Variabilisation and Differentiation Strategies in Road Taxation

Theoretical and empirical analysis

Final Report

MM, SB, SG, SHA
02 June 2000 var-diff-fin.doc
Table of contents

1. Introduction, scope of the study ................................................................. 1

2. Systems analysis ........................................................................................................... 5
   2.1. The charging objectives ......................................................................................... 5
   2.2. The leverage points .............................................................................................. 6
   2.3. Characterisation of fixed and variable charges .................................................. 7

3. Effects of fixed and variable charges: State of the art ........................................ 11
   3.1. Overview of reaction chains ............................................................................... 11
   3.2. Overview of elasticities ....................................................................................... 13
   3.3. Qualitative appraisal of tax differentiation ...................................................... 17
   3.4. Conclusions ........................................................................................................... 18

4. Model-based taxation scenarios: An illustration for Switzerland ..................... 21
   4.1. Four Swiss taxation scenarios ............................................................................. 21
   4.2. Comparison of effects .......................................................................................... 22
       4.2.1. Effects in transportation .............................................................................. 22
       4.2.2. Environmental and financial effects ................................................... 29
   4.3. Evaluation of the scenarios ................................................................................. 33

5. Objective of the empirical considerations .......................................................... 39

6. Overview: Today’s situation in Europe ............................................................... 41

7. Experience with differentiation and variabilisation in selected countries ............ 49
   7.1. Overview of the countries and measures analysed .............................................. 49
   7.2. Measures towards differentiation of fixed charges ........................................... 51
   7.3. Measures towards variabilisation of the tax system .......................................... 57

8. Assessment of the implemented taxation schemes ............................................. 63
   8.1. Criteria for the appraisal of the measures .......................................................... 63
   8.2. Appraisal of differentiation policies ................................................................. 65
   8.3. Appraisal of variabilisation policies ................................................................ 73
       8.3.1. Fuel price strategies ................................................................................. 73
       8.3.2. Road pricing measures ............................................................................ 76
9. Synthesis of the theoretical and the empirical part........................................83
   9.1. Overall assessment ................................................................................. 83
   9.2. Success factors ....................................................................................... 86

10. Policy recommendations...............................................................................90
   10.1. Differentiation or variabilisation? ......................................................... 90
   10.2. Towards an optimum mix of instruments ............................................. 91
Summary

a) The state of variabilisation and differentiation strategies
This study focuses on two different pricing strategies in the road sector. The first one is the differentiation of fixed charges (e.g. the annual vehicle tax) according to environmental criteria, the second one is the variabilisation of fixed charges according to the mileage driven. Possible leverage points are an increase of the fuel price or the introduction of road pricing schemes. In a first step, theoretical considerations are examined in order to develop transparent reaction chains and relevant elasticities. In a second step, different taxation strategies in European countries are examined according to a criteria set. Most important criteria are: efficiency of road use, environmental effectiveness and efficient use of resources, fiscal stability and fiscal neutrality, implementation and enforcement, minimum negative side effects, flexibility and independence from pricing policies in other European countries.

There is a wide range of possibilities to differentiate and variabilise taxes and charges. The most important existing charges are the fuel tax, the annual vehicle or purchase tax, and road user charges (flat-rate or mileage dependent). The vehicle and road user charges particularly can be differentiated according to environment related vehicle characteristics. The current practice in Europe is based on these three types of charges. The most important source of revenue is the fuel tax, with an average share of about 70% of all transport-related tax revenue.

Actual tendencies in road taxation policies show a shift from fixed charges to variable road user charges (for HGV’s on motorways, for urban transport). Most important driving factors are fiscal reasons (especially for motorways). The improved technical preconditions launched an intensive discussion on electronic road pricing schemes. At the same time, some countries (for instance Austria, Denmark, Sweden) have introduced differentiated vehicle taxes. The analysis shows that environmental arguments are usually the driving factor for this development.

b) Theoretical and empirical analysis
There is broad empirical evidence for the behavioural impacts of changes in fuel taxes. Some empirical estimates exist also for overall effects of annual vehicle and purchase taxes and road pricing schemes. There is poor evidence however on the effect of an environment-related differentiation of fixed taxes. Only qualitative information is
available. Nevertheless, one can state that the reaction chains and elasticities of variable charges are significantly higher than those for changes of fixed charges. This is due to the fact that a change in variable charges makes use of several leverage points (short and long run). The short-term fuel price elasticities in regard to fuel consumption vary between -0.2 and -0.3, the long-term elasticities between -0.4 and -0.9. The fuel price elasticities in regard to car use are smaller and vary between -0.1/-0.2 in the short run and -0.25/-0.35 in the long run. Purchase taxes have an impact on car stock in the long term, the elasticities vary between -0.3 and -0.9.

The theoretical analysis shows that the steering effects of the fuel tax for fuel-saving incentives are significant, as long as fuel tourism is not a major counterbalancing effect. In the long run, however, one has to consider also possible rebound effects due to the fact that lower specific fuel consumption leads to lower km cost.

The variabilisation of fixed charges to road user charges creates an important steering effect, even if the counterbalancing effects - like the change of routing - are expected to be significant.

In contrast, the differentiation of fixed charges do not cause major steering effects, since variable costs do not change. This is true, as long as the differentiation is a rather isolated measure.

The analysis and case study scenarios show different trade-offs:
- environmental effectiveness versus financial stability;
- avoiding counterbalancing effects and increased enforcement costs;
- steering effects and increased enforcement costs;
- significant steering effects and international independence.

These trade-offs are more significant within variabilisation scenarios whereas the differentiation of fixed charges leads to minor effects (positive and negative).

The empirical analysis shows a somewhat mixed picture: The evaluation of the experience of countries has shown that the possibilities of fuel tax increases are very limited due to negative side effects such as cross-border travelling (fuel tourism). Thus, differentiation of fixed taxes according to environmental criteria is widely accepted. Accompanying marketing and promotion measures (registration, labelling, involvement of the vehicle industry and dealers, voluntary agreements) are very important. Most important differentiation criteria are emission characteristics and specific fuel consumption. Noise criteria might be appropriate as far as lorries are concerned. As a second best criteria, weight holds for fuel consumption and road damages. The differentiation
of purchase taxes might have some slight advantages in comparison to annual vehicle taxes, since the criteria can be applied to new cars with standardised figures for fuel consumption or emission characteristics (i.e. EURO-classes).

c) Recommendations
Recommendations for future strategies towards an optimal policy mix have to consider the policy framework carefully. The analysis has shown that several combinations are possible, since none of the strategies analysed is – for itself – free of hindrance factors or obstacles. The following major paths can be distinguished:

- **Differentiation:**
  - differentiation of fixed charges according to environmental criteria (environmental context, especially air pollution strategies);
  - differentiation of fixed charges according to specific fuel consumption (energy policy context).

- **Variabilisation:**
  - variabilisation from fixed charges to fuel taxation (energy policy context);
  - variabilisation from fixed charges to road user charges (territorial financial context).

- **Variabilisation and differentiation (fiscal and environmental policy context):**
  - variabilisation of fixed charges to fuel price strategies with differentiation according to type of fuel (fuel tax, according to environmental criteria);
  - variabilisation of fixed charges to road pricing schemes with differentiation (differentiated km-tax, according to environmental criteria).

Differentiation strategies are easy to implement and are highly accepted, but their environmental steering effects are usually limited. Fuel price strategies only have significant effects if significant price increases can be obtained. The prevention of cross-border fuel tourism, however, is only achievable with an internationally co-ordinated strategy. A variabilisation of flatrate road user charges towards mileage dependent and differentiated schemes face – at least for the time being – major enforcement problems, especially for passenger cars. Thus, although there are major attempts for the variabilisation of taxes (based also on the recommendations of the White Book of the European
Commission on ‘fair payment of infrastructure use’), successful achievements are still rare. Most important are developments in motorway taxation, especially along the alpine transit axis. Many schemes are, however, in a planning phase. Nevertheless, in the near future road pricing systems will become the most important measure towards a more variabilised taxation system with additional potentials for differentiation. We can state that the taxation discussion is in a transition phase. With improved technical systems and increased international harmonisation, it will become easier to implement variable road user charges and differentiate them also according to environmental criteria. Thus, the recommendations have to consider these developments within a dynamic approach:

**Short run:**
- An increase in the fuel tax in parallel to a decrease in vehicle taxes is appropriate and not costly, as long as counterbalancing effects are expected to be small. As international co-ordination is not in sight, the potentials are, however, limited. The fuel price strategy should be embedded in a general CO₂ strategy. It is useful to continue to differentiate the fuel tax according to fuel qualities. Most appropriate is a tax differential between petrol and diesel (in order to consider the higher air pollution damage of diesel) and between different contents of sulphur (in order to raise incentives for low sulphur diesel).
- A differentiation of fixed vehicle taxes is useful and not costly. Although it is a second rate approach from a steering point of view, it is an important supplement since it guarantees regional and financial independence. The analysis has shown that flanking measures are very important and that a differentiation according to specific fuel consumption and emissions characteristics (i.e. EURO classes) is relatively effective, since the cars on offer have a wide range (especially with regard to specific fuel consumption).
- In order to raise acceptance, a fiscally neutral variabilisation or differentiation is a possible first step. In order to omit undesired fiscal losses due to steering effects, possible continuous adaptations of the tax system should be communicated at an early stage.
Long run

- A variabilisation of fixed charges (especially flat road user charges) is useful in the longer run, if an internationally co-ordinated strategy (especially with regard to taxes and charges) can be expected and technology for road pricing schemes is improving. If a vehicle identification is possible, a further differentiation of a km-tax according to emission characteristics is appropriate.

- A mix between fuel taxes and variable road user charges is most efficient in order to optimise the steering effects (local aspects like air pollution and noise by variable road user charges and global aspects like energy consumption and CO₂ emissions by the fuel tax). Fuel taxes and road user charges have both shortterm and longterm impacts, which are considerably more significant than the differentiation of fixed charges.
1. Introduction, scope of the study

Road user charges aim at charging road users in order to finance infrastructure investment and to use infrastructure in an efficient way. In the context of fair and efficient pricing of road infrastructure, the spectrum of possible price schemes is wide and depends on the original aims and the different leverage points. One can distinguish:

- **Variable charges**, which have an influence on the mileage driven and on transport behaviour. Examples are the fuel tax, kilometre-related charges, and electronic road pricing schemes,

- **Fixed charges** like annual or one-time charges which are tied to the vehicle, such as the vehicle registration tax or a purchase tax.

Ongoing transport policy (e.g. on EU-level) has particularly emphasised the **variabilisation of existing charges** that means a tax shift from fixed to variable charges, for example by introducing road user charges and lowering fixed charges at the same time. The development in the telecommunication sector favours such electronic road pricing schemes making them technically and economically feasible.

Besides the variabilisation of existing charges, it is also possible to **differentiate fixed charges**, for example according to environmental characteristics in order to raise incentives to buy more environmentally sound cars.

Whereas many studies have tried to measure the impact of variable charges (especially transport reactions due to a change in the fuel price), only little is known on the responsiveness of users to other charges and especially to new pricing schemes which consist of an (optimum) mix of different types of charges.

This study analyses the problem. The following questions are of major importance:

- What kind of charges exist? What are the different leverage points?

- What are the possible reaction chains for these charges? What can be said on impacts and effectiveness of different charges?

- What is today’s situation in Europe? What is the scope of the different charges?
Which directions for policy-making in order to develop consistent pricing schemes can be recommended?
- Variabilisation of fixed charges
- Differentiation of fixed charges.

This report tries to answer these questions with a theoretical and an empirical assessment of the measures. In a first step, within a systems analysis, the problem dimensions shall be described and mutual interrelations clarified. In a second step, the state-of-the-art of the empirical knowledge (taxation in Europe, impacts of different taxation schemes) will be shown. In the empirical part, we will first illustrate on the basis of four scenarios (based on data from Switzerland) possible steps towards more fair and efficient pricing. Secondly, we focus on the experience of countries which have already implemented some forms of differentiation or/and variabilisation. This cross-section analysis works out possible success factors for the improvement of existing tax schemes. Based on that, we will conclude with recommendations towards optimum taxation schemes in transportation.
Part 1: Theoretical considerations
2. Systems analysis

2.1. The charging objectives

Before discussing the different possibilities of road user charge designs, it is necessary to focus on the objectives of charging road infrastructure use.

The following objectives can be distinguished:

1. **Financing**: Road users pay their share of (historic and future) infrastructure cost in order to provide the financial means for new infrastructure investments and maintenance. Thus a charging system - based on the territorial principle - should secure respective revenue.

2. **Efficient road use**: The charging system should provide incentives to use as little (marginal) resources as necessary to satisfy mobility needs. That means low fuel consumption, low road and vehicle maintenance cost, low congestion costs etc.

3. **Safe and environmentally sound driving characteristics**: The charging system should create incentives in order to improve safety in the road sector and minimise ecological nuisances like air pollution, noise, CO₂ emissions, etc.

4. **Transparency and enforcement**: The charging system should be transparent for the users and should guarantee a maximum degree of enforcement.

5. **Low implementation and administration cost**: Charging systems may become costly if the degree of differentiation and sophistication is high. Therefore, the resources needed for the system itself have to be considered.

All these aims can be summarised by the aim of internalisation of external costs (especially the first three objectives). In practice however, different possible trade offs have to be considered, for instance between steering aims (efficient road use) and financing aims, or between efficiency and level of complexity of the charging system, which will influence transparency or implementation cost.
2.2. The leverage points

The process chain in road transport is an appropriate starting point for the analysis of different leverage points for variable and fixed charges. Figure 1 illustrates the different processes and cycles and illustrates several leverage points.

![Road transport process chain diagram]

Figure 1: The road transport process chain and the different leverage points for road transport charges
A very important aspect is the time horizon of different transport decisions. A decision to purchase a new car might be taken every 5 to 10 years, whereas decisions to undertake a specific trip at a specific time with a specific routing might happen every day. Thus, the impact of a road charge depends on the leverage points which are influenced.

2.3. **Characterisation of fixed and variable charges**

A characterisation of fixed and variable charges must look carefully at the reaction chains. In the long run, every charge is variable, whereas in the short run, many charges do not influence daily transport decisions at all. Based on the leverage points, it is useful to distinguish three groups of charges:

1. **Vehicle-based charges**: Vehicle tax, purchase tax, driving licences. These charges are independent of the vehicle use and therefore termed “fixed”.
2. **Fuel-based charges**: Fuel tax
3. **Road-use-based charges**: Road user charges.

However, the concrete design of these three charging types can differ significantly. Table 1 gives an overview of design features and their advantages and disadvantages.

---

1 We exclude insurance charges, because they are attached to a specific aim.
<table>
<thead>
<tr>
<th>Charging type</th>
<th>Concrete design</th>
<th>Implementation aspects</th>
<th>Examples</th>
<th>Differentiation possibilities</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle charges</td>
<td>Registration tax</td>
<td>Annual tax based on vehicle characteristics</td>
<td>Registration taxes in nearly all ECMT countries</td>
<td>Weight, motorisation, specific fuel consumption, emission characteristics (air pollution, noise) other vehicle characteristics</td>
<td>Easy and non-costly implementation Possible differentiation of important and sensitive vehicle characteristics</td>
<td>No short run impact (fixed after car is bought) Unwanted change of registration site, if tax level becomes too high.</td>
</tr>
<tr>
<td>Purchase tax</td>
<td>One time tax based on vehicle characteristics</td>
<td>Danish purchase tax</td>
<td>Like registration tax</td>
<td></td>
<td>Rather stable revenue</td>
<td>May slow down technical improvement cycle if tax level is too high.</td>
</tr>
<tr>
<td>Import tax</td>
<td>One time tax based on vehicle characteristics, levied at the border</td>
<td>Car import taxes in nearly all ECMT countries</td>
<td>Like registration tax country of origin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific taxes (e.g. tyres)</td>
<td>Tax connected with the purchase of tyres</td>
<td>U.S. tyre tax</td>
<td>Different types of tyres, for example according to noise characteristics</td>
<td>Slightly dependent on vkm Easy implementation</td>
<td></td>
<td>Small short run impact</td>
</tr>
<tr>
<td>Fuel charges</td>
<td>Fuel tax</td>
<td>Tax on fuel, levied at production sites and import</td>
<td>Fuel taxes in every ECMT country</td>
<td>Fuel types (petrol, diesel, biodiesel, gas, electricity, others)</td>
<td>Very easy and non costly implementation Easy adaptation of tax rate Stringent reactions short and long run on fuel consumption and thus CO2 emissions</td>
<td>No differentiation according to vehicle characteristics like air pollution and noise possible. A too strong steering effect might cause instable revenue due to fuel tourism (if tax raise is not harmonized) and strong reaction of users.</td>
</tr>
</tbody>
</table>

*Table 1: Characterisation of different road charges*
### Table 1: Characterisation of different road charges (continued)

<table>
<thead>
<tr>
<th>Charging type</th>
<th>Concrete design</th>
<th>Implementation aspects</th>
<th>Examples</th>
<th>Differentiation</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road user charges</td>
<td>Flat charge for road use</td>
<td>Annual charge to allow the use of specific parts of the road network, levied at car holders</td>
<td>Eurovignette Motorway vignette in Switzerland</td>
<td>According to vehicle characteristics like registration tax</td>
<td>Easy implementation Stable revenue</td>
<td>Very weak reaction on transport behaviour</td>
</tr>
<tr>
<td>Road tolls</td>
<td>Charge at specific passages (e.g. bridges, tunnels), levied continuously at road users Specific tariff system necessary</td>
<td>Tolls for Austrian tunnels Road tolls in Oslo and Bergen</td>
<td>Type of car (with regard to road use) Time of the day Location Type of use (once, frequently)</td>
<td>Specific inset possible Specific impacts Differentiation possible within a tariff system</td>
<td></td>
<td>Rather costly (specific lanes and personnel) Side effects (e.g. use of other routes) if charges are too high</td>
</tr>
<tr>
<td>Km-charge</td>
<td>Continuous charges for specific networks, levied on entry and exit points at users or general charge levied at car holders (different charging types possible)</td>
<td>Highway charging in Italy, France Km charges for HGV in Scandinavia Planned km-dependent HGV charge in Switzerland</td>
<td>Like road tolls If levied at vehicles (as a general Km-charge): Vehicle characteristics Different charging systems possible</td>
<td>Direct impact on driving distance Only limited side effects Differentiation according to vehicle characteristics possible</td>
<td></td>
<td>Rather costly for implementation Technical feasibility for Km-charging system for passenger cars</td>
</tr>
<tr>
<td>Electronic road pricing</td>
<td>Continuous charges levied at road users (off-vehicle and on-board unit) (specific tariff system) if linked to car registration, levied at car holders</td>
<td>Plans in different ECMT countries (Highway pricing, urban road pricing schemes)</td>
<td>Like road tolls If linked to car registration: Additional according to vehicle characteristics Different charging systems possible</td>
<td>Very specific inset possible Specific reactions on traffic behaviour, if charging system is transparent and sensible</td>
<td></td>
<td>High investment needed (technical equipment). Differentiation of vehicle characteristics only possible if link to car registration “big brother is watching you” effects.</td>
</tr>
</tbody>
</table>
3. Effects of fixed and variable charges: State of the art

3.1. Overview of reaction chains

In order to analyse the impacts of fixed and variable charges, we distinguish between direct and indirect as well as short and long-term impacts. Figure 2 summarises the most important effects of four types of charges identified.

Whereas fuel taxes and road user charges have a continuous short-term as well as long-term impact, annual and purchase vehicle taxes change behaviour only in the long run, according to the car’s life cycle. The effectiveness depends very much on the path of technological improvement. This is especially true for a differentiated purchase tax. This is because an increase in the level of the purchase tax leads to a prolongation of a car’s average life span. Whereas an environmentally oriented annual vehicle tax differentiation might be very effective if it helps to accelerate a clear technological path, a purchase tax differentiation might even slow down the renewal according to technical development, particularly if the tax differentiation foresees an increase in the tax level for environmentally unfriendly cars, but no tax decrease for technologically improved cars.

On the other hand, secondary effects have to be considered as well. An increase in the life span decreases the importance of indirect environmental effects like the “grey energy” due to car production.
Figure 2: Reaction chains of different charging types
(−: negative relationship; +: positive relationship)
3.2. Overview of elasticities

The effects of the different charging types depend on the behavioural changes induced in driving, car use, car purchase, etc. Demand elasticities measure these behavioural changes, i.e. they indicate the demand decrease (in %) induced by a price increase (in %). In the next section we will discuss the elasticities associated with a tax variabilisation and differentiation. We will look at:

- short and long-term elasticities;
- fuel price elasticities;
- elasticities of annual charges;
- elasticities of vehicle kilometre charges;
- elasticities of purchase taxes.

Short and long-term elasticities

The studies on elasticities distinguish between long and short-term elasticities. Long-term elasticities consider all adjustments of car demand (or car use) to a change in the level of existing charges or to the introduction of new charges. They indicate the behavioural changes necessary for reaching a new market equilibrium. This equilibrium occurs about five years after the price change. Short-term elasticities usually refer to demand adjustments which take place within a period of less than one year. Since, in the short run, the possibilities of reaction to a price increase (or to a new tax) are smaller than in the long run, short-term elasticities are lower (in absolute values). The short-term possibilities for avoiding a price increase are much more limited than in the long run, where more substitution possibilities (like the change of car demand) exist. Depending on the type of charge considered, only medium or long-term demand reactions are possible (for instance the effect of a vehicle tax differentiation or a purchase tax differentiation can be measured only in the long-term).

Fuel price elasticities

The most widely studied elasticities are the direct fuel price elasticities, which indicate how the fuel demand decreases with an increase in fuel price. The range of estimated values can be explained by econometric models used for estimation (static-dynamic model, use of cross section-time series data, etc.) and country-specific features (different spatial structure, availability of public transport, initial fuel price).

Fuel consumption can be reduced without reducing car use, for example with environmentally friendly driving behaviour. That means that, as a consequence of fuel price or tax increase, fuel consumption decreases more than car use (e.g. car mileage).
The difference between these two reactions can be imputed to a specific environmental behaviour. Consequently, the elasticities related to fuel consumption are larger than those related to car use, car stock or specific environmental behaviour.

Elasticities of annual charges
The effects of annual charges (costs) on car stock, fuel consumption etc., are calculated only for the long-term. It can be noticed that the effect of annual charges on car stock, on fuel consumption as well as on car use is considerably lower than the effect of fuel taxation. This is not surprising since a fuel tax has a direct effect on fuel consumption and car use. The small effect of annual charges on car stock can be explained by the lack of awareness of annual costs when the decision for car-owning is made.

Compared to the fuel price elasticities, there are few studies which analyse the behavioural impact of annual charges. Besides, some of these studies do not distinguish between annual charges and annual depreciation costs, but analyse the impact of an increase of both on car use. It can be assumed that the impact on demand of an increase in annual costs is more or less the same for both kinds of costs (annual charges and capital costs).

No studies could be found which explicitly analyse the impact of a differentiation of annual charges on car stock and use. Therefore, the estimates of the impact of tax differentiation on car use and car stock will be based on the direct elasticities of annual charges.

Elasticities of vehicle kilometre charges
The elasticities of vehicle kilometre charges (other than fuel taxes) show the reaction of car use when road pricing schemes are introduced. A major survey on road pricing elasticities was carried out by the European Commission\(^2\). This study evaluates the experience of different cities with road pricing. The estimated elasticities consider the effect of road pricing on car use, modal split and route choice\(^3\). They do not distinguish – at least not explicitly – between short- and long-term effects. The effects of road pricing on car use depend largely on the purpose of the trip: shopping and social trips have the highest, commuter trips the lowest elasticities. The cross-price elasticities (effect of the charge on modal split) depend on the transport mode considered (rail or metro) and on the level of the charge applied.


\(^3\) The effect of road pricing on alternative routes was estimated only for one city (Milan).
In Germany (Stuttgart) a field study\(^4\) was carried out to test the effectiveness of urban road pricing based on present traffic volumes. The study shows that a great behavioural reaction can be achieved even with moderate tariffs. The decrease in the road use was about 20% between Monday and Friday and 25% on Saturdays. The study aimed to record the evasive actions which have been chosen by car users: change of departure time, car pooling, change of route choice and the use of other transport modes. The field study has further identified the major problems which can arise with the introduction of a road pricing system, first of all the problem of the evasive actions which lead to an increase in traffic volume on other (not charged) roads. The different reaction patterns to road pricing were identified by interviewing the persons tested.

**Elasticities of purchase taxes**

A last type of elasticity considered is the *purchase tax* elasticity. Unfortunately, it was not possible to identify any studies which analyse the specific effect of purchase taxes on car ownership and car use. We could not find studies which analysed and quantified the effects of purchase tax differentiation either.

Different studies however analyse the effects of *car price* on car use and ownership. From the theoretical point of view, it can be expected that individuals react to a car price increase exactly in the same manner as to an increase of purchase taxes. The correct use of the car price elasticity for calculating the demand effect of a purchase tax increase implies that the purchase tax increase can be set in relation to the overall price of the car.

As expected, the car price affects the car stock in the long-term much more than taxes do. It is interesting that - according to the available studies - the reactions (car use, fuel consumption) on car price changes seem to be quite significant in comparison to annual vehicle charges. Here the definition of the elasticity has to be considered: the annual vehicle charges are just a small part of the annual capital cost of a vehicle. Thus it seems plausible that the corresponding elasticities differ in the described manner.

The following Table 2 summarises the empirical evidence of elasticities, based on different studies.

---

\(^4\) Within this field trial, a sample of selected car drivers (test persons) reported their driving behaviour for a specific time, facing different (virtual) tariffs within the urban area (Mock-Hecker Rüdiger, Würtgenburg Julian, 1998). The study is not listed in Table 2 since detailed elasticities of road pricing have not been estimated.
<table>
<thead>
<tr>
<th>Effects on</th>
<th>Fuel price/taxes</th>
<th>Annual charges (veh. taxes)</th>
<th>Vehicle km charges</th>
<th>Purchase taxes/car price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>short-term</td>
<td>long-term</td>
<td>short-term</td>
<td>long-term</td>
</tr>
<tr>
<td>Car stock</td>
<td>-0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.15/-0.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.08&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.38&lt;sup&gt;l&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>-0.2/-0.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.2 (-0.1)&lt;sup&gt;i&lt;/sup&gt;</td>
<td>-0.08/-0.04&lt;sup&gt;l&lt;/sup&gt;</td>
<td>-0.89&lt;sup&gt;e&lt;/sup&gt; (-0.4/-1.6)</td>
</tr>
<tr>
<td></td>
<td>-0.18/0.36&lt;sup&gt;h&lt;/sup&gt;</td>
<td>-0.18/0.36&lt;sup&gt;k&lt;/sup&gt;</td>
<td></td>
<td>-0.253&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>-0.081&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.08/-0.04&lt;sup&gt;l&lt;/sup&gt;</td>
<td></td>
<td>-0.77/-0.6&lt;sup&gt;j&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.18/0.36&lt;sup&gt;k&lt;/sup&gt;</td>
<td></td>
<td>-0.28/-0.57&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>-0.27/-0.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.71/-0.84&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.055&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.529&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>-0.20/-0.258&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.702&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.16/-0.02&lt;sup&gt;l&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.54/-0.96&lt;sup&gt;j&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1/-0.4 (-0.7)&lt;sup&gt;j&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car use (km)</td>
<td>-0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.062&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.1/-0.8&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.262&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.04/0.8 (0)&lt;sup&gt;i&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.55/-0.05 (-0.3)&lt;sup&gt;j&lt;/sup&gt;</td>
<td>-0.05/-0.15&lt;sup&gt;h&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Route choice</td>
<td>0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;a&lt;/sup&gt; (0.08/ 0.8)</td>
<td>0.062&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-0.287&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spec. envir. behav.</td>
<td>(0.7/-0.4)</td>
<td>0.05/0.4&lt;sup&gt;h&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Goodwin (1992), average values of different studies
<sup>b</sup> Hensher (1987, in Goodwin 1992), no explicit distinction between short and long-term
<sup>c</sup> Tanner (1981-83, in Goodwin 1992), no explicit distinction between short and long-term
<sup>d</sup> Goodwin (1992), values are calculated as difference between effects on fuel consumption and reduction of car use
<sup>e</sup> Harbour (1987, in Goodwin 1992, average of more than 90 estimates reviewed)
<sup>f</sup> Storchmann (1998), effects of annual charges and annual depreciation on car stock and on fuel demand per capita
<sup>g</sup> Sterner et al. (1992), dynamic model
<sup>h</sup> APAS, Pricing and financing of urban transport (1996), elasticity depends on the purpose of the trip, transport mode, level of road pricing
<sup>i</sup> Johansson et al. (1996), in brackets = „best guess“, <strong>annual charges = taxation other than fuel</strong> (sum of purchase taxes and annual taxes)
<sup>k</sup> Dargay 1998, elasticities for different income classes, differentiated in purchase costs and running costs (used as fuel price elasticity)

Table 2: Selected price elasticities for changes of different charges.
3.3. Qualitative appraisal of tax differentiation

Besides the elasticity studies, there are a lot of studies which qualitatively analyse the impact of taxes on car use and ownership in different countries. These studies reach the following conclusions:

A study of Schipper\(^5\) analyses the impact of taxation on car ownership and use (cross section and time series analysis for different countries). There is evidence that in countries where ownership tax is important, the value and the characteristics of the cars are affected. Generally, the impact of other taxes than fuel taxes on fuel consumption is appraised to be small, since only fuel taxation has a direct impact on fuel consumption. Nevertheless, purchase taxes appear to restrain ownership somewhat. Besides, it can be shown that there is an important relationship between acquisition and ownership taxes and the importance to car industry in a specific country. For instance, in the United States rebates on vehicles more efficient than average were considered but not enacted because of the concerns that this policy would favour imported vehicles at the expense of domestic models.\(^6\)

A study\(^7\) on the impact of a registration tax on new vehicles according to fuel efficiency, introduced in 1992 in Austria\(^8\), shows the theoretical impact of an annual registration tax on fuel consumption. Since the new tax subsidies efficient cars, people have an incentive to buy more efficient cars. Consequently, the costs for driving additional kilometres decrease which might raise incentives to drive even more. The impact of the new tax on energy conservation is therefore ambiguous (but most likely positive). The author does not exclude negative environmental effects of the tax if, as a reaction, more diesel vehicles\(^9\) will be bought. He concludes that an increase in petrol prices would be a better environmental policy.

Comparable conclusions are drawn in a US study\(^10\) where the authors suggest that even small vehicle tax differentials (averaging only 2% of new vehicle price) could

\(^5\) Schipper Lee 1995
\(^6\) De Cicco John, Gordon Deborah 1995
\(^7\) Wirl Franz 1992
\(^8\) This tax replaces a particular category of VAT (see part 2, empirical considerations for Austria).
\(^9\) Diesel- powered cars are taxed at lower rates.
\(^10\) Janson Jan Owen, Cardebring Peter 1989
achieve a substantial degree of fuel economy improvement. With stable or slowly increasing petrol prices, the kilometre costs of driving fall. In order to reach a reduction of emissions, it is therefore necessary to complement purchase taxes with a fuel tax increase sufficient to keep the cost of driving from falling. Such fuel tax increase would further be needed to avoid erosion of this revenue source due to the increased fuel economy.

The differentiation of annual taxes according to the emission level has been implemented in a few Swiss cantons.\textsuperscript{11} The tax exemption for cars with catalytic converters has shown the desired effects: in the cantons with tax differentiation/exemption, the share of cars with catalytic converters exceeded the Swiss average. On the other hand, a tax increase for polluting cars seemed to have no effect on the composition of the car stock. However, it must be taken into account that the tax increase was implemented only for three years, which is not enough to achieve long run demand effects (since a vehicle’s average life cycle is much longer).

### 3.4. Conclusions

The following impacts of variable and fixed charges can be noticed:

- **Fuel taxes** have a significant direct impact on fuel consumption and car use. In the short-term, changes of driving behaviour, in the long-term, increased incentives to buy fuel efficient cars play an important role. There are several studies which have analysed the impact of fuel price increases on travel behaviour. The level of the long-term fuel price elasticity is about twice the short-term elasticity. The range of fuel price elasticities with regard to fuel consumption varies between -0.2 and -0.3 for the short-term and -0.4 and -0.9 for the long-term impact. The effect of fuel price on car use is smaller, the elasticities vary between -0.1/-0.2 in the short-term and -0.25/-0.5 in the long-term.

- There are only a few recent studies which consider the impact of **kilometre charges** (road pricing) on car use. The transport reactions to road pricing are quite significant, especially when alternatives (public transport) on a high quality level exist, especially during peak hours. Evasive reactions of car drivers, like route

\textsuperscript{11} see part 2, empirical considerations for Switzerland.
changing, can be important and reduce the overall (environmental) impact of the measure. This impact depends on the level of flanking measures.

- The effects of **annual charges** are estimated only for the long run (since no short run impact can be expected). In comparison to variable charges, the effects of a **general** price change are rather small and in the short run even negligible. The estimated elasticities of a price change in relation to car stock vary between $-0.04$ and $0.08$. Similar magnitudes can be found in relation to car use.

There is quite small empirical evidence for the effects of a **differentiation** of fixed charges (purchase or annual taxes). Qualitative statements show that a tax differentiation leads to significant positive effects, if:

- alternatives (low-price and smaller cars, environmentally friendly technology like catalytic converters etc.) are easily available;
- the tax differentiation is communicated as a bonus-malus-system and subsequent marketing in order to promote bonus cars is practised;
- an accompanying adjustment in fuel prices prevents a decrease in kilometre costs and, as a consequence, negative environmental and fiscal impacts.

- The analysis of the impact of a change in purchase prices/taxes on car stock shows that car ownership, although relatively price-inelastic, reacts more sensitively to changes in car **purchase costs** than to changes in running costs. The effect can be seen only in the **long run**. The respective elasticities vary between $-0.3$ and $-0.9$.

- In general, all elasticities refer to **small changes** in price or tax levels. Thus, it is difficult to translate these estimated effects into large changes like a significant rise of fuel price or the introduction of a high and differentiated purchase tax. Also the possibility of non-symmetric price effects (i.e. consumers react to a price increase differently compared to a price decrease) is not analysed. These considerations restrict the applicability of elasticities in cases where price decreases or significant price changes take place.
4. Model-based taxation scenarios: An illustration for Switzerland

4.1. Four Swiss taxation scenarios

In this chapter, we apply and illustrate the theoretical results and conclusions summarised above for a specific country. The model-based approach is adopted to Switzerland as an illustrative example (Swiss transport figures 1995).

Two basic approaches can be used to vary the share of different types of charge:

1. **Variabilisation of fixed charges**: The share of vehicle-fixed charges will be decreased by an increase of variable charges, either by an increase of fuel taxes or the introduction of variable road user charges.

2. **Differentiation of fixed charges**: Instead of a decrease, the vehicle charges will be differentiated according to the environmental performance of vehicles (emission level).

Out of these approaches, four different scenarios can be designed. Table 3 indicates the assumptions and specifications:

<table>
<thead>
<tr>
<th>Taxes/Charges</th>
<th>Scenario 1: Variabilisation to fuel tax</th>
<th>Scenario 2: Variabilisation to Hi Tech User charges</th>
<th>Scenario 3: Differentiation of annual vehicle tax according to emission level</th>
<th>Scenario 4: Differentiation of annual vehicle tax according to specific fuel consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual vehicle tax</td>
<td>Cantonal tax (vehicle tax) reduced to zero</td>
<td>Cantonal tax (vehicle tax) reduced to zero</td>
<td>Differentiation according to vehicle emission level</td>
<td>Differentiation according to specific fuel consumption</td>
</tr>
<tr>
<td>Fuel tax</td>
<td>Increase of the fuel tax of about 40% 1)</td>
<td>No change</td>
<td>No change</td>
<td>No change</td>
</tr>
<tr>
<td>User charges</td>
<td>No change</td>
<td>Introduction of vehicle and km based road user charge on motorways of 0.08 CHF per km 1) differentiated according to vehicle emission level</td>
<td>No change</td>
<td>No change</td>
</tr>
</tbody>
</table>

1) These rates are precalculated in order to guarantee more or less stable revenue

Table 3: Description of the four scenarios evaluated for Switzerland
4.2. Comparison of effects

4.2.1. Effects in transportation

Scenario 1\(^\text{12}\)

The main effects of a variabilisation of annual charges to fuel taxes are:

- decrease of fuel consumption/car use due to a fuel price increase,
- increase in fuel consumption/car use due to a decrease of annual charges.

The estimates of the effects in transportation are based on the up-to-date Swiss car use and tax revenue figures. The variabilisation of fixed annual charges leads to a fuel price increase of about 30%. Table 4 illustrates the used elasticities.

<table>
<thead>
<tr>
<th>Elasticities</th>
<th>Short-term</th>
<th>Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect of fuel price on:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>-0.25</td>
<td>-0.7</td>
</tr>
<tr>
<td>Car use</td>
<td>-0.16</td>
<td>-0.3</td>
</tr>
<tr>
<td>Car stock</td>
<td>0</td>
<td>-0.1</td>
</tr>
<tr>
<td>Effect of annual taxes on:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>0</td>
<td>-0.11</td>
</tr>
<tr>
<td>Car use</td>
<td>0</td>
<td>-0.05</td>
</tr>
<tr>
<td>Car stock</td>
<td>0</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

Table 4: Scenario 1: Elasticities used for the empirical estimate

In the short-term only effects resulting from fuel price increase occur. For the long run we also estimate the effects of the variabilisation of the annual tax on fuel consumption, car use and car stock.

The following estimates are based on a static consideration of the impact of the taxes. Starting with the present car use and fuel consumption figures, we calculate the effects of a fuel tax increase (short- and long-term) and of a reduction of annual charges (only long-term) on fuel consumption, car use and car stock.

\(^\text{12}\) See Annex 2 for the detailed calculations. Note that fuel tourism is not considered in these estimations (assumption that the variabilisation is introduced in all countries at the same time).
### Table 5: Scenario 1: Effects on transportation of a variabilisation from annual taxes to a fuel tax

In the long-term there is an important impact on fuel consumption due to the increase in price elasticity of fuel consumption (see Table 4). On the contrary, the long-term impact on car use is less pronounced than in the short run due to the counterbalancing effect of the decrease of the annual tax. This reduces average vehicle kilometre costs and gives car owners an incentive to drive more. Furthermore, we can observe a positive long run net impact on car stock: the negative effect on car stock due to the increase in fuel prices is more than compensated by the positive effect of the decrease in annual taxes.

In order to assess the net effects on car stock it must be considered that:

- the elasticities used to calculate the impact of a decrease in annual taxes on vehicle stock are point elasticities and are therefore not very suitable for estimating large changes in the tax level (100% decrease of the tax)\(^{13}\);
- the elasticities assume symmetric reaction patterns to price increases and decreases. There is however some empirical evidence that the elasticity for a price increase is larger than the elasticity for a price decrease.\(^{14}\)

For these reasons, the effects on car stock are probably overestimated.

It can be noticed that the decrease in fuel consumption (-10%) is much more relevant than the decrease in car use (-4%). A part of car users reacts to the tax increase with more fuel-efficient driving or with the purchase of a fuel-efficient car in order to decrease fuel consumption.

---

\(^{13}\) Since there are no alternatives we have used point elasticities for estimating the effects on car stock.

\(^{14}\) See Dargay Joice, 1993.
Instead of a decrease in annual charges - which leads to a decrease in transport costs - the fuel tax increase could be compensated with a decrease in other taxes (for example income taxes). This compensation strategy guarantees that, in the long run, the effects on fuel and transport demand are much more significant compared to a situation with a decrease in annual taxes (decrease in fuel consumption of 21%, of car use of 9%). A slight car stock decrease can be achieved (-3%). The overall effect on revenue is positive as they can be increased by around 7%. On the other hand, it must be noticed that this would not correspond to a variabilisation strategy since fixed annual charges are not replaced by variable charges. Furthermore, the decrease in other taxes like income taxes will be very moderate (if revenue neutrality is to be achieved), so that it will be probably quite difficult to convince car drivers of the revenue neutrality of the measure.\textsuperscript{15} This can be a disadvantage for the (political) realisation of the measure.

