3.2.2 it is of course not possible to compare the mileage tax with the whole range of other internalisation instruments and with other transport policy measures within the frame of this sub report. Therefore, the discussion is limited to two different kinds of analysis:

- In the next section the question will be investigated whether a rather **simple version** of a mileage tax would also "do the job", or whether - with regard to the differentiation of the tax - a **more "sophisticated" version** is needed.
- In section 4.4.3 the mileage tax will be compared with the other form of a usage related tax for road freight transport, namely the **diesel tax**.

4.4.2 "Simple" or "sophisticated" mileage tax?

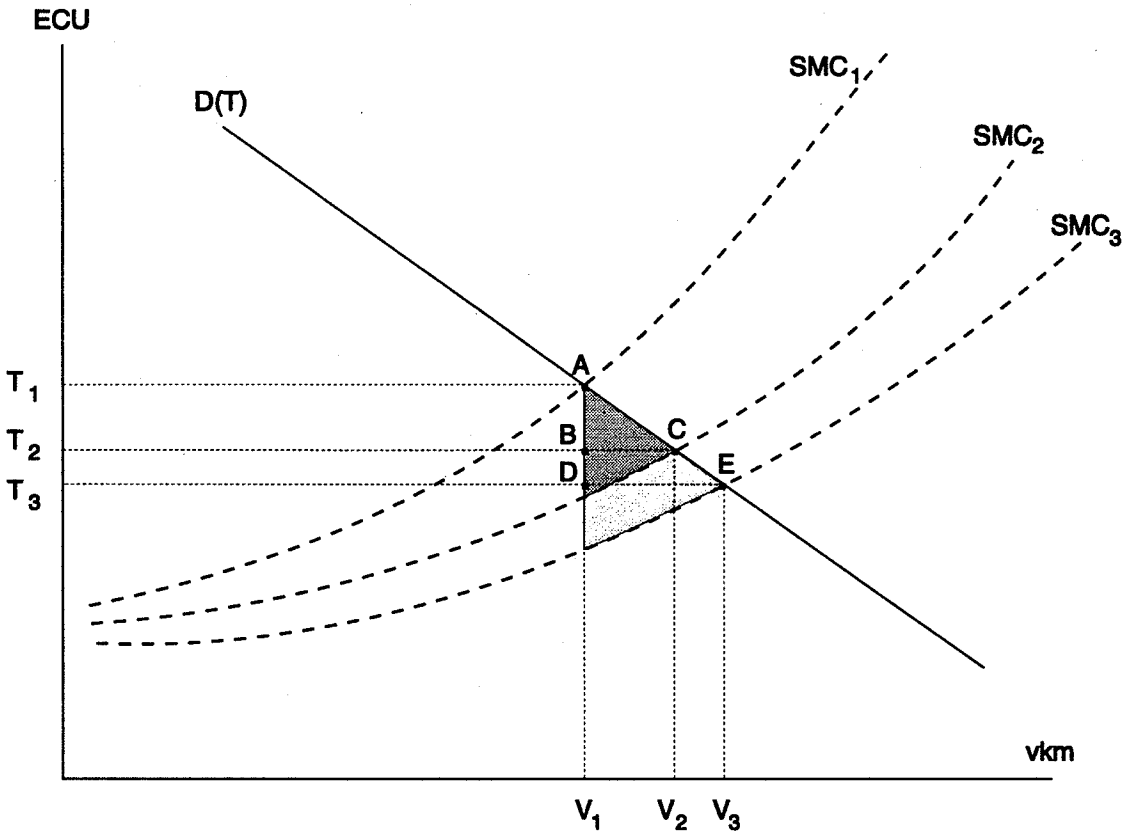
In chapter 3 three versions of a mileage tax were distinguished:

- **Basic version**: In the basic version the tax is defined by the kilometres driven and by the permissible total weight of the vehicle.
- **Extended version**: The notion "extended version" is used to describe a mileage tax whose tax rate is differentiated according to the emission abatement technology of the vehicle. Possible differentiation options are given in section 3.3. Due to the reasons mentioned in that section a differentiation according to the emissions of air pollutants is in the centre of interest.
- **Sophisticated version**: This version contains further differentiation options, namely a spatial and temporal differentiation of the tax rate (see section 3.4).

The theoretical framework of the comparison of different versions of the mileage tax is provided in the chapter "Theory of Internalisation" (section 2.3.3 of the synthesis report). The "decision rule" whether the mileage tax should be differentiated or not was graphically summarised in figure 2-6 and reads as follows: A differentiation option should be realised as long as the welfare gains resulting from this further differentiation are higher than the additional implementation costs caused by this differentiation option.

If this decision rule is applied to the **"extended version"** of the mileage tax the potential welfare gains of this version in comparison with the **basic version** can be described as shown in figure 4-8.

Figure 4-8: Potential welfare gains of the "extended version" of the mileage tax



Comment:

- SMC_1 represents the social (internal and external) marginal costs per vehicle kilometre caused by a HGV with an emission abatement technology only meeting the emission limits EURO I.
- SMC_2 shows the situation for a HGV meeting the requirements of EURO II.
- SMC_3 shows the situation for a HGV meeting the requirements of EURO III.
- D(T) shows transport demand.

In the basic version of the mileage tax the tax rate is T_1. The differentiation according to the emission abatement technology results in the three tax rates T_1, T_2 and T_3. The last two tax rates refer to cleaner HGV meeting EURO II and EURO III respectively. The potential welfare gains of this differentiation are given by the shaded areas in figure 4-8.[15] If these welfare gains are higher than the implementation costs of a differentiation of the taxation system according to the three different classes, the mileage tax should be differentiated as proposed in section 3.3.

15 The dark shade shows the welfare gain of the differentiation between T_1 and T_2, the dark and the light shade the one between T_1 and T_3.