\textbf{Scenario 2}

Scenario 2 is based on a variabilisation of annual taxes to Hi-Tech user charges on motorways. The charges are differentiated according to the emission level of vehicles (three air pollution categories)\textsuperscript{16}. The categorisation is based on the type of catalytic converter of the vehicle.

We calculate only the medium/long-term impact of this measure as no information about the short-term impact of the increase in user charges are available. Similar to scenario 1, we assume that annual taxes have an impact on transport demand only in the medium or long run. In order to calculate the impact of a reduction in annual taxes we use the same elasticities as for Scenario 1. The reduction to zero of annual cantonal taxes corresponds to a decrease of more or less 25\% of total annual costs (other charges, depreciation).\textsuperscript{17}

\textsuperscript{15} Compared to a slight decrease of income or indirect taxes, the additional burden of a fuel tax increase is felt very directly and strongly.

\textsuperscript{16} In urban areas a differentiation according to noise emissions would be appropriate, since noise is a significant urban transport-related problem. Problems arise with the definition of correct noise categories for cars, since noise emissions depend not only on the car technology but also on the tyres (which can be changed during the year) and the driving style. Therefore we limit our differentiation on cars with different emissions levels.

\textsuperscript{17} Several elasticity studies analyse the effects of a change of annual costs (annual taxes and depreciation costs) on travel behaviour.


The user charges were differentiated in such a way that the difference in tax revenue is minimised. Table 7 illustrates how the user charges were differentiated between the vehicle categories. Car drivers of vehicles equipped with a catalytic converter (new technology, 1991 onwards) pay 20% less than the average user charge. On the contrary, drivers of vehicles without catalytic converters pay 50% more than the average user charge.

<table>
<thead>
<tr>
<th>Air pollution/Noise</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without cat. converter</td>
<td>150%</td>
</tr>
<tr>
<td>With cat. converter (before 1991)</td>
<td>120%</td>
</tr>
<tr>
<td>With cat. converter (after 1991)</td>
<td>80%</td>
</tr>
</tbody>
</table>

Table 7: Scenario 2: Differentiation of user charges according to the emission level; the 100% user charge is about 0.08 CHF/km\(^{18}\).

Table 8 presents the estimated effects. It can be noticed that with the variabilisation of user charges total car use decreases of about 4,300m vehicle km, or 9% of total vehicle kilometres driven in Switzerland and 32% of vehicle kilometres driven on motorways. The most polluting vehicles are stronger affected by the differentiation of user charges. For instance, the use of the most polluting cars decreases by about 44% (-21% for commuter and business trips and about -59% for leisure and shopping trips). Also the vehicle kilometres driven with “clean” cars decrease by about 23% (-11% for commuting/business trips and -31% for leisure and shopping trips).

---

\(^{18}\) The user charge was calculated as the ratio of the annual revenue of cantonal taxes (1.1 billion CHF) and the vehicle kilometres on motorways (13,150 million vehicle kilometres).
Similar to Scenario 1, we also calculated the effect of a decrease in annual taxes on car stock. This effect is even larger than in Scenario 1 since we did not quantify the negative effect of an increase in road user charges (information on the impact of user charges on car stock are lacking). Therefore it must be taken into account, that the effect on car stock is overestimated.

An assessment of the results of the study must consider that the elasticity approach gives only rough indications of the impact of an introduction of road user charges on motorways. The major problem connected with this approach consists of the fact that we quantify the behavioural impact of the introduction of a new tax. The increase in the tax rate is therefore 100% (this increase is independent of the average road user charge considered).19

The figures obtained consider only the effects of user charges on motorways. The empirical evidence from Germany shows that user charges can lead to a significant increase in traffic volumes on other roads (between 2.4 and 7% of the vehicle kilometres driven on motorways avoid the road pricing by choosing another route). These effects taken into account, the measure would lose some of the effectiveness, i.e. the impact on fuel consumption and vehicle use would be smaller.

The decision to use another, non-charged road depends mainly on time and operational costs connected with an alternative routing. If these costs exceed the road user charge, car drivers will prefer to pay the charge. On the contrary, if costs of evasive

<table>
<thead>
<tr>
<th>Increase/Decrease of:</th>
<th>Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Absolute</td>
</tr>
<tr>
<td>Car use (million veh.km)</td>
<td>-4,300</td>
</tr>
<tr>
<td>Car stock (veh.)</td>
<td>127,000</td>
</tr>
</tbody>
</table>

Table 8: Scenario 2: Impact of user charges on car use (only on motorways) and on car stock

19 An alternative way to calculate the effects of an introduction of road user charges would be to calculate the increase in operational costs (CHF/veh.km) caused by the road charge. The behavioural response to this price increase can easily be calculated based on an elasticity approach (using an elasticity of operational costs). In this case we consider an increase in road user charges in the same way as an increase in fuel prices.
actions are relatively low - lower than road user charges -, car drivers will prefer the non-charged alternative. Relevant evasive actions can be minimised if:

- there are no alternative routes to the charged one (for example Alps’ transit roads, tunnels);
- the change to alternative routes is connected with high time and operational costs;
- the road user charges are relatively low (so that alternatives are always more expensive);
- not a specific road, but an area is charged (for example inner cities).

Significant negative side effects can be expected if alternative routes with low additional time and operational costs can be used.

**Scenario 3**

In Scenario 3 we calculate the impact of a differentiation of annual charges upon vehicle categories according to their emission level. Again we calculate only the long-term effects and we use the same elasticities as in the previous scenarios (see Table 4).

Table 9 shows the annual user charges differentiated according to the emission level. This differentiation allows the same revenue to be achieved as with a fixed charge (current average fixed charge per vehicle: 420 CHF).

<table>
<thead>
<tr>
<th>Change in charge level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Without cat. converter</td>
<td>30%</td>
</tr>
<tr>
<td>With cat. converter (before 1991)</td>
<td>10%</td>
</tr>
<tr>
<td>With cat. converter (after 1991)</td>
<td>-20%</td>
</tr>
</tbody>
</table>

*Table 9: Scenario 3: Differentiation of fixed annual cantonal taxes according to the emission level of vehicles*

The overall effects on car use are very small. For the most polluting vehicle categories a decrease in kilometres driven of about 1% can be expected. For the less polluting vehicles a slight increase in car use (+1%) can be observed due to the net cost decrease.
Effects of variabilisation on:

<table>
<thead>
<tr>
<th>Absolute</th>
<th>in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car use (million veh.km)</td>
<td>-33</td>
</tr>
<tr>
<td>Car stock (cars)</td>
<td>-2,850</td>
</tr>
<tr>
<td>Fuel consumption (t oil)</td>
<td>-5,000</td>
</tr>
</tbody>
</table>

*Table 10: Scenario 3: Impact of variabilisation on car use, car stock and fuel consumption*

The car stock of the most polluting vehicles decreases by about 2%. This decrease is in part compensated by an increase in the stock of less polluting cars (+1%). Fuel consumption decreases only slightly by about 0.2%.

**Scenario 4**

Scenario 4 illustrates the effects of a differentiation of annual taxes according to the specific fuel consumption of vehicles. We distinguish three categories of vehicles: vehicles with a lower than average, with an average and with a higher than average fuel consumption. The vehicle stock was distributed into the categories according to the cubic capacity of the cars.20 Since no information is available about kilometres driven with small, medium and large vehicles, we assumed the same average use for each of them.21

<table>
<thead>
<tr>
<th>Categories according to fuel consumption:</th>
<th>Allocation of car stock</th>
<th>Allocation of fuel consumption</th>
<th>Deviation from average of annual tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower than average</td>
<td>23%</td>
<td>17%</td>
<td>-50%</td>
</tr>
<tr>
<td>Average consumption</td>
<td>60%</td>
<td>60%</td>
<td>+20%</td>
</tr>
<tr>
<td>Higher than average</td>
<td>17%</td>
<td>23%</td>
<td>+40%</td>
</tr>
</tbody>
</table>

*Table 11: Scenario 4: Distribution of car stock and fuel consumption between the three categories*

The annual tax was differentiated in a way to minimise the negative effects on the overall tax revenue.

---

20 This method ignores that there are significant differences in fuel consumption between cars with the same cubic capacity and is therefore only a rough estimate of the fuel efficiency of cars.

21 The distribution of vehicle kilometres on the categories corresponds to the car share of the category.
Although the impact on car use and car stock is small, a steering effect on cars with a high specific fuel consumption can be achieved. On the other hand, the reduction of annual taxes gives an incentive to the owners of less than average fuel consuming cars to increase their car use (+2.4%) and fuel consumption (+5.5%).

<table>
<thead>
<tr>
<th>Categories according to fuel consumption:</th>
<th>Impact of a differentiation of annual taxes on (in %):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower than average</td>
<td>Car use 2.4%  Car stock 2.9%  Fuel consumption 5.5%</td>
</tr>
<tr>
<td>Average consumption</td>
<td>Car use -1.0%  Car stock -1.2%  Fuel consumption -2.2%</td>
</tr>
<tr>
<td>Higher than average</td>
<td>Car use -2.0%  Car stock -2.5%  Fuel consumption -4.4%</td>
</tr>
<tr>
<td>Total</td>
<td>Car use -0.4%  Car stock -0.5%  Fuel consumption -1.4%</td>
</tr>
</tbody>
</table>

Table 12: Scenario 4: Effects on car use, car stock and fuel consumption of a differentiation of annual taxes according to specific fuel consumption

It can be seen from Table 12 that the measure has a major impact on fuel consumption of cars with a high specific fuel consumption. Their fuel consumption decreases by about 4.4%.

4.2.2. Environmental and financial effects

Environmental effects

Figure 3 shows that a considerable reduction of vehicle kilometres cannot be achieved with a differentiation of annual taxes only (Scenarios 3 and 4). Scenario 1 achieves - compared to Scenario 2 - a smaller reduction of car use. However, since in Scenario 2 a part of the reduction of kilometres driven on motorways will avoid road pricing and change to other roads, it can be assumed that both scenarios have more or less the same impact on car mileage.
The variabilisation of annual taxes by an increase in fuel taxes (Scenario 1) leads to a significant reduction in fuel consumption. In Scenario 2 we have assumed that the decrease in fuel consumption is similar to the decrease in vehicle use since the measure adopted (decrease in annual taxes and increase in road pricing) has no (direct) effect on fuel consumption. Annual taxes differentiated according to the specific fuel consumption (Scenario 4) show, in the long-term, a net reduction of car stock, mileage and fuel consumption. In the scenarios with tax differentiation, the life cycle of cars is important and therefore major effects can be expected only in the long-term.

The overall environmental effects depend, on the one hand, on the reduction of the vehicle km and, on the other hand, on the change of car stock (share of environmentally sound cars).

A rough quantitative estimate of the environmental impacts (emissions of CO₂ and NOₓ) of the scenarios is given in Table 13.22 Only the effects of vehicle use, and not the environmental effects of a change in car stock, have been quantified.

---

22 The estimates are based on the average emission level per vehicle kilometre which have been calculated for Switzerland (INFRAS 1995). We did not quantify the emissions of particulate since they are of importance only for diesel cars. In Switzerland the share of diesel cars is less than 3%. 
Environmental effect (1,000 t avoided emissions) | Scenario 1: Variabilisation to fuel tax | Scenario 2: Variabilisation to Hi Tech User charges | Scenario 3: Differentiation according to emission level | Scenario 4: Differentiation according to specific fuel consumption
---|---|---|---|---
CO₂ | 946 | 884 | 9 | 35
NOₓ | 4.1 | 4.6 | 0.3 | 0.1
Noise | + | + (significant local impacts) | + | (+)

Table 13: Qualitative estimate of environmental effects of the different scenarios

- **Scenario 1** leads to a significant decrease of overall car use, without a distinction between more or less polluting vehicles. Nonetheless, fuel-inefficient vehicles will be more penalised than fuel-efficient cars. Fuel taxation provides an incentive to drive in a fuel-economising way and to buy fuel-efficient vehicles (which is an incentive to the industry to develop smaller and less fuel-consuming cars). The effects on CO₂ are therefore very positive. Since the relation between fuel consumption and NOₓ-emissions is not so strong, the effect of the measure on this type of emission is only average. In regard to the noise-emissions, there are only minor effects to expect (less old vehicles, increase in people who drive carefully).

- **Scenario 2** leads to a considerable reduction of car use on motorways. The reduction is very pronounced for leisure and shopping trips done with old, polluting cars. Thus, local effects (e.g. on inner city motorways) are very positive. On the other hand, it must be considered that drivers can avoid the user charges by switching to alternative roads. According to the importance of this effect, negative environmental impacts can arise, especially if the most polluting cars avoid the motorways and choose alternative main roads, often passing through inhabited areas. In this case the negative impact on the population would even increase. Also, the estimated environmental effects due to the decrease in car use must be reduced. On the other hand, the increase in car stock as a reaction to the decrease in fixed annual taxes leads to an increase of the indirect environmental impacts (the same impact can be expected in Scenario 1).

- **Scenario 3 and 4** lead to positive, however only minor environmental effects. These effects stem from the change of car stock (more environmentally sound cars), whereas in the other scenarios (1, 2) the reduction of car use is relevant. Since
direct driving costs are not affected, the effects of these measures on car use are very small. Nonetheless, a differentiation according to the specific fuel consumption can be achieved in the long-term - through a change of car stock from less to more fuel efficient vehicles - a significant decrease in specific consumption. However, it should be considered that a decrease in specific fuel consumption reduces driving costs, so that possibly some of the positive effects are counterbalanced by an increase in car use.

**Financial effects**

One of the objectives of the estimated scenarios was to achieve the same level of tax revenue as in the situation without tax differentiation or variabilisation. Table 14 shows the results of the different scenarios.

<table>
<thead>
<tr>
<th>(million CHF)</th>
<th>Annual cantonal tax</th>
<th>Fuel tax</th>
<th>User charges</th>
<th>Total</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue 1995</td>
<td>1,300</td>
<td>3,300</td>
<td>-</td>
<td>4,600</td>
<td>-</td>
</tr>
<tr>
<td>Scenario 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>short-term</td>
<td>-</td>
<td>4,300</td>
<td></td>
<td>4,300</td>
<td>-300</td>
</tr>
<tr>
<td>long-term</td>
<td>-</td>
<td>4,200</td>
<td></td>
<td>4,200</td>
<td>-400</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>-</td>
<td>3,000</td>
<td>1,000</td>
<td>4,000</td>
<td>-600</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>1,340</td>
<td>3,310</td>
<td>-</td>
<td>4,650</td>
<td>+50</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>1,400</td>
<td>3,300</td>
<td>-</td>
<td>4,700</td>
<td>+100</td>
</tr>
</tbody>
</table>

*Table 14: Financial effects of the scenarios: Yearly tax revenue in million CHF*

In **Scenario 1**, especially in the longer run, it is not possible to achieve the same revenue as in the present situation. The demand effect (decrease in car use) exceeds the revenue effect of a higher taxation. It would be necessary in the long run to vary the level of fuel taxes in order to minimise the revenue loss. But it has to be considered that this is not possible if tax rates become too high and the steering effect exceeds the revenue effect (especially if we consider fuel tourism).

In **Scenario 2** the additional revenue of the user charges compensates the revenue loss of the annual cantonal taxes. But if we consider the impact of the decrease in car use on
the revenue of the fuel tax\textsuperscript{23} we face a revenue loss of about 9\%. Thus, we face an even more adverse situation than in Scenario 1. The stability of revenue cannot be guaranteed.

**Scenario 3** is the only scenario where revenue remain more or less stable. In comparison to the other scenarios, this can be seen as a specific advantage. In **Scenario 4**, a small increase in tax revenue (+2\%) can be expected.

Generally, the aim of equal tax revenue can be achieved with a tax differentiation which has minor effects on overall fuel consumption and fuel tax revenue. Policy measures with large impacts on car use have most probably negative effects on tax revenue.

### 4.3. Evaluation of the scenarios

The following Table 15 presents a rough evaluation of the four different scenarios. The criteria refer to the taxation aims described in chapter 2:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Scenario 1: Variabilisation to fuel tax</th>
<th>Scenario 2: Variabilisation to Hi Tech User charges</th>
<th>Scenario 3: Differentiation according to emission level</th>
<th>Scenario 4: Differentiation according to spec. fuel consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiscal stability</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Efficiency of road use</td>
<td>+</td>
<td>++</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Environmental effectiveness</td>
<td>++</td>
<td>++ esp. local</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Transparency and Enforcement</td>
<td>-</td>
<td>--</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Implementation cost</td>
<td>-</td>
<td>--</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\textsuperscript{23} Since elasticities for the reaction of fuel consumption to user charges are not available, we used the changes in car use in order to estimate the impact on fuel tax revenues (i.e. tax revenues show the same percentage reduction as vehicle km).
Summarising the theoretical considerations, an analysis of the most important trade-offs is very interesting in order to prepare the basis for the empirical considerations:

- **Environmental steering and fiscal stability**: An increase in fuel taxes and the introduction of a road pricing system have significant environmental impacts. The latter leads additionally to local effects. On the other hand, the stability of revenue cannot be guaranteed. This would be especially the case if Switzerland were to increase fuel prices on its own, risking substantial fuel tourism due to fuel price differences in relation to neighbouring countries. Beside financial losses, environmental gains might shrink due to longer trips to these countries. The analysis shows that a full variabilisation of Swiss vehicle taxes would indeed cause fuel tourism, because fuel price differentials would change in comparison to all neighbouring countries except Italy. It can be expected that a price difference of more than 10 Ct. (0.07 EURO, i.e. a price increase of more or less 8-10%) causes significant fuel tourism.\(^{24}\) This means that with a fuel price increase of more than 10% in Switzerland alone, the fiscal stability can no longer be guaranteed. The maximum price differential which still allows stable revenue to be achieved, varies between countries and depends mostly on the domestic and foreign fuel price levels. In Scenario 1 we assumed a price increase of about 30%, i.e. an average fuel price increase from 1.22 CHF to about 1.59 CHF (from 0.8 to 1.02 EURO).

Even if an international co-ordination were possible\(^{25}\), the financial stability argument would still hold: in order to guarantee stable revenue, the fuel tax should be adjusted periodically to counterbalance the steering effect. This is usually no problem from a theoretical point of view. In political practice, however, annual changes in the levels of a fuel tax might cause acceptability problems.

- **Counterbalancing effects and enforcement cost**: The significant steering effects of Scenarios 1 and 2 increase the risk of counterbalancing effects (fuel tourism, detours/change of routing). If one takes them into account, the problems mentioned above might occur. Additional measures to counterbalance these effects (e.g. border control, improved electronic control, etc.) will cause significant enforcement costs or cause other problems, which might lower the acceptance (social control, additional police manpower, etc.).

\(^{24}\) In Switzerland a running study analyses and quantifies the fuel tourism problem (INFRAS, Tanktourismus in der Schweiz, study in progress).

\(^{25}\) The scenarios assume an internationally coordinated policy (no fuel tourism takes place).
• **Environmental steering and enforcement cost:** The more sophisticated and differentiated a tax system, the better is the environmental effect. This is especially true for a well developed road pricing scheme. However, the enforcement costs (especially for initial investments) are quite significant. From this point of view, the cost-benefit ratio might not be sufficient in comparison to other measures, especially in the short run. The technical development (telematics in the road sector), however, will change this situation quite fast. It has to be considered that this development depends also on the (political) demand of new and improved systems.

In Scenarios 3 and 4 this trade off is not very significant. It has to be noted, however, that changes in cantonal taxes might afford a high level of harmonisation since Switzerland has 26 cantons. The counterbalancing effects due to the reduction of cantonal taxes for environmentally sound cars must be taken into account. The reduction in driving costs and the consequent increase in car use should be minimised.

• **Overall effect and independence:** Only a variabilisation of the vehicle tax is in the short run independent of the taxation policies of other countries. A significant increase in fuel taxes and an introduction of a road pricing scheme must be coordinated at an international level, the first one politically, the second one politically and technically.
Part 2: Empirical considerations
5. **Objective of the empirical considerations**

In the theoretical part of the report it was shown how people (should) react to a differentiation of fixed charges respectively to an increase or decrease in variable charges.

It has been illustrated that fixed and variable charges operate differently: variable charges have a direct impact on the mileage of vehicles but have no direct impacts on the composition of the car stock, whereas fixed charges affect primarily the composition of car stock and its renewal rate. These two types of taxes – with their specific advantages and disadvantages – complement each other. In the context of an optimum tax mix, it would be necessary to have variable charges as well as differentiated fixed charges.

The empirical part is based on the concrete experience with variabilisation and differentiation policies. The main objectives of this part of the study are:

- to give an overview of the existing (and planned) policies at EU-level;
- to evaluate the success of strategies towards differentiation and variabilisation of the tax system already realised in selected countries;
- to identify the most important factors which have led to the success or failure of the measures;
- to illustrate the framework conditions which were necessary in order to implement the strategies;
- to make recommendations based on the experiences of countries which have realised such measures.
6. **Overview: Today’s situation in Europe**

This chapter provides basic information on the existing situation. The in-depth analysis in the second part presents further details for selected countries.

a) **Vehicle charges**

Vehicle charges are composed of sales taxes on new motor vehicles (also called purchase taxes) and annual motor vehicle charges. Table 16 presents the up-to-date situation of vehicle charges in selected European countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Vehicle</th>
<th>Principles</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Pass. car</td>
<td>Purchase tax on new motor vehicles about 6 to 16% of price. Annual registration tax</td>
<td>Fuel consumption Engine power</td>
</tr>
<tr>
<td></td>
<td>HGV27</td>
<td>Appr. 5.2 EURO per ton and month and 16,000 or 32,000 ATS/year (1995).</td>
<td>Vehicle weight</td>
</tr>
<tr>
<td>Belgium</td>
<td>Pass. car</td>
<td>Registration tax plus VAT, 2,500 up to 200,000 BF Annual circulation tax BF 2,000 up to 51,000 BF</td>
<td>Engine weight</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Annual circulation tax</td>
<td>Vehicle weight</td>
</tr>
<tr>
<td>Denmark</td>
<td>Pass. car</td>
<td>Registration tax based on the value of the car: 105% of the value of the car, (incl. the general sales tax of 25%) if value is less than 50,800 DKK, 180% if value is more than 50,800 DKK Green owner tax: about 2–3,000 DKK Taxes on the mandatory liability insurance.</td>
<td>Vehicle price Fuel consumption</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>HGV pay no registration tax Small vans up to 2 t pay 95% of the price above 12,100 DKK Larger vans (2–4 t) pay 30% of the price above 30,000 DKK</td>
<td>Vehicle price</td>
</tr>
<tr>
<td>Finland</td>
<td>Pass. car</td>
<td>Purchase tax based on value at custom (tax=100% of value at custom)28. Annual vehicle tax: Flat-rate charge</td>
<td>Vehicle price technical features (safety equipment, cat. converter)</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Circulation tax</td>
<td>Weight, number of axles</td>
</tr>
<tr>
<td>France</td>
<td>Pass. car</td>
<td>Registration tax (95 FF up to 195 FF per horsepower) Circulation tax (5,900 FF up to 12,900 FF)</td>
<td>Engine power</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Registration tax (local and para fiscal charge on national level) Circulation tax</td>
<td>Vehicle price Axles, Weight (over 16 tons)</td>
</tr>
</tbody>
</table>

*Table 16: Annual motor vehicles taxes and purchase taxes: Situation in European countries 1997 (EU 1997a, PETS, 1997).*

26 The information is based on EU research within the Transport programme (PETS 1997) and the report of the European Commission on Road Taxation in Europe (EU 1997a)

27 HGV: Heavy goods vehicles

28 Minus a reduction for safety equipment and catalytic converters, about 770 EURO.
<table>
<thead>
<tr>
<th>Country</th>
<th>Vehicle</th>
<th>Principles</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HGV</td>
<td>Circulation tax. (S1=Euro 1: Fuel 6.87 EURO/100 cm³, Diesel 11.24; S2=Euro 2: Fuel 5.20, Diesel 14.04)</td>
<td>Weight, emissions, noise</td>
</tr>
<tr>
<td>Greece</td>
<td>Pass. car</td>
<td>Consumption tax, Circulation tax</td>
<td>Cylinder capacity, Engine power, reduction for ‘clean’ cars</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Circulation tax</td>
<td>Engine power</td>
</tr>
<tr>
<td>Italy</td>
<td>Pass. car</td>
<td>Registration tax (plus additional provincial tax)</td>
<td>Fiscal horsepower/payload, Cylinder capacity, fiscal horsepower</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Annual circulation tax</td>
<td>Weight</td>
</tr>
<tr>
<td>Ireland</td>
<td>Pass. car</td>
<td>Registration tax, Circulation tax</td>
<td>Cylinder capacity</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Circulation tax</td>
<td>Weight, cargo capacity</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Pass.car</td>
<td>Flat purchase levy; annual circulation taxes</td>
<td>Engine power</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Circulation tax</td>
<td>Weight, axles, type of suspension</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Pass. car</td>
<td>Purchase tax based on weight, size of engine and effect of the motor²⁹</td>
<td>Weight and size</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Annual motor vehicle tax based on the weight of the vehicle.</td>
<td>Vehicle Weight</td>
</tr>
<tr>
<td>Norway</td>
<td>Pass. car</td>
<td>Purchase tax, Annual motor vehicle taxes for passenger cars and vans.</td>
<td>Weight, size of engine</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>There are 2 taxes, one is fixed for those vehicles weighting less than 12 ton and another for heavier vehicles based on weight and number of axles. There is also a separate tax for (semi) trailers.</td>
<td>Weight, number of axles</td>
</tr>
<tr>
<td>Portugal</td>
<td>Pass. car</td>
<td>Purchase tax, Annual motor vehicle tax</td>
<td>Cylinder capacity, Cylinder capacity and age of the car</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Annual motor vehicle tax</td>
<td>Net weight</td>
</tr>
<tr>
<td>Spain</td>
<td>Pass. car</td>
<td>Purchase tax, Annual motor vehicle tax</td>
<td>Engine power</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>The same as for passenger cars plus one surcharged called „Tarjeta de Transportes”.</td>
<td>Engine power</td>
</tr>
</tbody>
</table>

Table 16: Annual motor vehicles taxes and purchase taxes: Situation in European countries 1997 (EU 1997a, PETS, 1997); continued

²⁹ For the most expensive cars a value-based tax is also levied.
Table 16: Annual motor vehicles taxes and purchase taxes: Situation in European countries 1997 (EU 1997a, PETS, 1997); continued

Purchase taxes on vehicles are in most cases higher than on other goods. High sales taxes might reduce the rate at which the vehicle stock is renewed. The major economies levy only the VAT on the prices of new cars (Germany, Italy, France, UK). Additionally, some countries have been using fiscal incentives to scrap old vehicles, thus accelerating the replacement of older vehicles with new, less polluting vehicles. Also, for environmental reasons, a number of countries have recently begun to differentiate purchase taxes on private cars by engine size or other factors affecting the fuel used (see details in the following chapters).

Annual motor vehicles taxes usually take the form of fees for the use of motor vehicles. Annual motor vehicle taxes are levied in all Europe. In this respect there can be seen more harmony of practice in annual taxation than in acquisition taxation (PETS, 1997).

b) Fuel taxes
Excise duties on fuel are the method most widely used to raise revenue from road users. Their importance is shown in the following table.

<table>
<thead>
<tr>
<th>Country</th>
<th>Vehicle</th>
<th>Principles</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>Pass. car</td>
<td>Registration tax, Circulation tax</td>
<td>Vehicle price, Dead weight, type of fuel</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Circulation tax</td>
<td>Dead weight</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Pass. car</td>
<td>Cantonal annual vehicle tax; some cantons have a bonus system for cars with catalytic converters.</td>
<td>Weight, cylinder capacity</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Annual vehicle tax for trucks and trailers. It can be paid per day, per month or per year (starting in 2001 the fixed charge will be replaced by a variable charge related to mileage and weight of the lorry.).</td>
<td>Weight, Axles</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Pass. car</td>
<td>Vehicle excise duty</td>
<td>flat rate</td>
</tr>
<tr>
<td></td>
<td>HGV</td>
<td>Vehicle excise duty</td>
<td>Weight, number of axles</td>
</tr>
</tbody>
</table>
### Table 17: Excise duties on fuel: Situation in European countries January 1997 (EU 1997a).

<table>
<thead>
<tr>
<th>Country</th>
<th>Leaded petrol (1,000 litres)</th>
<th>Unleaded petrol (1,000 litres)</th>
<th>Diesel (1,000 litres)</th>
<th>LPG (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>482</td>
<td>4169</td>
<td>291</td>
<td>262</td>
</tr>
<tr>
<td>Belgium</td>
<td>569</td>
<td>510</td>
<td>292</td>
<td>0*</td>
</tr>
<tr>
<td>Denmark</td>
<td>530</td>
<td>447</td>
<td>308</td>
<td>353</td>
</tr>
<tr>
<td>Finland</td>
<td>613</td>
<td>536</td>
<td>310</td>
<td>0*</td>
</tr>
<tr>
<td>France</td>
<td>617</td>
<td>576</td>
<td>358</td>
<td>123</td>
</tr>
<tr>
<td>Germany</td>
<td>556</td>
<td>505</td>
<td>321</td>
<td>314</td>
</tr>
<tr>
<td>Greece</td>
<td>415</td>
<td>363</td>
<td>252</td>
<td>105</td>
</tr>
<tr>
<td>Ireland</td>
<td>440</td>
<td>395</td>
<td>343</td>
<td>152</td>
</tr>
<tr>
<td>Italy</td>
<td>580</td>
<td>534</td>
<td>390</td>
<td>312</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>402</td>
<td>349</td>
<td>254</td>
<td>102</td>
</tr>
<tr>
<td>Netherlands</td>
<td>597</td>
<td>531</td>
<td>320</td>
<td>51*</td>
</tr>
<tr>
<td>Portugal</td>
<td>503</td>
<td>469</td>
<td>327</td>
<td>103</td>
</tr>
<tr>
<td>Spain</td>
<td>396</td>
<td>363</td>
<td>264</td>
<td>776</td>
</tr>
<tr>
<td>Sweden</td>
<td>566</td>
<td>503</td>
<td>298</td>
<td>300</td>
</tr>
<tr>
<td>Switzerland</td>
<td>465</td>
<td>457</td>
<td>474</td>
<td>0*</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>567</td>
<td>501</td>
<td>501</td>
<td>288</td>
</tr>
</tbody>
</table>

* not applicable

**c) Road user charges**

Road user charges or tolls are direct charges, which are paid at the point of use. They are used to charge primary roads, motorways (some 30% of motorways in Europe are tolled) and for singular passages (like bridges or tunnels).
Overview: Today’s situation in Europe

<table>
<thead>
<tr>
<th>Flat Charges</th>
<th>Tolls/Road Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Motorway Vignette for passenger cars and lorries At present tolls are collected on selected motorways (Brenner, Tauern, Phyrn, Arlberg) and mountain roads. Electronic road pricing is planned.</td>
</tr>
<tr>
<td>Belgium</td>
<td>Eurovignette for lorries -</td>
</tr>
<tr>
<td>Denmark</td>
<td>Eurovignette for lorries -</td>
</tr>
<tr>
<td>Finland</td>
<td>- -</td>
</tr>
<tr>
<td>France</td>
<td>- Motorways are tolled depending on the type of vehicle (HGV, bus, car, etc.) and time of day/week</td>
</tr>
<tr>
<td>Germany</td>
<td>Eurovignette for lorries -</td>
</tr>
<tr>
<td>Greece</td>
<td>- Tolls on motorways</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Eurovignette for lorries Road Pricing on motorways planned</td>
</tr>
<tr>
<td>Ireland</td>
<td>- -</td>
</tr>
<tr>
<td>Italy</td>
<td>- Most of highways are tolled except the ones in Southern Italy and islands.</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Eurovignette for lorries -</td>
</tr>
<tr>
<td>Norway</td>
<td>- In addition to toll rings in Oslo, Bergen and Trondheim, some bridges/tunnels are tolled (concession system) for a specific period, usually 15 years.</td>
</tr>
<tr>
<td>Portugal</td>
<td>- Motorways are all tolled, tolls are set by government</td>
</tr>
<tr>
<td>Spain</td>
<td>- Only some motorways are tolled (concession system).</td>
</tr>
<tr>
<td>Sweden</td>
<td>Eurovignette for lorries -</td>
</tr>
<tr>
<td>Switzerland</td>
<td>A general toll for the use of motorways („vignette“) is collected (see description on the next page).</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>- currently none, private toll road proposal for Birmingham (planned)</td>
</tr>
</tbody>
</table>

Table 18: Road user charges/Tolls on roads: Current situation in selected European countries (EU 1997a, PETS, 1997).

Besides tolls on motorways (Austria, Italy, France, Portugal and Spain), there are toll rings in some urban areas used to promote a more efficient use of infrastructure, in order to reduce social costs or simply to collect revenue. These charges can be seen as “road pricing-like” vehicle user charges.

In urban areas all of the bigger cities in Europe levy fees for parking, both to collect revenue and to control use, thus controlling access to city centres and indirectly promoting a higher share of public transport.

For HGV, apart from the indirect charges, there are some direct variable charges. In Switzerland heavy vehicles from other countries have to pay a proportion of the Swiss...
HGV charge, where the amount payable depends on circulation time. Norway, Finland and Sweden used to levy an international distance-related charge on diesel-using HGV, where the vehicle is charged a standard rate per mile depending on the class of vehicle, but this was abandoned when Sweden and Finland joined the EU (PETS, 1997).

Besides, there are road user charges which have the character of fixed access charges. In Switzerland, any domestic or foreign vehicle under 3.5 tons has to purchase and display a “vignette” (or permit) which allows the vehicle to use all Swiss motorways for one year\(^\text{30}\). For HGV, there is a special tax. At present, it is a fixed tax based on the total weight of trucks and trailers. It can be paid per day, per month or per year. At present it is discussed, whether a tax that is related to the mileage or to the fuel consumption of the vehicles should be introduced (weight on km dependent HGV tax).

In the case of Belgium, Denmark, Germany, Netherlands, Luxembourg, and (from 1/2/98) Sweden, a Eurovignette is levied on HGV for the use of the motorway network. It costs 1,891 EURO per year for a three axles lorry, and 3,151 EURO for a vehicle with four or more axles; it can also be bought for a shorter period.

d) Revenue shares

Figure 4 concludes the situation for different countries, comparing the revenue from different types of taxes.

\(^{30}\) Permis d’access: 24 EURO per year.
Figure 4: Share of annual revenue for different type of taxes (EU countries 1997),
Source: EU 1997a

The fixed rate of vehicle charges are at an average of about 25% of the total revenue in
the compared countries. The vehicle charges lie between 8.5% in Spain and 45% in Fin-
land. As mentioned before, the fuel taxes are the most extensive revenue from road
using. In the selected countries, they amount to an average of about 70% of the total revenue.

Up to now, the lowest revenue result from the variable road user charges, which amount in the selected countries to an average of about 5%.
7. Experience with differentiation and variabilisation in selected countries

7.1. Overview of the countries and measures analysed

In the following chapters, we will analyse in more detail European taxation policies with regard to differentiation and/or variabilisation, in order to draw empirical conclusions and compare them with the results drawn from theoretical analysis. Therefore, selected interesting taxation examples will be chosen and evaluated according to an explicit criteria set. In order to collect the information afforded, specific interviews with national experts were carried out and background information was analysed. Annex 3 shows detailed information sheets for the countries and their instruments selected.

Since taxation policy is very dynamic, it is not easy to isolate the effects of specific measures introduced. Moreover, the instruments are usually part of a larger package, in order to increase the effects or simply to gain acceptance. Nevertheless we try to distinguish two groups of policies. The following Table 19 gives an overview of the countries and instruments selected for evaluation.
### Taxation scenarios: Experiences in chosen countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Experiences with variabilisation</th>
<th>Differentiation of fixed charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Introduction of a km-related HGV-tax on highways (planned for the year 2002) and replacement of flat rate user charge.</td>
<td>Purchase tax acc. to specific fuel consumption. Annual veh. tax: Rebates for vehicles with catalytic converters.</td>
</tr>
<tr>
<td>Denmark</td>
<td>Introduction of an energy and emission tax on fuels and differentiation acc. to fuel quality</td>
<td>Annual vehicle tax acc. to fuel consumption</td>
</tr>
<tr>
<td>France</td>
<td>Highways’ toll acc. to time and routing</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>-</td>
<td>Annual vehicle tax acc. to emissions</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Price index adjusted fuel tax Electronic road pricing (pilot scheme, introduction planned)</td>
<td>Purchase tax and annual vehicle tax acc. to fuel consumption (planned)</td>
</tr>
<tr>
<td>Sweden</td>
<td>Introduction of a CO2-tax and differentiation acc. to fuel quality Km-tax for diesel-driven vehicles (abolished)</td>
<td>Purchase tax acc. to emission criteria (abolished)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Km- and weight-related HGV-tax</td>
<td>Annual vehicle tax acc. to fuel consumption and emissions</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Fuel escalator and differentiation acc. to fuel quality</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 19: Overview of the countries selected with variabilisation and differentiation strategies (see details in annex 3)

The **differentiation** policies we looked at concern primarily **purchase taxes** and/or **annual vehicle taxes**, as the most relevant fixed charges levied in the transport sector. The specific “design” of the tax (tax basis, tax level) – and therefore the impact of differentiation – varies considerably between countries.

The **variabilisation** of the tax system is achieved either with an increase in **fuel taxes** (with the increase of specific types of fuel taxes respectively)\(^{31}\) or with the introduction of a **road pricing** system. The plans for the introduction of road pricing in Austria, the Netherlands and Switzerland are very different in regard to the specific aim, the level of the charge, the technical features of the measure (i.e. payment method), the area where road pricing will be charged, etc. We will focus therefore on the objectives of these measures as well as on the framework conditions which were/are necessary for implementation.

---

\(^{31}\) The differentiation of fuel taxes according to environmental criteria is discussed under the variabilisation measures, since fuel taxes are variable charges.
7.2. Measures towards differentiation of fixed charges

a) Differentiation of purchase taxes

The purchase or sales taxes\(^{32}\) are levied once and usually are coupled with the ownership of the vehicle.

<table>
<thead>
<tr>
<th>Country</th>
<th>Differentiation criteria</th>
<th>Tax level</th>
<th>Objective of differentiation</th>
<th>Implem. Costs, side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fuel consumption</td>
<td>Tax rate for fuel engine = (2 \times (\text{MVEG} - \text{fuel cons.} - 3)), tax rate is multiplied with cars’ price. Max. tax rate: 16%</td>
<td>Fiscal (revenue neutrality) and environmental objective</td>
<td>Low implementation costs, no negative side effects</td>
</tr>
<tr>
<td>NL</td>
<td>(\text{CO}_2) emissions (cars), EURO norms (HGV), tax rebate for veh. with catalytic converters</td>
<td>50 NLG per gram (\text{CO}_2) emission; for HGV, tax difference should compensate for sales price differences</td>
<td>Reduction of (\text{CO}_2) emissions</td>
<td>Low implementation costs because of few tax payers (car sellers)</td>
</tr>
<tr>
<td>S</td>
<td>Cat. converters, environmenal classes: differentiation abolished.</td>
<td>The tax differentials were approx. +2,000 SEK for the more pollutant veh. and –4,000 SEK for the less pollutant vehicles.</td>
<td>Quick introduction of veh. with cat. converters, promotion of env. friendly vehicles (tax difference compensates for price difference)</td>
<td>Implementation costs were modest, no side effects</td>
</tr>
</tbody>
</table>

Table 20: Overview of countries with vehicles purchase taxes and differentiation criteria

The features of differentiation of purchase taxes are as follows:

- The differentiation often used for the purchase tax is the fuel consumption, \(\text{CO}_2\) emissions (based on fuel consumption) or the technology (EURO-standard).

- At present, only a few countries have implemented a differentiation of purchase taxes. The state of implementation is different between the countries analysed.

- In Austria the differentiated tax is based on the fuel consumption (according to the MVEG/ECE values\(^{33}\)) of new vehicles. The tax is differentiated for diesel and petrol-driven vehicles:
  - Petrol-driven vehicles: \((\text{fuel consumption} - 3) \times 2 = \text{tax rate}\)
  - Diesel-driven vehicles: \((\text{fuel consumption} - 2) \times 2 = \text{tax rate}\)
  - The tax rate is multiplied by the car’s price in order to get the overall tax burden.