In this sub report it is not possible to give a final answer to the question whether the welfare gains are higher than the additional implementation costs or not. Important information that are needed to assess both, the welfare gains and the implementation costs, are not available:

- Figure 4-8 shows that the shape of **the demand and of the external cost curves** should be well-known to assess the potential welfare gains. Especially in the case of the external cost curves this is not the case.
- The additional **implementation costs** of a tax differentiation are the sum of two types of additional costs:
  - "**Classification costs**": Any differentiation of the mileage according to the emissions of the vehicles demands that each HGV is assigned to the category corresponding with its emission abatement technology. In the case of the "sophisticated" version of the tax a classification of the regions of Europe is necessary too.
  - **Additional costs of the metering system**: These costs depend on the choice of the metering system used to implement the mileage tax. This choice will only be possible after the several projects and programmes dealing with automatic debiting systems will be brought to a close. It should be noted that the "first" objective of the systems currently tested is to take account of all infrastructure costs according to the territoriality principle and to the user-pays-principle.

Because of these uncertainties we choose a pragmatic two-step procedure to assess whether and to what extent a tax differentiation can be justified:

- **Step 1**: Based on plausible assumptions the orders of magnitude of the potential welfare gains are estimated.
- **Step 2**: The results of the estimates are compared in a qualitative way with the possible implementation costs of different technical solutions.

a) Step 1: Welfare gains

Due to the uncertainties mentioned above, the welfare gains given by the shaded areas in figure 4-8 cannot be assessed directly. In the sense of an **approximation** one can estimate the size of the planes ABC and ADE. Implicitly, it is then assumed that the external marginal cost curve is a horizontal line, i.e. external marginal costs are assumed to be constant. In the case of air pollution one can rather expect an increasing external marginal cost curve, in the case of noise a decreasing one. The overall effect is uncertain.

There is another important point that must be considered when an approximate value for the size of the shaded areas in figure 4-8 is assessed. The result of such an assessment is strongly influenced by the "market share" of the different emission abatement technologies, i.e. the distribution of the HGV to the classes 1, 2 and 3. This distribution again is influenced by the differentiated mileage tax because the tax would accelerate the penetration rate of new technologies - in our case of technologies meeting the emission limits of EURO III. Thus, the welfare gains will vary considerably in the course of time. Accordingly, a **dynamic analysis** taking into account the changes in the market shares would be much more suitable than a static analysis.

In a very pragmatic way this dynamic aspect will be considered in our estimate by assessing an average approximate value over a time period with different market shares of the three technologies and by assuming a technology penetration rate with and without the differentiated mileage tax.

The assumptions taken to assess very roughly the welfare gains of a tax differentiation are given in table 4-9.

Table 4-9: Main assumptions for the assessment of the welfare gains of a tax differentiation according to the emission abatement technology of the HGV, case of air pollution

Parameter, assumption				Comments
market share of the different classes b: beginning of the period e1: end of period without differentiation e2: end of period with differentiation				the period begins in 1996 and ends in 2005, EURO II (the emission limit of the class 2) will become effective after 1995 (i.e. every new HGV will at least meet EURO II), EURO III is not introduced as a requirement for new HGV but only as a base for the tax differentiation
type of HGV	$share_b$	$share_{e1}$	$share_{e2}$	
class 1	0%	0%	74%	
class 2	2%	98%	24%	
class 3	98%	2%	2%	
lifetime of the HGV: 8 years				used to define the replacement rate
switch to class 3 instead of class 2 due to the differentiation of the mileage tax: 75% acceleration of replacement rate of HGV: 10%				The rates are based on the mileage tax differentiation according to the damage cost approach (see table 3-7) and are chosen rather high as the additional costs of class 1 are low in comparison to the available tax reduction
the other assumptions are the same as used in the previous sections of this chapter				e.g. elasticity, average price per vkm, tax rates and differentiation

Proceeding on the assumptions given in table 4-9 the result of the assessment of the welfare gain per "average" vehicle and year can be summarised as follows:

- The average size of the welfare gain over the period considered is about **15-25 ECU per vehicle and year** (max. value per year about 30 ECU). In other words: Additional implementation costs of around 150 ECU per vehicle would be justified to introduce a differentiation of the mileage tax according to the emissions. Though this figure should be understood only as a very rough approximate value, it gives an idea of the order of magnitude for the additional implementation costs that can be justified by the welfare gains of the tax differentiation.
- At first sight, the result seems low. However, it should be taken into account that many of the very preliminary assumptions and simplifications strongly influence the result of the assessment:

- The larger the differences between the single tax rates T_1, T_2 and T_3, the higher are of course the potential welfare gains of a differentiated mileage tax.
- In our assessment we had to neglect the possibility that the mileage tax could induce or accelerate the development of emission abatement technologies beyond today's knowledge. If this "innovation effect" of the tax should occur the potential welfare gains would increase.
- The level of the mileage tax rate bases on estimates of external costs (see section 3.2.3). The estimates used tend to underestimate the amount of external costs. However, a higher level of the basic tax rate would lead to an increase of the potential welfare gains.

In the assessment above, only a differentiation of the tax according to emissions of air pollutants was considered . Topic A and section 3.3 of this sub report have shown that also in the case of **noise** a differentiation between different types of HGV can be justified. An approximate value for the potential welfare gains of this kind of differentiation could be assessed in the same way and with - at least (!) - the same uncertainties as in the case of air pollution. Basing on the figure given in table 3-8 one can assume that the approximate values for the potential welfare gains would be slightly smaller but of a similar order of magnitude as in the case of air pollution.

So far, the analysis concentrated on the "extended version" of the mileage tax and has now to include the "**sophisticated version**" of the mileage tax. Here, we first of all look at a **spatial differentiation** of the tax.[16]
The two basic assumptions to assess an approximate value of welfare gains of this kind of differentiation are the following:

- Basing on section 3.4 it is assumed that marginal external costs per average vehicle kilometre driven in an urban area are twice as high as in rural regions.
- An average vehicle produces 50% of its road performance in urban areas and 50% in rural areas.

These assumptions given, the approximate value for the potential welfare gains amounts to almost **60 ECU per vehicle and year**.
The difference to the 15-25 ECU per vehicle and year of the "extended version" is caused by the fact that the two spatially differentiated tax rates differ much more than the three tax rates differentiated according to emissions of air pollutants.

b) Step 2: Implementation costs

It should be kept in mind that in the context of this sub report only the additional implementation costs caused by the tax differentiation are of importance and not the implementation costs of the automatic debiting system itself. These costs would be relevant in a cost-benefit analysis that compares the benefits of all potential ways to use such a

16 A temporal differentiation would be important if congestion costs were also included in the mileage tax, which is not the case in our proposal (see section 3.2.2).

system (e.g. charging for infrastructure costs, internalisation of external costs, control of traffic flow, fleet navigation of private haulage firms) with the costs and benefits of a transport policy strategy using other instruments than automatic debiting systems.

As mentioned, two cost categories have to be distinguished:

- **"Classification costs"**:
  - Extended version of the tax: The classification costs are of course lower if emission standards are introduced independently of the introduction of a mileage tax. In the case of air pollutant emission limits the classification system of EU for diesel driven HGV is more advanced (EURO I and II, German proposal for EURO III) than in the case of noise emissions (only emissions limits for 1990, proposal for 1996). However, more important is that the procedure of defining and measuring the emission limits is determined.
  - Sopisticated version of the tax: This version of the tax demands a new classification of the regions of Europe. Information on the level of pollution could be used for the assignment. Whatever criteria are used for the assignment the costs will certainly remain below the approximate value of the welfare gains assessed above.
- **Additional costs of the metering system**:
  - Extended version of the tax: One main requirement of any automatic debiting system is that the system can distinguish between different types of vehicles. All electronic metering systems in discussion[17] meet this basic requirement. Thus, all systems could also take into account differences in the emission abatement technologies provided all the vehicles are assigned to the different classes. The additional implementation costs would be very low.
  - Sophisticated version: The spatial differentiation of the mileage tax will cause considerable implementation costs for those metering systems that need large off-vehicle installations. A system based on beacons and on-board-units may be conceivable if only for a few very big european metropolitan areas a spatial differentiation is introduced. In any case, a metering system based on a global positioning system would be more cost-effective. With this system a very precise identification of the the spatial position of the vehicle is possible. Therefore, the additional costs of a spatially differentiated mileage tax would be restricted to a more sophisticated on-board-unit and debiting system.

c) Conclusions

Though the analysis carried out above had to face many uncertainties some first conclusions can be drawn:

- In the case of the extended version of the mileage tax the most relevant implementation costs are the classification costs. Regarding the possibilities of electronic metering systems the additional costs of the metering systems are rather negligible. The extended version would take profit from a situation in which a classification of the

17 For an overview of the systems see for example Heusch Boesefeldt und TÜV Rheinland (1993) Automatische Gebührenerhebung (AGE) auf Autobahnen in Deutschland.

vehicles is made independently of the mileage tax, for example in order to define emission limits of new registered HGV. In this context, it should be kept in mind that any transport policy measure taking into account the emission abatement technology needs a classifiction of the vehicles.

- The potential welfare gains of a spatial differentiation seem to be comparatively high. Thus, this kind of differentiation should be realised if it is possible at reasonable costs. This is not the case for a simple manual system.
- Out of the different electronic metering systems those based on the global positioning system are most suitable to realise this kind of differentiation at low additional costs. One can therefore conclude that the "sophisticated" and not only the "extended version" of the mileage tax should be the final objective of an introduction of this instrument.
- Automatic debiting systems are mainly developed and tested due to other reasons than the internalisation of external costs (charging for infrastructure costs, control of traffic flow, fleet navigation). As a consequence, the additional costs to use such systems for the implementation of a mileage tax may be substantially lowered. Therefore it is important, that the choice of a specific automatic debiting system is also based on criteria that are important from the point of view of an internalisation of external costs (e.g. the spatial differentiation).

4.4.3 Mileage or diesel tax?

Besides the mileage tax there is another usage related tax that could be used to internalise the external costs of road freight transport, the tax on diesel. In this section we will briefly discuss the main advantages and disadvantages of this alternative to the mileage tax described in chapter 3.[18]

The following points will be discussed:
- possible tax bases and differentiation options
- implementation costs
- incentive effects
- political aspects

a) Possible tax bases and differentiation options

This point refers to the discussion of section 3.2.2 in this sub report. For both, the mileage tax and the diesel tax, parameters that could form the tax base and different externalities which could be part of the tax are compared.

18 A very rough comparison contains chapter 3 of the synthesis report "Pre-selection of possible internalisation instruments".