\(^{32}\) In some countries this tax is also called registration tax.

\(^{33}\) ECE resp. MVEG refer to the old and new method of measuring fuel consumption.
The maximum tax rate is restrained to 16%, because of pressure coming from the car industry. Electric cars, as well as vehicles which fulfil special transport purposes (ambulance service, etc.), are exempt from taxation.

The introduction of a purchase tax was also a result of EU harmonisation. Previously, the purchase tax was linked to the VAT (special “luxury” VAT).

- **In the Netherlands** it is planned to partially replace the existing purchase tax by a tax based on the relative fuel consumption respectively on CO₂ emissions of the vehicle compared to vehicles of the same size. The proposed tax rate amounts to 50 NLG per gram CO₂/km according to the EU test cycle. The present purchase tax amounts to 45% of the price of the car. Additionally as a flanking measure, there are proposals for a new labelling method. The main feature of this method is that the fuel economy of each passenger car is labelled in relation to other cars within the same length x width category. The objective of the labelling is to provide consumers with accurate information on the fuel consumption/CO₂ emissions of new passenger cars in order to influence the choice of consumers towards more fuel-efficient passenger cars.

The differentiation of HGV and passenger cars purchase taxes was set equal to the price difference between vehicles with EURO 2 and EURO 3 and between vehicles with and without catalytic converters.

- **Sweden** abolished the differentiated purchase tax in 1996. The tax rebate for environmentally friendly vehicles (environmental class 1) was substituted by an exemption from the payment of annual vehicle tax for the first five years after vehicle purchase. The first differentiation of the Swedish vehicle purchase tax was implemented in 1987 and 1988 for cars which were voluntarily equipped with catalytic converters. The tax reduction was more or less equivalent to the additional costs for implementing the equipment. With the introduction of a new environmental classification system in the mid-90s, the purchase tax was differentiated in favour of vehicles belonging to classes 1 and 2 (class 3 being the class with the minimum environmental requirements). The differentiation of the environmental classes was made according to the Californian system (sharper environmental criteria than the EU system): Vehicles of class 1 had to fulfil the standards for LEV (low emission vehicles), vehicles of class 2 had to fulfil the USA 1994 standards. The Swedish tax system was complemented with a scrapping charge. The objective of this measure was to minimise the number of old cars abandoned and to accelerate the scrap-
ping of old vehicles with inferior exhaust gas treatment. In Sweden, the differentiation of purchase taxes according to environmental classes was abolished because of harmonisation problems with EU-requirements. The reasons for giving up the purchase tax (and simultaneously increasing the annual tax instead) were national policy decisions (the main argument was the positive effect on employment).  

b) Differentiation of annual vehicle taxes
The following Table 21 gives an overview of the characteristics of the differentiated annual vehicle taxes implemented in different European countries.

34 Swedish car manufacturers produce rather large vehicles not belonging to the better environmental classes. This has lead to a worsening of the competitive position of Swedish vehicles in comparison to smaller and environmentally friendlier foreign vehicles.
Table 21: Overview of differentiation policy of annual vehicle taxes

It can be noticed that:

- The most often used differentiation criteria is **specific fuel consumption**, although in some countries differentiation is based on the **specific vehicle technologies** (for example EURO technology), or **emissions** (air pollution and noise). The previous, undifferentiated annual vehicle taxes were usually based on the vehicles’ weight or engine power.

- The most important objective of differentiation of annual taxes was to give incentives for the **purchase of fuel-efficient vehicles**. The fiscal objective of most countries was a **revenue-neutral** change from one system to the other.

- In **Austria**, in order to stop the trend towards more powerful vehicles, the annual vehicle tax was based on the engine power of the vehicle. Diesel and petrol vehicles are taxed with the same rate. The tax increases linearly with the engine power (5 ATS per kW exceeding 24 kW). For vehicles which were taken into circulation before 1987 and are not equipped with the catalytic converter, the tax is in-
creased by 20%. The objective was to accelerate the scrapping of vehicles without catalytic converters.

Besides Austria, other countries also (not explicitly considered within this evaluation) have applied a rebate system in order to promote cars with catalytic converters.

- In **Denmark**, the differentiation based on the **fuel consumption** ('green owner tax') distinguishes two tax rates, for petrol and diesel vehicles. The tax is based on the car’s potential fuel consumption according to the EC standards. There are twenty tax steps on the scale of fuel economy. The typical Danish car is taxed with around 390 EURO for an average fuel economy of 8 l/km. As one of the expected gains from the green owner tax is an increased fuel efficiency in new cars, the tax steps are proposed to increase by 1.5% each year in order to maintain the same level of tax pressure.

  Since the excise tax on diesel is lower than on petrol (for reasons of competitiveness), the annual vehicle tax is set at a higher rate for diesel-driven cars. The tax scale considers the fact that diesel-driven cars have a higher fuel efficiency than petrol cars. The break-even point above which driving a diesel car is cheaper is calculated at 16,000 km per year.

  Because official and comprehensive measurements of potential fuel consumption (according to the EC standards) are available only for new vehicles, in **Denmark**, where the differentiation is carried out according to this criteria, there are at the moment two taxation systems, the undifferentiated system for cars taken into circulation before 1997\(^{35}\) and the differentiated system for new cars. This twofold taxation system has to be applied until all older cars are taken out of circulation (the same holds true in Germany and in Austria in the context of the purchase tax differentiated according to fuel consumption).

- In **Germany**, since 1997, a differentiated tax scheme is applied. It distinguishes six different tax rates, according to EURO-classes, petrol and diesel cars and \(\text{CO}_2\)-emissions. This combination considers, the size, the air pollution and the climate change effects at the same time.

\(^{35}\) From 1997 the “potential” fuel consumption measured by EU standards was made obligatory.
• In the Netherlands it has been proposed to differentiate the annual vehicle tax according to the vehicles’ technological standard. Cars which fulfil the emissions standards for the year 2005 (EURO 4) get a rebate on the annual tax. The rebate differentiates between diesel and petrol vehicles and is paid as long as the standard is not compulsory for new vehicles.

• In Switzerland, three designs of a differentiation of annual vehicle charges are discussed:
  1. Differentiation of the current system\(^{36}\),
  2. Introduction of a yearly "bonus-malus system" in addition to the existing undifferentiated annual charge,
  3. Introduction of a once-off "bonus-malus system" in addition to the existing undifferentiated annual charge.

The canton Lucerne has introduced a “bonus-malus system"\(^{37}\) based on the fuel consumption of vehicles. This differentiation measure does not replace the undifferentiated tax but it complements the annual vehicle tax (which is based on the engine power of vehicles). The fuel consumption is derived from the EU standards. The “bonus-malus system” differentiates between diesel- and petrol-driven vehicles (differentiation criteria: 1 kWh=0.115 l petrol = 0.102 l diesel) and will be in force until 2002. All vehicles, new as well as old ones, passenger cars and lorries, benefit or are charged with the bonus or malus respectively.

There are some proposals to change the system to a once-off system. This would imply that the owner will get the money or has to pay the malus at the time of the first registration of the vehicle. It is believed that a tax with this design could be more effective because of the larger amount which has to be paid respectively which the owner gets back.

• The implementation costs of the differentiation of annual vehicles taxes are very moderate. There are no experiences with negative side effects.

---

36 Depending on the Cantons the annual registration tax is usually based on the vehicles’ weight, engine size or power.

37 Bonus-malus system means that the owners of the more fuel-efficient vehicles get money (receive the “bonus”), whereas the owner of the fuel-inefficient vehicles have to pay an amount to the canton (have to pay the “malus”).
7.3. **Measures towards variabilisation of the tax system**

**a) Fuel price strategies**

Fuel price strategies consist of increased fuel prices at the one hand and the differentiation of fuel duties according to environmental criteria. The following Table 22 gives an overview of the measures considered within the evaluation.

<table>
<thead>
<tr>
<th>Country</th>
<th>Variabilisation measures</th>
<th>Objectives</th>
<th>Implement. Costs, side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>DK</td>
<td>Introduction of a CO2-tax (1992) and an energy tax (1998); Fuel taxes differentiated according to environmental criteria 1998 (leaded/unleaded, standard of petrol station, benzene content)</td>
<td>Fiscal objectives, environmental incentives</td>
<td>No additional implementation costs</td>
</tr>
<tr>
<td>NL (since 1997)</td>
<td>Differentiated fuel taxes, automatic adjustment to inflation</td>
<td>Avoidance of a decrease of real fuel prices</td>
<td>No implementation costs, side effects due to tank tourism in the border regions</td>
</tr>
<tr>
<td>S (since 1986)</td>
<td>Fuel taxes, differentiation according to environmental classes (leaded/unleaded, CO2, sulphur and VOC content)</td>
<td>Fiscal and environmental objectives</td>
<td>Modest implementation costs, revenue neutrality could not be achieved due to the rapid fuel shift</td>
</tr>
<tr>
<td>UK (since 1993)</td>
<td>Increase of the fuel duty by 3% p.a. (since 1995 5% p.a.); since 1997 differentiation of the fuel duty acc. to fuel quality</td>
<td>Fiscal and environmental objectives (UK climate strategy)</td>
<td>No specific implementation costs</td>
</tr>
</tbody>
</table>

Table 22: **Overview of fuel price measures**

- An increase in the fuel price usually also has fiscal and environmental aims, whereas a differentiation of fuel taxes is realised in order to promote the use of more environmental friendly fuel types.

- In **Denmark** the excise tax on fuels is levied on petrol and diesel and consists of a CO₂ tax, an energy tax and a sulphur tax. Petrol is differentiated in three categories: leaded and unleaded petrol, stations with or without vapour recovering equipment and since 1998 according to the benzene content of the fuels. Diesel is differentiated between normal and light diesel, the differentiation criteria is the sulphur content (light fuel: less than 0.05%).

- In **Sweden** the petrol tax was differentiated on unleaded and leaded petrol (1986). In 1991 energy taxes on diesel (including heavy fuel oil) were differentiated in three environmental classes according to the sulphur content, VOC content and...
the boiling temperature of oil. In 1994 the unleaded petrol was further differentiated in two environmental classes (class 3: standard class, class 2: environmentally superior class).

- **In the Netherlands** fuel tax has recently been indexed to inflation. The first adjustment was carried out in 1997. The prices were raised by 15 cents for petrol and by 6 cents for diesel. The increase in fuel tax with inflation occurs automatically. Trucks receive a rebate on the diesel consumption. To compensate for the price differential between diesel and petrol, the purchase taxes on diesel vehicles are higher.

- **In the UK**, a combined strategy was chosen: the fuel duty escalator leads to a continuous increase in fuel prices, raising the incentives for fuel-efficient behaviour and offsetting possible reductions of revenue due to lower specific fuel consumption. The quality differentials distinguish between leaded and unleaded petrol, between petrol and diesel, and between the sulphur content of diesel.

- The **implementation costs** of these strategies are **very low**. The example of Sweden, however, has shown that people react quickly to price differences between types of fuel. The rebate on environmentally friendlier fuel was a strong incentive for changing from traditional fuels to the new types. The quick and significant switch towards the cheaper type of fuel has caused unforeseen fiscal losses to the government.

- The possibilities for a variabilisation through an **increase in fuel taxes** are very **restricted** due to the problem of cross-border fuel tourism. This is especially true for small countries like the Netherlands and Denmark who have to consider the tax level in Germany.

b) **Road pricing measures**

The introduction (and differentiation) of road user charges is another major variabilisation strategy. The following examples were examined.
<table>
<thead>
<tr>
<th>Country</th>
<th>Variabilisation measures</th>
<th>Objectives</th>
<th>Implement. Costs, side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (introduced in 2002)</td>
<td>Road Pricing for HGV on motorways, axles-related (in addition to existing tolls)</td>
<td>Financing maintenance and construction costs</td>
<td>Impl. costs: 0.25 - 0.29 b. EURO, Minor negative side effects for rail, ev. possibility of evasive actions</td>
</tr>
<tr>
<td>CH (introduction in 2001)</td>
<td>Overall km-tax for HGV (linked with an increase of weight limits), related to km, weight and EURO norms</td>
<td>Covering of external effects of HGV, fiscal revenue for financing investments in rail transport</td>
<td>Implementation costs lie between 3 and 6% of revenue. Private costs (elec. system): 620 - 930 EURO/vehicle, possible negative side effects for rail transport</td>
</tr>
<tr>
<td>F (since 1992)</td>
<td>Differentiation of Motorway tolls according to time and routing, first realised on Lille-Paris Lower tolls on Sundays at ‘green hours’ (afternoon, late evening), higher tolls in evening peak hours (+/- 25%)</td>
<td>Congestion, revenue raising</td>
<td>Specific enforcement cost (information, payment)</td>
</tr>
<tr>
<td>NL (planned for 2001)</td>
<td>Road pricing in urban areas</td>
<td>Reduction of congestion costs</td>
<td>Approx. 115 million EURO implementation costs, 55 million EURO running costs, use of revenue: reduction of income taxes/investments in public transport</td>
</tr>
<tr>
<td>S (since 1974 abolished 1993)</td>
<td>Mechanical km-charge for diesel vehicles and change to diesel excise duty</td>
<td>To cover infrastructure costs and externalities of HGVs</td>
<td>High implementation costs, tax was not EU compatible, problem with int. competitiveness, high cheating possibilities</td>
</tr>
</tbody>
</table>

Table 23: Overview of road pricing measures

- In the future, different plans for road pricing will be implemented in various European countries (Austria, Switzerland and The Netherlands). In addition (but not examined here in detail), Germany plans to introduce a variable km-tax in order to replace the existing (flat-rate) Eurovignette.

- Similarly, in Austria it is foreseen to switch from a time-related tax to a **km and axles** (three categories)-**related one**. The toll will be levied on HGVs (with a maximum weight higher than 3.5 t) on motorways. The objective is to guarantee the fiscal revenue necessary for the construction and maintenance of the motorways’ network. The toll has to be paid by a “half open dual system”, which means the driver can decide if the toll shall be paid by conventional payment or by an electronic system. This system consists of main toll stations and secondary toll stations. Secondary toll stations have to be built on the access and exit roads of motorways before and after main toll stations. To enforce the payment of the toll on the trucks, special equipment will be installed in order to take pictures of all...
transiting vehicles with a total weight exceeding 3.5 t. Up to 2002, 23 main toll stations and 67 secondary toll stations have to be built.

- The **Swiss** road pricing system depicts a **real variabilisation policy** since the fixed annual tax for lorries will be replaced by a variable km- and weight-referred tax levied on the whole road network. The charge has fiscal and environmental objectives. It will be based on an on-board unit (OBU) measuring the kilometres driven and identifying the vehicle. The enforcement system is based on dedicated short-range system technology (DSRC) and GPS (global positioning system). It is foreseen that the charge will also be differentiated according to emission criteria (EURO-classes). At a later stage, surcharges (for specific routes) are discussed.

- In **France** some experiences have been carried out with differentiation of motorway tolls on some sections and during certain periods of the year (holiday departure time) or on specific days of the week (on Sundays). The differentiation is carried out according to the vehicle type and the distance driven, as well as according to temporal criteria or the route chosen. The latter meaning that on alternative, less congested routes, motorway tolls are cheaper than on the main route. The objective is the decrease of congestion and an improvement of security by temporal and spatial spreading.

- There are plans to introduce road pricing also in the **Netherlands**. The main objective is the reduction of **congestion** during peak hours. A (fixed) tax will be levied at the entry of metropolitan areas during fixed hours of the day (between 7.00 and 9.00 o'clock, on roads entering the ‘Randstad’). All vehicles will have to pay the tax. A **revenue neutral** introduction of road pricing was planned, with the redistribution of revenue back to households (for example through a reduction of income taxes). The problem with the redistribution of revenue to population is that according to the EU this measure could constitute a discrimination against drivers of foreign vehicles. Investing the returns from road pricing in public transport would avoid this problem (but reduce acceptance of population). It is not decided yet how the revenue from road pricing will be used or refunded. Most probably they will be kept by the involved cities. After having collected the first experiences, it is possible that the Dutch system will be improved with the introduction of a kilometre-related road-pricing system.
• Between 1974 and 1993 Sweden levied a kilometre tax on diesel vehicles. This road-pricing system was abolished because of problems with EU compatibility and competitiveness of haulage firms. Additionally, there were major problems with the on-board unit used for measuring of mileage, which could easily be manipulated. The stops and time losses at the borders were an additional reason for abolishing the kilometre tax. The kilometre tax was substituted with a diesel and energy tax and a flat-rate HGV tax (Eurovignette). The condition for the change of the taxation system was that the total revenue from the taxes was to remain mainly unchanged. Even so, the HGVs are heavily burdened in Sweden (compared to other EU countries), therefore the level of the annual vehicle tax for HGV was reduced by around 20%. The total burden of the kilometre/fuel tax and fixed annual vehicle tax before and after the change shows that only the heaviest vehicles with trailers have benefited from the change.

• The introduction of electronic road pricing is linked to major implementation costs and enforcement problems. In addition to the costs for the construction of the payment and electronic stations (financed by the state or the firm which provides the infrastructure), vehicle owners have to equip their vehicles with the electronic mileage measuring device. In Switzerland, this equipment is compulsory for Swiss vehicles. There are some proposals to distribute the electronic devices to haulage firms free of charge and finance them with the revenue collected in the first years of implementation. The yearly running costs are also quite important. In Switzerland it will be necessary to control the mileage of every vehicle and calculate the tax on this basis. In Austria and in the Netherlands the running costs are caused primarily by the personnel costs for the served payment stations.
8. Assessment of the implemented taxation schemes

8.1. Criteria for the appraisal of the measures

The assessment of the measures presented in chapter 7 will be carried out on behalf of the criteria already used for the appraisal of the Swiss case study within the theoretical part. In order to consider also the overall political framework, we regroup and extend these criteria slightly:

- **Efficiency of road use**: Does the measure improve the use of road infrastructure and reduce/minimise congestion? Is it possible to minimise detours (linked with negative environmental impacts)?

- **Environmental effectiveness and efficient use of resources**: Is the measure able to minimise air pollution and noise emissions? Does the measure give incentives for a more efficient fuel consumption? To what extent does the measure contribute to a reduction of CO₂ emissions? Does the measure give an incentive towards an optimum fuel mix (diesel, petrol, LPG, others) of the vehicle fleet?

- **Fiscal stability and fiscal neutrality**: Is it possible to meet fiscal and steering elements at the same time, or are there any trade-offs visible? Is a revenue-neutral introduction of the measure possible or is it linked to an increase/decrease of overall tax burden?

- **Implementation and enforcement**: What is the level of the once-off costs and running costs for the implementation of the measure? Are there any problems arising with regard to enforcement? What are the fraud systems of the measure?

- **Negative side effects**: Can evasive actions by car drivers be expected (as for example detouring in order to avoid the payment of road pricing or fuel tourism)?

- **Flexibility**: Is it possible to adapt the instrument to technological and environmental changes? Can a strengthening or relaxing of the measure be easily implemented (according to the changing framework conditions and political objectives)?

- **Dependence/independence from pricing policies in other European countries**: Is it possible to implement the measure without a co-ordinated action between
neighbouring countries? What are the possible negative side effects of a unilateral introduction of a specific pricing policy?

Additionally, we will use some other, more general factors for the evaluation of the implemented measures:

- Importance of political and environmental framework conditions, Political acceptance: What were the political factors for the introduction (or the abolition) of the measure? What were the major arguments?

- Importance of the international framework conditions (harmonisation, international pressure, etc.)?

- Importance of an overall strategy of the tax system (Links and importance of the measures within the overall pricing policy in the transport sector).

The objective of the comparative analysis of the measures is to identify the most important elements for a successful implementation of differentiation and variabilisation policies.

The assessment of the implemented and planned differentiation and variabilisation measures is based on:

- Interviews with experts\(^\text{38}\) with regard to the implementation and realisation of the measures. The judgement of the effectiveness and efficiency of the measures depends on the focus of the experts within the ministries involved (Ministry of Finance, Ministry of Transport, Ministry for Economic Affairs or the Ministry for Environment). Since we carried out interviews with persons from different ministries, it was possible to have an overall impression of success and problems linked with the specific measures.

- Literature on the country-specific measures\(^\text{39}\).

- On the theoretical consideration carried out in the first part of the report. The assessment of those measures, in particular, for which practical experience with their

\(^{38}\) See the list of the interview-partners at the beginning of the country-specific information sheets in annex 3.

\(^{39}\) The country-specific literature is noted at the beginning of the information sheets in annex 3.
implementation is lacking, will be carried out on behalf of the theoretical considerations.

Since the quality and level of in-depth analysis differs somewhat between the different countries considered, the appraisal will be mainly qualitative. It is important to mention that detailed studies evaluating the measures with respect to their short- and long-term effects are usually not available. The research showed very clearly that especially the effects of variabilisation policies are difficult to measure, since long-term effects are of major importance. In general, it is very difficult to isolate the effect arising from the price changes in comparison to all the other factors influencing transport demand.

8.2. Appraisal of differentiation policies

We will focus on the elements which, respectively, are responsible for success in the one case and failure in the other. An overview of the success of the differentiation policies is illustrated in Table 24.
### Table 24: Assessment of the differentiation strategies according to predefined criteria (see details in Annex 3)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Differentiated annual vehicle taxes</th>
<th>Differentiated purchase taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency of road use</td>
<td>No impact</td>
<td>No impact</td>
</tr>
<tr>
<td>Environmental effectiveness and efficient use of resources, importance of flanking measures</td>
<td>The differentiation shows slight impacts on the purchase decision, especially in the first years after introduction. The overall impact on fuel efficiency and environmental performance is generally very modest. However an acceleration of technology development (e.g. emission classes is possible). Flanking measures are important.</td>
<td>The tax can be successful at strengthening the switch towards more fuel-efficient vehicles within a determinate vehicle class. An acceleration of the adaptation of new emission standards is possible. Flanking measures are important.</td>
</tr>
<tr>
<td>Fiscal stability and fiscal neutrality</td>
<td>The differentiation can be introduced (more or less) in a fiscal neutral way. Revenue are stable.</td>
<td>A revenue neutral differentiation is possible (higher/lower taxes for less /more environmentally sound vehicles). If short-term steering effects are very high, fiscal adjustments become necessary.</td>
</tr>
<tr>
<td>Implementation and enforcement</td>
<td>Costs are very modest when the differentiation criteria are known and an annual tax already exists. Enforcement causes no problems</td>
<td>Costs are modest when differentiation criteria are known and a purchase tax already exists. Enforcement causes no problems.</td>
</tr>
<tr>
<td>Negative side effects</td>
<td>Restrained turnover of vehicles with a high purchase tax, advances in technology are delayed; sales prices are adapted to the level of the purchase tax, decrease in safety due to smaller vehicles.</td>
<td>Same negative side effects as purchase tax but more moderate.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Adjustment of tax rate to new technologies/vehicles is possible, if informed in advance.</td>
<td>Adjustment of tax rate to new technologies/vehicles is possible, if informed in advance.</td>
</tr>
<tr>
<td>Independence from foreign countries</td>
<td>Independence is given, the measure can be introduced unilaterally.</td>
<td>The measure can be introduced unilaterally if not directly linked to VAT.</td>
</tr>
<tr>
<td>Framework conditions</td>
<td>Revenue-neutral schemes are well accepted. The introduction of new (differentiated) purchase taxes depends partly on the presence of automobile industry.</td>
<td>In all countries the revenue-neutral introduction of the differentiation was well accepted.</td>
</tr>
<tr>
<td>Political and environmental conditions</td>
<td>No impact on taxation of annual vehicle taxes; different countries had to switch from a special VAT rate to a specific vehicle purchase tax (because of harmonisation of VAT in EU countries), generally no impact of international framework conditions on differentiation, as long the differentiation considers EU-wide standards (e.g. Fuel measurements, EURO-norms).</td>
<td></td>
</tr>
<tr>
<td>International conditions</td>
<td>The policy of the different countries analysed varies widely. The Scandinavian countries generally have overall strategies for an adjustment of the tax system in order to give incentives for a more environmentally friendly policy. The effectiveness of the instruments is improved with a mix of fiscal incentives and flanking measures (like for example a purchase tax linked with a scrapping premium, or the labelling of cars).</td>
<td></td>
</tr>
</tbody>
</table>
The most important elements of the overall appraisal of the measures are:

- **Efficiency of road use**: The experience with differentiation of fixed charges has practically shown *no impact on the efficiency of road use*. The extremely high purchase taxes in Denmark restrains car ownership but has only minor impact on car use. It can be noticed however that the differentiation of fixed taxes according to vehicle characteristics (environmental criteria as well as weight and engine power) is a contribution to a taxation which considers the polluters’ pay principle.

- **Efficient use of resources, improvement of environmental effectiveness**: The differentiation of *annual vehicle taxes* has apparently had only a *minor impact* on car stock. One reason for the only slight reaction of car owners to a differentiation of annual taxes is, on the one hand, the *small range of differentiation* (at least in Austria) and, on the other hand, the indirect importance of this tax on purchase decision.

  In Switzerland (canton Lucerne), the first year of the introduction of the bonus-malus-system was successful, the share of the cars which benefited from the bonus for fuel-efficient cars being more than twice as high as in other cantons (4.4% in comparison to 2.2% in the rest of Switzerland). In the next year, however, the effect decreased, since specific information and marketing activities only took place in the first year. Another argument is the fact that the malus is differentiated according to EURO-norms, where the reaction of car drivers is diminishing.

  The differentiation was judged to have been more *successful in Denmark*, where the range of the tax rate varies between 60 and 2,000 EURO/year. In the first year, *fuel efficiency* of vehicles was *raised by around 4%*. The improvement in fuel efficiency has been reached through a shift within the specific vehicle categories from less towards more fuel-efficient vehicles. No significant shifts between vehicle classes (from large to small vehicles) could be noticed.

  In the Netherlands, the differentiation of purchase taxes for HGVs was very successful, around 70% of the new vehicles fulfilled the EURO 2 norm before this norm became mandatory (best share in Europe).

  The differentiation of annual charges in order to promote vehicles with catalytic converters (mid-80s) was *not as successful as expected*, at least in Switzerland and in Austria. The main reason is that this differentiation was too early. Some important factors were:
– There were uncertainties with regard to the technology. There were some fears that the catalytic converter could reduce the life span of cars. Thus, the differentiation foreseen was too early.

– In the early 1980s, the network of petrol stations with unleaded petrol was quite small, especially abroad (this was only a problem in the first years following introduction). Similar problems arise nowadays with low sulphur diesel.

– The tax release was not large enough to compensate for the additional costs or disadvantages of a vehicle with catalytic converters.

The differentiation of purchase taxes has been judged positively with regard to the impact on resource use and fuel efficiency. The measure was successful in the Netherlands and in Sweden, where the tax rebate was set equal to the price differential between vehicles of new and old requirements. In Sweden however the opposition from the car industry (against the tax itself) and the harmonisation problems by joining the European Union (with regard to the differentiation) were the main reasons for abolishing the purchase tax. For the time being, plans are being discussed to differentiate up-to-date annual vehicle taxes according to environmental classes.

In general, the interviews have shown that flanking measures (see below) can play an important role in order to increase the desired effect. Taking this into account, the steering effects of a differentiation of a purchase tax might be bigger than differentiated annual vehicle taxes, if car manufacturers do not adjust prices and since marketing activities (for instance the involvement of the car industry) are easier to apply.40

• Fiscal neutrality and fiscal stability: In all countries, it was an objective to carry out the shift from the undifferentiated to the differentiated tax in a revenue neutral way, the objective of fiscal stability being important. The revenue neutral switch of the taxation system has increased public acceptance. Systems which are based on the fuel consumption have to adapt the tax rate to the technological development of the vehicle fleet in order to guarantee revenue neutrality also in the long-term. Otherwise, the share of vehicles which benefit from differentiation by

40 This is not exactly true in the Swedish case, since many companies are providing cars for their employees as part of their wages.
payment of a lower tax will increase, leading to a continuous decrease in tax revenue. This indicates the trade-off between fiscal and steering aims. The examples analysed, however, have shown (e.g. in Denmark) that a periodic adjustment of the tax is possible if people are informed properly in advance.

• Implementation and enforcement: The implementation costs are very modest for the differentiation of both annual and purchase taxes as long as these taxation elements already exist and the differentiation criteria are well known and easily applicable. This holds true for standardised criteria like a differentiation according to EURO-norms or fuel consumption according to EU-measurements. A differentiation of the annual vehicle tax might cause minor enforcement problems, however, since the relevant values for old cars (before 1996) are not available. Thus countries apply a dual system, taxing older cars according to general criteria like weight and engine power, and new cars according to fuel consumption standards. This element leads to the conclusion that the differentiation of the purchase tax is easier to handle, since only new cars (where fuel consumption values are available) are taxed. Generally, the introduction of a new purchase tax can be linked to VAT; by using the existing tax collection structures, the implementation costs are minimised. The same holds true for the differentiation of the annual charge which can be linked to the annual taxation system (which exists in all countries analysed). Also a separate system, like a bonus-malus-system (foreseen in Switzerland), can be linked to the annual vehicle taxation and in this way be realised with a minimum of implementation costs.

• Negative side effects: No negative side effects have been experienced with the differentiation of annual vehicle taxes. The annual vehicles taxes could trigger the same negative side effects as the purchase taxes, but on a more moderate level, since the reactions of car drivers are usually not as strong. The differentiation of tax rates for diesel- and petrol-driven vehicles (the tax rate of diesel-driven vehicles being higher) has prevented an increase in the share of diesel-driven vehicles. This differentiation has been implemented in Denmark, Switzerland (Lucerne), Germany, the Netherlands and in Sweden. Only in Austria does the annual vehicle tax not distinguish between fuel types. In order to prevent a switch to diesel-driven vehicles in Austria, the purchase tax there is higher for diesel vehicles. Since the differentiation of the annual taxes implies a shift of tax burden from fuel-
Assessment of the implemented taxation schemes

efficient (respectively environmentally friendlier) towards fuel-inefficient (respectively environmentally more harmful) vehicles, some negative side effects in terms of an overall increase in the vehicle fleet could arise. In any case, this effect could not be ascertained in the countries which have experienced the differentiation of annual charges.

The negative side effects of a differentiation of purchase taxes could be:

- Importers/sellers of the vehicles adjust the sales prices to the level of the purchase tax, therefore reducing the overall effect of the tax (the price increase for more polluting vehicles is less pronounced),
- High purchase taxes lead to a restrained turnover of the vehicle fleet. The introduction of new technologies is delayed. In order to minimise this side effect, Sweden introduced a scrapping premium (with the premium diminishing with the life span of the vehicle) which was successful in preventing old cars from being abandoned, but it does not seem that the premium gives an incentive for a premature renewal of old cars. Of course, the effectiveness of this measure depends on the magnitude of the financial incentive for the scrapping of the vehicle. The car stock in Sweden is still older than the European average. It is assumed that a further differentiation of the scrapping charge respectively of the premium according to the year in which the vehicle first came into circulation could achieve better results. Another idea is the combination of purchase and abandonment. A premium should be paid upon purchase of a new car when simultaneously an old car is being scrapped.
- Depending on the design, the differentiation of annual and purchase taxes could give an incentive towards the purchase of smaller vehicles with a low fuel consumption. In order to prevent the switch from heavier (and safer) vehicles towards smaller (and possibly less safe) vehicles, the Netherlands plans to differentiate purchase taxes according to fuel consumption of the vehicle compared to vehicles of the same size (differentiation according an indicator ‘CO₂-emission per m²’).
The mentioned negative side effects could be noticed in Denmark as well as in Sweden\textsuperscript{41}. Other negative side effects like, for example, the increase in the share of diesel vehicles or the increase in the overall vehicle fleet, have not been ascertained.

- **Independence from the fiscal policy of foreign countries**: Both measures can be introduced without co-ordination with other countries. Since the taxes are burdened only on residents, the measure has no effect on the car stock composition of foreign vehicles. This is a disadvantage for small countries with a high share of (transiting) foreign vehicles. However, the differentiation criteria have to consider EU-standards (e.g. emission standards, fuel cycle measurements, etc.). The example of the Swedish purchase tax showed that the adaptation problems of the tax system (i.e. change from Californian standards to EU-standards) was at least one argument for the abolition of differentiation according to environmental classes.

- **Flexibility**: Both measures can be adjusted quite easily to new technologies and to improvements in cars’ fuel efficiency. In order to achieve revenue neutrality in the long-term, it is important that the tax system is anticipating new technological improvements (automatic annual adaptation of the tax rates or of the vehicles in the specific classes). The periodical adaptation of the tax rates to the development of vehicles’ technology does not seem to be a major political problem with the countries evaluated, since it is linked to the revenue neutrality of the overall taxation system.

- **Framework conditions needed for the introduction of a differentiation policy**: The experience of different countries shows that differentiation is well accepted if revenue neutrality can be guaranteed. The low implementation costs and the incentives given by the measure are judged positively. The measure could be more effective if the tax rate were higher, but this would restrict the political (and social) acceptance and therefore the realisation chances of the measure. The environmental arguments – on which the differentiation of fixed charges are founded – are well accepted. A very high acceptance could be reached if stakeholders were involved in marketing activities.

One important success factor in order to increase acceptability is a ‘just’ system,

\textsuperscript{41} Sweden has one of the oldest (and heaviest) car fleet in Europe, the high Danish purchase tax may restrain fleet turnover, so overall fleet intensity may not reflect advances in technology as robustly as in other economies (OECD 1998).
not leading to unwanted side effects as discussed above (such as shifts to diesel cars causing major air pollution emissions or shifts to small cars which might lead to disadvantages for specific groups (like families for instance)).

- **Importance of the “overall tax system”:** A differentiation of fixed charges alone is **not sufficient** for attaining the environmental objectives. Appropriately designed (with regard to the tax basis and level) differentiated fixed charges can **contribute** – in the **long-term** – to an **adjustment of car stock composition** towards more fuel-efficient and environmentally friendly vehicles. This goal can be reached primarily with a differentiation of purchase taxes. The tax differentials have to be **high enough** to give a real monetary incentive to buyers for the purchase of fuel-efficient and environmentally friendly vehicles.\(^\text{42}\) The success of the measure depends on the reaction of car buyers as well as on the reaction of car importers and sellers. Since the latter determine the price of new car models and versions, the taxation system should give them an incentive to sell cars with lower taxes (increasing their profits if selling these types of cars).

In most countries, a very relevant success factor was the **promotion of flanking measures**, for example information campaigns (Switzerland, the Netherlands) and new labelling systems (proposal of the Netherlands). So it is, for instance, essential that buyers of new cars are informed about the (overall long-term) costs connected to the purchase of the different vehicle types (information not only about the purchase costs, but also about the annual and running costs), which is the precondition for an optimum purchase decision. The Dutch proposal for the new labelling system goes in this direction. The main idea of the labelling system is to promote the purchase of the most fuel- (or emission-) efficient vehicle in a determinate vehicle’s category. Therefore, the labelling is based on fuel consumption or CO\(_2\)-emissions of each vehicle in relation to the fuel consumption of other cars within the same length x width category.

---
\(^\text{42}\) In Austria, the maximum increase of 16% of the vehicle price is judged to be too low for a significant reaction in the purchase behaviour. On the contrary, the Danish purchase tax (up to 180% of the taxable value of the vehicle) has a significant impact on car ownership as well as on car stock composition.
8.3. Appraisal of variabilisation policies

The appraisal of variabilisation policies is based on the instruments presented in chapter 7.3. As discussed before, there are only a few examples for real variabilisation measures, founded on a change from a fixed tax towards a variable one. Some countries, however, plan to introduce specific measures (e.g. road pricing), which is an important future strategy also promoted by the European Commission.

Since the two strategies (fuel price strategies) and road pricing are quite different, we evaluate them separately.

8.3.1. Fuel price strategies

Table 25 illustrates an overall assessment of the variabilisation measures according to the predefined criteria.
Assessment of the implemented taxation schemes

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Fuel price increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency of road use</td>
<td>The implemented fuel price increases had only modest impacts on the overall road use, because of the restriction in the range of fuel price increases.</td>
</tr>
<tr>
<td>Environmental effectiveness and efficient use of resources</td>
<td>Fuel price increases are judged to be very effective for achieving the objective of a more efficient use of resources. Particularly due to fuel tourism, this measure cannot be implemented successfully at the moment. The differentiation of fuel prices according to type of fuel might be effective also, if the alternative is well established (i.e. unleaded petrol, low sulphur diesel).</td>
</tr>
<tr>
<td>Fiscal stability and fiscal neutrality</td>
<td>The increase in fuel taxes is normally linked to a change in total tax revenue. In some cases, however, automatic price increases are used to offset possible revenue reductions due to increased fuel consumption. A differentiation according to fuel qualities might cause short-term fiscal distortions if steering effects are significant.</td>
</tr>
<tr>
<td>Implementation and enforcement</td>
<td>Cost are modest since taxes on fuels are already collected.</td>
</tr>
<tr>
<td>Negative side effects</td>
<td>The major restriction set to a unilateral fuel price increase is the problem of fuel tourism; problems can also arise with international competitiveness of haulage firms. Tax reduction for diesel might lead to an unwanted shift towards diesel vehicles.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Flexibility is restrained due to fuel tourism and arguments in favour of international competitiveness.</td>
</tr>
<tr>
<td>Independence from foreign countries</td>
<td>Fuel tax increases have to be internationally co-ordinated, particularly in the case of small countries with a considerable amount of transit traffic.</td>
</tr>
</tbody>
</table>

| Political and environmental framework conditions | Fuel price increases usually find only a minor acceptance, as long fiscal aims are most important. However, a differentiation of the fuel duties according to fuel qualities are accepted, if they are fiscally neutral. |
| International framework conditions          | They are important for the co-ordination of fuel taxes (comparable fuel consumer prices) |
| Overall tax system                          | In some countries (DK, NL, S, UK) the increase of fuel taxes is an element of the overall fiscal and/or environmental strategy. |

Table 25: Assessment of the fuel price strategies according to predefined criteria

- **Efficiency of road use**: The realised fuel tax increases had only minor impacts on the efficiency of road use. In this regard, it must be considered that the experienced variabilisation is limited on the implementation of very low tax increases.

- **Environmental efficiency and efficient use of resources**: Making car use more expensive, both measures give an incentive in reducing mileage. Since the magnitude of fuel tax increases is limited (see “negative side effects”), the effect on fuel consumption and environment is not very significant either. In countries with CO₂ or energy taxes (DK, S, fuel escalator in UK) the effects may be greater. The evaluation period however is too short for a detailed evaluation. The differentiation of fuel taxes according to fuel qualities, however, is quite effective. This was true for the differentiation of unleaded and leaded petrol in order to promote catalytic converters, and this also holds true for the promotion of low
sulphur diesel. Significant reactions were visible in Denmark, the Netherlands, Sweden and the UK.

- **Fiscal stability and neutrality**: Fuel tax increases are usually linked to an increase/decrease in revenue. In the case of **Sweden**, the shift to cheaper unleaded petrol was faster than expected by the government. As a consequence, the fiscal incentive in favour of unleaded petrol caused a loss of revenue to the State. Thus, a differentiation of fuel qualities should anticipate the (desired) reactions in order to prevent floating revenue. The policies in the Netherlands (automatic fuel duty adjustment) and in the UK (fuel escalator) are good examples of the above.

- **Implementation and enforcement**: The advantage of a **fuel tax** increase is that the implementation costs are very moderate, since this tax already exists. In general, no major implementation problems arose. This would change if border adjustment measures had to be taken into consideration in order to prevent car drivers from fuel tourism. No country however has applied these measures up to now.