Table 4-10: Possible tax bases for the mileage and the diesel tax

Parameters	**Mileage tax**	**Diesel tax**
Emission abatement technology of HGV	May serve as a tax base through a differentiation of the tax rate according to emission factors	At most, may partly serve as a tax base through a tax rate differentiation according to the diesel quality
Deterioration of performance (engine, abatement technologies)	May influence the tax if periodically the emission behaviour of the vehicles are tested	Some influence on the tax through the probable increase of fuel consumption
Place of driving	Possible tax base through a spatial differentiation of the tax rate	It is not possible to differentiate the diesel tax spatially
Time of driving	Possible tax base through a differentiation of the tax rate according to time	It is not possible to differentiate the diesel tax according to time
Elements of external costs	**Mileage tax**	**Diesel tax**
CO_2	Only indirect relationship	Direct relationship between fuel consumption and CO_2-emissions
Air pollution (NO_x, VOC, SO_2, particles)	Strong relationship as emissions are dependent on the technology	Only indirect relationship between emissions and fuel consumption
noise emissions	Strong relationship if the mileage tax is differentiated according to noise emissions	Almost no relationship between diesel tax and noise emissions
accidents	Second best solution	Second best solution
congestion	Strong potential relationship through a temporal and spatial tax differentiation	Almost no relationship between the diesel tax and congestion

Comments:

- Regarding the possible tax bases, the two taxes are first of all good complements of each other. The advantages of the mileage tax refer to those points where the diesel tax has its disadvantages and vice versa.
- Table 4-10 supports the proposal to combine the mileage tax with a European or even OECD wide CO_2/energy tax to internalise the external costs of CO_2 emissions (see synthesis report, chapter 3 "Pre-selection of possible internalisation instruments").
- The mileage tax can take into account more different external cost elements than the diesel tax, which is limited to energy consumption and CO_2 emissions. However, it would need a thorough analysis to assess and compare the overall impacts of both taxes on the external costs of transport.

- If a diesel tax is used to internalise the external costs of freight transport it would be difficult to take into account spatial and temporal differences in the level of pollution. Regional and/or urban road pricing systems were a possible way out but then the advantage of low implementation costs (see next section) will be lost.
  However, in both cases, the disadvantages could be partly removed with other policy measures like speed limits, driving education or differentiated sales taxes.

b) Implementation costs

In table 4-11 different aspects of the implementation costs of the two instruments are compared.

Table 4-11: Implementation costs of the mileage tax and of the diesel tax

Parameters	Mileage tax	Diesel tax
Basic system costs	Comparatively high, a new electronic metering system is needed	Low additional costs because fuel is already taxed, no additional metering system is required
Sources of additional costs and of cost reductions	– Clearing office to redistribute the revenues: Necessary if the mileage tax should also charge for infrastructure costs and if not all roads are state-owned. – Combination option: Automatic debiting systems are developed for other purposes than the internalisation of external costs (control of traffic flow, fleet navigation). This may lead to a substantial reduction of the additional implementation costs of a mileage tax.	– Enforcing the territoriality principle: This general objective of the Common Transport Policy (CTP) could only be realised with border controls. Border controls disturbing the free traffic flow are not allowed within the internal market. A technical device to check automatically the content of the fuel tank is necessary, costs are unknown. Vehicles must be equipped with standard tanks. – Different petrol pumps at the filling stations: Necessary if the tax rates for HGV and passenger cars are different and/or if the tax distinguishes between different qualities of diesel. – Clearing office to redistribute the revenues: Necessary if the diesel tax should also charge for infrastructure costs and if not all roads are state-owned

Comments:

- The features and impacts of a CO_2/energy tax have been discussed extensively. It would be no problem to add an extra-charge for HGV to the diesel tax. Already now, the diesel tax is a sum of different components (general taxes, infrastructure charges, VAT).
- However, the advantage of the diesel tax most often mentioned, the low implementation costs, is only partly true. First of all the border problem is unsolved. In the case of the mileage tax the metering systems in discussion are all capable to identify spatial frontiers. In the case of the diesel tax a new system would have to be developed if the territoriality principle should be realised.
- The comparatively high basic system costs of the mileage tax were lower if a simple manual system (e.g. basing on the disks of the speedometer) was introduced. However, such a solution would face the problem that the main advantages of the mileage tax would not be available, namely the differentiation options (space, time). Therefore, it is probable that a diesel tax also lacking these options would be more cost-efficient than a mileage tax based on a simple manual system.
- If the different possible purposes of an automatic debiting system are taken into account in the development of the metering systems the costs that are to be assigned to a single purpose will be lower as if a system was developed especially for this purpose alone. The potential of an electronic metering system to pursue different objectives (mileage tax including a charge for infrastructure costs, control of traffic flow, fleet navigation) is a major advantage of the mileage tax, not only with regard to the implementation costs.

c) Incentive effects

Table 4-12 compares the (dynamic) incentive effects of a mileage tax and a diesel tax.

Table 4-12: Incentive effects of the mileage tax and of the diesel tax

Parameter	Mileage tax	Diesel tax
Innovation effects	Strong incentive to develop technologies with reduced emissions of noise and air pollutants. The more the mileage tax is differentiated according to emissions the stronger are these effects	Strong and lasting incentive to develop less fuel consuming HGV, but no direct incentive to reduce the emissions of noise and air pollutants as NO_x, VOC, SO_2 or particles.
Kilometres driven	Lasting incentive to reduce the kilometres driven	Lasting incentive to reduce the kilometres driven
Way of driving	No influence of the mileage tax	Direct influence of the diesel tax
Price distortions	No negative incentive effects	Negative incentive to switch to gasoline operated light goods vehicles.

Comments:

- Both taxes have positive dynamic incentive effects to reduce the kilometres driven and therefore influence the modal split in European freight transport.
- The diesel tax sets a strong incentive to develop less fuel consuming diesel engines and to drive in a fuel efficient way. In this respect, the diesel tax has an advantage over the mileage tax which is not so consumption oriented. On the other hand, the diesel tax alone sets a negative incentive to switch to gasoline operated LGV as the price of gasoline is not increased in the same way. This disadvantage could be avoided with a general CO_2/energy tax. Therefore, it can be concluded that also in respect of the incentive to introduce less fuel consuming engine technologies a combination of a mileage tax and a general CO_2/energy tax (as it is proposed in this sub report) has to be prefered to a mileage tax.
- Only the mileage tax has the potential to set an incentive to develop technologies with reduced emissions of noise and air pollutants (NO_x, VOC, SO_2, particles). The more the mileage tax is differentiated according to emission factors the stronger this incentive. In this sub report only three emission classes were defined to demonstrate the principle of differentiation. Of course, it would also be possible to introduce more emission classes or even a continuous differentiation of the mileage tax.

d) Political aspects

The criteria "political aspects" refers to the aspects given in table 4-13.