- **Negative side effects**: The most important negative side effect of a **fuel tax** increase lies in the problem of **fuel tourism**. Car users react to price differentials between countries by filling their tanks on the side of the border where fuel is cheaper. This reduces the environmental effectiveness of the measure, causes financial losses to the State and implies economic losses for the owners of the fuel stations. Studies on the magnitude of cross-border fuel tourism have been carried out in Switzerland\(^4\) and in Austria. These studies have shown that the reactions to price differentials are significant - in Austria, it has been estimated that the price elasticity of demand in regard to a change in the price level abroad (in the case of Austria, the price level of Germany) lies around \(-0.32\). According to the appraisal of the interview partners, fuel tourism is the major argument against an increase in fuel taxes. Fuel tourism is particularly relevant in small countries like the Netherlands, Denmark, Austria and Switzerland where a high share of the population lives near the border regions. Due to the short distances involved, the incentive for travelling abroad in order to fill the tank is therefore high. The problem of fuel tourism is a little less pronounced in Sweden and in the UK, due to the greater distance to countries with lower fuel taxes (i.e. lower fuel prices). Therefore, a fuel tax

----

\(^4\) Ongoing study of INFRAS, for Austria see Wifo/Puwein 1996
increase is more easily possible in these countries.\footnote{This does not mean that the problem of fuel tourism is not known. The distance to other countries constitutes a threshold which restrains fuel tourism a little.}

An attempt by the Dutch government to minimise the economic impact on the owners of fuel stations located near the borders, through a compensation of the losses caused by fuel tourism, has not been allowed by the EU (a judgement by the EU court is still outstanding, but it is very probable that the measure will be judged to not conform to EU legislation).

A further problem of fuel taxation is linked with the different taxation of petrol and diesel fuels (which cause higher \(\text{NO}_x\) and \(\text{PM}_{10}\) emissions). The (usually) lower diesel taxes provide an incentive for buying diesel passenger cars. This trend would be strengthened by a unilateral increase in petrol taxes.\footnote{In the Netherlands, the diesel price for HGV is slightly subsidised with the reimbursement of a share of the tax paid at the petrol station.} The lower diesel taxes are based on the argument of international competitiveness in the transport sector.

- **Independence from foreign countries**: Significant variabilisation in terms of an increase in fuel taxes can be achieved only through an international co-ordinated policy. On the other hand, the differentiation according to fuel qualities can be done unilaterally.

- **Framework conditions needed for the introduction of a variabilisation of fixed charges**: The environmental objectives (especially the objectives with regard to the reduction of \(\text{CO}_2\) emissions) predominate the discussion on variabilisation policy. The introduction of the fuel escalator in the UK and the different environmental taxes (in DK and S) are good examples of this.

- **Importance of the “overall tax system”**: A fuel price strategy is usually embedded in an overall \(\text{CO}_2\) abatement strategy.

### 8.3.2. Road pricing measures

The following Table 26 gives an overview.
Table 26: Assessment of road pricing policies according to predefined criteria

- **Efficiency of road use**: The introduction of road pricing, as well as the differentiation of motorway tolls, have a more local impact on road use with a higher potential in reducing congestion. This could be observed in France at weekends. In the Netherlands, these measures are planned to be introduced with the main objective of decreasing congestion during peak hours. In Switzerland and Austria, road pricing for HGVs was also environmentally and fiscally motivated. Thus, only locally differentiated road-pricing measures are able to increase road use efficiency.

46 A real variabilisation would imply a change from fixed to variable charges and could be implemented in a revenue-neutral way. On the contrary, the measures introduced in the European countries are new variable charges. Only in Switzerland and Austria is an old fixed charge replaced by a variable one. These charges were not introduced in a fiscally neutral way because of the fiscal motivation of the change.
considerably. Besides, there are also efficiency increases to be expected for the use of vehicles (higher loading factors, optimisation of routing).

• **Environmental efficiency and efficient use of resources**: Road pricing is expected to have a **major impact on mileage** if it is related to mileage and if the level of the charge is important, all the more if it is levied on the overall road network (as is the case in Switzerland for HGV). Since road pricing – unless fuel economically differentiated – is not related to fuel consumption directly, it provides only minor incentives for the purchase and use of more fuel-efficient or environmentally friendly vehicles. The general environmental effectiveness of road pricing is somewhat reduced if the charge is levied only on particular roads and people have the possibility of avoiding charges by using other roads or adjusting their departure time. Reduced congestion, however, reduces environmental problems as well.

• **Fiscal stability and neutrality**: The countries analysed can be divided into two groups. In **Austria and Switzerland**, the fiscal aim is very important, since institutional changes and cross-financing (road-rail) is envisaged. In **the Netherlands**, it was planned to redistribute the revenue of road pricing to the population in order to achieve **fiscal neutrality**. These plans can probably not be realised due to the fiscal aims of the cities involved. The differentiation of road tolls in France has no specific fiscal aims.

• **Implementation and enforcement**: Electronic road pricing schemes are required for those countries without specific infrastructure (lanes, toll houses). These systems are not yet well developed and are linked to **high investments and running costs** (personnel costs for the control and payment of the charge). In order to avoid evasive actions, it is necessary to build up a tight network of payment or registration units. The Swiss HGV tax is probably the most advanced system envisaged. Since the system has to be applied to around 60,000 trucks, enforcement is easier. There are still major enforcement problems with the pricing of passenger cars, although the pilot experiment in the Netherlands (Rekeningrijden in the Randstad region) was judged to be successful from a technical point of view.

• **Negative side effects**: The possible negative side effects which could arise with **road pricing** are:
  - Car drivers use **other roads** or take into account **longer routes** in order to avoid the payment of the charge. This can lead to more traffic on minor roads or in
inhabited areas. This was observed in France, where lack of information was seen as a major reason. In Austria, the predominant idea is that detouring will be restricted to the first few months after the introduction of the charge. In the medium and long run, drivers will compare time losses due to detouring with the monetary gains of not paying the charge. It is assumed that the time losses are much more significant than the gains of the avoided payments of road pricing. In Austria and the Netherlands, the problem of detouring has been solved by building up a tight network of payment stations. In Switzerland, the payment occurs through the equipment of vehicles with an on-board unit. Since all roads are burdened, there are no incentives for detouring. The choice of a longer route in order to minimise fiscal burden could be an alternative for transiting foreign HGV-drivers, who could then have a monetary incentive for avoiding the route through Switzerland (detours through Austria or France). In order to minimise detouring, road pricing for HGVs is linked to an increase in weight limits to 40 tons and to an improvement of rail infrastructure. In Switzerland, the km charge and the investments in rail infrastructure should shift – in the medium to long run – the freight transport from road to rail.47

In the Netherlands, road pricing will be charged only during the rush hours of the morning. The charge will be fixed and not dependent on the mileage driven. There are some fears that the effectiveness of the measure would be somewhat reduced if employers agree to pay the charge.48

- Independence from foreign countries: Road Pricing can be implemented without special co-ordination with other countries. The field which needs the strongest co-ordination is the standardisation of the on-board unit and the electronic devices for the measurement of mileage and passages. For the time being, a lot of actions are taking place, on a European as well as on a bilateral level.

In Austria, the requirements concerning public debt which had to be fulfilled in order to be allowed to participate in and become a member of the monetary union have induced the Government to privatise the motorways’ infrastructure. The requirement of cost coverage – at least 50% – necessitates the raising of new revenue.

47 In 1994, the Swiss accepted in a popular ballot an article in favour of the protection of the Alpine regions. This article foresees all freight transport transiting on the road shifting to rail. The shift has to occur with fiscal measures.

48 Some firms will probably pay the road pricing charge, in addition to the car parking charge. In any case, no special measures are planned for avoiding the payment of the charge by employers.
• **Framework conditions needed for the introduction**: Together with the improvement of rail infrastructure, the environmental goal was an important argument in Switzerland. In Austria, the introduction of road pricing was **fiscally motivated**. In both countries, road pricing will be paid exclusively by HGVs, which has contributed to the measure being **well accepted** by the population (in Switzerland, only the smaller haulage firms were against the measure, since they feared that the productivity effects of the increase of the weight limit would not offset the tax increase).

In the **Netherlands**, a majority in the political sphere is in favour of the introduction of road pricing. Recent polls, however, have shown that there is massive opposition by the public. One of the major objections is that the revenue would be used by the Ministry of Finance instead of being redistributed to the public. In addition, a part of the public is afraid that road pricing will not solve the congestion problem because of the low charge level. One point which strengthens this belief is that public transport would not cope with a significant modal shift (due to capacity problems).

The reasons for the abolition of the km-tax in **Sweden** in 1993 – which remained in force nearly 20 years – were the complicated administrative control costs, the possibilities for fraud, technical problems with the mileage measurement and problems with EU compatibility and competitiveness. The countries which will implement road pricing in the next year will focus particularly on these elements (a reliable kilometre-measuring instrument not easy to manipulate and which minimises implementation costs).

The km tax was replaced by a diesel and energy tax (a variable charge) and the Eurovignette (a flat-rate user charge); the objective was a revenue neutral switch.

• **Importance of the “overall tax system”**: The success factors of variabilisation measures are not definite. At the moment, there are various road pricing systems – with different tax designs – planned.

Road pricing is seen not only as an efficient fiscal instrument for achieving a reduction in congestion, but also for achieving environmental objectives. The need for investments, new technologies and equipment for vehicles, however, cause significant implementation costs. These investments should guarantee that the problems which arose in Sweden do not arise in other countries.
Part 3: Conclusions and Recommendations
9. Synthesis of the theoretical and the empirical part

9.1. Overall assessment

In order to compare the different strategies evaluated in the theoretical and empirical analysis properly, an overall assessment according to the predefined criteria is shown in Table 27.

<table>
<thead>
<tr>
<th>Differentiation of Variabilisation towards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Efficiency of road use</td>
</tr>
<tr>
<td>Low use of resources / fuel efficiency</td>
</tr>
<tr>
<td>Environmental effectiveness</td>
</tr>
<tr>
<td>Fiscal stability and neutrality</td>
</tr>
<tr>
<td>Implementation and enforcement</td>
</tr>
<tr>
<td>Side effects</td>
</tr>
<tr>
<td>Flexibility</td>
</tr>
<tr>
<td>Independence from abroad</td>
</tr>
<tr>
<td>Acceptance</td>
</tr>
</tbody>
</table>

\(^1\) Impact of the fuel tax increases implemented including differentiation according to fuel quality
\(^2\) Foreseen impacts
\(^3\) High impacts if time dependent scheme
\(^4\) Positive if linked to promoting measures, labelling (scrapping premium)
\(^5\) Only if significant changes and differentiated according to fuel quality
\(^6\) Depends on the design
\(^7\) If revenue neutrally designed

**Table 27:** Overall assessment of the pricing policies: The positive and the negative effects are judged according to the experience of the selected countries and the theoretical considerations

- \(+/++\): positive impacts
- \(0\): neutral
- \(-/--\): negative impact

There is quite a significant gap between the theoretical and the empirical considerations. Whereas the theoretical considerations favour variabilisation strategies due to their stronger (expected) steering and long-term effects, the empirical (political) analy-
Synthesis of the theoretical and the empirical part

sis shows more positive aspects for differentiation strategies. Therefore, the design of the case studies and the political framework conditions are major reasons.

a) Evaluation of differentiation strategies

• One of the advantages of the measures focusing on differentiation of fixed charges is the independence from transport policy in foreign countries. In fact, these measures do not require major international co-ordination and can therefore be introduced in the short-term and with low implementation costs.

An appropriate design of differentiation measures allows the attainment of the objectives of fiscal stability and revenue neutrality.

• In the last few years, different countries have made first steps towards a "greening" of the taxation system in the transport sector and have implemented a differentiation of annual and purchase taxes (Austria, Switzerland, Germany, Denmark, the Netherlands, Sweden49). The strategies are very similar. The measures are judged to have a positive impact. Besides a general (and long-term) change of car purchase behaviour, the short-term steering effects (e.g. acceleration of emission classes or fuel efficiency within consumer categories) are significant if alternatives are available and accepted.

• The acceptance of differentiation strategies by the public is rather good considering the empirical examples evaluated. One major precondition is a revenue-neutral introduction. Some problems with the acceptance of a differentiation of fixed charges can arise in those countries with a strong automobile industry (for example Sweden or Germany) if significant distribution effects have to be expected.

• The practical problems linked with the implementation of differentiated annual and purchase taxes are very moderate. The differentiation of annual vehicle charges according to fuel consumption is linked to the introduction of a dual system, since comprehensive and official figures on fuel consumption are available only for new vehicles. In general, negative side effects (e.g. shift to diesel cars) can be omitted with an appropriate differentiation design.

49 The differentiation of the purchase tax was abolished in 1996.
b) Evaluation of variabilisation strategies

- The advantages of the instrument focusing on the variabilisation of flat rate charges are increased incentives towards an efficient use of infrastructure and towards lower fuel consumption. The efficient use of road infrastructure can be attained particularly with the introduction of a time- and route-differentiated road-pricing scheme on those roads or areas which are most affected by congestion. The impact of an increase in fuel taxes is more “width”, which means that the efficiency of road use is improved through the overall effect of the fuel tax increase on car use and is not focused on a specific area or road. This assessment occurs mostly on theoretical considerations, since the empirical evidence of variabilisation policies (due to its long-term effects) is very difficult to measure.

- The positive impact of fuel taxes on the use of resources is attained either by a change in driving behaviour (less fuel consuming) or directly by a reduction in car use. Since the primary incentives of variable charges are directly linked to the vehicle use, they develop a greater environmental effectiveness in the short run than differentiation measures. Indirectly, variable charges influence the purchase behaviour and contribute in the long run to an improvement in fuel efficiency of the vehicle fleet (of course, the positive effect on the composition of the vehicle fleet can be strengthened by differentiated vehicle purchase and annual taxes).

- The fuel tax increases analysed in the empirical part are very small; in most countries they are reduced to an adjustment to inflation. Therefore, the small environmental impacts and the effects of the empirical examples on fuel efficiency should not be surprising. Major reasons for this are the arguments of cross-border fuel tourism, but also the low acceptance by the public and fears with regard to a worsening of the competitiveness of the transport sector.

- The practical problems of road pricing concern the implementation and enforcement, mainly the high initial investment costs. It has to be noted that only electronic road pricing schemes are able to allow for the desired steering effects. These systems have not yet been developed on a grand scale. The pilot schemes showed that there are no major technical obstacles. If a high level of enforcement should be attained, however, significant problems and high cost will arise, at least as long there is no general international standard for passenger cars. For HGV’s however, the technical obstacles are quite moderate nowadays. Thus several countries are planning to replace the existing flat rate user charges by an electronic scheme.
• It has to be noted that all variabilisation strategies also contain elements of differentiation. Fuel price strategies differ between different fuel types. Usually the effect of differentiation (on fuel market shares) are more significant and easier to measure than the general long-term effect with regard to fuel consumption. The same holds true for time- and route-differentiated road-pricing strategies. Thus, a variabilisation strategy is usually aimed at raising taxes varying with the mileage driven considering different environmental features at the same time. The planned design of the Swiss HGV tax demonstrates this combination, since the tax depends on the mileage and is differentiated according to vehicle weight and EURO-standards.

• The acceptance and, therefore, the political enforcement is larger in the case of a revenue-neutral introduction. This holds especially true for the variabilisation of flat rate user charges towards mileage-dependent charges. There is also acceptance for automatic adjustments in order to omit revenue decreases, especially in the case of fuel taxes if the (desired) increase in fuel efficiency leads to lower revenue.

9.2. Success factors

Looking at the experience of the countries analysed, the following elements can be identified as being important for the success of the measures:

a) Differentiation strategies

• The leverage point and criteria for differentiation should be easy to communicate and should anticipate negative side effects (i.e. undesired shifts of vehicle categories). A differentiation according to EURO-classes and specific fuel consumption is most appropriate. For HGV’s, a differentiation according to noise level is another possibility. A differentiation according to fuel consumption should distinguish between different vehicle categories (small and large vehicles, petrol and diesel). Possible leverage points are the CO$_2$ emissions and the weight and size of the car. In order to raise incentives within the different vehicle categories properly, differentiated rates for different categories should be considered. These elements are also important for an increased acceptance by the public. The more sophisticated the tax design, the lower the risk of unfair treatment between different car categories.
The success of differentiation policies depends on the level of the tax differentials. The effects are larger if the tax differences compensate for the additional costs incurred by the purchase of an environmentally friendlier vehicle. This is especially true if the differentiation should help to provoke a desired shift from one available technology to another (e.g. acceleration of the adaptation of EURO-classes, shift to specific categories like electric vehicles, etc.).

In order to increase fuel efficiency, a differentiated purchase tax is easier to implement than a differentiated annual vehicle tax, since only new cars have to be taken into consideration where EU-wide standardised values are available.

The promotion of and information about the differentiated taxes is important. Environmental benefits and fuel-saving effects should be communicated. Buyers must be informed about the different overall long run costs associated with the purchase of different types of vehicles and the reasons for differentiation. Flanking measures such as the compulsory declaration (e.g. of specific fuel consumption) and the combination with a labelling system are other important success factors.

The success of the measure is increased if sellers/importers have incentives for selling environmental friendlier or more fuel-efficient vehicles.

The differentiation should be introduced in a revenue-neutral way in order to increase acceptance. On the other hand, there should be a dynamic adaptation of the charge levels to prevent unwanted financial losses due to very high (short-term) steering effects.

A high purchase tax can be coupled with a scrapping premium in order to prevent a decrease in the renewal cycle of less fuel-efficient vehicles.

In general we can conclude that the differentiation of fixed charges is possible for purchase taxes and annual vehicle taxes at the same time. There are no major differences between these two instruments. Due to the arguments mentioned above (treatment of new cars with standardised fuel consumption values, easier communication and concentration on the purchase decision), the differentiation of purchase taxes is slightly more preferable to the differentiation of the annual vehicle tax.
b) Fuel price strategies

- The success of an increase in fuel taxes depends on the possibilities of an international co-ordination. At the moment, it does not seem realistic that single European countries introduce a variabilisation of the tax system based exclusively on significant fuel tax increases because of too large negative side effects, mainly cross-border fuel tourism. Given the restriction imposed by a fuel tax increase, road pricing represents an alternative for charging drivers according to car use and thus for the realisation of the polluter-pays principle.

- Taking this into consideration, the acceptability in a country will be increased if the fuel price strategy is imbedded within a general CO₂ or energy strategy and/or the fuel price strategy is more related to a differentiation according to fuel quality instead of a general price increase.

- An important factor is the treatment of diesel cars. The taxes on petrol and diesel should be taken into consideration, bearing in mind the fact that diesel cars emit much higher particles which are more dangerous to human health, especially in urban areas.

- An overall communication strategy is important, too; firstly, as support to increase the effects by promoting alternatives (new driving styles, new cars); secondly, to anticipate the fiscal effects. A dynamic strategy (as pursued in the UK or the Netherlands) will help to counterbalance possible negative revenue effects.

- In general, the design of fuel taxes is easier to implement (and more accepted) if fiscal aims and steering aims are treated separately. A variabilisation strategy could thus contain a specific CO₂ tax where tax revenue is used for tax relief.

c) Road Pricing strategies

- Transparency with regard to the use of additional revenue seems to be an important factor for the success and the acceptance of road pricing schemes. The revenue can be used to cover infrastructure costs, redistributed to the public or used for investments in the transport infrastructure (road and rail). It seems to be important that the revenue is not used for general fiscal purposes.

- In the case of Austria and Switzerland, one reason for the acceptance of road pricing was that only HGVs are charged. In addition, the share of foreign HGV is high
in these two alpine countries. The argument that foreign vehicles have to contribute to the high infrastructure costs in the Alpine regions was important.

- In order to reach acceptance for a road-pricing system, it is necessary that the public is aware of the environmental and congestion problems which arise in a situation without road pricing. The environmental problems along the transit routes in Switzerland and Austria have probably enforced the acceptance of fiscal instruments which reduces the HGV share.

- The technological devices used for the mileage measurement and/or payment of road pricing must minimise the fraud possibility. Other requirements for successful implementation of the measure are: no time losses at the border, minimisation of investments as well as administrative and control costs, minimisation of the costs for the on-board units, a simple payment method for foreign vehicles and transparency of costs for drivers.

- A standardisation of the on-board unit is needed in order to minimise the investments of vehicle owners. Road-pricing schemes are easier to implement if these units do not cause major additional user cost.

- A communication strategy is important in order to prepare the stakeholders for the desired (or undesired) effects. A differentiation according to daytime, for example, should be communicated in advance in order to help the users to react properly.

- The success of the measures is also related to the alternatives to road transport. The public must be sure that the free capacity of public transport is high enough to allow for a modal switch from private to public transport. This holds true for passenger transport as well as for freight transport.
10. Policy recommendations

10.1. Differentiation or variabilisation?

There is a wide range of possibilities for differentiation and variabilisation of taxes and charges in the transport sector. We can distinguish three main strategy paths:

- Differentiation:
  - differentiation of fixed charges according to environmental criteria (environmental context, especially air pollution strategies)
  - differentiation of fixed charges according to specific fuel consumption (energy policy context).

- Variabilisation:
  - variabilisation from fixed charges to fuel taxation (energy policy context)
  - variabilisation from fixed charges to road user charges (territorial financial context)

- Variabilisation and differentiation (environmental and fiscal context):
  - variabilisation of fixed charges to fuel price strategies with differentiation according to type of fuel (fuel tax, according to environmental criteria)
  - variabilisation of fixed charges to road-pricing schemes with differentiation (differentiated km-tax, according to environmental criteria).

The analysis has shown that several combinations are possible, since none of these strategies alone is free of hindrance factors or obstacles. Differentiation strategies are easy to implement and highly accepted, but their environmental steering effects are usually limited. Fuel price strategies only have significant effects if significant price increases can be obtained. This would only be achievable, however, with an internationally co-ordinated strategy in order to prevent cross-border fuel tourism. A variabilisation of flat rate road user charges towards mileage-dependent and differentiated schemes face – at least for the time being – major enforcement problems, especially for passenger cars. Thus, although there are major attempts for the variabilisation of taxes (based also on the recommendations of the White Book of the European Commission on ‘fair payment of infrastructure use’), successes are still rare. Most important are developments in motorway taxation, especially along the Alpine transit axis. However, many schemes are in a planning phase. Nevertheless, road-pricing systems will become, in the near future, the most important measure towards a more variabilised
taxation system with additional potentials for differentiation according to environmental criteria.

It can be stated that the taxation discussion is in a **transition phase**. With improved technology and increased international harmonisation, it will become easier to differentiate variable road-user charges according to environmental criteria also. Thus, the recommendations have to consider these developments within a dynamic approach.

### 10.2. Towards an optimum mix of instruments

**Short run**

- An increase in the fuel tax and simultaneously a decrease in fixed vehicle taxes is appropriate and not costly as long as counterbalancing effects are expected to be small. As long as an international co-ordination is not in sight, the potentials will be limited however. Hence, it is very useful to continue with the differentiation of the fuel tax according to different fuel qualities in order to consider environmental aims. Most appropriate is a tax differential between petrol and diesel (in order to consider the higher air pollution damage of diesel) and between different contents of sulphur (in order to raise incentives for low sulphur diesel). This could be achieved through an energy- or emission-related tax basis (e.g. tax unit/Joule or tonne of CO₂ emissions) instead of a purely consumption-related bases (tax unit/litre).

  It is very important to discuss the fuel price measures within a general CO₂ strategy considering also other sectors.

- A differentiation of fixed vehicle taxes according to environmental criteria is very appropriate and not costly. Although the differentiation is a second rate approach from a steering point of view (in comparison to a fuel tax increase), it is an important supplement since it guarantees regional and financial independence. The analysis has shown that a differentiation according to specific fuel consumption and emission classes is relatively effective, since the cars on offer vary widely with regard to specific fuel consumption. On the other hand, a tax differentiation according to noise emissions is quite difficult to implement since noise emissions depend not only on car technology, but also on local characteristics and on driving
behaviour. For HGVs, however, noise differentiation might be a possible supple-
ment.

- The differentiation measures should be accompanied by the introduction of a new
labelling and marketing system which informs buyers of new vehicles about the
fuel efficiency and the technology (emissions) of the vehicles. The information can
be given in relation to the average of a specific category (benchmark) in order to
encourage the purchase of small (second) cars. Furthermore, the impact of the dif-
ferentiation could be strengthened if car importers/sellers had an incentive in
selling environmentally sound vehicles. This could be arrived at, for instance, if
they were considered in the distribution of the tax rebate.

- In order to increase the effectiveness of a differentiation of fixed charges, the vehi-
cle categories which benefit from a lower charge have to be adapted to the techno-
logical improvements. The combination of fiscal incentives and of regulatory in-
struments (with regard to standards which have to be fulfilled within a determi-
ned period) can accelerate technological improvement of the vehicle fleet.

- In order to raise acceptance, a fiscally neutral variabilisation or differentiation is a
possible first step. In order to omit undesired fiscal losses due to steering effects,
continuous adaptations of the tax system (adjustment of charge levels) should be
communicated in an early state.

**Long run**

- A variabilisation of fixed charges (especially flat-rate road user charges) is useful
in the longer run, if an internationally co-ordinated strategy (especially with re-
gard to taxes and charges) can be expected and technology for road pricing
schemes is improving.

- If a technology for km-charges (combined with vehicle identification systems, as
foreseen for the Swiss HGV tax) is available, an additional differentiation of the
variabilised charges according to emission classes and specific fuel consumption is
useful and increases incentives towards environmentally sound traffic. An overall
km charge gives incentives for a more parsimonious use of vehicles, but it is in the
long run not enough for solving congestion or high emission concentration (noise,
air pollution) in specific areas. The combination with a time-related road pricing or
a regionally differentiated road pricing (in metropolitan areas or on roads with high traffic flows) could maximise the desired effects.

- A combination of fuel taxes and variable road-user charges is most efficient in order to optimise the steering effects (local aspects like air pollution and noise by variable road-user charges and global aspects like energy consumption and CO₂ emissions by the fuel tax). Fuel taxes and road-user charges have both short- and long-term impacts, which are considerably more significant than the differentiation of fixed charges.
Annex
### Annex 1: Overview of survey on elasticities

<table>
<thead>
<tr>
<th>Author, Source (Year)</th>
<th>Study</th>
<th>Methodology, Type of Elasticity</th>
<th>Value of elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.-H. Storchmann, Zeitschrift für Verkehrs-wissenschaft (1998)</td>
<td>Cross section analysis</td>
<td>Long run effects of depreciation, annual car taxes, fixed costs, petrol price, income on car stock and use, specific petrol consumption, petrol demand per person Analysis has considered 15 EU-countries and has been carried for the year 1994. Different elasticities according to the model used (neoclassical model, household production function model)</td>
<td>Effects on car stock per capita: Depreciation: -0.253; Car tax: -0.081; Income: 0.366 Effects on petrol consumption per capita: Depreciation: -0.529; Car tax: -0.055; Petrol price: -0.551; Income: 0.344 Effects on specific petrol consumption: Depreciation: -0.041; Car tax: -0.035; Petrol price: -0.297; Income: 0.085</td>
</tr>
<tr>
<td>Thomas Selz, Zeitschrift für Verkehrs-wissenschaft (1993)</td>
<td>Survey</td>
<td>Effects of improvements in infrastructure supply on the transportation demand; calculation of induced transportation demand according to a reduction of travel time</td>
<td>IC-Transport (GB): -0.53/-1.08 and -0.69/-1.31 (\approx) elasticity depends on the change in travel time TGV (F): -1.06/-1.44 (\approx) elasticity depends on the change in travel time Zumkeller: -0.02/-0.03</td>
</tr>
<tr>
<td>O. Johansson and L. Schipper, Journal of Transport Economics and Policy (1996)</td>
<td>Time series and cross section analysis</td>
<td>Different functional forms and estimation techniques were tested. Effects of fuel price, income, taxation, population intensity and lagged endogenous. variable on vehicle stock, mean fuel intensity, mean annual driving distance Estimation of the long run travel demand elasticities including indirect effects</td>
<td>Effects of fuel taxes on [best guess]: vehicle stock: -0.017/-0.086 [-0.1] mean fuel intens.: -0.015/-0.45 [-0.4] mean annual driving distan.: -0.061/-0.33 [-0.2] car fuel demand (long run): -1.0/-4.4 [-0.7] car travel demand (long run): -0.55/-0.05 [-0.3] Effects of taxation (purchase taxes/ import fees/present value of annual taxes) on vehicle stock: -0.045/-0.060/-0.0087</td>
</tr>
<tr>
<td>T. Sterner, C. Dahl, M. Franzén, Journal of Transport Economics and Policy (1992)</td>
<td>Time series and cross section anal.</td>
<td>Price, income and vehicle elasticities (short, intermediate and long run), aggregated and country specific elasticities Lag of the endogenous variable; Policy analysis of a country-specific petrol tax</td>
<td>Short run price elasticity of fuel consumption: -0.2/-0.25 Long run price elasticity of fuel consumption: -0.54/-0.96</td>
</tr>
<tr>
<td>P. S. McCarthy, Aggregate</td>
<td>Effects of aggregate models of intercity travel; analysis of</td>
<td>Different cross elasticity of travel time and travel costs on</td>
<td></td>
</tr>
<tr>
<td>Author, Source (Year)</td>
<td>Study</td>
<td>Methodology, Type of Elasticity</td>
<td>Value of elasticities</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
<td>--------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Journal of Transport Economics and Policy (1997)</td>
<td>Time series</td>
<td>the merits of alternative econometric formulations; Dependent variable: passenger-miles on mode divided by total passenger-miles Elasticities of travel mode (air, rail, intercity bus, car) with regard to travel time of the modes and to travel costs of the modes; real per capita GDP elasticities</td>
<td>modal share; Own cross elasticity of travel time: on air: -0.054/-0.017 on rail: -0.05/-0.014 on car: -0.008/-0.002</td>
</tr>
<tr>
<td>Yu Hsing, Energy Economics (1990)</td>
<td>Time-series regression</td>
<td>Dependent variable: per capita petrol consumption Explanatory variables: petrol price, disposable income, lagged dependent variable, technology-quality improvement (high degree of multicollinearity); long-run price and income elasticities of the demand of petrol</td>
<td>Long run price elasticity at the mean: -0.632 Long run income elasticity at the mean: 0.722</td>
</tr>
<tr>
<td>J. M. Dargay, Journal of Transport Economics and Policy (1993)</td>
<td>Survey, Comment</td>
<td>Analysis of the difference between reversible and irreversible models, the effects on fuel consumption of a price increase is greater than the effect of a price reduction.</td>
<td>Irreversible long-run price elasticity: Price rise: -0.8 (France), -0.44 (Germany), -1.5 (UK), -0.67 (US) Price fall: -0.45 (France), -0.02 (Germany), -0.1 (UK), -0.31 (US)</td>
</tr>
<tr>
<td>ECOPLAN (1997a+b)</td>
<td>Application of elasticities</td>
<td>Own and cross price elasticities for different freight categories; definition of the upper and lower border of the elasticities; elasticities depend on the travel distance. Analysis of the effects of road pricing in the city of Berne</td>
<td>Analysed price elasticity components: effects on stock of vehicle, type of vehicle, speeding up of technical progress, shift of sales abroad</td>
</tr>
<tr>
<td>Herry, Dieter (1995) KDZ (1990)</td>
<td>Survey</td>
<td>Discussion of the effect of a fuel price increase and the introduction of a toll system, KDZ: analysis of the results of an inquiry about the effects of the introduction of a toll of different magnitude</td>
<td>Effects of fuel price on travel demand: -0.05/-0.15 Effects of fuel price on new vehicle fuel efficiency: 0.2/0.4</td>
</tr>
<tr>
<td>DeCicco J., Gordon D., Transportation and Energy</td>
<td>Survey</td>
<td>Discussion of estimated or implied fuel price elasticities on travel demand and on fuel efficiency. Qualitative appraisal of the vehicle pricing effects (gas guzzler tax, taxes related</td>
<td></td>
</tr>
<tr>
<td>Author, Source (Year)</td>
<td>Study</td>
<td>Methodology, Type of Elasticity</td>
<td>Value of elasticities</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
<td>---------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>(1995)</td>
<td></td>
<td>to the emissions or fuel economy) and vehicle market analysis</td>
<td></td>
</tr>
<tr>
<td>Dargay Joyce, TSU (1998)</td>
<td>Pseudo-panel approach</td>
<td>Definition of different cohorts. Car ownership is defined as a function of income, costs of car ownership and use, public transport fares and socio-demographic characteristics of households.</td>
<td>Effect of running costs on number of cars of households: -0.18/-0.36 (high/low income) Effect of purchase costs on number of cars of households: -0.28/-0.57</td>
</tr>
</tbody>
</table>
Annex 2: Case study Switzerland: Calculation of different taxation scenarios

Scenario 1

Variability of annual cantonal tax to fuel tax

Data basis

Vehicle tax

Fuel consumption (toil. q.) 3'037'999
Fuel consumption (m & l) 3'617
Car stock (toil. q.) 3'771'795
Average fuel price 1.22
Fuel with add. tax 1.59
Fuel increase 30%
Tax increase 40%
Reduction of annual tax 100%

=> Variability of annual charges to fuel taxes; total revenues shouldn't change

| Annual cantonal tax | Fuel tax
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue (M CHF)</td>
<td>Tax/veh. (M CHF)</td>
</tr>
<tr>
<td>1'328 419</td>
<td>419</td>
</tr>
</tbody>
</table>

Fuel tax

Fuel price elasticities:

<table>
<thead>
<tr>
<th>Short term</th>
<th>Long term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on fuel consumption</td>
<td>-0.25</td>
</tr>
<tr>
<td>Effects on car stock</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Annual tax elasticity:

| Effects on fuel consumption | -0.11 |
| Effects on car stock of fuel price increase | -0.16 | -0.3 |
| Effects on car stock of annual tax elasticity | -0.05 |
| Effects on car stock of annual tax elasticity | -0.06 |

Estimates of the impact of variability

1. Definition of the tax increase

Short term

=> we consider only the negative effect on fuel consumption of fuel price increase

<table>
<thead>
<tr>
<th>Increase in fuel price</th>
<th>Increase in fuel tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>40%</td>
</tr>
</tbody>
</table>

New revenues without considering reduction in fuel consumption

<table>
<thead>
<tr>
<th>Revenue (M CHF)</th>
<th>Tax/veh. (M CHF)</th>
<th>Tax/liter (CHF/litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4'637</td>
<td>1.03</td>
<td></td>
</tr>
</tbody>
</table>

2. Estimates of the effect of fuel demand, car use and car of the fuel tax increase, annual tax decreases

Elasticities

<table>
<thead>
<tr>
<th>Elasticity * fuel price increase * fuel consumption</th>
<th>Increase in fuel consumption</th>
<th>Increase in fuel tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term long term</td>
<td>-228'590</td>
<td>-8%</td>
</tr>
<tr>
<td>Final car demand</td>
<td>2'809'409</td>
<td></td>
</tr>
</tbody>
</table>

Effects on car use

<table>
<thead>
<tr>
<th>Elasticity * fuel price increase * veh. km</th>
<th>Fuel price increase</th>
<th>Reduction car use (m &amp; l)</th>
<th>Reduction in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final car demand</td>
<td>-2'130</td>
<td>-1'782</td>
<td>-4.8%</td>
</tr>
</tbody>
</table>

Estimates of the impact of variability

1. Definition of the tax increase

Short term

=> we consider only the negative effect of fuel consumption increase as well as decrease in annual tax

Elasticities

<table>
<thead>
<tr>
<th>Elasticity * fuel price increase * fuel consumption</th>
<th>Increase in fuel consumption</th>
<th>Increase in fuel tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term long term</td>
<td>-228'590</td>
<td>-8%</td>
</tr>
<tr>
<td>Final car demand</td>
<td>2'809'409</td>
<td></td>
</tr>
</tbody>
</table>

Effects on car use

<table>
<thead>
<tr>
<th>Elasticity * fuel price increase * veh. km</th>
<th>Fuel price increase</th>
<th>Reduction car use (m &amp; l)</th>
<th>Reduction in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final car demand</td>
<td>-2'130</td>
<td>-1'782</td>
<td>-4.8%</td>
</tr>
</tbody>
</table>
3. Estimate of the fiscal effects due to the fuel tax increase

<table>
<thead>
<tr>
<th>Fiscal effects, short term only fuel tax effect</th>
<th>Net CHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>New tax on 1000 teq/per* (1.25) * reduction of fuel consumption</td>
<td></td>
</tr>
<tr>
<td>Reduction revenue</td>
<td>-349</td>
</tr>
<tr>
<td>Revenue loss</td>
<td>349</td>
</tr>
</tbody>
</table>

4. Estimate of the environmental effects

<table>
<thead>
<tr>
<th>Environmental effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects on car use (Mio veh. km)</td>
</tr>
<tr>
<td>Effects on car stock (Mio CHF)</td>
</tr>
</tbody>
</table>

Same share of cars with and without catalyst, as in scenario 2

Total environmental effects

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Avoided emissions (g veh. km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>3.094</td>
</tr>
<tr>
<td>NOx (w/Shortcatconv)</td>
<td>0.231</td>
</tr>
<tr>
<td>NOx (w/Shortcatconv)</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Assumption: measure has no effects on road infrastructure.

Impact of increase in car stock is not considered.
Scenario 2

Variabilization of annual cantonal tax to Hi-Tech user charges

Data basis

Vehicle tax

<table>
<thead>
<tr>
<th></th>
<th>Moteways</th>
<th>Cantonaltax</th>
<th>Fueltax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M b veh.km</td>
<td>M b CHF</td>
<td>CHF/veh.km</td>
</tr>
<tr>
<td>Commuter/Business</td>
<td>13147</td>
<td>5259</td>
<td>0.10</td>
</tr>
<tr>
<td>Lékum/Shopping</td>
<td>40%</td>
<td>7888</td>
<td></td>
</tr>
<tr>
<td>Carstock</td>
<td>3571795</td>
<td>419</td>
<td></td>
</tr>
</tbody>
</table>

Decrease of annual charges -25% Decrease of annual cantonal tax -100%

The cantonal tax corresponds to or less than 25% of annual charges (depreciation, other charges)

Share of vehicles in the different emission categories

Air pollution

<table>
<thead>
<tr>
<th></th>
<th>Without converter 25%</th>
<th>With converter (before 1991) 30%</th>
<th>With converter (after 1991) 45%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuter/Business</td>
<td>1'315</td>
<td>1'578</td>
<td>2'366</td>
</tr>
<tr>
<td>Lékum/Shopping</td>
<td>1'972</td>
<td>2'366</td>
<td>3'550</td>
</tr>
<tr>
<td>Total</td>
<td>5'259</td>
<td>7'888</td>
<td>13'147</td>
</tr>
</tbody>
</table>

Distribution of vehicle km on the different categories

<table>
<thead>
<tr>
<th></th>
<th>Commuter/Business</th>
<th>Without converter 25%</th>
<th>With converter (before 1991) 30%</th>
<th>With converter (after 1991) 45%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1'972</td>
<td>1'578</td>
<td>2'366</td>
<td>3'550</td>
</tr>
<tr>
<td>Total</td>
<td>5'259</td>
<td>7'888</td>
<td>13'147</td>
<td></td>
</tr>
</tbody>
</table>

Average increase of user charges (+100%)

0.10 CHF/km = Cantonal tax revenues/M b veh.km on moteways

Elasticities

Elasticity of user charges with respect to car use

<table>
<thead>
<tr>
<th></th>
<th>Commuter/Business</th>
<th>Lékum/Shopping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.15</td>
<td>-0.4</td>
</tr>
</tbody>
</table>

Annual tax elasticity:

<table>
<thead>
<tr>
<th></th>
<th>Effects on car use</th>
<th>Effects on fuel consumption</th>
<th>Effects on carstock of annual tax elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.05</td>
<td>-0.11</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

=> medium/long term elasticity

=> long term elasticity

INFRAS
Differentiation of user charges according to emission level (increase of average)

Without catalyst converter
- 150%
- 120%
- 80%

With catalyst converter (before 1991)
- 120%
- 80%

With catalyst converter (after 1991)
- 80%

Estimates of the impact of the differentiation

1. Estimate of the effects on car use (veh. km) and on car stock

<table>
<thead>
<tr>
<th>Category</th>
<th>Mio veh. km</th>
<th>Decrease</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuter/Business</td>
<td>1'035</td>
<td>-21%</td>
<td></td>
</tr>
<tr>
<td>Without catalyst converter</td>
<td>1'035</td>
<td>-21%</td>
<td></td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>1'133</td>
<td>-17%</td>
<td></td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>1'212</td>
<td>-11%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4'961</td>
<td>-15%</td>
<td></td>
</tr>
</tbody>
</table>

Leisure/Shopping

<table>
<thead>
<tr>
<th>Category</th>
<th>Mio veh. km</th>
<th>Decrease</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without catalyst converter</td>
<td>813</td>
<td>-59%</td>
<td></td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>1'313</td>
<td>-17%</td>
<td></td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>2'112</td>
<td>-11%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4'532</td>
<td>-15%</td>
<td></td>
</tr>
</tbody>
</table>

Decay of car use (Mio veh. km)

<table>
<thead>
<tr>
<th>Category</th>
<th>Mio veh. km</th>
<th>Decrease</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>4'461</td>
<td>-15%</td>
<td></td>
</tr>
</tbody>
</table>

2. Estimate of the financial effects

<table>
<thead>
<tr>
<th>Category</th>
<th>Mio CHF</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues from user charges</td>
<td>280</td>
<td>W Without catalyst converter 108</td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>312</td>
<td>W Without catalyst converter 108</td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>369</td>
<td>W With catalyst converter (after 1991) 101</td>
</tr>
<tr>
<td>Total</td>
<td>961</td>
<td>Total</td>
</tr>
</tbody>
</table>

3. Estimate of the environmental effects

<table>
<thead>
<tr>
<th>Category</th>
<th>Mio CHF</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual cantonal tax</td>
<td>1'328</td>
<td>-1'328</td>
</tr>
<tr>
<td>User charges</td>
<td>961</td>
<td>961</td>
</tr>
<tr>
<td>Fuel tax</td>
<td>2'998</td>
<td>-311</td>
</tr>
<tr>
<td>Total</td>
<td>4'637</td>
<td>-677</td>
</tr>
</tbody>
</table>

Environmental effects

<table>
<thead>
<tr>
<th>Emission factors</th>
<th>Total environmental effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2, NOx</td>
<td>CO2, NOx</td>
</tr>
<tr>
<td>Without catalyst converter</td>
<td>220</td>
</tr>
<tr>
<td>With catalyst converter</td>
<td>209</td>
</tr>
<tr>
<td>Total</td>
<td>884</td>
</tr>
</tbody>
</table>
## Scenario 3

### Differentiation of annual canton tax according to the emission level

#### Data basis

<table>
<thead>
<tr>
<th>Vehicle tax</th>
<th>Annualcantonal tax</th>
<th>Fueltax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>Carstock</td>
<td>Fuelcons.</td>
</tr>
<tr>
<td>44225</td>
<td>3571795</td>
<td>19128</td>
</tr>
</tbody>
</table>

#### Elasticity

- Annual tax elasticity:
  - Effects on car stock: -0.06
  - Effects on car use: -0.25
  - Effects on fuel consumption: -0.31

#### Categories

- Air pollution
  - Without converter: 25%
  - With converter (before 1991): 30%
  - With converter (after 1991): 45%

#### Differentiation of user charges according to emission level (increase of average)

- Without converter: 30%
- With converter (before 1991): 10%
- With converter (after 1991): -20%

#### Distribution of the car stock on the different categories

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>Fuel consumption of the categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) M</td>
<td>(2) M &amp; CHF</td>
</tr>
<tr>
<td>11056</td>
<td>7427649</td>
</tr>
</tbody>
</table>

#### Distribution of car km on the different categories

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>M km</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) M</td>
<td>(2) M &amp; CHF</td>
</tr>
<tr>
<td>11056</td>
<td>7427649</td>
</tr>
</tbody>
</table>

#### Estimate of the effects of a differentiation of annual taxes

1. Calculation of the effects of differentiation on car stock and car use

<table>
<thead>
<tr>
<th>Effects on car stock</th>
<th>Carstock</th>
<th>Red. cap.</th>
<th>in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>M without converter:</td>
<td>778476</td>
<td>14872</td>
<td>-2%</td>
</tr>
<tr>
<td>M with converter (before 1991):</td>
<td>945629</td>
<td>5709</td>
<td>-1%</td>
</tr>
<tr>
<td>M with converter (after 1991):</td>
<td>1444835</td>
<td>-17128</td>
<td>1%</td>
</tr>
<tr>
<td>Total:</td>
<td>3768940</td>
<td>2955</td>
<td>-0.29%</td>
</tr>
</tbody>
</table>
### Effects on car use ( mio vehicle km)

<table>
<thead>
<tr>
<th></th>
<th>Mio veh. km</th>
<th>in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without catalyst converter</td>
<td>-163</td>
<td>-1%</td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>-65</td>
<td>-0.5%</td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>195</td>
<td>1.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-33</td>
<td>-0.1%</td>
</tr>
</tbody>
</table>

### Effects on fuel consumption (t oil)

<table>
<thead>
<tr>
<th></th>
<th>t oil in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without catalyst converter</td>
<td>-25'063</td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>-10'025</td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>30'076</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-5'013</td>
</tr>
</tbody>
</table>

#### 2. Calculation of the effect on revenues

### Effects of differentiation of annual taxes (Mio CHF)

<table>
<thead>
<tr>
<th></th>
<th>Mio CHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without catalyst converter</td>
<td>424</td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>436</td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>484</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1'343</td>
</tr>
</tbody>
</table>

### Effects on fuel tax revenues of a decrease in car use (Mio CHF)

<table>
<thead>
<tr>
<th></th>
<th>Mio CHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without catalyst converter</td>
<td>-27</td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>-11</td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td>33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-5</td>
</tr>
</tbody>
</table>

#### 3. Calculation of the environmental effects

### Environmental effects

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>NOx</th>
<th>Avoided emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO2</td>
<td>NOx</td>
<td></td>
</tr>
<tr>
<td>Without catalyst converter</td>
<td>220</td>
<td>2.22</td>
<td>36</td>
</tr>
<tr>
<td>With catalyst converter (before 1991)</td>
<td>209</td>
<td>0.51</td>
<td>-27</td>
</tr>
<tr>
<td>With catalyst converter (after 1991)</td>
<td></td>
<td></td>
<td>Total: 9 0</td>
</tr>
</tbody>
</table>

Assumption: emission factors of cars with old cat. conv. correspond to emissions of an average CH-car.

### Total environmental effects

<table>
<thead>
<tr>
<th></th>
<th>1000 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>9</td>
</tr>
<tr>
<td>NOx</td>
<td>0.29</td>
</tr>
</tbody>
</table>
### Scenario 4

**Differentiation of annual cantonal tax according to specific fuel consumption**

#### Vehicle tax

<table>
<thead>
<tr>
<th>Alman asks</th>
<th>Carstock</th>
<th>Fuel consumption</th>
<th>Fuel tax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carstock</td>
<td>CHF/vehicle</td>
<td>CHF/vehicle/km</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alman asks</td>
<td>Carstock</td>
<td>Fuel consumption</td>
<td>Fuel tax</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Effect of demand elasticity

- Effects on car stock: -0.06
- => Long term elasticity
- Effects on causes: -0.25
- => Synergistic effects

#### Emissions

<table>
<thead>
<tr>
<th>Carstock</th>
<th>Fuel consumption</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than average</td>
<td>23%</td>
<td>Less than average</td>
</tr>
<tr>
<td>Average fuel consumption</td>
<td>60%</td>
<td>Average fuel consumption</td>
</tr>
<tr>
<td>More than average</td>
<td>17%</td>
<td>More than average</td>
</tr>
</tbody>
</table>

#### Differentiation of annual tax revenues according to specific fuel consumption (increase of average)

- Tax revenues: 2'996'260
- Fuel tax: 3'264
- => Total effects on tax revenues: 4'679

- Emission factors (g veh. km)
  - CO₂: 0.09
  - NOₓ: 0.09

- Avoided emissions (1000 T)
  - CO₂: 209
  - NOₓ: 0.51

- Total environmental effects:
  - CO₂: 35
  - NOₓ: 0.29

=> Environmental impacts according to the Swiss vehicle average
Annex 3: Country specific information sheets

EURO Exchange rates

<table>
<thead>
<tr>
<th>Country</th>
<th>Exchange rates (1/99)</th>
<th>100 currency units correspond to .... EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>13.76030  ATS</td>
<td>7.267</td>
</tr>
<tr>
<td>Denmark</td>
<td>7.44878  DKK</td>
<td>13.425</td>
</tr>
<tr>
<td>Germany</td>
<td>1.95583  DM</td>
<td>51.129</td>
</tr>
<tr>
<td>France</td>
<td>6.55957  FRF</td>
<td>15.245</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2.20371  NLG</td>
<td>45.378</td>
</tr>
<tr>
<td>Sweden</td>
<td>9.48803  SEK</td>
<td>10.540</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1.60778  CHF</td>
<td>62.198</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.705455  GBP</td>
<td>141.752</td>
</tr>
</tbody>
</table>

*Table28: EURO exchange rates from 1–31 January 1999: Currency exchange rates used in this study (Source: European Commission’s EURO budget rates on Internet)*
# Information sheet for Austria

## Interviews

We have carried out interviews with:

- Mr. Schwarz-Herda, Federal Ministry of Economics Affairs
- Mr. Schwarz, International Road Transport Ecopoint Department, Federal Ministry of Science and Transport
- Mr. Quantschnigg, Head of Tay-Policy Division, Ministry of Finance
- Mr. Steinbuch, Ministry of Finance

## Literature and data sources

- ASFINAG, Fahrleistungsabhängige LKW-Maut – Die Grundzüge im Überblick, November 1998
- Steuerreform 2000 – Bericht der Steuerreformkommission an den Bundesminister für Finanzfragen Rudolf Edlinger, Wien, November 1998
Variable charges for road transport:

Road pricing for lorries

Description of the charge:
In Austria, there exist about 1,600 km motorways and 300 km expressways. At present, a charge has to be paid by all road users on 140 km only (7% of road infrastructure). On the other 93% of the road network, passenger cars (up to a maximum weight of 3.5 t), lorries (up to a maximum weight of 12 t) and buses have to pay a “vignette”. Lorries with 12 t or more maximum weight have to pay a flat rate road user charge (time-related, for one year or one day). The current system is essentially based on fixed time-related charges – that is road-user charges for a fixed period of time, such as one day or month. The present charges do not depend on infrastructure use. In 1996, a new law on the financing of motorways was introduced. This law foresees the introduction of a road-pricing system for lorries on the entire network of motorways and expressways in 2002. Vehicles with a maximum weight above 3.5 t have to pay the toll instead of the vignette (vehicles up to 12 t) or the road-user charge (vehicles above 12 t maximum weight).

Objective of the measure:
The main objective of road pricing is to finance the maintenance and construction costs of the infrastructure of motorways and expressways. Moreover, one important objective has been the introduction in the taxation system of elements based on the polluter-pays principle. The toll is basically differentiated according to the costs of the route. Since route-specific costs are not available in detail, an overall allocation of costs takes place. The measure does not have environmental objectives, although a reduction in freight transport and therefore a positive impact on emissions is expected to occur. It is expected that some positive impacts on rail transport will be felt.

Differentiation criteria:
The road pricing system is differentiated according to:
- the number of axles of a lorry (2, 3 or 4 axles) and
- the type of route considered.
According to the number of axles, a lorry has to pay the average road charge (100% of the average road charge for 3-axle vehicles) respectively less (70% for 2-axle vehicles) or more than average (120% for 4 or more -axles vehicles). The average charge is...
2 ATS (incl. VAT, 0.15 EURO) for a vehicle with 4 or more axles.

Three features of the route determine the level of the tax: The distance, the topography (subdivided into three categories) and the quality of the road, which depends primarily on the presence of tunnels, bridges, etc. The infrastructure network is divided into routes with a length between 50 and 85 km, for which differentiated charges are levied. The maximum and minimum road pricing levels are fixed: e.g. for a 4-axle-lorry the minimum charge for the route amounts to 90 ATS (6.5 EURO), up to a maximum of 150 ATS (11 EURO). The reason for fixing a maximum charge lies in the payment method. It is foreseen to introduce a dual system: an electronic payment system (through an on-board unit) and a “traditional” payment system. Lorries provided with an electronic payment system are charged according to the kilometres driven. Lorries without the on-board unit have to pay at the payment station which is located approximately in the middle of the route. The current plans foresee 23 major toll stations. Some secondary toll stations are located before and after the major stations in order to avoid evasive actions of drivers (who could quit the motorway shortly before the payment station and get on it shortly after). In order to avoid lorries without an on-board unit having to pay systematically the maximum toll for the route (also if they have used the route for a shorter distance), it was decided to limit the level of the toll to a maximum.

As an alternative to the axles-related charging system, a weight-referred system was evaluated but – because of problems with implementation of the dual system – was not pursued further.

Criteria for the tax level:
The toll level is based on the financing needs of infrastructure provision. The differentiation according to topographic criteria reflects the different infrastructure costs.

Success of the measure:
The measure will be introduced in 2002 and therefore, at present, it is not possible to judge its success or failure. Some positive minor side effects are expected to be experienced as far as rail transport is concerned (shift from road to rail).

Possible problems:
It has been modelled that evasive actions (the use of other roads) can take place up to a maximum of 10% of today’s traffic flow. Different flanking measures are planned in the case that significant evasive actions arise. Possible measures evaluated are the installation of minor payment stations at the motorway exits – especially before the ma-
Major payment stations – increased police controls and physical barriers. It is expected that evasive actions will take place only during the initial period after tax introduction. The additional time and car use costs due to the detour will in the majority of cases exceed the costs of road pricing.

**Implementation and administration:**

**Implementation costs:** The implementation costs are estimated to be about 3.5–4 billion ATS (0.25–0.29 billion EURO). The yearly running costs amount to 700–800 million ATS (51–58 million EURO); these are mainly staff costs. The yearly net revenue is estimated at about 3.5 billion ATS or 0.25 billion EURO (2–2.5 billion without VAT, 0.14–0.18 billion EURO). The magnitude of implementation costs – particularly the investments – depends largely on the decisions regarding the optimum level of control measures necessary for minimising evasive actions.

**Use of revenue:**

Revenues are used to finance infrastructure maintenance and new constructions.

**Exemptions/Restrictions:** The road-pricing system is not charged on inner-city motorways because of technical problems with its realisation. Since this electronic charge system is not compulsory, it is necessary to install “traditional” payment stations. These have a significant place requirement. Because of the lack of land for the construction of payment stations for inner-city motorways, it was necessary to exempt these routes from road pricing.

Generally, the introduction of a road pricing system is restricted to motorways and expressways (restriction due to EU legislation).

**Overall framework conditions:**

**Political framework conditions:** The key element for the realisation of the road pricing system on motorways was the treaty of Maastricht (“European monetary union”) which defines the level of domestic public debth each country is permitted to reach at the maximum in order to be allowed to join the monetary union. To reach these goals, Austria has privatised the infrastructure of motorways and in this way significantly reduced the public debt. The EU legislation foresees that the private society which provides road infrastructures (ASFINAG) must finance at least 50% of its costs through economic instruments. The introduction of a road pricing scheme was therefore a consequence of the need to reduce public debt.
**Environmental framework conditions:** Environmental arguments were not relevant for the introduction of the motorways’ toll. The sensitivity of the public towards environmental problems is a possible explanation for the overall acceptance of the new tax.

**International framework conditions:** They have an important impact on Austrian fiscal policy. The requirements of the treaty of Maastricht and, generally, the participation in the EU have twofold effects: On the one hand, they have pushed the introduction of road pricing for lorries but, on the other hand, they restrict the possibilities for introducing a road pricing scheme to the whole network.

**General fiscal strategy in transport:** There are plans for the future to apply the electronic road pricing system also to passenger car use. The road-pricing system is not part of an overall fiscal strategy in transport.

**Overall appraisal of the measure:**
The road-pricing system is a useful measure for securing short-term financial resources. Some other positive side effects (positive environmental impacts) can be achieved.

**Recommendation for differentiation policies:**
Since the tax has not yet been introduced, it is not possible to make specific recommendations with regard to optimum differentiation policies.
Differentiated taxes for road transport:

**Differentiated annual vehicle tax (engine-related insurance tax)**

**Description of the tax:**
The tax is charged on vehicles with a total weight of up to 3.5 tons. The tax is paid together with the insurance tax (Haftpflicht).

**Differentiation criteria:**
The tax is differentiated according to the horsepower of the vehicle. The tax is calculated as:

\[(kW - 24) \times 5.00 \text{ till } 5.50 \text{ ATS} = \text{amount to be paid monthly}\]

The differentiation between 5.00 and 5.50 ATS depends on the periodicity of payment: The lowest value must be used when the payment occurs yearly, the highest must be paid when the tax is paid monthly.

The tax increases by 20% for vehicles with fuel engines without catalytic converters whose first registration in Austria took place before January 1987. The importance of the differentiation is getting smaller, since the share of vehicles without catalytic converters decreases year by year.

**Objective of the measure:**
The objective of the differentiation was to promote the purchase of vehicles with catalytic converters before they became compulsory.

**Success of the measure:**
The measure was judged not to have been very successful. It is estimated that only 5–10% of the population have reacted to this measure. The reasons for the small impact of the differentiation are as follows:

- As the measure was introduced there was uncertainty with regard to vehicles with catalytic converters. There were fears that these vehicles had a shorter life span. In addition, the network of petrol stations with lead-free fuels was not very dense.
- The monetary incentive was judged to be too small to encourage the purchase of vehicles with catalytic converters.

**Improvements of the measure:** Within the framework of a general reform towards a more ecological tax system, the possibility of an increase in the annual registration tax
has been analysed. The proposal of the commission consists of a monthly increase in 2 ATS/kW, i.e. an increase from 5 to 7 ATS (if the tax is paid once for the whole year). In the meantime, the tax allowance should decrease from 24 to 20 kW. Due to the switch to the EURO, the tax will be expressed in terms of the new European currency (0.5 EURO/kW). The revenue should increase by more or less 50%.

Furthermore, the annual taxes for HGVs should also be increased to 140 ATS per month and per ton of total weight. The current level of the annual HGV tax lies between 70 and 85 ATS per month and per ton of total weight.

The objectives of the proposals are:
- to reduce the trend towards more powerful vehicles,
- to stop the trend towards diesel-driven vehicles,
- to adapt the tax to price level increases in past years (tax rate has not been adapted since 1984),
- to make some further steps towards a more ecological tax system. A first step in this direction was carried out with the change of the tax basis from cubic capacity to the horsepower of vehicles (since 1st may 1993).

Some members of the commission criticise the fact that the tax burdens only private households. Some members of the commission are against an increase in the annual HGV taxes since this would not have any effect on traffic behaviour. Furthermore, they fear a disadvantage for domestic haulage firms in comparison to foreign ones.

Implementation and administration:

Criteria for the tax level and implementation costs: The differentiation can be carried out with relatively small implementation costs, since the differentiation criteria are well known.

Use of revenues:
Revenue is used to finance the general state budget.

Overall framework conditions:

General fiscal strategy in transportation: At the end of 1998, a report with different proposals for an ecological reform of the tax system, worked out by a tax reform commission, was published. The reform foresees some changes towards an increase in fuel taxation (a unilateral price increase in Austria and in the border countries might be successful) and an increase in transport taxation in general. At present, it is not possible to judge the implementation chances of the proposed measures. The commission itself
did not reach an agreement for a proposal supported by all commission members. Probably, only the adaptation of the tax rate to the price level increase since 1984 will be realised.

**Overall appraisal of the measure:**
The annual registration tax has not been adjusted to price increases since 1984. The particular incentive given for the purchase of vehicles with catalytic converters in the 1980s seems not to have been very successful. The reasons are twofold: firstly, the tax incentive has been judged to be too small for achieving a significant switch towards vehicles with catalytic converters; secondly, the small price incentive was linked with a lack of information with regard to the catalytic converter technology. Furthermore, the network of petrol stations which offered unleaded petrol – especially abroad – was small, which was a further disadvantage for vehicles with catalytic converters.

**Recommendation for differentiation and variabilisation policies:**
The experience with a tax differentiation shows that such a policy has to be linked with an overall information of consumers focused on the objectives of the measure implemented. Moreover, it is necessary that the price differentiation has an important magnitude in order to lead to a change in consumer behaviour.
Differentiated purchase tax ("Standard fuel consumption tax")

Description of the tax:
Before 1992, there were three VAT rates in Austria: 10% (for example on food), 20% (normal rate of VAT) and 32% (luxury VAT rate, e.g. on cars). The luxury VAT rate was abolished in order to conform the tax system to the EU requirement, in view of Austria’s membership of the EU. In order to guarantee the fiscal revenue, the luxury tax was replaced by an “EU-suitable” differentiated registration tax. The tax basis is the price of the car (including VAT). The tax has to be paid when the first registration of private cars and motorcycles takes place. For foreign vehicles without a confirmation of consumption, the average consumption is estimated to be 0.2 of the power measured in kWh. The tax was introduced in 1992 and replaces the luxury VAT.

Differentiation criteria:
The tax rate is calculated based on the car’s fuel consumption reduced by 2 litres for petrol cars and 3 litres for diesel cars, respectively. The adjusted consumption is multiplied by the factor 2% in order to arrive at the total tax rate.\(^{50}\) The specific fuel consumption is based on the MVEG and ECE values.\(^{51}\)

- Private cars with fuel engines:
  \[(\text{MVEG/ECE} - \text{fuel consumption} - 3) \times 2 = \text{percentage}\]
- Private cars with diesel engines:
  \[(\text{MVEG/ECE} - \text{fuel consumption} - 2) \times 2 = \text{percentage}\]

The tax is restricted to a maximum rate of 16% (until 1996: 14%) because of pressure coming from the car supply industry (Austrian firms supplying the European automobile market).

Electric cars, as well as vehicles which are used for the ambulance service, the transport of diseased persons, rental cars and cars used in driving schools, are exempt from the tax.

Restrictions (GATT/WTO, EU):
The luxury tax rate was abolished in order to bring the Austrian tax system closer to that of the EU.

---

\(^{50}\) The tax rate of a petrol car with a fuel consumption of 10 litres is: \((10 - 3) \times 2 = 14\%\). The tax results from the tax rate multiplied by the car price.

\(^{51}\) ECE resp. MVEG refer to the old and new methods of measuring fuel consumption.
Objectives of the measure:
The main objective of the measure was to replace the fiscal revenue of the luxury tax, although the official objective was to promote the purchase of fuel-efficient cars. Furthermore, the differentiation was introduced in order to stop the trend towards diesel-driven cars and cars with a high horsepower and give incentives for small and fuel-efficient cars.

Criteria for the tax level:
The fiscal criteria has determined the tax level, since the objective was to reach the same revenue as the luxury VAT rate.

Success of the measure:
The financial aims were able to be achieved, but there were no significant changes in the purchase behaviour of car drivers.
The tax was very well accepted, since it was not meant to be a new tax but to replace the luxury VAT rate in order to guarantee fiscal revenue.

Failure of the measure:
The trend towards diesel-driven cars could not be stopped because of the low diesel prices. To avoid fuel tourism, Austria fixes fuel prices at the level of German prices. This pricing strategy limits the possibilities for the introduction of some effective measures against the purchase of diesel cars, such as an increase in the diesel price. In fact, the strong preference for diesel-driven cars – the share of diesel cars reaches 40% in Austria – can basically be explained by low diesel prices. In addition, the technological improvements reduce the negative effects connected to the use of diesel cars. Moreover, the preference for powerful cars – with a growing share during past years – could not be reduced by the introduction of the new tax. One reason could be found in the maximum tax rate favouring cars with a high fuel consumption (they pay a maximum rate of 16% of the car price).

Possible improvements of the measure:
Within the framework of an overall tax reform scheme, it has been proposed to increment the tax rate to 2.5% and to reduce the adjustment factor for diesel cars to 1 litre (instead of the present 2 litres). The maximum tax burden will be increased from 16% to 30%. The different tax burden between diesel- and petrol-driven cars would increase to 5%, in comparison with the present 2%. The main positive effect of this reform pro-
posal is seen in the adjustment of the present tax system towards a more ecological one. Furthermore, in combination with an increase in the annual vehicle tax, the trend towards more powerful and diesel-driven vehicles could be stopped.

The arguments against this reform stress that those branches which supply the car industry could indirectly be negatively affected by this measure.

**Implementation and administration:**
The introduction of the measure did not cause major implementations costs. The tax is levied only on new vehicles, for which there exist official statistics on the fuel consumption (the so called MVEG cycle).

**Use of revenue:**
The revenue amounts to 5.3 billion ATS (385 million EURO).

**Overall framework conditions:**
**General fiscal strategy in transportation:** The special purchase tax has not been introduced as an element of a general fiscal strategy.

**Political framework conditions:** Similar to the road pricing scheme, the special purchase tax was introduced in order to achieve an EU-compatible tax scheme in transport.

**Environmental framework conditions:** The new tax was very well accepted by the public, whereby the awareness of environmental problems probably contributed to its good acceptance. Furthermore, the special purchase tax did not represent a new tax but the replacement of an old one. This also simplified its introduction.

**International framework conditions:** The international framework conditions, mainly the membership of Austria into the EU, have induced Austria to replace the third VAT rate with a differentiated tax.

**Overall appraisal of the measure:**
The special purchase tax has reached the fiscal objectives but not the environmental ones, since the trend towards diesel-driven and more powerful cars could not be stopped. Nonetheless, the new tax is judged positively by the population as well as by the state. The major opposition towards this tax came from the car supply industry, which feared reprisals (Retorsionsmassnahmen) from the foreign car industry. It seems
that it would be easier to reach the environmental goal with measures focusing on car technology.

**Recommendation for differentiation and variabilisation policies:**
Although the differentiation was not very effective in reaching the goals, it seems nonetheless to be the right direction for taxation in transport. The effectiveness of the measures crucially depends on the level of the tax and on the existence of an overall fiscal strategy which aims at reaching the same objectives. A variabilisation in the form of an (unilateral) increase in fuel prices is not possible in Austria because of fuel tourism, as long as German prices are lower than those in Austria. A preliminary condition for a fuel tax increase is a harmonisation of fuel taxation policy in the border countries.
Information sheet for Denmark

Interviews

We have carried out interviews with:

- Mr. Larsen, Ministry of Taxation
- Ms. Westergaard, Ministry of Taxation

Literature and data sources


EUROPEAN ENVIRONMENT AGENCY 1996: Environmental Taxes, Copenhagen, 1996

LOVTIDENDE A 1997: ‘Lov om afgift efter braendstofforbrug for visse personibel’ (Law about taxation dependent on fuel consumption for certain passenger cars), paper no 75, Denmark, June 1997

MINISTRY OF TAXATION 1997: Denmark: Newly introduced or revised fiscal instruments in the field of environmental taxation, 2 p., Copenhagen, November 1997

MINISTRY OF TAXATION 1998a: Note on the Danish taxes on energy. Fax by Hans Larsen, 10 p., Copenhagen, August 1998

MINISTRY OF TAXATION 1998b: Green Taxation: the development in Denmark, Copenhagen, September 1998


MINISTRY OF TAXATION 1998d: Taxation systems on motor vehicle. Questionnaire from Embassy of Japan with answers from the Ministry of Taxation, Copenhagen, July 1998

MINISTRY OF TAXATION 1999a: Taxes on Motor Vehicles, Transparencies, Copenhagen, January 1999

Overall framework conditions

Overview of the history of the taxes:
Denmark has had a high level of taxation on cars for many years. It produces no vehicles which has been one reason for very high car purchase taxes (registration taxes) on private cars. This has restrained car ownership, but not necessarily use. As a part of its policy to obtain sustainable economic growth and redirect the existing taxation of cars towards a more environmental efficient taxation, the Danish Government has listed targets for reducing the traffic-related emissions of CO₂, CO, HC, NOₓ, SO₂, lead, benzene and particulates.

The taxation of cars and other motor vehicles consists of different parts:
1) the registration tax (incl. 25% VAT),
2) the annual weight tax (since July 1997 replaced by the annual green tax),
3) excise taxes on motor fuels,
4) the third party liability insurance duty, and
5) the road toll for trucks over 12 tons.

Not discussed in the following information sheets are the obligatory third party liability insurance duty – which is 50% of the premium paid for insurance of registered motor vehicles – and the road charge\(^{52}\). The latter was introduced in Denmark in January 1995 for heavy goods’ vehicles and vehicle combinations weighing at least 12 t.

\(^{52}\) = Eurovignette = flat-rate road user charge: Vehicles with 3 axles pay 5,649 DKK/yr. (760 EURO), vehicles with \(\geq 4\) axles pay 9,416 DKK/yr. (1,264 EURO). The rate for foreign vehicles also depends on the number of axles and the period of time spent in the payable countries.
within the framework of the Eurovignette including Denmark, Sweden, Belgium, Luxembourg, the Netherlands and Germany.

By July 1997 a green vehicle tax reform had been introduced with the aim of providing larger incentives to use more fuel-efficient cars – measured by the fuel consumption. This new green tax replaced a yearly weight tax for new cars because the link between weight and fuel consumption is not always straightforward. Thus, the weight duty sends the wrong signals in terms of environmental damage to the potential buyer. Diesel-driven cars are liable to an additional duty, an equalising duty, as the diesel fuel is taxed at a lower rate than petrol.

In summary, the overall taxes on passenger cars are very high, those on vans are low and trucks are not taxed at all (except for the fuel and annual weight taxes). Vans for private use have a lower sales tax than passenger cars. Vans for private use have higher annual taxes than vans for business use. Owners of buses are only obliged to pay the registration and annual tax if the buses are used for private purposes. Public buses are exempt.

The summarised transport taxes in Denmark, meaning the registration tax, the annual tax and the fuel tax (including energy, CO₂ and sulphur tax), more or less equalise the externalities and infrastructure costs caused by private car driving. The somewhat lower taxes for trucks do not cover the external costs.

Objective of the measure:
The primary objective of taxation of cars and car transport is revenue raising. The revenue is not earmarked for special purposes but is incorporated in the general state budget. This goes for the road-user charges as well.

Car stock and car use:
High car purchase taxes (registration taxes which are approx. 110% of the taxable value in average and 180% on the margin) restrained car ownership. In spite of this low car ownership, car use relative to GDP is similar to that of other countries. But the average distance each car is driven per year is higher than in any other European country.

---

53 EU regulations 80/1268 and 93/116
54 While the average lifetime of a car in Denmark is not significantly longer than for example in Sweden (only 1–2 years), the average number of kilometres the car is driven in its lifetime is roughly 30% greater than in Sweden.
High purchase taxes do suppress car size somewhat, leading to lower fuel intensity because cars are small. However, high purchase taxes may also restrain fleet turnover, so overall fleet intensity might not reflect advances in technology as robustly as other economies. The consequence of this high level of car and fuel taxation is that there are “only” 350 cars per 1,000 inhabitants in Denmark – compared to 495 in Germany and 411 in Sweden (figures from 1995) – presumably with an increasing trend.

A large majority of cars are petrol-driven. The share of diesel cars of all the Danish passenger cars is about 2% and therefore very low.

As far as freight is concerned, Denmark stands out as somewhat of an oddity. The level of freight is low relative to industrial GDP, but the share of trucking is high and fuel use per ton kilometres of trucking is among the highest within Europe. Consequently, carbon emissions from freight, in relation to inhabitants or GDP units, are rather high in Denmark.

**Road pricing systems:**
The only kind of road pricing in Denmark is the flat-rate road toll (Eurovignette) for HGVs. The decision about the introduction of a regionally restricted road pricing or tolling scheme – as it is for example considered in the Netherlands – lies in the competence of each municipality. However, congestion is not a real problem in Denmark, not even in Copenhagen. This is mainly due to the rather high parking fees which are now set at 15 DKK (2 EURO) per parking hour in central Copenhagen. Therefore, about 20% of all Copenhagen travelling and 10% of leisure travelling is made by means of public transport. As a consequence, the fastest means of transport in Copenhagen is still the private car.

**Revenue from transport taxation:**
The total revenue of the vehicle and transport taxes was approx. 38 billion DKK (5.1 billion EURO) in 1998. The total revenue for all green/environmental taxes in Denmark is about 60 billion DKK (8 billion EURO).

The following table gives an overview of revenue resulting from transport taxation. With regard to CO$_2$ and sulphur taxes, only the total revenue including other sectors than transport is available.

---

55 Energy taxes, excise duty on motor fuel, annual vehicle taxes, registration tax, eco taxes
### Table 29: Green transport taxes in Denmark 1980–1998 (Source: Ministry of Taxation 1999b)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol tax</td>
<td>3,690</td>
<td>5,744</td>
<td>7,387</td>
<td>8,219</td>
<td>8,541</td>
<td>8,775</td>
</tr>
<tr>
<td>Weight tax</td>
<td>2,888</td>
<td>4,363</td>
<td>4,404</td>
<td>4,918</td>
<td>5,172</td>
<td>5,650</td>
</tr>
<tr>
<td>Registration tax</td>
<td>3,049</td>
<td>8,007</td>
<td>14,967</td>
<td>15,363</td>
<td>16,366</td>
<td>17,800</td>
</tr>
<tr>
<td>Third part liability insurance</td>
<td>476</td>
<td>933</td>
<td>944</td>
<td>1,068</td>
<td>1,336</td>
<td>1,350</td>
</tr>
<tr>
<td>Road toll</td>
<td>–</td>
<td>–</td>
<td>289</td>
<td>262</td>
<td>270</td>
<td>286</td>
</tr>
<tr>
<td>Energy tax (total)</td>
<td>6,557</td>
<td>14,150</td>
<td>17,932</td>
<td>20,006</td>
<td>20,905</td>
<td>23,475</td>
</tr>
<tr>
<td>CO₂ tax (total)</td>
<td>–</td>
<td>–</td>
<td>3,245</td>
<td>3,693</td>
<td>3,930</td>
<td>4,550</td>
</tr>
<tr>
<td>SO₂ tax (total)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>296</td>
<td>396</td>
<td>400</td>
</tr>
</tbody>
</table>

**Political framework conditions:**

The Danish Government and the tax administration give high priority to information on tax incentives, also in the way of general communication as specific information to the targeting group. As regards road transport, it is the clear intention of the Government to encourage the use of public transport and to take all relevant steps – at both national and international level – in order to reduce the problems of transport. In this respect, the tax instrument is a very important instrument.

**Overall appraisal of the measures:**

The Danes are clearly strategising for the demand-side of transport/vehicle taxation. To some degree, this strategy is one of necessity, not having an automobile industry of its own means that supply side policies of the Danish government would not be effective.

The differentiation of the green tax and the very high registration taxes are considered as satisfying measures to cover the financial and environmental needs. The general opinion is that – at least in the short and medium run – there are no big shifts or changes expected in the Danish system of transport taxation. Nor is the initiation of new taxes very probable, since “the Danish rather watch other countries, like Germany, what they are doing and which strategies are chosen by them”. A further improvement
in the system is politically not considered possible for passenger cars for the time being, whereas for vans a tax differentiation of the annual green tax seems possible if the EC emissions’ standards become compulsory.

The differentiation of the green tax, particularly, has demonstrated rather positive effects on the fuel efficiency and hence the environmental performance. It could also be said that Denmark seeks to meet an optimum mix of transport taxation with the combination of differentiated purchase (registration) taxes, differentiated annual (green) taxes, and additional excise taxes on fuels (energy, CO₂ and sulphur taxes). In isolation these taxes would become significantly less effective than as an overall package which succeeds in a multi-faceted CO₂ policy with its strong focus on demand-side incentives. The road charge meets the need to burden also the freight sector, at least at a minimum level.

The Danish experiences show the importance of the balance between fixed and variable costs in the transport/environment equation. High car acquisition and registration costs may indeed be effective at retarding the growth of car ownership, but if variable costs are not similarly high, those households with cars will use them more frequently than in countries with higher variable costs. “For this reason, Danish policy is slowly trying to variabilise costs.”
Variable charges for road transport:

Fuel taxes (Excise taxes on motor fuels)

Description of the charge:
The excise tax on motor fuels is levied on petrol and diesel. It consists of an energy duty, a CO₂ tax and a sulphur tax. The differentiation is based on environmental criteria such as lead content and the toxic/carcinogenic impact of exhaust outcome.

Objective of the measure:
The main objective of fuel taxes is revenue-raising. The differentiation of the fuel taxes should compensate for the extra costs for the more environmentally friendly fuel quality and should foster the application of the optimum fuel for the connected modern technologies (i.e. catalytic converter).

Since the Danish “green tax reform” of 1994–98, fuel taxation is more environmentally focused. Carbon, energy and sulphur taxes are now based on environmental or emissions’ criteria. The CO₂ tax (introduced in 1992) and the energy tax (levied according to the energy content of the fuel in 1998) should help to come closer to the high targets set: a 20% reduction in CO₂ emissions in Denmark between 1988 and 2005. The target for the transport sector is a stabilisation of the CO₂ emissions by 2005, at the 1988 level.

Differentiation criteria:
The differentiation on petrol is made on 3 levels, between leaded and unleaded petrol, between stations with or without vapour-recovering equipment and since July 1998 according to the benzene content (carcinogenic outcast) of the fuels.

1) 0.65 DKK/l (0.087 EURO) differentiation between leaded & unleaded petrol
2) 0.03 DKK/l (0.004 EURO) differentiation between petrol stations with and without recovering of fumes. Stations with fume-recovering system is given a rebate.
3) Differentiation based on the content of benzene.

The rebate on petrol tax is mentioned in the table below:

---

56 Unintentionally, the 1988 reference year was a year with considerably low CO₂ emissions.
57 The differentiation has little relevance today, as unleaded petrol covers 100% of the market of petrol.
58 Less than 50% of the petrol used has a low benzene content. The differentiation is adjusted with increasingly better petrol performance every summer.
Year of introduction | Reduction in petrol tax [DKK/ litre petrol] depending on the benzene content |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>1998, 1 July</td>
<td>-0.04</td>
</tr>
<tr>
<td>2000, 1 January</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

Table 30: Rebate of energy tax on petrol (in DKK/litre) depending on the benzene content
(Source: Ministry of Taxation 1998d)

The average tax rates on petrol in 1998 were:
– 3.35 DKK/l unleded petrol, gradually increasing to 4.05 DKK/l in 2002
– 4.00 DKK/l leded petrol, gradually increasing to 4.70 DKK/l in 2002

The tax on diesel is differentiated between normal and light diesel with 0.1 DKK/l (0.13 EURO). The differentiation criteria is – among other things – the sulphur content which is less than 0.05% for light diesel.

The average rates in 1998 were:
– 2.12 DKK/l normal diesel
– 2.02 DKK/l light diesel (minus 0.1 DKK/l)
– 0.27 DKK/l CO2 tax

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Energy tax / litre</th>
<th>CO2 tax / litre</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unleaded petrol</td>
<td>3.77 DKK / 0.5 EURO</td>
<td>–</td>
<td>3.77 DKK / 0.51 EURO</td>
</tr>
<tr>
<td>Leaded petrol</td>
<td>4.42 DKK / 0.6 EURO</td>
<td>–</td>
<td>4.42 DKK / 0.59 EURO</td>
</tr>
<tr>
<td>Normal diesel</td>
<td>2.12 DKK / 0.28 EURO</td>
<td>0.27DKK / 0.04 EURO</td>
<td>2.39 DKK / 0.32EURO</td>
</tr>
<tr>
<td>Light diesel</td>
<td>2.02 DKK / 0.27 EURO</td>
<td>0.27DKK / 0.04 EURO</td>
<td>2.29 DKK / 0.31EURO</td>
</tr>
</tbody>
</table>

Table 31: Fuel taxation in Denmark in 1999 (Source: Ministry of Taxation 1998c)

Criteria for the tax level:
The overall tax level consists of the total of the energy, CO2 and sulphur taxes. The tax basis for the carbon tax is 100 DKK/t CO2 (13 EURO), for the energy tax 41 DKK/GJ (5.5 EURO, by July 1998) and for the sulphur tax 20 DKK/kg sulphur (2.7 EURO). The sulphur tax depends on the actual sulphur content and is only charged on fuels with a sulphur content above 0.05%. For petrol and light diesel, the S-content is below 0.05%.
Success of the measure:
The preference for light diesel as opposed to normal diesel – differentiated according to the sulphur content – leads to a reduction in particulates: For each 0.05% of sulphur reduction in diesel oil, there are 30% less particulates emitted.