Table 4-13: Political aspects of the mileage tax and the diesel tax

Parameters	Mileage tax	Diesel tax
Co-ordination with current EU policy	User charges, tolls and automatic debiting systems are an important topic of the Common Transport Policy (CTP) (see section 4.5)	CO_2 / energy tax discussion at EU level, new initiatives within the Spanish EU presidency is announced
Co-ordination with policy in other OECD countries	Less important, because it does not deal with global problems and "only" refers to the freight transport sector	CO_2 reduction policy as a complex international issue (global problem, inclusion of emissions from industry and households)
Political acceptance	Main difference to the diesel tax: privacy problem (for the other points see section 4.5)	

Comments:

- The diesel tax cannot be treated irrespective of the CO_2/energy tax. The CO_2/energy tax is a politically and internationally highly complex and interlinked issue (as is the climate change in general). The introduction depends (according to certain views) on the introduction of similar instruments in other regions of the world.

e) Conclusions

From the qualitative discussion the following conclusions can be drawn:

- From the point of view of the incentive to reduce external effects of air pollution and noise the mileage tax has marked advantages compared to the diesel tax because only the mileage tax can be differentiated according to emission factors.
- It is not obvious which tax has the better cost-benefit ratio. Actually, the two instruments can hardly be compared because they pursue different objectives and have not the same incentive effects. In many respects they are rather complements than substitutes.
- A more useful comparison would have to base on packages of instruments to internalise external costs of road freight transport. The packages would consist of the mileage tax or the diesel tax plus useful accompanying policy measures. The core of the two packages could, for example, consist of the following instruments:
  - Core of package 1: CO_2/energy tax as global incentive charge and a differentiated mileage tax ("sophisticated version")
  - Core of package 2: Diesel tax, annual vehicle and/or sales taxes and urban road pricing schemes

  Both packages can take into account the most important external cost elements and influencing parameters (technology, spatial and temporal differences, way of driving). Again, it is not obvious which package is more cost-efficient.
- Compared to a general CO_2/energy tax, a diesel tax is only a second best solution because with a CO_2/energy tax there are no price distortions between different kinds of fuel and, correspondingly, no negative incentive effects. Additionally, if diesel driven cars do not have to pay the diesel tax, different diesel pumps at the filling stations are necessary. As it may be difficult to introduce a diesel tax independently of the political discussion about a CO_2/energy tax it seems to be the advantageous strategy to promote first of all the introduction of a CO_2/energy tax.
- An argument in favour of a transport policy strategy basing on a differentiated mileage tax is the fact that such a strategy would fit the current CTP (key word in this context: user charges, tolls) and the development in road freight transport (key word in this context: telematics).

4.5 Political assessment

In the last decade, the use of economic instruments has been promoted extensively by economists and also by politicians. One can say that on the intellectual side the battle is won but on the implementation side many efforts are still necessary. These efforts partly refer to technical aspects (e.g. the development of a reliable metering system) but especially to the question how to gain political acceptance for a more frequent use of economic instruments.

In the following two sections we concentrate on this question:

- In section 4.5.1 we briefly analyse some of the reasons for the obstacles to the introduction of a mileage tax.
- Basing on the findings of section 4.5.1 we outline some measures that could contribute to outgrow these obstacles (see section 4.5.2).

4.5.1 Major obstacles to the introduction of a mileage tax

A fruitful approach to analyse the reasons for the objections to the introduction of economic instruments in transport policy is the framework of institutional economics.[19] Starting point of this approach is the definition of the parties involved, i.e. the players in the social game, their interest and their viewpoints. The parties in the "transport policy game" can be categorised as given in table 4-14.

Table 4-14: Parties involved in the introduction of a mileage tax

Category	Sub-category	Interest
Commercial road user	haulier	more net trip benefit
	business (shipper)	reliable and cheap transport
Public transport user		service quality of the public transport system
Private	consumer	cheap consumer goods
	resident	relief from environmental problems
Expert	economist	economic efficiency based on marginal social costs
	engineer	technical reliability of metering system, simplicity
	road planners	use of the revenues for road infrastructure
Politician		re-election, more supporters for him

19 The following discussion bases on Jansson, J.O., Nemotooch T. and Petterson H.-E. (1990), Road-pricing from Theory to Practice and Rothengatter W. (1994), Obstacles to the Use of Economic Instruments in Transport Policy.

Though there are differences in the political power of these actors in different countries and at different time periods these players will dominate the political debate on the introduction of a mileage tax.
Following Jansson et al. we have summarised the major viewpoints of the different players in table 4-15. The summary shows the variety of viewpoints and points out the difficulties that can be expected in generating social and political consensus on the introduction of a mileage tax.