To fulfil the goal of a CO₂ emission stabilisation by 2005 at the 1988 level for the transport sector, a hypothetical CO₂ tax of 2,000 DKK/t CO₂ (270 EURO) instead of 100 DKK/t CO₂ (13 EURO) should be imposed on the public. The calculations made for the fixing of the CO₂ tax level to reach the CO₂ reduction goal is within the responsibility of the Ministry of Finance.

It would appear difficult for that goal of a stabilisation in 2005 to be reached since the political framework conditions do not allow the necessary increase in the carbon tax. Overall, carbon emissions per capita from travel are average for the European countries.

Implementation and administration:
There are no real implementation costs on fuel taxes.

Use of revenue:
Revenue is used for general budget purposes.

Restrictions:
Denmark’s fuel pricing policy depends largely on the fuel consumer prices in the surrounding countries. Nowadays, the most constraining factor is the difference in the level of petrol taxes between Denmark and Germany (diesel is only slightly cheaper in Denmark). In the mid-1980s, there was a big price difference which gave rise to many parliamentary discussions. Three to four years later, the petrol taxes were reduced to the German level. In January 1999, the petrol taxes in Denmark were increased by 0.4 DKK/l (0.05 EURO)59. Yet, German petrol is about 1.30 DKK/l (0.17 EURO) cheaper60 and cross-border travelling has been increased.61 It is estimated by the Ministry of Taxation that the revenue loss due to fuel tourism is about 420 million DKK/yr (56

59 A further petrol tax increase is considered: + 1.5 DKK in January 2000, 2001 and 2002. Nevertheless, a tax increase is unlikely to take place if the German tax level is not going to be levied at the same time.
60 The profit is nevertheless higher for Danish petrol filling stations than for German ones.
61 Buying petrol is not the only reason for cross-border travelling. Other cross-border shopping also has to be faced.
million EURO). There has been some discussion between the ministries about the consequences for the border trade because of price differences. Danish authorities also believe that Germany’s agreeing to higher fuel prices to prevent border leakage in Denmark (and also in other countries) will be a crucial component of their strategy.

**Political framework conditions:**
Denmark was hit very hard in the 1973 oil shock, and took strong measures to reduce oil dependence. While nearly self-sufficient in oil and gas, the government still taxes very highly individual energy consumers (households) today. Therefore, transport taxes are also at a very high level (per capita) compared with other European countries. Relatively high petrol taxes throughout the late 1980s were slowly lowered, both to reduce border sales with Germany and to comply with EU directives. Diesel fuel was not heavily taxed, and VAT-registered truckers could get all their diesel tax refunded, leading to some misuse of road diesel fuel for space heating.

**Overall appraisal of the measure:**
Differentiated fuel taxes are important and sustain the environmental objectives of the high registration taxes on private cars. It could be shown that high registration or annual taxes could lower car ownership but not prevent people from excessive car use. Therefore, the incentive for less car use could probably be improved by increasing the fuel taxes.

The fact that the fuel tax is directly related to CO₂ and SO₂ emissions is environmentally very effective. The energy content is also a criteria for the tax level. This system change in Danish energy taxation increased the incentives to environmental concerns such as CO₂ emissions reduction.
Differentiated taxes for road transport:

**Purchase tax (Registration tax)**

**Description of the charge:**
Denmark has a very high car registration tax (110% in average and 180% on the margin). The first time a motor vehicle is registered in Denmark the registration tax is paid. The registration tax is a value-based vehicle tax and the taxable value includes the general sales tax (VAT) of 25%. Supplementary technical equipment such as airbags, ABS, etc. can be deducted from the gross value and is therefore not taxable. For cars and vans with less than two airbags there is an additional charge. All passenger cars as well as vans and trucks weighing not more than 4 t total weight are charged when the vehicle is registered for the first time.

**Objective of the measure:**
The main objective of this tax is revenue raising. The structure of the differentiation goes back to over 50 years ago when the differentiation had no environmental intention. The major objective was having a high tax which was really progressively calculated.

**Differentiation criteria and tax level:**
The registration tax is based on the price (incl. VAT of 25%) of the new vehicle. It is progressively levied with increasingly higher rates for more costly vehicles (see the following table):

---

62 The registration tax is not part of the tax base for VAT.
63 These deductions correspond to the actual costs of the equipment and are lowered with time when the equipment becomes cheaper.
### Table 32: Registration tax rates for the different vehicle categories: Vehicles for private use are additionally charged with 25% VAT. (Source: Ministry of Taxation 1999a)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>105% of first 50,800 DKK (6,820 EURO)</td>
<td>180% of the rest</td>
</tr>
<tr>
<td>Small vans: 0–2 t</td>
<td>0% of first 12,100 DKK (1,625 EURO)</td>
<td>95% of the rest</td>
</tr>
<tr>
<td>Larger vans: 2–4 t</td>
<td>0% of first 30,000 DKK (4,030 EURO)</td>
<td>30% of the rest</td>
</tr>
<tr>
<td>Private buses</td>
<td>0% of first 12,100 DKK (1,625 EURO)</td>
<td>60% of the rest</td>
</tr>
<tr>
<td>Public buses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorcycles</td>
<td>0% of first 6,400 DKK (860 EURO)</td>
<td>105% of value between 6,401 DKK and 11,700 DKK (1,570 EURO)</td>
</tr>
<tr>
<td></td>
<td>180% of the rest</td>
<td></td>
</tr>
<tr>
<td>Trucks / Vans &gt; 4 t</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An exemption from the registration tax on electric cars was introduced in 1983 for a period of three years. The motivation was to encourage the use of electric cars for environmental reasons. The tax exemption was extended several times and is now valid until the end of 2000.

**Success of the measure:**
The high taxation of new cars has effectively restrained car ownership but does not affect the total car use of the Danes.
The exemption from the registration tax on electric cars since 1983 has had only minor effects. By 1997, only 26 cars were registered.

**Implementation and administration:**
Tax payers are the car dealers and sellers, or the car importers, respectively on behalf of the buyers.

**Use of revenue:**
Revenue is used for general budget purposes. The annual revenue in 1998 resulted in 17,800 million DKK (321 million EURO). The 1997 registration tax revenue was 16,366 million DKK (2,197 million EURO).

**General fiscal strategy in transportation:**
Private people are willing to pay really high prices for cars. This shows that elasticity in the private transport sector is very low. It is not foreseen to reduce the registration tax because of the high amount of revenue which would have to be replaced. According to
the Ministry, the lowering of taxes should principally be initiated on the also very high income taxes, rather than on the registration taxes.

**Overall appraisal of the measure:**
According to the Ministry of Taxation the experiences with the rather high registration taxes are very satisfying, such that changes in the system should not be undertaken easily.
Weight duty / Annual Green tax (Annual vehicle taxes)

Description of the charge:
At present, there are two annual taxes on the ownership of motor vehicles.

1) The annual weight duty is a weight-based annual charge and is levied on old passenger cars (0–2 t; registered before July 1997) as well as on other motor vehicles like motorcycles, buses, vans (0–4 t), and trucks.

2) With regard to new cars (registered since 1 July 1997), the annual green tax came into effect at the end of 1997. The annual green tax is based on the official fuel consumption according to EU standards for fuel consumption measurement, obligatory since 1997. This new tax underlies an environmentally sound tax base. There are two tax scales, one for petrol-driven cars and another one for diesel-driven cars. Vans, trucks and motorcycles are still taxed according to their total weight, and all motorcycles are taxed at the same rate. Objective of the measure:

The main objective of the switch from the weight-based annual tax to the fuel consumption-based green owner tax is that the Government wished to strengthen the incentive to include environmental considerations when buying a new car. Since the weight of a car is not always properly linked to its fuel consumption, the weight duty sends the wrong signals in terms of environmental damage to the potential buyer. The green tax is constructed so as to stress the environmental effects by linking the tax level directly to fuel consumption.

Most buyers select a car from cars of the same size and price rather than between small and large cars. But cars within the same range of size can differ significantly in fuel consumption. The green tax will encourage the demand of more fuel-efficient cars within the same range. As car pollution mainly originates from the use of the car, and less from manufacturing and waste process, the green tax is indirectly linked to emissions.

Additionally, this measure gives cause for concern with regard to the reduction target of the CO₂ emissions. The overall goal is the maintenance of CO₂ emissions in the transport sector at the 1988 level for 2005 and a reduction of 25% in 2030 compared to

---

64 Vans used 100% by private individuals are liable to an additional tax.
65 also “green owner tax”
1988. Another objective was to realise a revenue neutral shift from one to the other tax system.

**Differentiation criteria:**

1) For old *passenger cars*, the *weight tax* varies from 1,420 DKK/yr (190 EURO) to 5,660 DKK/yr (760 EURO). The typical car is taxed at 2,360 DKK/yr (317 EURO). There is an *additional charge for diesel-driven vehicles* to equalise the tax and price difference between diesel and petrol.

Privately used *vans* are taxed with an annual rate of 1,700–2,500 DKK/yr (228–336 EURO) for small vans (0–2 t), and 7,000–7,500 DKK/yr (940–1,007 EURO) for heavy vans (2–4 t), inclusive of the additional tax of 750 DKK (100 EURO) for small vans (0–t) and 4,400 DKK (590 EURO) for heavy vans (2–4 t).

The weight duty on vans\textsuperscript{66} is environmentally differentiated: new vans complying with EU NO\textsubscript{x} standards for 2000 and 2005 are in favour of a reduced weight tax (see Table 33). This rebate is gradually decreased over the years and expires as the emission standards become compulsory. The rebate for a van fulfilling year 2000 standards equals 50–60% of the existing weight duty.

<table>
<thead>
<tr>
<th>Permitted total weight in kg</th>
<th>Suggested EU standards</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EU 2000 standard: Annual rebate until 2000 in DKK (EURO)</td>
<td>EU 2000 standard: Additional rebate per year in DKK (EURO)</td>
</tr>
<tr>
<td>500–1,000</td>
<td>350 (47)</td>
<td>100 (13)</td>
</tr>
<tr>
<td>1,000–2,000</td>
<td>700 (94)</td>
<td>200 (27)</td>
</tr>
<tr>
<td>2,000–2,500</td>
<td>900 (121)</td>
<td>350 (47)</td>
</tr>
<tr>
<td>2,500–3,500</td>
<td>1,150 (154)</td>
<td>450 (60)</td>
</tr>
</tbody>
</table>

*Table 33: Environmentally differentiated weight duty on vans (Source: Ministry of Taxation 1998d)*

Full (100%) company usage of vans and trucks is not subject to the additional annual tax. In case of combined use for private and business purposes, the additional annual tax is charged at a 50% level.

2) The green owner tax is based on the car’s potential fuel consumption according to the EC standards\textsuperscript{67}. For petrol-driven cars, the tax varies from 420 DKK/yr (56 EURO)

\textsuperscript{66} In the absence of a standard of reference for fuel consumption for vans, the Government preferred a differentiated weight tax. So the use of vans, already fulfilling the suggested EU standards can be encouraged by the use of economic instruments.

\textsuperscript{67} This tax differentiation was made possible with the introduction of the fuel consumption measurements of new cars according to EU 80/1268 and 93/116 standards.
for cars driving more than 20 km/l (< 5 l/100 km) to 15,440 DKK/yr (2,073 EURO) for cars driving less than 4.5 km/l (22 l/100 km). There are twenty tax steps on the scale of fuel economy as can be seen from Table 34. The typical Danish car is taxed with 2,920 DKK/yr (392 EURO) for an average fuel economy of 12.5 km/l (8 l/km). The share of diesel-driven passenger cars is less than 2% of the car stock.

<table>
<thead>
<tr>
<th>Categories of fuel consumption in km/litre</th>
<th>Tax rates (1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum km/l</td>
<td>minimum km/l</td>
</tr>
<tr>
<td>&gt; 20.0</td>
<td>420</td>
</tr>
<tr>
<td>20.0</td>
<td>18.2</td>
</tr>
<tr>
<td>18.2</td>
<td>16.7</td>
</tr>
<tr>
<td>16.7</td>
<td>15.4</td>
</tr>
<tr>
<td>15.4</td>
<td>14.3</td>
</tr>
<tr>
<td>14.3</td>
<td>13.3</td>
</tr>
<tr>
<td>13.3</td>
<td>12.5</td>
</tr>
<tr>
<td>12.5</td>
<td>11.8</td>
</tr>
<tr>
<td>11.8</td>
<td>11.1</td>
</tr>
<tr>
<td>11.1</td>
<td>10.5</td>
</tr>
<tr>
<td>10.5</td>
<td>10.0</td>
</tr>
<tr>
<td>10.0</td>
<td>9.1</td>
</tr>
<tr>
<td>9.1</td>
<td>8.3</td>
</tr>
<tr>
<td>8.3</td>
<td>7.7</td>
</tr>
<tr>
<td>7.7</td>
<td>7.1</td>
</tr>
<tr>
<td>7.1</td>
<td>6.7</td>
</tr>
<tr>
<td>6.7</td>
<td>6.3</td>
</tr>
<tr>
<td>6.3</td>
<td>5.9</td>
</tr>
<tr>
<td>5.9</td>
<td>5.6</td>
</tr>
<tr>
<td>5.6</td>
<td>5.3</td>
</tr>
<tr>
<td>5.3</td>
<td>5.0</td>
</tr>
<tr>
<td>5.0</td>
<td>4.8</td>
</tr>
<tr>
<td>4.8</td>
<td>4.5</td>
</tr>
<tr>
<td>&lt; 4.5</td>
<td></td>
</tr>
</tbody>
</table>

Table 34:  Green tax rates for petrol-driven cars depending on fuel consumption (Source: Ministry of Taxation 1998d)

As one of the expected gains from the green owner tax is an increased fuel efficiency in new cars, the tax steps are proposed to increase by 1.5% each year in order to maintain the same level of tax pressure. The annual increase applies to new as well as old cars.

Criteria for the tax level:
The linear coherence between weight and fuel consumption for petrol-driven cars driving 100 km is approximately 2.5–3 litres of petrol plus circa 0.5 l for each 100 kg weight of the car. For a car weighing circa 800 kg the expected fuel consumption is about 14.8 km/l.
The tax differences between the tax classes will produce an incentive to acquire more fuel-efficient cars. On average, the green tax imposes the same incentives on increased fuel efficiency as a rise in the petrol price of 5–6 DKK/l (0.67–0.8 EURO), calculated at an average of 15,000 km driven per year. The incentive is thus equivalent to a rise in petrol price at 5–6 DKK in excess of the petrol expenditure.

Since the excise tax on diesel is lower than on petrol (for reasons of competitiveness), the annual tax is set at a higher rate for diesel-driven cars. This equalisation tax is embraced in the green tax. The tax scale includes the fact that diesel is taxed lower than petrol and that diesel-driven cars have a higher fuel efficiency than petrol cars. Also, there is an additional annual tax for diesel-driven vehicles (passenger cars, vans and smaller trucks) liable to the weight tax. The break-even point above which driving a diesel car is cheaper is calculated at 16,000 km/yr.

Taxis driving on petrol, cars belonging to or used by disabled persons and electric cars (until 31 December 2000) are exempt from the green tax, while taxis driving on diesel are subject to 35% of the rates for diesel cars.

Success of the measure:

Environmental objectives: The Ministry of Taxation confirmed the expected trend that people tend to buy more fuel-efficient cars within certain size categories rather than buying smaller cars with better fuel-economy performance. During one year of controls and measures a slight shift towards higher fuel efficiency could be observed: The fuel efficiency of cars was increased by 4% for an average car.

Given the global insignificance of Danish car sales, it is unrealistic to expect that an increased Danish demand for fuel-efficient cars will influence car manufacturers, but within each car class the manufacturers are expected to send the most fuel-efficient to the market.

Revenue objective: The aim that the system change from the annual weight tax to the green owner tax should be revenue neutral was adequately achieved since the revenue from this tax shift increased by only 1.5%. For approximate calculations, a single formula for indexation was used. The table below gives examples of the average tax difference for car owners to be paid before and after the introduction of the green tax. The

---
68 There are 20 fuel efficiency classes.
69 This figure meets the expectations.
balance point where the green tax equals the weight duty will gradually move towards higher fuel economy.

<table>
<thead>
<tr>
<th>Fuel economy in km/litre</th>
<th>&gt;18</th>
<th>&gt;16</th>
<th>&gt;14</th>
<th>&gt;12</th>
<th>&gt;10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel economy in litre/km according EU standard tests</td>
<td>&lt;5.55</td>
<td>&lt;6.25</td>
<td>&lt;7.14</td>
<td>&lt;8.33</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Extra tax to be paid with the new green tax in DKK/yr</td>
<td>−765</td>
<td>−430</td>
<td>0</td>
<td>575</td>
<td>1,375</td>
</tr>
</tbody>
</table>

*Table 35: Difference between the average annual amount to be paid based on the car weight and that assessed on the basis of fuel economy upon introduction of the green tax in January 1998. (Source: OECD/IEA 1998)*

Implementation and administration

**Administration:** The taxpayer is the owner of the vehicle.

There are some minor control problems with regard to how much company vans are used for private purposes, but this problem is no different to other control problems and is, in any case, not regarded as a big problem.

**Implementation costs:** The implementation costs arising from the introduction of the green owner tax were very moderate.

**Use of revenue:**

Revenue is used for general budget purposes.

The 1998 revenue resulted in 5,650 million DKK (760 million EURO), compared with 5,172 million DKK (695 million EURO) in 1997.

**Restrictions:**

The non-availability of standardised fuel efficiency measurement of vehicles other than passenger cars makes it necessary to continue to impose the weight tax on other vehicles.

**Overall framework conditions:**

**Political framework conditions:** Originally the car importers and dealers suggested the adjustment of the annual taxes according to the development of the fuel-efficiency and consumer price index. They also initiated the proposal towards a greener annual taxation. Just as the proposal was being discussed in the parliament they changed their
minds, mainly because the green taxes were going to be higher than they had expected.\textsuperscript{70}

**International framework conditions:** Due to new EU regulation, information on fuel consumption on new cars sold within the EU is compulsory. The fuel consumption is measured following a uniform method ensuring the same standard of reference, independent of the car (EU 80/1268 and 93/116 standards). Comparative information on fuel consumption is presently only available for passenger cars; therefore the fuel-economy-based green tax cannot be applied for other vehicles.

**General fiscal strategy in transportation:**
The shift from the annual weight-based vehicle tax to the fuel-based green tax was meant to be revenue neutral. Ultimately, the increase in revenue was very low, only 1.5%.
The price adjustment is based on:
1) the average increase of fuel efficiency/car productivity which is set 0.75 per year and
2) the consumer price index.
In the beginning of 1999 the taxes had increased by 4.5% compared to 1998. At the same time, the weight taxes of older cars were also levied at the same 4.5% rate (for generation of extra revenue).

**Overall appraisal of the measure:**
The green tax is independent of the mileage and total fuel consumption and the incentive to acquire a fuel-efficient car expressed in DKK/l is less with a high mileage than with a lower mileage.
Compared to the weight tax, the green tax will not cause significant redistribution. However, as smaller cars often have a better fuel economy, they will in general be entitled to tax relief, while bigger cars face a tax raise.
The earlier weight tax has been criticised for conflicting with concerns for road safety, as heavier cars tend to be safer. This drawback is mitigated as consumers will pay fewer taxes by buying heavy, safe but fuel efficient cars.

---

\textsuperscript{70} The original purpose of the importers and dealers was to a certain extent a lowering of the tax.
In general, the new system favours diesel cars and small-engine petrol cars. This could, in the long run, bring about an increased share of diesel-driven passenger cars unless measures against it are taken.

Yet, the introduction of the differentiated green tax definitely improved the system of transport taxation. Denmark’s system of high car acquisition taxes has been somewhat successful at restraining trends toward large, fuel-intensive cars.
**Information sheet for France**

**Interview**

We have carried out an interview with:

- Mr. Heux, Ministère de l’Equipement, des Transports et du Tourisme

**Literature and data sources**

- COFIROUTE: Tarifs par classe de véhicules, n°45 en vigueur au 01/02/97
- EUROTOLL: Extraits du rapport européen: Cas français
- MINISTÈRE DE L’ÉQUIPEMENT, DES TRANSPORTS ET DU LOGEMENT: Evolution du réseau routier trans-européen
- MINISTÈRE DE L’ÉQUIPEMENT, DES TRANSPORTS ET DU LOGEMENT: Mémento de la route 98

**Overall framework conditions**

In France the following taxes in transportation exist:

- **Fuel tax** (revenue 1997: 185.7 billion FF; 28.3 billion EURO\(^{71}\)) is the main source of revenue. It has been decided (1998) to reduce the difference in the level of taxation of diesel (2.35 FF; 0.36 EURO) and petrol (3.78 FF; 0.58 EURO, 160% of diesel tax) to the European mean difference within 5–7 years. The diesel tax will be increased yearly (1999: growth of 0.07 FF; 0.011 EURO), the petrol tax will be stabilised. LPG is subsidised and charged only with VAT.

---

\(^{71}\) 100 FF = 15.245 EURO
• **Ownership tax** (revenue 1997: 16.4 billion FF; 2.5 billion EURO): The tax is levied by the countries. The ownership tax depends on the engine power (horse power: HP, threshold for vehicles with more than 7 HP). The tax is halved for vehicles which are older than 5 years and vehicles older than 20 years are exempt (for social reasons).

• **Motorway tolls** (revenue 1997: 27.7 billion FF; 4.2 billion EURO): These charges are not considered as taxes but as revenue used for the maintenance and the construction of motorways. Around 0.5 billion FF (76 million EURO) are levied each year to finance the police on the motorways. Since 1995, around 2 billion FF (0.3 billion EURO) have been levied yearly to feed a fund designed to contribute to investment in rail, waterways and some non-tolled motorways.

• **Other taxes** are less important as sources of revenue, for example the tax on driving licences (0.4 billion FF; 61 million EURO) or the purchase tax (6.5 billion FF; 991 million EURO). The level of the purchase tax differs between the regions; the tax base is the engine power of the vehicle. More important with regard to revenue is the **car insurance tax** (13.0 billion FF; 2 billion EURO), which is designed to cover some social security expenses linked to road injuries.

<table>
<thead>
<tr>
<th>Tax</th>
<th>Revenue [billion FF]</th>
<th>Revenue [billion EURO]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel tax (incl. VAT)</td>
<td>185.7</td>
<td>28.3</td>
</tr>
<tr>
<td>Registration tax</td>
<td>6.5</td>
<td>1</td>
</tr>
<tr>
<td>Ownership tax (incl. company cars)</td>
<td>16.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Tax on driving licence</td>
<td>0.4</td>
<td>0.06</td>
</tr>
<tr>
<td>Car insurance tax</td>
<td>13.0</td>
<td>2</td>
</tr>
<tr>
<td><em>Specific</em></td>
<td>6.1</td>
<td>0.93</td>
</tr>
<tr>
<td><em>Specific to social security</em></td>
<td>6.9</td>
<td>1.05</td>
</tr>
<tr>
<td>Motorway tolls</td>
<td>27.7</td>
<td>4.2</td>
</tr>
<tr>
<td><em>Contribution to police on motorway</em></td>
<td>0.5</td>
<td>0.08</td>
</tr>
</tbody>
</table>

*Table 36: Revenue from transport taxes in France 1997 (Sources: NEI, 1998)*

---

72 Including ownership tax on company cars.
Variable charges for road transport:

Differentiated motorway tolls

Description of the tax:
In France, the contracts for the construction and maintenance of motorways are given to licensed firms \(^73\) which are allowed and responsible for levying tolls for the use of the motorways. There are at present nine licensed enterprises, of which eight are publicly as well as privately financed; one is financed only with private capital.

The level of the tolls depends on the
- **type of vehicle**, in particular on the number of **axles** and the **vehicle height**. The following categories are distinguished:
  1. cars and minibuses (with 2 axles and a height at maximum equal to 1.3 m),
  2. cars with trailer (with > 2 axles and a height at maximum equal to 1.3 m),
  3. vehicles with 2 axles higher than 1.30 m, camping cars,
  4. lorries with > 2 axles and higher than 1.30 m.,
  5. motor cycles.

- **distance** driven.

The objective of the toll is to finance the maintenance of the existing and the construction of new motorways. In order to contribute to an **efficient use** of the infrastructure, differentiation of the toll level on some motorway trunks was introduced in 1992.

Differentiation of motorway tolls:
On certain routes, motorway tolls are differentiated according to **temporal criteria** and to the **route** chosen by drivers (different routes are charged differently). The objective of differentiation is to increase the traffic flow, and to decrease congestion and improve security, respectively.

Temporal differentiation:
The temporal differentiation was first realised on the motorway Lille–Paris (A1, enterprise SANE) in 1992. Different toll levels were introduced for traffic returning to Paris

\(^73\) 6,939 km are managed by licensed firms, 2,628 km are not licensed (this last figure includes also planned motorways).
on Sundays: during the **green hours** (between 14.30–16.30 and 20.30–23.30) the toll is reduced by 25% whereas during the **red hours** (between 16.30–20.30) the toll is increased by 25%. During the other days of the week and on Sunday mornings the toll level remains unchanged. The differentiation was introduced in a revenue neutral way (toll increase and decrease compensate each other).

Similarly, on the common trunk of the motorways **A10** and **A11** (entering Paris)\(^74\) the toll was increased on Sundays (increase for the trips back from the weekend). The differentiation was introduced between 24 March and 26 November 1996. In 1997 the measure was not implemented because of problems with the communication of the measure and because of low traffic flows.

A similar differentiation was introduced on the **AREA network** (a licensed motorway network enterprise). The differentiation was called “Destination snow – blue hours” and was implemented during the winter 1993/94 and 1994/95. The objective was to reduce congestion during weekends at the beginning of the winter holidays. Differentiation according to the routes:

The objective of motorway tolling, differentiated according to the routes chosen, was to give incentives for the use of alternative, less frequented routes. This sort of differentiation was realised on the motorway **A1** (Paris–Lille) and **A26** (Reims–Calais). At the beginning of the summer holidays in 1994 and 1995, the tolls of the motorway A1 were slightly increased (+9 FF) and the tolls of the motorway A26 decreased (-30 FF). After 1995, the differentiation was given up since the alternative route was well known. Furthermore, it was necessary to avoid situations of congestion on the motorway A31 (at the south of Langres) in order to maintain the credibility of the measure.

The differentiation on the motorways **A5/A6** during the departure days of the winter holidays compensated for the longer route (around 70 km) of the alternative motorway (difference of the toll level: 50 FF; 7.6 EURO). This differentiation was first introduced in 1995 and was extended to the 1\(^{st}\) May, for vehicles returning to Paris.

**Toll bridges:** Tolls for crossing the Seine river were introduced on two bridges – the Normandy and Tancarville bridges at “Le Havre“. After the opening of the Normandy bridge in 1995, the pricing system was able to influence the route choice (33 FF

---

per crossing on Normandy, 18 FF on Tancarville bridge\textsuperscript{75}. The most significant results concern user behaviour and effect of tolls on route choice according to characteristics of routes (toll fare, travel time, distance) and type of users.

**Success of the measure:**
The toll differentiation on the motorway A1 Lille–Paris has led to a reduction in traffic flow during the red hours of around 10\%, or around 2,000 vehicles every Sunday during the four hours, with an increased toll level. After about one year, 25\% of the users were still not aware of this operation. Despite initial difficulties – particularly due to a lack of information and some difficulties linked with the complexity of the operation – a reduction in traffic of around 8–12\% during the red hours has been noted on the A10–A11 motorway.

Thanks to spreading, the peak congestion was significantly reduced (e.g. by an estimated 60\% on “Cofiroute network”).

The differentiation of alternative routes has lead to a shift in traffic flow of around 15\% from the usually more often used and therefore congested routes to the less congested routes. On 1\textsuperscript{st} of May the shift was even greater, about 18–20\%.

The route choice over the two toll bridges shows an estimated effect of tolls on traffic transfers between 1,700 and 2,500 vehicles/day (20–30\% of transferable flows, induced traffic not taken into account\textsuperscript{76}). Concerning the mode of payment used by companies, the subscription card is satisfying, since this system is seen as simple, convenient and clear regarding monthly invoicing.

**Safety** data are collected on the A1 network with details on location and time. Yet, the assessment on safety is more related to change of user behaviour and their effect on the network. The conclusion to be drawn is that there is no particular effect of toll differentiation on safety.

\textsuperscript{75} Price for paying cash, with credit card or foreign money. Price reduction when automatic fee collection is used, with a card for 20 crossings, for a return ticket or with a monthly pass.

\textsuperscript{76} The induced traffic due to the opening of the new Normandy bridge can be estimated between 20 and 25\% of its traffic and 8\% of total traffic on both bridges.
Problems of the measure:
At the beginning of the toll differentiation, some users stopped at the rest areas before the toll plaza and along the emergency lanes to wait for the green period tariff. This attitude can be negative for safety and was avoided with accompanying enforcement measures (police, information). This underlines the need for such accompanying measures to avoid such a reaction.

Price differentiation, according to the routes carried out with lower motorway tolls on alternative but longer routes, are not very effective when applied to reducing congestion during the beginning/end of holidays. As is shown on the A5/A6, the price is not a major criterion for route choice when it is an occasional interurban long trip (people have already included the toll in their holiday budget). But free-flow could weigh out a longer distance on an alternative route.

Overall appraisal:
The experience with differentiation was generally very successful. The following points can be stressed:

• The most important framework condition for the success in differentiation of motorway tolls is providing adequate information to road users. Differentiation measures which were not preceded by intensive information campaigns were significantly less successful. The efficiency of such measures relies much on the identification of the essential road users that allows targetted information campaigns, signposting, etc. The signposting has a high impact and appears to be very important, especially for a new route.

• It has been noticed that relatively small decreases in traffic flows diminish congestion risks significantly.

• Problems arise when, due to differentiation – and the consequent shift from one route to the other – congestion develops on alternatively chosen routes. In these cases, differentiation was given up in order to maintain the credibility of the measure.

• The introduction of differentiation was not easy, since its acceptance by drivers is relatively low (although the road is congested, they have to pay more). Good communication is therefore very important.
• Free-flow is the main criterion for route choice over longer distances besides the
distance criterion and is therefore a stronger incentive than the amount of tolls to
be paid.

• The acceptance increases if the differentiation is introduced in a revenue neutral
way, meaning that periods with high-toll levels would be compensated with low-
toll level periods. Compared to non-varied tolls, toll-differentiated motorways
show a small decrease in the toll revenue each year (i.e. about 1 million FF/yr; 0.15
million EURO on the A1) which should be considered from the beginning.

• The introduction of an information system, which automatically interrupts the
radio programme in case of important messages referring to the road conditions,
improves the efficiency of infrastructure use.
Information sheet for Germany

Literature and data sources


• Ekkehard Hofmann & Klaus Wehrt: Die Reform der KFZ-Steuer – wirtschaftspolitisch betrachtet, p. 263–271, Hamburg

• Wissmann: Reform der KFZ-Steuer ist ein voller Erfolg, 2 p.

Overall framework conditions

Overview of the history of the taxes:
The German taxation policy of car transport could be characterised as a traditional one, based on the two main sources, fuel taxes and annual vehicle taxes.

In Germany the following taxes in transportation exist:

– Fuel tax with a special fuel stock tax (on diesel, leaded and unleaded petrol);
– Emission-based annual motor vehicle tax for passenger cars;
– Weight-based vehicle tax for HGV differentiated according to emission and noise;
– Eurovignette levied on HGVs over 12 tons for the use of the motorways;
– Insurance tax for car ownership (15% of the insurance volume);
– Registration fee on car buying.

On the acquisition of new passenger cars only the regular VAT of 15% is levied. The new registration of vehicles costs 50 DM/vehicle (26 EURO). The vehicle tax, the registration fee and part of the fuel tax is within the responsibility of the different federal states (Bundesländer).
The fuel stock tax\(^{77}\) was introduced in order to guarantee the provision of fuel in case of oil shortages.

Congestion pricing is no issue at all in Germany despite serious congestion problems.\(^{78}\)

In the case of Germany, a **Eurovignette**\(^{79}\) (road user charge) is levied on HGVs for the use of the motorway network, as it is in the Netherlands, Luxembourg, Denmark and Sweden. For HGVs, a distant-related road user charge is planned to be introduced after 2002, whereas a road pricing system related to passenger cars is refused to be considered by almost all political parties\(^{80}\). The road pricing for HGVs is intended to be electronic and at first be differentiated according to weight and number of axles, later on possibly also according to other criteria.

**General fiscal strategy in transportation and objective of the measure:**

It was the intention of the legislator that the purpose of taxing car transport in Germany be aimed at financing road infrastructure. This intention is reflected in the earmarking of fuel tax revenue for road construction since 1955 (motorways and federal trunk roads). Since 1973, revenue from fuel taxation could also be spent for other purposes in the transport sector. Apart from the aim of increasing the federal income, the plan to tax cars according to environmental damages caused is added (e.g. different fuel tax rates for leaded and unleaded petrol). In this respect, the vehicle tax reform 1997 has fixed tax rates for passenger cars according to their emissions.

**Revenue from transport taxation:**

The most important revenue is that raised from the fuel and annual vehicle taxes. Revenue is generally used for governmental budget purposes. Only the revenue from fuel taxes is earmarked to the transport sector\(^{81}\). According to calculations of DIW\(^{82}\) for the year 1994, revenue from fuel and vehicle taxation exceeded the cost of roads (de-

---

\(^{77}\) = “Erdölbevorratungsbeitrag”: The tax rate amounts to 0.0089 DM/l (0.0046 EURO) for petrol and 0.0075 DM/l (0.0038 EURO) for diesel.

\(^{78}\) The total congestion costs at motorways only were estimated at 524 million DM (268 million EURO) in 1994 (DIW/INFRAS/HERRY/NERA 1998)

\(^{79}\) An eurovignette costs 1,891 EURO per year for a three axles lorry, and 3,151 EURO for a vehicle with four or more axles. It can also be bought for a shorter period.

\(^{80}\) except the CSU

\(^{81}\) 0.06 DM/l (0.03 EURO) for urban transport infrastructure, 0.01 DM/l (0.005 EURO) for federal roads, 50% of the remaining tax rate for federal roads.

\(^{82}\) Deutsches Institut für Wirtschaftsforschung (German institute for economic research)
precipitations, interests, running costs) by almost one third. Table 37 gives an overview of the financial volume of revenue from different transport taxes:

<table>
<thead>
<tr>
<th>Tax</th>
<th>Revenue [billion DM]</th>
<th>Revenue [billion EURO]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel tax</td>
<td>56.0 (42.4 for pass. cars, 1997)</td>
<td>28.6 (21.7 for pass. cars, 1997)</td>
</tr>
<tr>
<td>Fuel stock tax</td>
<td>0.39</td>
<td>0.2</td>
</tr>
<tr>
<td>Vehicle tax</td>
<td>14.4 (11.1 for pass. cars, 1997)</td>
<td>7.4 (5.7 for pass. cars, 1997)</td>
</tr>
<tr>
<td>Insurance tax</td>
<td>5.9 (for 1995, pass. cars only)</td>
<td>3.0 (for 1995, pass. cars only)</td>
</tr>
<tr>
<td>Registration fee</td>
<td>0.18</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>77</strong></td>
<td><strong>39</strong></td>
</tr>
<tr>
<td>Tax deduction (commuting exp.)</td>
<td>8.4 (for 1994)</td>
<td>4.3 (for 1994)</td>
</tr>
<tr>
<td>Tax deduction (depreciation of company cars.)</td>
<td>4.0 (for 1994)</td>
<td>2.0 (for 1994)</td>
</tr>
</tbody>
</table>

Table 37: Revenue from transport taxes in Germany (Sources: Heike Link, 1998)

It must be added that the deduction of passenger car-related costs from the taxable income (i.e. for commuting expenses and depreciation for company cars) plays an important role in the overall German taxation system.

**Political framework conditions:**

Generally, it can be stated that – particularly with the recent change of government in Germany – the introduction of new financial schemes, such as road pricing or an increase of transport taxes (i.e. fuel taxes), is at present being seriously discussed. Because of a lot of political pressure coming from the German automobile manufacturer industry, the opposition to any changes in transport policy is quite strong. Moreover, the increase of fuel taxes in 1994 was justified with raising funds for paying the debts of Daimler–Benz (car manufacturer). At the same time, the fuel tax on diesel was not increased to the same extent as that on petrol in order to guarantee the competitiveness of the German road haulier.

The announced increase in fuel tax by 0.06 DM/l (0.03 EURO) within the “so called” ecological tax reform envisaged by the new German government lies within the “normal” margin of increases in the past. The originally planned equal treatment of car users and users of public means of transport concerning the possibility of reducing taxable income has also been postponed.

---

83 The automobile industry is an important employer in Germany with strong political influence.
Overall appraisal of the measures:
The effects of environmentally oriented taxation policies show a differentiated picture:

- The new emission-differentiated vehicle tax seems to be quite effective, also in terms of environmental issues. Besides, its acceptance is quite high. There is potential related to about 10 million older vehicles (older than 9 years) to be equipped with catalytic converters.

- In the case of the differentiated fuel tax rates between leaded and unleaded petrol, there was a significant effect on the fuel demand. Meanwhile, the share of leaded petrol amounts to only 5%.

- The increases of fuel taxation in 1972/73, 1984/82, 1991 and 1994 caused only limited decreases in road transport related to total fuel consumption and could not be looked at as environmentally effective.
Differentiated taxes for road transport:

**Annual motor vehicle tax (KFZ-Steuer)**

**Description of the tax:**
In 1994, the vehicle tax for HGVs was differentiated according to ecological criteria. Already in 1985 first steps in the direction of fostering emission-reduced passenger cars were taken. From July 1997, the differentiation was significantly broadened and the new tax rates for passenger cars were introduced. Therefore, passenger cars are now taxed with six different tax rates according to their emissions. The amended law on the vehicle tax envisages a one- or two-step increase of these tax rates up to the year 2005 (but in January 2001 at the earliest). Passenger cars which meet the emission standards of EURO 3 and EURO 4 as well as low-emission vehicles (3- or 5-litre cars) will be charged with reduced taxes until the end of 2005.

**Objective of the measure:**
The differentiation of the vehicle tax according to six emission classes for passenger cars aimed at adding an environmental component to the purely fiscal measure (before July 1997). Incentives should be set for both car users and car producers to reduce emissions. Incentives should also be given to re-equip non emission-efficient passenger cars according to new technological standards (e.g. catalytic converters) or to scrap them earlier than originally intended.

**Differentiation criteria:**
Since July 1997 the annual vehicle tax has been differentiated according to:

– vehicle emissions,
– type of fuel used,
– engine size (cubic capacity of the engine).

As can be seen from the table below, there are six different tax rates applied – each for petrol- and diesel-driven vehicles.

Possible tax reductions or exemptions are valid up to 31 December 2005 according to the amended law from 1997 for the following types of vehicles:

- EURO 3 (from 1 July 1997, for cars in use before 1 Jan. 2001):
  - *petrol cars*: max. 250 DM (128 EURO),  *diesel cars*: max. 300 DM (153 EURO)
- EURO 4 (from date of concluded EC resolution, for cars in use before 1 Jan. 2005):
  - *petrol cars*: max. 600 DM (307 EURO),  *diesel cars*: max. 1,200 DM (614 EURO)
“3-litre cars”, max. CO$_2$ emissions 90 g/km$^{84}$: max. 1,000 DM (511 EURO),
“5-litre cars”, max. CO$_2$ emissions 120 g/km: max. 500 DM (256 EURO).

The following categories of non-registered vehicles are also taxable:
– Off-road vehicles with a maximum speed limit exceeding 20 km/h,
– Low-powered motorcycles (Leichtkrafträder),
– Off-road trailers with a maximum speed limit exceeding 25 km/h,
– Special trailers for transportation of equipment or animals for sports purposes with a maximum speed limit exceeding 25 km/h.