Table 4-15: Major viewpoints in political controversies[20]

Player	Viewpoint	Position*
Haulier	tangible charge and vague benefits	no
	a reasonable way of raising revenues for improvements of road infrastructure	yes
	study report prepared by the public authorities is not credible	no
	difficulty in enforcement	no
	unnecessary, due to relatively moderate environmental effects of transport compared to other sources of emisson	no
business (shipper)	harmful to competitiveness because of higher transport costs (especially for certain transport intensive industries)	no
	increase of reliability of road transport (less congestion)	yes
	promoting new technologies, innovations (metering system)	yes
	a reasonable way of raising revenues for improvements of road infrastructure, reduction of burden for public finance	yes
Public transport user	probable improvement of public/combined transport system in the long term	yes
	not feasible capacity expansion to cope with demand transferred from road freight transport	no
Consumer	discrimination against the poor	no
	discrimination against remote regions (if there is one)	no
Resident	necessary to tackle the severe environmental problems	yes
Economist	high efficiency of economic instruments compared to other policy measures (polluter-pays-principle)	yes
Engineer	technical feasibility of electronic metering systems	yes
Road planner	a reasonable way of raising revenues for the extension of road infrastructure	yes
Politician	importance of strong political leadership	yes
	resistance of powerful lobby groups	no

* : yes = an approving viewpoint with regard to an introduction of a mileage tax
no = an opposing viewpoint with regard to an introduction of a mileage tax

20 Basis: Jansson, J.O., Nemotooch T. and Petterson H.-E. (1990), Road-pricing from Theory to Practice, plus extension according to Dienst für Gesamtverkehrsfragen (1993), Politische Umsetzung, Soziale Kosten und Nutzen des Verkehrs.

From table 4-15 the following conclusions can be drawn with regard to a successful introduction of a mileage tax:

- The introduction of a mileage tax is only acceptable if it can be associated with positive consequences by a majority of the powerful actors involved. Regarding table 4-15 this can for example mean that the revenues must to be used at least partly to improve road infrastructure though this solution is not welcome from an environmental point of view.
- Distributive effects are obviously of major importance. The public authorities will have to convince the major actors who believe to be put at a disadvantage that this is either a misjudgement or that the use of the revenues will offset this disadvantage.
- The introduction of a mileage tax has to be discussed with all major actors involved. A thorough communication process accompanied by a sound information campaign are inevitable. Otherwise, politicians who want to be re-elected will not consent to a mileage tax if there is still strong resistance from major lobby groups. This search for consensus will most probably lead to a solution that is not optimal from the point of view of economic theory.

4.5.2 Policy measures to improve political acceptance

If one tries to overcome the opposition of the major actors given in table 4-15 a bundle of policy measures seems necessary. We can make out four different action lines:[21]

a) Improving and harmonising the evaluation of external costs

Despite numerous efforts on the scientific side the diversity of the quantified findings for the external effects of transport is still too high to avoid the impression of some actors that these studies are based on arbitrary calculations. Even with regard to terms and concepts (e.g. the question of external benefits) there are still controversies between the specialists and accordingly between other actors.
Therefore, it is necessary to define more precisely the various terms used in the analysis of external costs and internalisation and the methods to estimate the different types of external effects to ensure the comparability and robustness of the findings. The 4th Framework programme would be a suitable opportunity to generate some further consensus on this topic (e.g. in the frame of "concerted actions").

b) Transparency of internalisation measures

Another important issue in the political debate refers to the internalisation instruments. The following aspects should be borne in mind:

21 See also Bonnafous A. (1994), Summary and conclusions of the 1993 OECD/ECMT seminar "Internalising the social costs of transport" and Dienst für Gesamtverkehrsfragen (1993), Politische Umsetzung, Soziale Kosten und Nutzen des Verkehrs.

- Among economist the ability of price signals to change behaviour is a commonplace. Though knowledge in the public is rising too, it is essential to communicate the difference between a mileage tax to internalise external costs and another tax imposed by the state.
- There must be an explicit link between the objective of internalisation and instrument used
- Any proposal for an internalisation strategy must be accompanied by a sound analysis of the impacts (e.g. on the economy, on the income of the inhabitants).
- It must be explained how the charging of the external costs fits in the general transport policy strategy followed by the responsible authorities.
- The internalisation strategy must be capable to take into account the specific characteristics of particular cases (e.g. the level of pollution).

The points mentioned above and in subsection a) should be followed when the programme for the introduction of a mileage tax (see section 3.7.1) is elaborated.

c) Use of the revenues

In section 3.8 we have described possible ways to use the revenues from a mileage tax. Regarding table 4-15 we can conclude that a mix of different options - as proposed in section 3.8 - should be capable to increase the political acceptance of a mileage tax. To summarise the mix comprises

- a partly earmarking of the revenues for transport infrastructure
- the financing of rescue packages for the environment (redressal of burdens of the past) and
- a redistribution of the revenues to the economy in order to comply with the requirement of fiscal neutrality.

d) Communication strategy

The need to include all major actors in the discussion on the introduction of a mileage tax was one conclusion of section 4.5.1. One possibility is a communication strategy consisting of the following elements:

- **Interdisciplinary group of opinion leaders:** In a first step a network of contact persons of the major actor groups must be established. Out of this network selected opinion leaders form a working group that accompanies the implementation process. The interdisciplinary group would ensure the flow of information from the public authorities to the actor groups and vice versa. The interdisciplinary group acts as an advisory board to the public authorities, i.e. the Commission.
- **Dialogue process**: In a second step, the detailed programme for the introduction of mileage tax (see section 3.7.1) is worked out in a dialogue process between the Commission and the advisory board. The detailed programme forms the base of a new Directive of the Council.

- **Information concept: Dissemination of the findings**: The political acceptance of new environmental protection measures increases with the improvement of environmental knowledge.[22] Therefore, the main findings of the research work (e.g. expected growth rate of road freight transport, impacts on the environment and on human health, costs caused to the economy and to the households) and of the dialogue process must be opened to the public in a suitable form.

e) Conclusions

We conclude that these efforts to increase the political acceptance of a mileage tax can be taken into account more or less unproblematically by our proposal described in chapter 3. From this - optimistic - point of view the introduction of a mileage tax at EU level should not fail because of too little political support.
The case of Switzerland shows that at least public acceptance can be expected if a sound information strategy is followed to make the topic "external costs" familiar to the public: In a vote the Swiss agreed with the objective of the national government to introduce a mileage tax that takes into account the external costs of road freight transport.