<table>
<thead>
<tr>
<th>Vehicle classes</th>
<th>Tax rate in DM (EURO) per 100 cm$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EURO 3, EURO 4, 3-litre cars $^1$</td>
<td></td>
</tr>
<tr>
<td>petrol cars</td>
<td>13.2 (6.7)</td>
</tr>
<tr>
<td>diesel cars</td>
<td>37.1 (19.0)</td>
</tr>
<tr>
<td>EURO 2 cars $^1$</td>
<td></td>
</tr>
<tr>
<td>petrol cars</td>
<td>13.2 (6.7)</td>
</tr>
<tr>
<td>diesel cars</td>
<td>37.1 (19.0)</td>
</tr>
<tr>
<td>EURO 1 and similar cars $^1$</td>
<td></td>
</tr>
<tr>
<td>petrol cars</td>
<td>13.2 (6.7)</td>
</tr>
<tr>
<td>diesel cars</td>
<td>37.1 (19.0)</td>
</tr>
<tr>
<td>Non low emission vehicles $^1$</td>
<td></td>
</tr>
<tr>
<td>petrol cars</td>
<td>21.6 (11.0)</td>
</tr>
<tr>
<td>diesel cars</td>
<td>45.5 (23.3)</td>
</tr>
<tr>
<td>Low emission cars not allowed to be used in case of ozone warning</td>
<td></td>
</tr>
<tr>
<td>petrol cars</td>
<td>13.2 (6.7)</td>
</tr>
<tr>
<td>diesel cars</td>
<td>37.1 (19.0)</td>
</tr>
<tr>
<td>Other cars</td>
<td></td>
</tr>
<tr>
<td>petrol cars</td>
<td>18.8 (9.6)</td>
</tr>
<tr>
<td>diesel cars</td>
<td>42.7 (21.8)</td>
</tr>
</tbody>
</table>

$^1$ Cars allowed to be used in case of ozone warning

Table 38: Vehicle tax rates in Germany; 100 DM = 51.129 EURO (Sources: Bundesministerium der Finanzen; Federal Ministry of Finance 1997)

Success of the measure:
It will not be evaluated if the differentiating measure from 1997 can be regarded as successful until 2002. First indications show that the introduction of emission-

$^{84}$ According to EC directive 93/116/EG
differentiated vehicle taxes exceeds by far the expected effects.\textsuperscript{85} To date, 700,000 vehicles have been re-equipped with catalytic converters to meet the EURO 1 standard\textsuperscript{86}. While in July 1997 only 0.36% (1,178 out of 326,394 cars) of the newly registered passenger cars were low-emission cars according to the “D 3” standard, already 70% (226,155 out of 323,078 cars) of all new passenger cars met this standard (3.5 million of the total car fleet) in July 1998. At the same time, the number of cars not complying with this “D 3” standard (so called high emission cars) was reduced by 2 million cars within the first year after the introduction of the vehicle tax differentiation. In addition, car manufacturers are trying hard to produce vehicles meeting the impending EURO 3 and EURO 4 emissions standards.

A similar effect can be seen from the differentiation of the vehicle tax on HGVs. In 1995 – one year after the introduction of the differentiated vehicle tax – only 0.9% of the HGV fleet met the EURO 2 standard. At the beginning of July 1998, already 27.2% were complying with this standard. Even stronger was the reduction of noise impacts from HGVs.

Besides the environmental effects, it can be said that the acceptance of the new measure by the public is rather high.

**Implementation and administration:**

With each vehicle licence the “key” of the emissions economy is enclosed. The up-to-date tax can be easily calculated by viewing this key number and multiplying the corresponding tax rate by the total engine size (in 100 cm\(^3\) cuts off). If the car is fulfilling stricter emission criteria (i.e. EURO 3), the car manufacturer has to state this on the vehicle licence.

**Use of revenue:**

The legislative competence for the annual vehicle tax lies at the federal level. However, the federal states (Bundesländer) receive the revenue. The total revenue from the vehicle tax related to passenger cars amounted to 11,100 million DM (5,680 million EURO) in 1997 and is not earmarked. In principal, a revenue neutral shift (over the time from 1997 to 2000) was considered while introducing the new tax measure.

\textsuperscript{85} Despite the goal of reducing emissions by differentiating the vehicle tax according to emissions categories, the overall environmental potential is rather low.

\textsuperscript{86} Today 80% out of 41.7 million passenger cars meet the EURO 1 standard.
Political framework conditions:
As an alternative to the introduction of the emission-related vehicle tax, the abolition of the vehicle tax and its replacement with an increase in the mineral oil tax was discussed. This step towards variabilisation was rejected recently by the reasoning – *inter alia* – that the renewal of the vehicle stock could be less influenced in comparison with a differentiated vehicle tax.

International framework conditions:
The international framework for the introduction of this emission-differentiated tax is mainly given with the directive 98/69/EG, dated 28 December 1998, and the corresponding previous directive, respectively.

Appraisal of the measure and recommendations:
The success of the measure shows that the differentiation of the vehicle tax according to emissions criteria – and therefore the strategy of fiscal incentives – was indeed the correct way to reduce the overall emissions caused by road traffic. A possible alternative strategy introducing scrapping premiums to dispose of veteran vehicles – as it is, for example, applied in France or in Sweden – is not regarded to be as effective in emission reduction as the differentiation of the vehicle tax.
Information sheet for the Netherlands

Interviews

We have carried out interviews with:

- Mr. Daniëls, Mr. Boot, Ministry of Transport, Public Works and Water Management
- Mr. In’t Velt, Ministry of Finance
- Mr. Könings, Oil and Gas Division Directorate-General for Energy, Ministry of Economic Affairs
- Mr. Brouwer, Mr. Zuidegeest, Ministry of Housing, Spatial Planning and the Environment, Directorate-General for Environmental Protection, Directorate for Noise and Traffic

Literature and data sources

CE (Centre for Energy Conservation and Environmental Technology), Optimizing the fuel mix for road transport, study commissioned by the Dutch ministries of Economic Affairs/Housing, Spatial Planning & Environment/Transport, Public Work & Water Management, May 1997

Erasmus University Rotterdam, Summary of pricing and taxation measures in the Netherlands, PATS, 1999


Ministry of Finance, Taxation in the Netherlands, April 1998


Proposal by the Netherlands for an integral approach for fuel economy labelling and CO₂ monitoring of new passenger cars, January 1998, Draft


**Overall framework conditions**

- **Environmental and political framework conditions**: The public generally accepts the need for reform in the tax system towards greener taxes on condition that the reform is revenue neutral. In the Netherlands, the goals fixed in Kyoto have political relevance and different measures have been elaborated in order to reach the CO₂ reduction targets.

- **International framework conditions**: The Netherlands is a small country and therefore border effects have to be faced. This small country size is a very important framework condition, particularly with regard to the possibilities of an increase in fuel taxes.

- **General fiscal strategy in transport**: In the Netherlands, the discussion on the reform of the tax system in transport focuses on two major innovations: on the one hand, the change towards variabilisation, on the other, the liberation of the tax system from elements which are not linked to transport. The objective of the tax system reform is to have the prices in the transport market which give the incentive for driving less. The internalisation of external costs is one objective of this reform. Today, infrastructure costs as well as the estimated external costs are cov-
ered by passenger cars\textsuperscript{87} (revenue from the transport system: around 20 billion NLG 1997 (approx. 9 billion EURO\textsuperscript{88}) to such an extent that there is no need and no argument for raising further taxes or for increasing the existing ones. Nonetheless, the revenue raising argument still has importance in the decision of which changes of the tax system should be implemented since the tax revenues in transportation are used for general financial purposes. This means that also in transportation the tax system cannot be completely “liberated” from revenue considerations.

- The variabilisation of fixed charges through an increase in fuel taxes is limited because of the price differentials with the neighbouring countries, especially with Germany (more or less 25 cents price difference for petrol, 20 cents for diesel). As far as HGVs are concerned, the diesel price is subsidised (reimbursement of a share of the tax paid at the petrol station) for international transportation.

- The Ministry of Finance has initiated a general reform programme of the tax system called “Making the fiscal system cleaner”. The programme focuses on passenger transport. In the spring, plans on the non-fiscal instruments suitable for reaching the goals were presented to Parliament.

The programme follows three main objectives:

1. **Cleaner vehicles**: In order to reach this goal, MRB\textsuperscript{89} rebates are given for 2–3 years for clean vehicles (2005 standards).

2. **More efficient cars**: This goal could be achieved with a change from price factors towards efficiency criteria. The improved purchase tax will be implemented in the middle of the year 2000, at the earliest.

3. **Optimum fuel mix**: The aim is the optimisation of the car stock with regard to the fuel mix (shares of petrol, diesel and LPG cars). A study\textsuperscript{90} has estimated for which vehicle use the different type of fuels are best (petrol optimum for low-mileage vehicles, diesel optimum for high-mileage vehicles out of town, etc.). The optimum fuel mix crucially depends on the balance of climate policy and CO\textsubscript{2}

\textsuperscript{87} This is not the case for lorries.

\textsuperscript{88} Exchange rate: 1 EURO \textasciitilde 2.22 NLG (1997-8)

\textsuperscript{89} = Motorrijtuigenbelasting, the annual vehicle tax

\textsuperscript{90} CE, Centre for Energy Conservation and Environmental Technology, Optimizing the fuel mix for road transport, Delft, 1997, the study was commissioned by the Dutch ministries of Economic Affairs (EZ), Housing, Spatial Planning & Environment (VROM) and Transport, Public Work and Water Management (V&W).
emissions’ abatement on the one hand and PM10\textsuperscript{91} abatement on the other hand. If little priority is given to CO\textsubscript{2} abatement, petrol is the best fuel for all categories of cars and vans. The up-to-date share of diesel cars amounts to 12\% of the car stock, the share of diesel cars on the new purchases has risen to around 20\%. The optimum share has been estimated to be around 8\%. The optimum amount for LPG cars is estimated to be 10\% (present share: 4\%, share of the purchased new cars: 3\%). In order to reach the objectives, the MRB (annual vehicle tax) for diesel cars should be increased and those for LPG cars decreased. The taxes will be optimised in such a way that the break-even point for the purchase of a diesel car compared to a petrol-driven car lies at around 21,000 km and for a LPG car around 17,000 km. Since people are informed about the break-even point (every car seller has computer programmes which can calculate the break-even point) they react accordingly. Different incentives given for the purchase of electric cars were not successful because of the uncertainties in relation to the quality of this technology. Much is expected of hybrid cars from 2000 onwards (for example, the Toyota Prius model). Hybrid cars are fully exempt from the purchase tax\textsuperscript{92}.

- HGVs are taxed less than passenger vehicles (no purchase tax, relatively low annual vehicle tax, low fuel prices). The taxation of HGVs is harmonised within the EU.

- The amount of the most important revenue of the transport sector is illustrated in the table below:

<table>
<thead>
<tr>
<th>Type of tax</th>
<th>Revenue 1997 in million NLG</th>
<th>Revenue 1997 in million EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax on purchase of new vehicles</td>
<td>4,550</td>
<td>2,050</td>
</tr>
<tr>
<td>Excise tax on petrol</td>
<td>6,400</td>
<td>2,880</td>
</tr>
<tr>
<td>Excise tax on diesel\textsuperscript{1}</td>
<td>4,090</td>
<td>1,840</td>
</tr>
<tr>
<td>Annual vehicle tax (MRB)</td>
<td>4,000</td>
<td>1,800</td>
</tr>
<tr>
<td>Eurovignette</td>
<td>170</td>
<td>80</td>
</tr>
</tbody>
</table>

\textsuperscript{1} This amount also includes the taxes on other fuels, the main part is attributed to diesel consumption.

\textsuperscript{91} Particulate matter smaller than 10 µm

\textsuperscript{92} For the Toyota Prius model this will amount to 15,000-20,000 NLG (6,760-9,000 EURO).
Variable charges for road transport:

Fuel taxes

- **Description of the tax:** The fuel tax has recently been indexed to inflation. The first adjustment was carried out in 1997. The increase in fuel tax with inflation occurs automatically. Trucks receive a rebate on the diesel consumption.

  The tax paid on a litre of petrol in the Netherlands is around 1.25 NLG (0.57 EURO) and the tax on diesel is around 0.72 NLG (at the beginning of 1999, 0.33 EURO). In 1997, the prices were raised by 15 cents for petrol and by 6 cents for diesel. The prices at the pump station amount to around 1.36 NLG (0.621 EURO) for diesel and 2.00 NLG (0.9 EURO) for petrol. To compensate for this price differential, the purchase taxes on diesel vehicles are higher.

  The fuel price increase in 1997 widened the price gap between the two types of fuels giving an incentive for the purchase of diesel cars.

- **Variabilisation criteria:** There is no specific variabilisation criteria. The adjustment of the tax level occurs according to the price level increase.

Objectives and success of the measure

- **Objective of the measure:** The objective of the adjustment of fuel taxes to inflation is to avoid a real fuel price decrease which would give the “wrong” incentives to car drivers. There are no definite objectives which the measure will reach. The rebate for trucks has the objective to guarantee the international competitiveness of the transport sector.

- **Improvements of the measure:** Improvements have been analysed with regard to the rebate for HGVs. Alternatives to the current system consisted of the introduction of a new colour for fuel or the construction of new filling stations for trucks.

  The comparison of different alternatives has shown that the ex-post refund of one part of the diesel tax was the easiest and cheapest way to realise the rebate.

  Generally, it is expected that diesel prices will also increase in the coming years.

- **Problem of the measure:** The main problems of a unilateral increase in tax level are seen in a decrease of international competitiveness of the transport sector as well as of fuel stations located on the borders. The only solution to this problem is an internationally co-ordinated fuel pricing policy.

  Legal problems were caused by the amount of money which the government gave
to the owners of petrol stations in order to compensate them for the losses caused by the price differentials in neighbouring countries. The compensation amounted to a maximum of 100,000 EURO per station. This kind of compensation is allowed by the European Treaty as long as different firms profit from the compensation and it does not lead to discrimination of companies. The EU has objected that in the case of petrol stations this condition was not fulfilled since only a few companies are the owners of petrol stations. The judgement of the EU court is – at present – still outstanding.

In order to compensate the transport sector for the price increase, a rebate of 5 cents for HGVs has been introduced. This rebate was introduced because of the political pressure of the transport lobby.

One negative side effect of the measure is that the gap between diesel and petrol prices has widened.

Implementation and administration

Implementation costs: There are no significant costs of the fuel tax adjustment to inflation. The rebate system for trucks causes around 5–10 million NLG per year. The transport companies would prefer a rebate system linked to specifically coloured diesel since – in comparison to the present solution – this would have reduced the paper work.

Overall appraisal of the measure and recommendations

At present, due to the restrictions linked to the unilateral increase in fuel taxes, it seems that fuel efficiency goals can be achieved more easily by promoting fuel efficient cars with economic instruments other than fuel price incentives.
Road pricing in urban areas (planned)

Description of the charge:
It is foreseen to introduce road pricing in four metropolitan areas ("Randstad": cordons around Amsterdam, Rotterdam, the Hague, Utrecht). It is thought that road pricing will be introduced in one region (Amsterdam) in 2001, whereas in 2003 the introduction in remaining major cities in the "Randstad" should follow. The charge amounts to 5 NLG (2.25 EURO) per passage and it is collected only in the morning rush hours, between 7.00 and 9.00 on week-days. The price does not depend on the kilometres driven (fixed charge). Cars without a smart card for the electronic registration are burdened with 7 guilders (3.15 EURO) per passage due to the additional costs involved and in order to promote the use of the on-board units. The road pricing fee has to be paid at the entrance of the metropolitan areas independently of the type of road used.

The Randstad experiment ("Rekeningrijden"): The time before the introduction of road pricing is used for the pre-qualification and selection of Electronic Fee Collection (EFC) suppliers by European tender, the system development including test and user research, final system development and system realisation. The primary technical demand to the systems are:

- The systems have to regulate traffic during rush hours,
- The introduction of road pricing may not cause congestion elsewhere,
- The privacy of road users has to be guaranteed. It should be made impossible to access information on individuals’ movements,
- The systems’ technology has to be prepared for European standardisation. In the future, all European road pricing systems must be inter-operable.
- Available chip card technology must be used, and the security of transaction needs to be guaranteed.

In February and March 1999, the Ministry of Transport conducted a system test on road pricing on a Dutch highway. It reported on that test to Parliament in August 1999

---

93 15 page report in Dutch; according to information of the Ministry of Finance
on technical aspects of electronic fee collection and data transmission,
establishing percentages of technical faults like failure to recognise/read car plates.

Objective of the measure:
The metropolitan areas – which account for the most populated areas of the Netherlands – experience congestion almost all day long. It is the political aim to solve this problem with economic incentives, meaning by introducing a road pricing scheme. This new charge will provide an economic incentive towards a more parsimonious use of cars during peak hours (increasing the load of cars, for example with car sharing) and for the use of alternative modes of transport, for example bicycles. Other possibilities for avoiding the charge are foreseen in changes in travel behaviour, i.e. the time of departure, or in changes in working behaviour, i.e. an increase in tele-working or a reduction in working days per week (four instead of five working days per week).

Criteria for the tax level:
There were no precise economic criteria for the level of the charge. The Ministry of Transport fixed the charge with the assumption that a charge at this level could considerably reduce congestion during the morning peak hours. Furthermore, a charge at this level seems to be politically accepted. The introduction of the charge is seen as an experiment: After the collection of the first experiences, it could be possible that adjustments in the price level will occur.

Success of the measure:
The “Randstad Rekeningrijden” experiment of spring 1999 seems to have been successful from a technical point of view. However, it has a limited value when looking at the real road pricing plans: for instance, no payments by car owner were made and therefore reimbursement was not a topic. Neither were questions about the tax level or the differentiation criteria answered.94

Model estimates have shown that road pricing can lead to a decrease in traffic intensity by 10–15% and a decrease in congestion by 30–40%, having positive side effects on the environment at the same time. In any case, a reduction in congestion by 20% would also be judged positively. In spite of these estimated road pricing impacts, there is the

94 Source: Ministry of Finance
view that the tax is not high enough to achieve a significant reduction in congestion. This will be accentuated if companies pay the charge for their employees.

**Political framework conditions**

- Due to massive resistance from people (potentially tax-paying car owners in and around the cities) and also due to critical attitudes within the parliament, it is, however, questionable if road pricing will be introduced in 2001.

- Due to politically important objections to the introduction of road pricing, the Dutch government decided in June 1999 to downscale the planned introduction in 2001 from an all out Randstad introduction (Amsterdam, Rotterdam, The Hague, and Utrecht) to an introduction in 2001 around only one of these four towns. Therefore, the Ministry of Transport is now trying to persuade Amsterdam to begin with to adopt road pricing in exchange for additional government funding.\(^95\)

- Beside the road pricing in municipal areas, a km charge is being studied. It stipulates that a very simple km charge will take at least 3.5 years to develop into a working system. This estimate concerns the technological development only. It does not include political decision-making. Furthermore, the idea of a km charge to compensate for environmental damage seems to have lost much of its appeal as cars and trucks get cleaner every year.\(^{96}\)

**Possible problems:**

In addition, because of massive resistance from people, it is questionable if road pricing will be introduced in 2001. Today, 87% of the Dutch population are against road pricing.

- One objection by people is that additional revenue is used by the Ministry of Finance and/or the city introducing the road pricing, and is not – as originally intended – to be refunded.

- A second objection is that the objective of a significant reduction in congestion could possibly not be reached because of the low tax level. In this regard, it must also be considered that a 10% shift from road to public transport is judged not to

---

\(^{95}\) Source: Ministry of Finance and Ministry of Transport; Amsterdam is offered 600 million NLG (270 million EURO)

\(^{96}\) Source: Ministry of Transport
be possible due to capacity problems of public means of transport. The lack of alternatives is one of the big problems to be solved in order to reduce congestion.

- Some small towns in the neighbourhood of the metropolitan areas fear a traffic flux increase because minor roads from these towns to the city centre are ultimately not charged. In order to avoid the charge, people may use these minor roads to the metropolitan area. To avoid these negative side effects, the Ministry of Transport foresees charging the fee basically on all roads, highways and local roads.

- However, local roads also will have to be priced or else equipped with infrastructure impediments to traffic during the hours of road pricing to prevent traffic escaping from the toll net. Local residents who want to cross these physical barriers for purposes other than working (or more frequent than “regular” commuters, e.g. to bring their children to school) and who do not contribute to congestion on the highways will still have to pay. This is one of the reasons why there is such massive resistance to road pricing.

Yet the main problem impeding the introduction of road pricing in the Netherlands is not technical, but social and political. Other possible problems to be considered are:

- The public transport capacity in the Netherlands and especially in and around the large cities is limited. Additionally, recent Dutch studies show that public transport has no beneficial effect on the environment (and it costs a lot of subsidies). Based on these studies, preferential treatment of public transport may soon disappear.

- Some problems are expected to arise in relation to the construction of the road pricing stations. These are linked in some cases to legal proceedings for the expropriation of the land.

---

97 If they have to make two trips during road pricing hours, they will have to pay twice.
98 Personal point of view of the Ministry of Finance.
99 According to the Ministry of Transport, the study is based on empirical Dutch data but also on cost estimates. It will be available around October 1999.
Implementation and administration:

Implementation costs: The estimated costs of implementation amount to 250 million NLG (110 million EURO). The running costs are judged to be around 120 million NLG/yr (54 million EURO). The costs of the on-board unit, in which the prepaid card is inserted, amount to 100 NLG (45 EURO). The costs for expropriation of the ground in order to construct toll stations are paid by the state.

It is difficult to predict the (today’s very low) acceptance of the charge by the public. Politically, it is not certain whether a majority is in favour of the introduction of this measure.

Use of the revenue:

The estimated revenue amounts to 400 million NLG (180 million EURO). Road pricing is not intended to cover the costs of infrastructure. It has been foreseen to redistribute revenue to the general public through a (income) tax rebate without increase in the overall fiscal burden. However, the problem is that – according to the EU – this measure could constitute discrimination against drivers of foreign vehicles. Investing the returns from road pricing in public transport, for example, would avoid this problem.

It is not yet clear how the revenue from road pricing will be used, but most probably it will be kept and used by the involved city authorities and not be refunded.

Exemptions/Restrictions: There are no exemptions from the payment of road pricing.

Overall appraisal of the measure:

Variabilisation of the tax system is a goal of the Dutch Government. In the future, the objective of taxes will not only be fiscally motivated. Taxes are seen as instruments which can be used for specific goals (transport-related or environmental). The shift of the fiscal burden from fixed charges to charges related to car use is seen positively. The differentiation and variabilisation measures are – originally – not aimed at achieving additional revenues (revenue neutral introduction).

The introduction of road pricing is an important step in this direction. At present, no other measures towards variabilisation have been introduced, except an increase in fuel taxes (adjustment of fuel taxes to inflation, first step in 1997).

The acceptance of the tax will not be very high if it is introduced as a new and additional tax. The main problems to be solved by introducing road pricing in the Netherlands are still not technical, but social and political.
Recommendation for differentiation and variabilisation policies:
The realisation of these strategies is an important objective of the Ministry of Transport. The main idea is that in the long-term – within the next 20 years – all charges should be differentiated or variabilised. In order to successfully implement this strategy, it is necessary that the EU policy supports these kind of measures.
**Differentiated taxes for road transport:**

**Purchase taxes on passenger cars (planned)**

**Description of the tax:**
The purchase tax – based on the value of the vehicle – will be probably partially replaced by a new tax based on the relative fuel consumption of the vehicle compared to vehicles of the same size.\(^{100}\)

Electric and hybrid cars are exempt from the tax payment.

Experiences have been collected with a differentiation of purchase taxes on HGVs.

**Differentiation criteria:**
The tax amounts to 50 NLG (22.5 EURO) per gram CO\(_2\) emission/km according to the EU test cycle. The present purchase tax amounts to 45% of the price of the car.

**Objective of the measure**
It has been estimated that the tax of 50 NLG/g CO\(_2\) per km will lead to a reduction in CO\(_2\) emissions by 300 tons; a tax of 100 NLG/g CO\(_2\) reduces emissions by 1,000 tons.

**Success of the measure:**
The success of the measure depends on the reaction of car buyers and also importers. Since the latter determines the price of new car models and versions, they have an incentive to sell cars with lower taxes if at the same time their profit increases. Nonetheless, the Dutch car importers are against the proposed measure.

A previous tax reduction for HGVs was very successful: Around 70% of the new vehicles fulfilled the EURO 2 norm (best share in Europe) before it became mandatory.

**Possible problems:**
It can be observed that the price level of cars differs significantly between European countries according to the purchase taxes in some countries (a purchase tax exists only in a few countries). The car lobby has another opinion with regard to the optimum tax mix in transport and is against the purchase taxes. The proposal of vehicles’ importers is to decrease or delete the purchase tax and to increase annual taxes (MRB).

---

\(^{100}\) In this regard there exists a strong political support for a change of the tax base. It is expected that a proposal to this effect will be discussed in the course of 1999 in the Dutch parliament.
Possible improvement of the measure: A study\textsuperscript{101} has been carried out on fuel-economy labelling. This proposal foresees a classification of vehicles according to the parameter “length x width”. The fuel consumption or CO\textsubscript{2} emission of an individual model and version is compared to the average fuel consumption (or CO\textsubscript{2} emission) of all passenger cars within the same length x width category. It has been estimated that this classification minimises distortions in the existing market categories as used by the automotive sector.

Implementation and administration:
Implementation costs: The tax payers of the purchase tax are the buyers of the cars; the importers of the vehicles collect this tax and pay it to the Ministry of Finance. The measure could be implemented at a low cost, since there are few tax payers.

Use of revenue:
Revenue is used for general budget purposes.

International framework conditions:
The specific purchase taxes are not harmonised between member countries of the EU.

Overall appraisal of the measure:
The differentiation of purchase taxes can be recommended.

Rebates for HGV

At the beginning of the 1990s, tax cuts for HGVs with EURO 1 and 2 technologies were introduced (tax reduction of around 5,000 NLG per vehicle). This tax reduction was financed by a previous increase in fuel taxes. A similar measure is planned for vehicles which fulfil EURO 3 norms. It is foreseen to decrease taxes in order to compensate for the price difference between EURO 2 and EURO 3 (around 5,000 NLG per vehicle, 2,300 EURO). This measure is restricted to 1½ years (budget for the measure: 80 million NLG, 36 million EURO).

\textsuperscript{101} Proposal by the Netherlands for an integral approach for fuel economy labelling and CO\textsubscript{2} monitoring of new passenger cars, January 1998
Annual vehicle tax (MRB) (planned)

Description of the tax:
The annual vehicle tax depends on the weight of the car. The tax for the smallest cars amounts to around 300–400 NLG per year (135–180 EURO) and for the biggest cars to around 1,800–2,000 NLG (810–900 EURO). The revenue is not earmarked. LPG and diesel cars must pay additional charges. It has been proposed to differentiate the tax according to emissions in order to give an incentive for the purchase of clean (EURO 4) vehicles. It is not the objective of the Ministry of Transport to provide an incentive for the purchase of small cars, but for the purchase of clean cars.

Differentiation criteria:
It has been proposed to differentiate the MRB (Motorrijtuigenbelasting) tax according to the vehicles’ technological standard. If a person buys a car which fulfils the EU recommendation for the year 2005, the MRB is reimbursed. The rebate amounts to 700 NLG (315 EURO) for petrol vehicles, and 1,200 NLG (540 EURO) for diesel vehicles. The rebate is given only for a few years, as long as the new technology is not compulsory for all vehicles. The amount of the rebate takes into consideration that the new emission control technology for diesel-driven vehicles is more expensive than for petrol-driven vehicles.

Objective of the measure:
The main objective of the proposal is to give economic incentives for the purchase of vehicles which fulfil the most ambitious technological emission standards.

Success of the measure:
A tax reduction of the MRB for clean vehicles has not yet been introduced.

Implementation and administration:
Implementation costs: The tax exemption for clean cars has no relevant additional implementation costs since the information for exemption is easily available. The revenue needed for the rebate are financed by a temporary increase in annual road taxes of 3–4% for all cars.

Revenue: Revenue is used for general budget purposes.
Information sheet for Sweden

Interviews

We have carried out interviews with:

- Mr. Larsson, Ministry of Finance, Taxation Department
- Mr. Eriksson, Ministry of Industry, Employment & Communications
- Dr. Perby, Ministry of Environment
- Mr. Nyström, Swedish Environmental Protection Agency, Section for Environmental Economics

Literature and data sources

ATKINS W.S. 199x: Electronic Km Charging. Study commissioned by EC, B1, p. A14–A18


SWEDISH ENVIRONMENTAL PROTECTION AGENCY (SwEPA) 1997: Environmental taxes in Sweden – economic instruments of environmental policy, Stockholm, March 1997

SWEDISH NATIONAL ROAD ADMINISTRATION: Owning a car – or other motor vehicle: Registration, change of ownership, moor insurance, inspection, abeyance/cessation of abeyance motor-vehicle tax, deregistration

Overall framework conditions

Overview of the history of the taxes:
Sweden has a rather long tradition in using taxes and charges for environmental purposes. The large tax reform of 1990–91 could be seen as an early example of a “green tax shift”: Taxes on labour were reduced (cuts in employers’ social security contributions) and taxes on energy were increased (through an introduction of a CO₂ tax and VAT on energy). During the whole period since the 1950s, the level of taxation of petrol has been significantly higher than for other fuels. Taxes on private motoring have a long tradition in Sweden, mostly in the form of taxes levied on motor fuels. But it is only recently that taxes on petrol and diesel have been motivated by environmental reasons. As early as 1986, the petrol tax was differentiated so that unleaded petrol was taxed at a lower level (see information sheet on fuel taxes).

According to the law on vehicle emissions, passenger cars, trucks and buses are divided into environmental classes. This classification system could be applied to the annual vehicle tax or to the sales tax if the tax were to be introduced again.

The sales tax on passenger cars was abolished in the summer of 1996 as a result of national policy decisions102.

Furthermore, an annual vehicle tax103 is levied on passenger cars, buses, trucks, motor cycles, tractors and trailers. The sales tax was replaced by an increase in the annual tax, the total income from road taxes being at the same level before and after the reform.

There was a km-tax from 1974 until 1993, followed by a CO₂ tax (extra energy tax) on diesel from 1993. Now a road user charge vignette is requested for HGVs exceeding 12 tons.

The government has announced a review of the taxation of road traffic. The analysis will concentrate on the appropriate balance between sales tax, annual vehicle tax and fuel taxes with the aim of improving the overall steering effect with regard to environment and road safety.

102 The general sales tax and the environmental differentiation were given up at different dates and for different reasons (see following sub-chapters).
103 also: registration fee or annual circulation tax
The following table gives an overview of the introduction, abolition and changes of new taxes in the transport sector and other closely related taxes influencing those.
<table>
<thead>
<tr>
<th>Year</th>
<th>Tax/Charge</th>
<th>Introduction, Abolition, Change of Tax or Charge</th>
<th>Main Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>Annual vehicle tax</td>
<td>Introduction</td>
<td>Fiscal</td>
</tr>
<tr>
<td>1929</td>
<td>Motor fuel taxes</td>
<td>Introduction</td>
<td>Fiscal</td>
</tr>
<tr>
<td>1957</td>
<td>Electricity tax General energy tax</td>
<td>Introduction</td>
<td>Fiscal; tax also on electricity, coal, LFO, HFL, diesel</td>
</tr>
<tr>
<td>1960</td>
<td>General sales tax</td>
<td>Introduction</td>
<td>Fiscal, turnover-related tax</td>
</tr>
<tr>
<td>1969</td>
<td>VAT</td>
<td>Replacement of the general sales tax with the newly introduced VAT</td>
<td>Fiscal (VAT: not on energy consumption)</td>
</tr>
<tr>
<td>1974</td>
<td>Mineral oil tax</td>
<td>Increase</td>
<td>Fiscal purpose: Shift away from electricity out of fossil fuels</td>
</tr>
<tr>
<td>1974</td>
<td>Kilometre tax</td>
<td>Variabilisation: Introduction for all diesel-driven vehicles</td>
<td>Fiscal: Cover road infrastructure costs</td>
</tr>
<tr>
<td>Mid 1980s</td>
<td>Energy tax (on coal and natural gas)</td>
<td>Increase of energy tax on coal and natural gas</td>
<td>Fiscal, adjustment to energy tax on other fossil fuels</td>
</tr>
<tr>
<td>1986</td>
<td>Petrol tax</td>
<td>Differentiation: tax reduction for unleaded petrol, tax increase for leaded petrol</td>
<td>Additional environmental aspect promotion of rapid introduction of unleaded petrol</td>
</tr>
<tr>
<td>1987–88</td>
<td>Sales tax</td>
<td>Differentiation acc. to emissions’ criteria on pass. cars: Reduction of sales tax on vehicles with cat. converters of model 1987 + 1988</td>
<td>Fiscal incentive (equivalent to the extra cost) for the consumer to install a catalytic converter</td>
</tr>
<tr>
<td>1990–91</td>
<td>Energy tax (excise duty)</td>
<td>Decrease of energy tax on electricity and fossil fuels, except petrol (green tax reform)</td>
<td>Fiscal, adjust energy tax on coal to the same level as for other fossil fuels</td>
</tr>
<tr>
<td>Jan. 1991</td>
<td>Sulphur tax</td>
<td>Introduction (green tax reform)</td>
<td>Environmental (fiscal) purpose, tax on coal, peat, min. oils, promoting a shift towards fuels with low sulphur content</td>
</tr>
<tr>
<td>Jan. 1991</td>
<td>CO₂ tax</td>
<td>Introduction (green tax reform)</td>
<td>Environmental (fiscal) purpose</td>
</tr>
<tr>
<td>Jan. 1991</td>
<td>Energy tax on diesel</td>
<td>Differentiation of diesel according to three environmental classes</td>
<td>Environmental purpose: Stimulation of introduction of motor fuels with superior environmental properties</td>
</tr>
<tr>
<td>Jan. 1992</td>
<td>Energy tax on diesel</td>
<td>Increase of env. tax differentials on motor fuels: higher rebates for classes 1 and 2 coupled with harder criteria to be fulfilled</td>
<td>Environmental purpose: Stimulation of introduction of motor fuels with superior environmental properties</td>
</tr>
<tr>
<td>Oct. 1993</td>
<td>Kilometre tax on diesel-driven vehicles</td>
<td>Abolishment and replacement by an extra energy tax on diesel</td>
<td></td>
</tr>
<tr>
<td>Oct. 1993</td>
<td>Energy tax on diesel</td>
<td>Increase of energy tax and of tax differentials by an increase of tax rebate for environmental class 1 fuel</td>
<td>Extra energy tax on diesel instead of kilometre tax (revenue neutral), stronger environmental incentives</td>
</tr>
<tr>
<td>Oct. 1993</td>
<td>Annual vehicle tax for HGV</td>
<td>Decrease by around 20%</td>
<td>Compensation for heavily taxed HGV compared to the EU</td>
</tr>
<tr>
<td>Dec. 1994</td>
<td>Energy tax on petrol</td>
<td>Differentiation of motor fuels according to two environmental classes</td>
<td>Environmental purpose: Stimulation of introduction of motor fuels with superior environmental properties</td>
</tr>
<tr>
<td>Oct. 1995</td>
<td>Energy tax on diesel</td>
<td>Expansion of the special diesel tax for transport purposes on off-road vehicles</td>
<td>Environmental: incentive covers all motor vehicles; Fiscal</td>
</tr>
<tr>
<td>July 1996</td>
<td>Environmental zones program</td>
<td>Introduction of restricted zones for trucks and buses</td>
<td></td>
</tr>
<tr>
<td>June 1996</td>
<td>Sales tax on passenger cars</td>
<td>Abolition of sales tax and simultaneous increase of annual tax for existing cars by 55% (petrol) and 15% (diesel).</td>
<td>Positive employment and environmental effects with same revenue level</td>
</tr>
<tr>
<td>Oct. 1996</td>
<td>Sales tax on HGV</td>
<td>Abolition</td>
<td></td>
</tr>
<tr>
<td>Jan. 1997</td>
<td>Environmental differentiation of sales tax</td>
<td>Abolition of environmental differentiation of sales tax on passenger cars &amp; small light commercial vehicles</td>
<td>As a consequence of EU legislation (EU directives 94/12/EC and 96/69/EC)</td>
</tr>
<tr>
<td>Jan. 1998</td>
<td>Environmental differentiation of sales tax</td>
<td>Abolition of environmental differentiation of sales tax on the remaining light commercial vehicles</td>
<td>As a consequence of EU legislation</td>
</tr>
<tr>
<td>Feb. 1998</td>
<td>Road user charge</td>
<td>Introduction of the Eurovignette for vehicles &gt;12 tons</td>
<td>Fiscal: revenue raise Political: Joining other EU countries</td>
</tr>
</tbody>
</table>
Table 39: Chronological overview about introduction, abolition and changes of taxes in transportation.

**Car stock and car use:**
Environmental policy has largely focused on private motoring which has had the fastest growth of means of transport over the last fifty years. Private motoring accounted for 25% of total personal transport in 1950 and approximately 75% in 1994.

This development is illuminated by the development in the number of passenger cars:

- 1923: 37,823 cars, 159 persons/car
- 1994: 3,594,199 cars, 2.5 persons/car

The percentage of diesel-driven passenger cars is quite low but increasing. The overall car stock has a share of about 4–5% diesel cars, whereas for new cars the share is approximately 10%, or even 20% just taking larger cars into consideration. The break-even point above which driving diesel cars is profitable is quite low, estimated at 14,000 km/yr. The share of diesel cars increased after the km-tax on diesel-driven vehicles was abolished in 1993 and the annual vehicle tax increased less for diesel-driven cars (+15%) than for petrol-driven cars (+50%) in 1996. The share of the environmental class 1 cars sold in Sweden is considerable, estimated at 5–10%.

**Transport expenditures:**
Today’s household expenditures for petrol account for approximately 65% of total transport expenditures, while expenditures for public transport account for approximately 25%. The remaining 10% is other travel expenditures (e.g. taxis, annual vehicle tax, etc.).

**Objective of the measures:**
The development in differentiating and variabilising transport taxes is merely part of a general overall strategy planned for the long run. It seems, to a certain extent, that policy is dependent on the ruling parties, but also on the urgency of improving and optimising the up-to-date transport problems. Above all, changes in the tax system could be seen as fiscal measures to regulate the general federal budget.

Yet, changes in the Swedish tax system are thought to be given a stronger environmental profile: in 1995, the Swedish Government appointed a parliamentary committee.

---

104 Source: Discussion with the Swedish Environmental Protection Agency
to study the potentials for a “green tax reform”. In its final assessment, the committee discussed both the future potential for creating a more environmentally friendly tax system, and the restrictions\textsuperscript{105} that have to be taken into account (Ministry of Finance, 1997).

**Overall appraisal of the measures:**
Based on Swedish experiences, the following measures could be looked at as overall successful (concerning environment, administration, political acceptance, economic, competitiveness, etc.) in differentiating and variabilising transport taxes:

- Differentiation of **fuel taxes** according to environmental quality is very effective (i.e. upon introduction of unleaded petrol or petrol/diesel with a better environmental performance).
- Overall energy, CO\textsubscript{2} or sulphur taxes directly related to the energy/CO\textsubscript{2}/sulphur content of the fuels.
- The relief for environmental class 1 cars of the annual vehicle tax during five years\textsuperscript{106}.
- Rebates or tax reductions on sales taxes or preferably on annual vehicle taxes based on environmental vehicle classification (incentive as tax relief for a fixed initial sum being less than the cost of better technology).

The following measures are regarded as less successful or environmentally indifferent:

- The present Swedish system of scrapping charges and premium.
- General km tax (i.e. for diesel-driven vehicles) based on a mechanical charging system.
- Vignette systems or general road user charge for HGVs, because of technical problems with the measurement of mileage and problems at the borders.
- The differentiation of diesel qualities before the introduction of coloured diesel categories (the market for diesel used in transportation and light fuel oil used for

\textsuperscript{105} Two examples of such restrictions are effects in the form of structural changes in the business sector and effects on international competitiveness.

\textsuperscript{106} The environmental class 1 cars (with a quite advanced technical standard) have a rather high share of sales between 5 and 10%. An indication of the success is that the five year exemption is frequently used as a sales argument.
heating purposes must be clearly separated to be successful and not too costly): Fiscal incentives must only cover the products that were intended to be stimulated.