22 See for example Diekmann A. (1995), Umweltbewusstsein oder Anreizstrukturen (a large-scale empirical study carried out in Switzerland). The fact that Swiss voters agreed with the intention of the national government to introduce a mileage tax that also charges external costs can at least partly be explained by the rather high environmental knowledge and awareness of the Swiss population (See Diekmann A. und Frantzen A. (1995), Ergebnisse aus dem Schweizer Umweltsurvey, p. 23).

5 Conclusions and recommendations

5.1 Overview of the proposal

In table 5-1 the main features of the proposal for a mileage tax have been summarised.

Table 5-1: Summary of the main features of the proposed mileage tax

features of the tax	description	comments
basic idea	variable tax for heavy goods vehicles (HGV) to internalise external costs	based on the territorial principle
object of the tax	HGV, permissible total weight > 3.5 t	
field of application	whole road network of the Member States	
tax base	permissible total weight and kilometre driven	
tax rate: "basic version"	lower bound: 0.006 ECU/t_{tw}km upper bound: 0.012 ECU/t_{tw}km	based on estimates of external costs that are available at present, to be adjusted in the course of time
tax payer	owner of the HGV (haulage companies)	
differentiation of the tax rate	– "extended version": differentiation according to emissions of air pollutants and noise of vehicle type – "sophisticated version": taking account of spatially different levels of pollution and of congestion	Three emission classes for air pollutants: EURO I, II and III; based on avoidance costs or on external (damage) costs e.g. a doubling of the tax rate in urban areas and higher tax levels during rush hours and for bottlenecks in the transport system
metering system	– electronic road pricing system – two-way data communication between vehicle and a vehicle identification system	first best solution is based on a global positioning system or on an electronic impulse of the speedometer
implementation	– EU: defining main features and minimum requirements (lower bound tax rate) – Member State: introduction	new Directive of the Council in compliance with the Directive
introduction scheme	– gradual increase of the tax rate – transitional period for "first mover" initiatives of the Member States	starting tax rate: lower bound
use of the revenues	– stage 1: earmarking for less polluting transport modes, financing of rescue packages for the environment – stage 2: redistribution of the revenues to the economy	at EU level: only recommendations => national solutions stage 1: only as interim solution reduction of labour costs, probably in the frame of an ecological tax reform

The design of the mileage tax given in table 5-1 is a proposal based on today's knowledge. Due to efforts in European research, new findings will be generated in the course of time. Accordingly, the design of the mileage tax would have to be adjusted.

5.2 Assessment of the mileage tax

Regarding the main impacts of the mileage tax the analysis has to distinguish between the impacts on the transport sector, on the other sectors of the economy and on the environment. Additionally, a technical assessment including a comparison of the mileage and the diesel tax was carried out. At last, the political aspects of a mileage tax were assessed.

a) Impacts on the transport sector

- Given the various assumptions[1] the expected **increase of average road transport prices** is around 13% in the case of the lower bound tax rate and around 26% if the upper bound of the tax rate is applied.
- The proposed mileage tax will cause a rather **modest reduction of the road freight transport volume** of about 2-6%. Compared to the expected growth of road freight transport, the mileage tax will only lead to a small decrease of the annual growth rate.
- Approximately three-fourth of the reduction of road freight transport will be achieved by a **shift of freight transport to rail**. Due to differences in total capacity this shift would correspond to an increase of rail transport by about 7-17%.
- The **shift to inland shipping** is expected to be modest. Geographical reasons, transportation time and the rather different characteristics of the goods transported by ships (i.e. bulk goods) and HGV prevent a large shift from road transport to inland shipping.
- In the **road transport sector** itself probable impacts of the mileage tax are:
  - raise of average occupancy rate
  - adjustments in the vehicle fleet (cleaner and smaller HGV)
  - strengthening of the trend towards larger haulage companies
  - positive effect on combined transport
  - improving competitiveness of haulage firms with a modern vehicle fleet.

1 Some of these assumptions are of rather speculative character. Therefore, the results derived from the estimates should be considered as orders of magnitudes and not as exact figures.

b) Impact on other sectors of the economy

The influence of the mileage tax on the cost structure and thereby on product prices of the other sectors was assessed on the base of the transport intensity of the sectors (the transport intensity being defined as the ratio between the sector specific road freight transport costs and the value of the gross production of the sector).
From the calculations of the direct and indirect effects[2] of the mileage tax on the production costs of the sectors with a high (road freight) transport intensity the following conclusions can be drawn:

- The proposed mileage tax will only have a **very moderate influence on the production costs of other sectors**. Compared to other influences (the exchange rates, the wage level or technical progress) the impact is nearly negligible.
- The calculations show that for the lower bound of the proposed mileage tax the **maximum increase of the production costs comes to 0.2 - 0.5% for almost every sector with a high transport intensity**. Only for two sectors (cement, lime, building materials and petroleum products, refineries) it is conceivable that the cost effect will be above 0.5%. For all other sectors, particularly the whole services sectors, the cost effect amounts to less than 0.3%. Taking the upper bound of the mileage tax, approximately doubled cost effects compared to the lower bound mileage tax have to be expected.
- On account of the above results the proposed mileage tax will **not have a noticeable impact on the competitiveness and on the growth rate of the European economy**. This is true all the more as the revenues of the mileage tax are not lost but would be refunded to the economy (e.g. through a reduction of the social security contributions or through a wage sum bonus).
- At last, it must be remembered that the introduction of the mileage tax sets an incentive for adjustment processes towards a **more efficient and welfare optimising road freight transport system**.

c) Ecological impact

Two effects determine the ecological impact of the mileage tax:

- The **reduction of the transport volume** and therefore of the road performance of road freight transport reduces total emissions. Due to the low reduction of the transport volumes this effect is rather modest. This is also a consequence of the very low values of external costs that were used to define the basic tax rate.
- More important than the first effect is the **incentive set by the tax to improve the emission abatement technology** as the potential of improved technologies is considerable. The proposed differentiation of the tax rate will accelerate the use of less

2 The **direct effect** corresponds to the impacts of the mileage tax on the cost and price structure of all other sectors. The higher costs of road freight transport will partly be transferred to ancillary sectors and to customers of other sectors (**indirect effect**).

polluting trucks. If the differentiation is adjusted in the course of time a lasting incentive for truck manufacturers to develop emission abatement technologies beyond today's knowledge will be set.

d) Technical assessment

The technical assessment of the mileage tax shows that the development and running costs of an electronic metering system to implement the mileage tax can be justified by the positive effects of the mileage tax on the environment and human health.

- Although the "extended" and the "sophisticated" version of the mileage tax cause higher classification costs (the HGV have to be classified in different categories corresponding to their emission factors) the **welfare gains of a differentiation of the mileage tax are remarkable** and seem to justify these higher implementation costs.
- Out of the different electronic metering systems those based on the **global positioning system** are most suitable to realise this kind of differentiation at low additional costs. One can therefore conclude that the "sophisticated" and not only the "extended version" of the mileage tax should be the final objective of an introduction of this instrument.
- Automatic debiting systems are mainly developed and tested due to other reasons than the internalisation of external costs (charging for infrastructure costs, control of traffic flow, fleet navigation). As a consequence, the **additional costs to use such systems for the implementation of a mileage tax may be substantially lowered**. Therefore it is important, that the choice of a specific automatic debiting system is also based on criteria that are important from the point of view of an internalisation of external costs (e.g. the spatial differentiation).

e) Mileage or diesel tax?

In this sub report it was not possible to carry out a full scale cost-benefit analysis of the mileage and the diesel tax. But, based on a **qualitative comparison**, the following conclusions can be drawn:

- From the point of view of the **incentive** to reduce external effects of air pollution and noise the mileage tax has marked advantages compared to the diesel tax because only the mileage tax can be differentiated according to emission factors.
- It is not obvious which tax has the better **cost-benefit ratio**. Actually, the two instruments can hardly be compared because they pursue different objectives and have not the same incentive effects. In many respects they are rather complements than substitutes.
- A more useful comparison would have to base on **packages of instruments** to internalise external costs of road freight transport. The packages would consist of the mileage tax or the diesel tax plus useful accompanying policy measures. The core of the two packages could, for example, consist of the following instruments:

- Core of package 1: CO_2/energy tax as global incentive charge and a differentiated mileage tax ("sophisticated version")
- Core of package 2: Diesel tax, annual vehicle and/or sales taxes and urban road pricing schemes

Both packages can take into account the most important external cost elements and influencing parameters (technology, spatial and temporal differences, way of driving). Again, it is not obvious which package is more cost-efficient.

- Compared to a general CO_2/energy tax, a diesel tax is only a second best solution because with a CO_2/energy tax there are no price distortions between different kinds of fuel and no corresponding negative incentive effects. Additionally, if diesel driven cars do not have to pay the diesel tax, different diesel pumps at the filling stations are necessary. As it may be difficult to introduce a diesel tax independently of the political discussion about a CO_2/energy tax it seems to be the advantageous strategy to promote first of all the introduction of a CO_2/energy tax.
- An argument in favour of a transport policy strategy basing on a differentiated mileage tax is the fact that such a strategy would fit the current Common Transport Policy (key words: user charges, tolls) and the development in road freight transport (key word in this context: telematics).

f) Political assessment

Based on an analysis of the major obstacles to introduce a mileage tax several policy measures are proposed to overcome potential opposition against the mileage tax.

The proposed measures are

- **to improve and harmonise the evaluation of external costs** in order to increase the comparability and robustness of the findings. The research work within the 4th Framework programme will probably contribute to this objective.
- **to improve the transparency of internalisation measures** in order to reduce misunderstandings of the objectives of an internalisation of external costs.
- **to develop a convincing concept for the use of revenues** because distributive effects often dominate in the political debate. Therefore, the way the revenues of the internalisation instruments are used can considerably contribute to an increase of political acceptance. Ways have been found to ensure revenue neutrality.
- **to implement a concise communication strategy** in order to include all major actors in the discussion on the objectives and introduction of the internalisation strategy.

5.3 Conclusions and recommendations

Based on the analysis of the mileage tax for European road freight transport in this sub report we come to the following general conclusions:

- The mileage tax corresponds to one of the main objectives of the environmental policy of the EU, the realisation of the **polluter-pays principle**. From a theoretical point of view, the mileage tax is a convincing approach to reduce the negative impacts of road transport on the environment and on human life.
- The tax is an efficient instrument for **one of the most important and most growing polluters** of the environment in Europe.
- The tax would be a useful **completion of the CO_2/energy** that is still planned to be introduced by the Member States.
- Even with conservative values for the external costs the internalisation leads to a **substantial rise in costs of road freight transport**.
- The tax **improves the efficiency of the whole transport system** and gives room for manoeuvre for alternative, less polluting transport modes.
- The tax will **not reduce competitiveness of the European economy**. On the contrary, "first-mover" advantages may result from innovations of European firms in the field of emission abatement technologies for HGV and of metering systems for electronic road pricing schemes.

Therefore, we recommend to set up a detailed programme for the introduction of a mileage tax to internalise external costs of road freight transport at EU level.
Ongoing and further research work will yield additional results that can be integrated in the programme. The results will allow to deepen and complete knowledge especially in the fields of the assessment of external costs and of the technical feasibility of metering systems and to overcome many of the difficulties connected with the introduction of a mileage tax. The fact that the tax will have to be introduced gradually is an additional reason to start as soon as possible with the introduction process.

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