A (not yet existing) tolling system over bridges or through natural corridors would – correctly used – almost certainly be very successful. But, because of lack of experiences with road tolls\textsuperscript{107}, no empirical data indicating success are available.

The **Swedish EU membership** involved new, formal requirements with a view to international harmonisation (e.g. vehicle exhaust regulations). As a new member of the EU, Sweden, due to limited national resources, had to choose between concentrating on influencing EU policies (taking active part in the programmes) or “wasting” the energy on national measures with a very limited impact on real life emissions.

**Recommendation for differentiation and variabilisation policies:**
When introducing a price differential according to environmental classes, the **tax neutrality** should be considered for the long run. If the price incentive to use the cheaper fuels of better quality is big enough, a shift to environmentally sound fuel quality could be achieved very quickly. Therefore, the price relations should be calculated early and carefully to prevent unconsidered fiscal revenue losses resulting from a quick change to the better (and cheaper) fuel quality.

**Transparency and communication are very important when introducing a new differentiation and variabilisation system:** Everyone should understand *why* a tax is differentiated and what the *profit* from this differentiation for each individual (or company) would be. The differentiation criteria must be *transparent and easily understood*. The incentive must be high enough and the overall gain from the measure should be seen. **People are willing to pay if they see what they get for their money.** Price is the main factor determining consumer choice when purchasing a *homogenous product* (such as petrol or diesel). Although there are no empirical data showing the effectiveness of various forms of incentives, market people used to say that a lower annual tax was a better incentive than a lower sales tax. Conclusively, it must be said that economic instruments have a very pronounced effect.

\textsuperscript{107} Only one road tolling system on a bridge in northern Sweden was to be tried, but the acceptance by the local people in this sparsely populated area was low.
Variable charges for road transport:

Fuel taxes

Description of the charge:
The fuel tax consists of an excise duty on energy (energy tax) varying according to different fuel types and a CO₂ tax.

Since over the years there have been several measures in differentiating fuel taxes, the different measures are referred to over this information sheet with the same numbers (e.g. No. 1) for the differentiation of the petrol tax on leaded and unleaded petrol.

1) In January 1986, the petrol tax was differentiated on unleaded and leaded petrol respectively.

2) In December 1994, the tax on unleaded petrol was also differentiated according to two environmental classes. The class 3 is the standard class and the class 2 the environmentally superior class. Environmental class 1 is reserved for future petrol qualities. The requirements for environmental class 2 petrol enable catalytic conversion of exhaust emissions to work better and last longer and there are fewer emissions of sulphur, NOₓ, VOC, benzene and carcinogens from this petrol. Now the transition to environmental class 2 petrol is completed.

3) In January 1991, the energy taxes on diesel and heating gas oil (including heavy fuel oil) were differentiated according to three environmental classes. To apply a tax differentiation only to diesel oil used as motor fuel would have required that the oil was marked, which was not the case. It was therefore not possible to separate oil for heating purposes from oil for motor fuel. Consequently, the tax differentiation introduced covered all heating gas oil and diesel, regardless of use.

Objective of the measure:
The main purpose of fuel taxation is fiscal. The differentiation of the fuel taxes adds an environmental component to the taxation.

1) The differentiation on petrol was introduced in 1986 in connection with the Parliament decision to impose stricter emissions’ criteria on new vehicles. The new criteria was voluntary on new cars from 1987 and mandatory from 1989. The introduced emission limits were such that only petrol cars equipped with catalytic converters (using unleaded petrol) had any chance of meeting the criteria. With the intention of promoting the introduction of unleaded petrol, the government proposed a reduction in the
tax rate on unleaded petrol which was not supplied in Sweden significantly before 1986. At the same time, the sales tax on cars equipped with catalytic converters was reduced for two years before the catalytic converter became compulsory for new petrol-driven cars.

2) The aim of the tax differentiation for unleaded petrol was to create the conditions for a changeover to petrol of better environmental quality.

3) The main objective of differentiating diesel according to environmental classes with the introduction of a tax rebate was to stimulate the introduction of motor fuels with superior environmental properties.

Differentiation criteria:
1) The differentiation criteria is simply the lead content in fuels.

2) Since 1.12.94, Sweden has applied two different rates of excise duty on unleaded petrol. The tax difference between environmental class 2 and 3 now amounts to 0.07 SEK/l (0.006 EURO) as can be seen in table 1. The prior tax difference upon introduction was 0.06 SEK/l and was created by a tax increase of 0.06 SEK/l on all petrol, except environmental class 2. The quality requirements for the petrol in each class were laid down in an amendment of the Chemical Products Act.

3) Since 1991, there has been a differentiation of the energy tax rate of three environmental categories for diesel and kerosene. The classification of the three environmental classes depended on, inter alia, sulphur content, VOC content and the boiling temperature of the oil. Oil products belonging to environmental class 1 have the best environmental criteria, while standard oil products belong to environmental class 3. The following tax rebates were introduced in 1991:
   - environmental class 1: −350 SEK/m³ (−37 EURO)
   - environmental class 2: −250 SEK/m³ (−26 EURO)
   - environmental class 3: 0 SEK/m³

One year later, in 1992, the rebates for classes 1 and 2 increased by 100 SEK/m³ (10.5 EURO) coupled with sharpened criteria to be fulfilled. With the abolition of the kilometre-related tax on diesel-driven vehicles in 1993, both the energy tax on diesel and the rebate for environmental class 1 fuel (+85 SEK/m³, +9 EURO) were increased. Since July 1994 – due to revenue loss and questionable environmental benefits (see also success of the measure and implementation cost) – the tax rebate (reduced by 100 SEK/m³,
approx. 10 EURO) has only been eligible for diesel used in motor vehicles but has disappeared for heating purposes. The low taxed oil was then coloured green, to separate high taxed fuel for motor vehicles from gas oils used for heating purposes. The shift had the immediate effect that gas oil for heating purposes belonging to environmental class 2 disappeared from the Swedish market.

The variabilisation of the fuel taxes is as follows:

<table>
<thead>
<tr>
<th>Type of Energy</th>
<th>per unit (1998)</th>
<th>CO tax SEK</th>
<th>Energy tax SEK</th>
<th>Total tax SEK</th>
<th>Total tax EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel / Kerosene, EC 1</td>
<td>litre</td>
<td>1.058</td>
<td>0.112</td>
<td>1.641</td>
<td>0.17</td>
</tr>
<tr>
<td>Diesel / Kerosene, EC 2</td>
<td>litre</td>
<td>1.058</td>
<td>0.112</td>
<td>1.840</td>
<td>0.19</td>
</tr>
<tr>
<td>Diesel / Kerosene, EC 3</td>
<td>litre</td>
<td>1.058</td>
<td>0.112</td>
<td>2.138</td>
<td>0.23</td>
</tr>
<tr>
<td>unleaded Petrol, EC 2</td>
<td>litre</td>
<td>0.86</td>
<td>0.091</td>
<td>3.61</td>
<td>0.38</td>
</tr>
<tr>
<td>unleaded Petrol, EC 3</td>
<td>litre</td>
<td>0.86</td>
<td>0.091</td>
<td>3.68</td>
<td>0.39</td>
</tr>
<tr>
<td>leaded Petrol</td>
<td>litre</td>
<td>0.86</td>
<td>0.091</td>
<td>4.27</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Table 40: Excise duty on energy and CO\textsubscript{2} tax for transport fuels in 1998 (Source: Tax Administration 1998)

**Criteria for the tax level:**

1) The extra production cost of unleaded petrol was estimated at 0.1 SEK/l (0.011 EURO). The rebate was set at 0.16 SEK/l (0.017 EURO), by lowering the tax on unleaded petrol by 0.14 SEK/l and increasing the tax rate on leaded petrol by 0.02 SEK/l. The decision to **set the tax rebate at a higher level than the extra production cost** was motivated by an urge to promote a rapid introduction of unleaded petrol throughout the country (Ministry of Finance 1997). With the increase in the leaded petrol tax (see implementation costs), the tax difference ended up at 0.2 SEK/l (0.021 EURO).

2) The price differential of 0.07 SEK/l unleaded petrol roughly corresponds to the **extra cost for oil companies to produce the more environmentally friendly petrol**.

3) The starting point for the calculations of the tax rebate on oil belonging to environmental classes 1 and 2 diesel oil was that the energy tax on standard oil (class 3) should remain unchanged at 540 SEK/m\textsuperscript{3} (57 EURO), exclusive of CO\textsubscript{2} tax. The level of the tax rebate was determined such that it would cover the **additional refinery costs for production of classes 1 and 2 diesel oil**. The second rebate adjustment in 1994 (the difference between classes 1 and 3 fuel was 535 SEK/m\textsuperscript{3}, 56 EURO) implied a breach of the
initial principle that the tax rebate was to approximate the extra refinery cost for producing environmental classes 1 and 2 fuels.

**Success of the measure:**

1) The market share of unleaded petrol in 1986 was estimated to be insignificant. The **shift to unleaded petrol was much faster** than the government had planned: as early as 1989 the share of unleaded petrol was higher than 50%. Between 1989 and 1992 the increase in the unleaded petrol share stagnated because of the large share of older passenger cars without catalytic converters.

Interesting enough was the invention and introduction of a lead-free petrol quality (where lead had been replaced with sodium\(^{108}\)) by a Swedish oil company in 1992. This petrol could be used in cars without catalytic converters. Other oil companies soon developed corresponding petrol qualities where lead was replaced either with sodium or potassium. Unleaded petrol gained new market shares and in 1994 leaded petrol disappeared completely from the Swedish market. As far as lead-free petrol for older vehicles is concerned, it might be noted that no real problems even for veteran cars have been recorded in Sweden. The Swedish Association for Historic Cars, for example, explained that the lack of leaded petrol is no problem even for veteran cars, but a contribution to the environment. Therefore, a major result of the phase out of leaded petrol was the (unsurprisingly) full reduction of lead emissions from traffic between 1985 (760 tons) and 1995 (0 ton).

Thus, this measure of differentiating the petrol tax was **extremely effective,**

- mainly because it was a real fiscal incentive for car drivers,
- partly because the environmental advantage of buying unleaded petrol can be easily understood by everyone and
- partly because of the framework conditions of introducing stricter emissions’ criteria.

2) The **shift to the new petrol qualities was very rapid,** and environmental class 2 made up 97% of the total volume sold in 1995. The transition was completed nationwide in 1995, one year after the tax differentiation was introduced.

3) The development of sales of diesel belonging to environmental classes 1 and 2 turned out to be **faster than expected.** Already in 1992 (one year after the introduction of the differentiation of the three environmental diesel classes), 50% of all diesel oil

---

108 Sodium has the same lubricating effect as lead.
sold as motor fuels belonged to EC1 or EC2. In 1993, that share increased to 80%\(^{109}\)!

Since the rebates compensated the oil companies more than enough for their extra production cost and it therefore became more profitable to sell diesel and heating gas oil belonging to environmental classes 1 and 2, it is not surprising that in this example also the effect from an environmental point of view is satisfying. On the other hand, there are limited environmental benefits of heating gas oil in the environmental classes 1 and 2\(^{110}\) and the environmental benefit of tax subsidies on heating gas oil is therefore questionable. The tax shift giving up the tax rebates for heating fuels in 1994 implied that the incentive to use environmentally superior fuel in off-road vehicles, excavators, tractors, etc. disappeared, since these vehicles (consuming approx. 1 million m\(^3\)) were not yet liable to pay the special diesel oil tax. Since October 1995 off-road vehicles have also been liable to the high taxed diesel and thus the environmental incentive covers all motor vehicles.

**Implementation and administration:**

**Administration:** The administration of the tax is said to work well. Environmental classification does not give rise to any particular problems of fraud. The differentiation of petrol tax (or energy tax in general) on different fuels has not resulted in appreciably greater administration.

An earlier evaluation made by the special tax office just after the introduction of environmental classification of diesel oil indicated that errors in tax return had increased somewhat, but that the extra workload could be dealt with by existing personnel.\(^{111}\)

**Implementation costs:**

1) There was no real implementation cost. But the government calculated that the differentiation of the petrol tax (leaded versus unleaded petrol) would be fiscally neutral in the first year of implementation. Since the interest in unleaded petrol was growing faster than expected, a net revenue loss had to be faced. To compensate for foregone revenue the government proposed\(^{112}\) a tax increase on both unleaded and leaded petrol over and above already advertised increases. However the proposal was changed in

---

109 Instead of the expected 10–20% market share for class 1 fuel
110 The reason is that combustion in a boiler is more extensive than in a diesel engine.
111 A total of some 700 companies pay energy tax, 56 of them sell petrol.
112 in the Bill 1986/87:139
Parliament to only include a tax increase on leaded petrol with 0.04 SEK/l (0.004 EURO).

3) From a public finance point of view the problem was that environmental classed heating gas oil was being sold in large volumes. The development in the sales of environmental classed heating gas oil was not predicted by the government and foregone revenue increased quickly. In 1994, Parliament decided to end the tax rebate on heating gas oil. The rebate was kept on diesel oil for vehicles.

**Use of revenue:**
Revenue is used for general budget purposes and for compensating the extra production cost.

**Restrictions:**
Due to a successful request to the Council of Ministers for permission to apply reduced tax rates (see international framework conditions), there are no restrictions – other than political framework conditions within Sweden – to the differentiation of fuel taxes.

One exception concerns the emission or **energy taxation for aircraft**. The tax was thought to be differentiated according to the distance, the type of engine, and the NO$_x$ emissions, respectively. Based on international agreements (Chicago convention), Sweden was not allowed to tax fuel for air transport or aeroplanes, including domestic flights. This restriction was confirmed by an EU decision (EU case C–346/97, based on directives 92/12 and 92/81, art. 8(1)b).

**Political framework conditions:**
1) In the example of leaded petrol, the tax differentiation was part of a larger package (e.g. sales tax reduction for cars with catalytic converters in 1987/88). It is therefore not that easy to separate the effects from the different measures. The switch to unleaded petrol could partly be explained by the Parliament decision in 1985 which introduced

---

113 In 1993, almost 40% of all heating gas oil sold belonged to env. class 2.
114 The total revenue loss for diesel and heating oil for env. class 1 and 2 fuels was estimated by the Green Tax Commission (nominal prices) at 366 million SEK (39 million EURO) in 1992, 901 million SEK (95 million EURO) in 1993, 1,112 million SEK (117 million EURO) in 1994, and 966 million SEK (102 million EURO) in 1995. If the whole annual consumption of gas oils in 1993 had belonged to env. class 1, the tax rebate would have implied a cost for the Government of 3,200 million SEK (337 million EURO) in foregone tax revenue. (Source: Ministry of Finance 1997)
Annex 3: Sweden

stricter emissions’ criteria on new passenger cars. Since 1989, all new vehicles could only run with unleaded petrol fulfilling the stricter emissions’ criteria.

3) In addition to the introduction of the three environmental classes for diesel, a kilometre tax on diesel-driven vehicles was also introduced in 1974 (see road user charge/road pricing). The kilometre-related mileage tax was abolished on 1 October 1993. A diesel tax of 1.30 SEK/l (0.14 EURO) was introduced in its place.

A recent proposal (by the left wing parties, the social democrats and the green party) suggests an increase in the diesel tax of 0.25 SEK/l (0.026 EURO). This proposal stands a good chance of being accepted by the public\textsuperscript{115}.

International framework conditions:
To date, the EC Mineral Oil Directive has been interpreted to allow only one tax rate for a given fuel. One exception concerns the tax on petrol, which, according to the directive, should be differentiated to reflect whether it is leaded or unleaded. In addition to such compulsory exceptions, member states can apply to the Council of Ministers for permission to apply certain reduced tax rates. Accordingly, Sweden has applied for and has been granted exemption so as to be able to differentiate the tax on different environmental classes of diesel oil and petrol.

Other framework conditions:
Company cars: Usually people are less sensitive about fuel price differentials when buying a new car than about interesting sales arguments. In Sweden, the company often pays for privately used cars and looks at this as part of the income. This means that people are not at all concerned about the car prices, but about the comfort or sometimes also about the running costs of car use, such as fuel prices. So the existence of “company cars” somewhat distorts the market situation and gives – in the case of Sweden – higher incentives.

Due to cheaper fuel in neighbouring countries, cross border travelling existed, but is not considered a major problem. Diesel vehicles were taken partly to Finland or Germany to buy cheaper fuels. The Swedish law restricted the amount of fuels that could be brought across the border for trucks. As a result some truck drivers fixed a dividing plank in the tanks, so that the part of the tank behind this plank could be filled up with

\textsuperscript{115} According to the Ministry of Industry, Employment & Communications.
fuel while the visible part of the tank which was controlled at border crossing was almost empty. The dividing mechanism was automated and could be initiated with pressing a button.

Overall appraisal of the measure:
1) Tax differentiation between leaded and unleaded petrol has often been presented as a good example of how economic instruments in environmental policy can have significant impacts. The fact that unleaded petrol had a tax advantage over leaded petrol made it even profitable to develop a lead free petrol which could be used in vehicles without catalytic converters.

The experience from the fuel tax differentiation (i.e. leaded vs. unleaded petrol) shows that economic instruments in combination with other measures can play an important part in environmental policy.

2) The acceleration of the transition towards a more environmentally friendly fuel quality is well achievable by introducing a tax differential as a main incentive. However, the Swedish Environmental Protection Agency considered that it ought to be possible to introduce a better petrol quality (at present it is the environmental class 1 petrol) to be generally available within two years of deciding to introduce it and that large-scale introduction could take place by agreement with the industry without any tax differential.

3) The coupling of the tax incentives with the environmental classification systems of mineral oils is effective: almost all diesel used in the transport sector now belongs to the environmental class 1 quality. The experience of tax differentiation also shows how difficult it can be to estimate the effects and, in particular, changes in consumer behaviour. The undesired and unexpected development of the sales of environmental classified gas oil for heating purpose, shows that fiscal incentives must only cover the products that were intended to be stimulated.

The experience of the environmental classification of mineral oils is that tax differentiation can give powerful effects.

Recommendation for differentiation and variabilisation policies:
There have been mainly good experiences in differentiating fuel taxes, or as the Agency concluded in its report (SwEPA 1997):
“Price is the main factor determining consumer choice when purchasing a homogenous product such as petrol or diesel. Economic instruments therefore have a very
pronounced effect. It is difficult to see how any form of administrative regulation would have achieved the same environmental effect anything like as cost-effectively as differentiation. The scope for different refineries and oil companies to introduce new fuels has varied and it would have been very difficult to impose stringent general regulation. The economic incentives have also provided the impetus for technical developments.”

Besides the improvement of environmental fuel qualities, vehicle manufacturers are “forced” to adapt car technologies which are compatible with better fuel qualities for reasons of competitiveness.
Kilometre charge\textsuperscript{116}

\textbf{Description of the charge:}

From 1974 until 1993, Sweden had a \textbf{km-tax} on vehicles which ran on fuel other than petrol or liquid gas. Thus, this tax was liable to diesel-driven passenger cars, trucks and buses. From June 1976, a km-tax was also charged on trailers pulled by those trucks paying the km-tax, if the total weight of the lorry was above 3,000 kg. Since 1985, this km-charge on trailers was abandoned, and the tax on the trucks for such trailers was raised by a corresponding amount.

The km-tax implies taxation directly related to the travelled distance of each vehicle. Above all, the tax can be clearly related to the real road infrastructure costs, since it can be differentiated to vehicle types, vehicle weight and the number of axles on the vehicle.

When this tax was abolished in October 1993 and replaced by a special tax on diesel oil, this was a major change in the Swedish road traffic tax system (Atkins W.S. 1997).

\textbf{Objective of the measure:}

The kilometre tax system was originally adopted to make HGVs pay for the costs that they imposed on the road system and to cover the externalities. These costs were mainly supposed to consist of road wear. Therefore, it was important to separate the use of diesel oil for road transport and its use in other sectors such as industry and agriculture. A basic idea of the km-tax was that it could be restricted to the traffic sector in a more efficient manner than the earlier diesel oil tax. Control was thought to be easier by separating the users in different tax systems.

\textbf{Differentiation criteria:}

The km-tax was charged as a certain amount per kilometre driven. It was differentiated according to the

- \textbf{type of vehicle},
- \textbf{type of fuel used} (only diesel-driven vehicles were taxed)
- \textbf{number of axles}
- \textbf{vehicle weight}, and of course
- \textbf{amount of kilometres driven}.

\textsuperscript{116} Atkins W.S. 1997
In the last months before the km-tax was abandoned, the charges were as shown in the table below:

<table>
<thead>
<tr>
<th>Type of vehicle</th>
<th>Tax weight [kg]</th>
<th>Base rate [SEK/10 km]</th>
<th>Addition per 100 kg [SEK/10 km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Private passenger car</td>
<td>≤ 900</td>
<td>1.65</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>900–</td>
<td>1.83</td>
<td>–</td>
</tr>
<tr>
<td>2. a) Bus with 2 axles</td>
<td>≤ 1,600</td>
<td>1.70</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1601–</td>
<td>1.71</td>
<td>–</td>
</tr>
<tr>
<td>2. b) Bus with ≥ 3 axles</td>
<td>≤ 1,600</td>
<td>1.70</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>1601–</td>
<td>1.71</td>
<td>0.009</td>
</tr>
<tr>
<td>3.1 Truck with arrangement for trailer</td>
<td>≤ 1,600</td>
<td>2.40</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1,601–</td>
<td>2.43</td>
<td>0.026</td>
</tr>
<tr>
<td>3.2 a) Other truck with 2 axles</td>
<td>≤ 1,600</td>
<td>2.40</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1,601–</td>
<td>2.42</td>
<td>0.020</td>
</tr>
<tr>
<td>3.2 b) with 3 axles</td>
<td>≤ 1,600</td>
<td>1.70</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1,601–</td>
<td>1.71</td>
<td>0.014</td>
</tr>
<tr>
<td>3.2 c) with ≥ 4 axles</td>
<td>≤ 1,600</td>
<td>1.70</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1,601–</td>
<td>1.71</td>
<td>0.011</td>
</tr>
<tr>
<td>4.1 Trailer (&gt; 3 tons), pulled by a km-chargeable truck (with steering axles)</td>
<td>3,001–</td>
<td>1.00</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>3,001–</td>
<td>1.00</td>
<td>0.023</td>
</tr>
<tr>
<td>4.2 Other trailer</td>
<td>≤ 1,600</td>
<td>1.70</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1,601–</td>
<td>1.71</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>≤ 1,600</td>
<td>1.70</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>1,601–</td>
<td>1.71</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Table41: The km-charge for specific vehicle groups in 1993, 1 SEK ≅ 0.10540 EURO (Source: Atkins W.S.)

Success of the measure:
The km-tax was generally accepted within Sweden, but was difficult to maintain for reasons of EU compatibility and competitiveness. Since it was a mechanical system, fraud was possible.

Implementation and administration:
Administration: The km-tax demanded quite a large effort in administration. The number of cases subject to administrative treatment was large, due to the control of the kilometre counters and the volume of evasion investigations. The km-tax was paid in
arrears for each tax period, usually every four months. The vehicle owner stamped a card in the km-counter in the last month of the tax period (stamp month) and sent this card to the Traffic Safety Bureau which through automatic data processing calculated the km-charge based on the km count. This system could lead to fraud. Also, the cases of missing reports meant a good deal of extra work for the tax administration as it had to assess the distances travelled in other ways.

A special simplified system for foreign vehicles was adopted in Sweden based on total weight and number of days within the country. The control problems dealing with foreign traffic were also substantially reduced when Sweden adopted the same charging system as the neighbouring countries within the EU.

Prior to the km-tax, there was a tax charged on diesel oil that was used for the vehicle operation. However, the diesel tax collection was also suffering from large control problems and from a large amount of withheld tax. After the kilometre charge ceased, the resources spent on control of the system were substantially reduced.

**Implementation costs:** The costs of administrating the km-tax were estimated at 2.6% of the tax income in 1985 (excluding related court costs).

**Use of revenue:** Revenue is used for general budget purposes.

**Restrictions:**
With the km-tax on diesel-driven vehicles, it was necessary to check the kilometres each time the Swedish border was crossed. Even though the system was much simplified for foreign vehicles, it was not accepted by several countries partly because it demanded stopping at the border upon its crossing. Therefore, bilateral agreements were made that would exempt vehicles from road taxes in the other country. This made the conditions of competition for road hauliers even more confusing, nationally and internationally. The regulations of the European transport market stipulate that taxation rules should be applied so that border control of (foreign) HGVs is no longer necessary.

In addition, the tax rates and rules for diesel tax within the EU have been harmonised.
General fiscal strategy in transportation:
It has been a declared condition that by changing the system from km-tax to diesel and
energy tax the total revenue from these taxes was to remain mainly unchanged. Nev-
ertheless, HGVs in Sweden have been heavily taxed compared to the EU and neigh-
bouring countries. Therefore, the level of the annual vehicle tax for HGVs was reduced
by around 20%. This also reduced the progressive element along with weight.

The total burden of km/fuel tax and fixed annual vehicle tax before and after the
changes made from October 1993 (giving up the km-tax, increasing the diesel tax and
decreasing the vehicle tax) shows that only the heaviest vehicles with trailers have
benefited from the change. For fuel of environmental classes 1 and 2 (the most envi-
r ironmental friendly) the tax burden was reduced after 1993. For the other vehicles speci-
fied, the total taxes increased. Relatively, the largest increases are for the smallest vehi-
cles.

Overall appraisal of the measure
The following knowledge has been drawn from the experiences with the km-tax.

- The tariff system of the kilometre tax was sophisticated enough to reflect the pro-
gressively rising road wear cost. The system with kilometre recorders proved more
complicated to administer and control than originally supposed.

- Evasion of the charge also proved a lot easier than presumed when the system
was planned. The reason being that tampering with kilometre counters could often
be done without great danger of being exposed.

- Having the same type of tax system as the surrounding countries has proved to be
a substantial simplification. This goes for the taxing authorities as well as for the
haulier industry.117

- The precise amount of money saved on simplification of administration and better
control has been difficult to assess, but resources have been liberated for more ex-
tensive control and other purposes.

117 Setting a maximum amount of diesel fuel allowed at border crossings – as was done later – is much
easier to administer than trying to apply different rules for different nationalities.
Recommendation for differentiation and variabilisation policies:
From the point of view of environmental effects and internalisation of external (infrastructure) costs, a km-tax is highly effective. Once implemented, it is also quite easy to differentiate the charge according to various criteria, such as vehicle and fuel type, weight, number of axles. With its implementation, some aspects should be focused:

- The kilometre related tax system should be easy to administer, both for the drivers and for the controllers.

- Vehicles crossing the border should not have to stop. An electronic system (with smart cards) could be a solution to be considered. For foreign cars – in case a tax exemption is not possible – the system should also be simple and acceptable.
Differentiated taxes for road transport:

Vehicle purchase tax

Description of the charge:
In 1960, a general sales tax was introduced. It was constructed like a turnover tax. This general sales tax was replaced by a value added tax (VAT) in 1969.

1) The first differentiation of the sales tax was a tax reduction in 1987 and 1988 for cars which were voluntarily equipped with a catalytic converter. The tax reduction was more or less equivalent to the additional costs for implementing the equipment.

2) With the introduction of the environmental classification system\textsuperscript{118} in 1991 on diesel- and 1994 on petrol-driven cars, the sales tax on vehicles was differentiated in favour of vehicles belonging to classes 1 and 2 (class 3 = minimum requirements). Vehicles of 30 years old or more were not subject to the tax (only to the scrapping charge).

The vehicle sales tax for passenger cars was taken away in June 1996. Since October 1996, HGVs have also been relieved of the sales tax. Today, only motorbikes, buses and trucks weighing less than 3,500 kg are eligible for the sales tax. The sales tax was replaced by an increase in annual tax, the total income from road taxes being at the same level before and after the reform.

However, the environmental differentiation of the sales tax was retained until 1 January 1997 for cars and small light commercial vehicles and until 1 January 1998 for the remaining light commercial vehicles. These taxes were given up as a consequence of EU legislation. The previous voluntary standard for environmental class 2 (EU directives 94/12/EC and 96/69/EC) became mandatory. Therefore, the general sales tax and the environmental differentiation were given up at different dates and for different reasons.

Objective of the measure:
1) The rebate on vehicles with catalytic converters installed was to quickly introduce the new, environmentally less-harmful technology.

\textsuperscript{118} Passenger cars, trucks and buses are divided into environmental classes according to the law on vehicle emissions.
2) The differentiation of the sales tax according to environmental classes was mainly to promote environmentally sound vehicles.

**Differentiation criteria:**
The different rates for sales taxes were differentiated according to the environmental classification of the vehicles.

The differentiation of the environmental classes was made according to the Californian system which had sharper environmental criteria than the EU system.

As far as petrol cars were concerned, the differentiation of the environmental classes was based on the emissions (NO\textsubscript{x}, HC, CO). CO\textsubscript{2} emissions were not considered. With regard to diesel-driven vehicles, the differentiation was mainly based on particulates exhaust.

At first, the sales tax on **passenger cars** in class 3 (minimum requirements) was raised by 2,000 SEK and that on class 1 was lowered by 4,000 SEK. The same differential was introduced for light commercial vehicles and buses.

In January 1995, the reduction for class 1 vehicles was withdrawn. Instead, such vehicles were exempt from the annual motor vehicle tax for their first five years (5 x 1,000 SEK). It was considered to supplement the environmental classification system with two new classes in 1996: 1E for electric automobiles, 1H for hybrid automobiles. However, these two additional classes were never applied although a special law exempts electric cars (i.e. electricity-driven buses) from sales taxes.

The specification of the classes in the old system prior to the EU membership was:

- **class 1**: Standards for LEV (Low emission vehicles) in California
- **class 2**: USA 1994 standards (originally the federal requirements), Modification according to the EU standard which took full effect in January 1997
- **class 3**: Statutory minimum requirements

In June 1996, the sales tax on vehicles belonging to the former class 3 was reduced to 2,000 SEK. Instead, the annual vehicle tax was raised by 50% (15% for diesel vehicles of year model 1994 or later).

In October 1996, standards corresponding to class 2 became compulsory. There is no class 1 for HGVs at present.
The tax basis of the vehicle sales tax is the total kerb weight (including driver’s weight) for different types of vehicles.

- **Light-weight buses and vans** with a gross weight of up to a maximum of 3.5 tons are taxed at 6.47 SEK/kg (0.68 EURO) total kerb weight.
- For **environmental class 3 vehicles**, a further 2,021 SEK (213 EURO) is levied.
- **Flat-bed lorries** belonging to environmental classes 1 and 2 and **environmental class 3 heavy-weight lorries and buses** equipped with a diesel engine are taxed at 6,064 SEK (639 EURO).
- **Motor-cycles** are taxed in relation to their total kerb weight:
  - 1,354 SEK (143 EURO) up to 75 kg,
  - 1,779 SEK (188 EURO) for 75-160 kg
  - 2,729 SEK (288 EURO) for 160-210 kg
  - 4,528 SEK (477 EURO) over 210 kg
- **Electrical** battery-run vans and buses are subject to the tax as per environmental class 1 cars

**Criteria for the tax level:**
The tax differentials were considered to correspond to the additional cost of manufacturing vehicles to meet the standards for classes 1 or 2. It was intended that the differentials should be fiscally neutral.

**Success of the measure:**
The rebate in 1987 and 1988 for cars which were voluntarily equipped with a catalytic converter was a very effective measure to quickly introduce the new technology.

Environmental classification of motor vehicles seems to have helped to accelerate the introduction of vehicles with better **environmental performance** to the Swedish market. If the tax differential corresponds to the additional costs entailed in manufacturing each class, as intended, the total extra investment cost of the environmentally classified automobiles is approx. 340 million SEK (35.8 million EURO).

This represents an annual capital cost of about 40 million SEK (4.2 million EURO). This extra cost means that emissions of nitrogen oxides in 1995 were about 460 tons lower than they would have been if all vehicles had merely met the compulsory minimum standards.

This also represents a reduction of 0.4% of total emissions of NOx from road traffic. If the sales tax for a class 2 automobile (i.e. 2,000 SEK) is added to the reduction in emis-
sions of NO\textsubscript{x}, the abatement cost may be estimated at 80 SEK/kg NO\textsubscript{x} (8.4 EURO). The additional cost (2,000 SEK) also leads to a reduction in other emissions, such as those of HC or CO. Thus, the requirements for the previous environmental class 2 must be regarded as having been cost-effective.

**Use of revenue:**
Revenue is used for general budget purposes. The expected revenue in 1994 was 1,450 million SEK (153 million EURO).

**Restrictions:**
Swedish EU membership involved new, formal requirements with a view to international harmonisation (e.g. vehicle exhaust regulations). This would have meant an adaptation of the differentiation of the environmental classification system as follows:

1. The voluntary level must be a level which in the future will be compulsory in the EU (EU instead of Californian standards).
2. The tax can only be differentiated by introducing a single voluntary standard in addition to the compulsory one (exemptions could have been applied for).
3. The tax differential must be less than the additional cost of manufacturing vehicles of the higher environmental class.

The Swedish price differentials were too high (as concerned the environmental class 1). However, there is no evidence that the Commission was concerned about this situation. It is, however, evident that the class 1 incentive currently over-compensates for the additional costs. It will therefore be reduced in the future.

**Political framework conditions:**
The reasons for giving up the general sales tax in June 1996 were national policy decisions. The motives were the following:

1. A positive effect on employment (considering the fact that two domestic manufacturers have quite large market shares).
2. A positive environmental effect due to the replacement of old cars.

Simultaneously, the annual tax for existing cars was increased by 55% for petrol-driven cars and 15% for diesel-driven cars, keeping the revenue at the same level.
However, the environmental differentiation of the sales tax was retained until 1 January 1997 for cars and small light commercial vehicles and until 1 January 1998 for the remaining light commercial vehicles. These taxes were given up as a consequence of EU legislation. The previous voluntary standard for environmental class 2 (EU directives 94/12/EC and 96/69/EC) became mandatory.

When the environmental classification system for differentiating the sales tax was abandoned, the possible differentiation of the annual taxes was discussed but has not yet been put into force. An alternative energy/fuel economy-related sales tax could not have been implemented because of competitiveness and political problems119.

Considerations of changes in the tax system have not so far been decided. Yet, it is being discussed that the differentiation according to environmental classes should be reintroduced for HGVs and also for cars weighing less than 3,500 kg. The differentials could be implemented within the annual vehicle tax or within a new sales tax120. A differentiation on the annual tax is preferred. Sweden is awaiting the EU suggestions on this matter.121

Environmental framework conditions:
The environmental classification system is related to compulsory exhaust emission approval for new vehicles. The class can be chosen by the automobile manufacturers. The differential tax has only involved minor procedural changes in the collection of vehicle sales tax and the annual vehicle tax. The administrational costs are thus very low.

119 The car lobby would not have agreed on a fuel economy based differentiation because the vehicles manufactured in Sweden are rather large and therefore fuel-consuming.

120 If there will be a kind of sales tax it could only be for the differentiation of the environmental classes, because the vehicle sales tax per se no longer exists and will not be reintroduced.

121 According to the Ministry of Finance the proposed differentials suggested by the EU are rather low.
Annual motor vehicle tax

Description of the charge:
The motor vehicle tax\textsuperscript{122} is levied as a fixed annual tax. Taxable vehicles are passenger cars, trucks, buses, motor cycles, tractors, self-propelled machinery and heavy cross-country vehicles such as tractors and trailers.\textsuperscript{123} As a registration certificate, a valid tax sticker is despatched when the vehicle is taxed, insured and inspected. The tax rate rises in relation to increased tax weight.

For cars in abeyance (which are taken off the road for a while, i.e. during winter) neither the motor-vehicle tax nor the motor insurance have to be paid. Charges payable for cessation of abeyance are, in addition to the motor-vehicle tax, a registry maintenance charge, a number-plate charge and a charge for a certificate as to cessation of abeyance.

When the sales tax was given up in June 1996 (for passenger cars), the annual tax for existing cars was increased simultaneously by 55\% for petrol-driven cars and 15\% for diesel-driven cars, keeping the revenue at the same level.

Objective of the measure:
The objective of this weight-differentiated tax is purely fiscal.

Differentiation criteria:
The annual vehicle tax is mainly differentiated according to the vehicles’ weight. Fuel economy as differentiation criteria has been discussed, but was never implemented. The differentiation is made according to the

\begin{itemize}
\item type of vehicle,
\item vehicle weight,
\item number of axles on the vehicles (for HGV),
\item fuel type (diesel/petrol),
\item model year, and
\end{itemize}

\textsuperscript{122} annual vehicle tax = annual weight tax = registration fee = annual circulation tax
\textsuperscript{123} Not taxable are a) semi-trailers with a taxable weight of over 3,000 kg, if they are drawn exclusively by cars, lorries or buses that are diesel-powered or by terminal tractors, b) hobby vehicles, i.e. motorcycles, cars, lorries or buses that according to the Motor Vehicle Registry are of a model thirty or more years old. A trailer for a road tractor is taxable if used for transport on a public highway.
– if there are technical arrangements for a semi-trailer (clutch mechanism).

In the case of tractors, self-propelled machinery and heavy cross-country vehicles, account is also taken of how they are used. Class 1 (road) tractors with a payload of over 2,000 kg could be used for transportation on public highways, whereas class 2 tractors comprises other tractors or tractors almost exclusively used for agricultural transport.

For HGVs, the clutch mechanism is used for the control of the differentiation according to environmental vehicle classes.

The following tables give examples of the tax rates:

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Fuel</th>
<th>Tax weight [t]</th>
<th>Vehicle tax [SEK/yr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger car</td>
<td>petrol</td>
<td>1.2</td>
<td>1,032</td>
</tr>
<tr>
<td>Passenger car, model 93 and earlier</td>
<td>diesel</td>
<td>1.2</td>
<td>2,062</td>
</tr>
<tr>
<td>Passenger car, model 94 and later</td>
<td>diesel</td>
<td>1.2</td>
<td>3,952</td>
</tr>
<tr>
<td>Truck, 2-axles with attachment for semi-trailer</td>
<td>diesel</td>
<td>16</td>
<td>18,504</td>
</tr>
<tr>
<td>Truck, 2-axles without attachment for semi-trailer</td>
<td>diesel</td>
<td>16</td>
<td>10,062</td>
</tr>
<tr>
<td>Trailer, 2-axles, drawn by diesel-driven vehicle, not semi-trailer</td>
<td>–</td>
<td>20</td>
<td>9,056</td>
</tr>
<tr>
<td>Bus</td>
<td>diesel</td>
<td>16</td>
<td>1,545</td>
</tr>
<tr>
<td>Tractor class I (road tractor)</td>
<td>petrol or diesel</td>
<td>6</td>
<td>4,115</td>
</tr>
<tr>
<td>Tractor class II (agricultural tractor)</td>
<td>petrol or diesel</td>
<td>–</td>
<td>225</td>
</tr>
</tbody>
</table>

Table 42: Annual motor vehicle tax varying according to vehicle and fuel type and tax weight, i.e. kerb or gross weight, 100 SEK ≅ 10.54 EURO (Source: Tax administration 1998)
<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Weight of vehicle [ton]</th>
<th>Number of axles</th>
<th>Base rate [SEK]</th>
<th>Addition per 100 kg [SEK]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>0–1.6 t</td>
<td>2</td>
<td>720</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1.6–3 t</td>
<td></td>
<td>775 (for 1.6 t)</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>3–6 t</td>
<td></td>
<td>1,545 (for 3 t)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>6–10 t</td>
<td></td>
<td>1,676 (for 6 t)</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>10–14 t</td>
<td></td>
<td>2,821 (for 10 t)</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>14–17 t</td>
<td></td>
<td>6,737 (for 14 t)</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>≥ 17 t</td>
<td></td>
<td>11,984 (for 17 t)</td>
<td>229</td>
</tr>
<tr>
<td></td>
<td>6–11 t</td>
<td>≥ 3</td>
<td>1,556 (for 6 t)</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>11–15 t</td>
<td></td>
<td>2,271 (for 11 t)</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>15–18 t</td>
<td></td>
<td>5,351 (for 15 t)</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>≥ 18 t</td>
<td></td>
<td>9,443 (for 18 t)</td>
<td>172</td>
</tr>
<tr>
<td>Trailer</td>
<td>3–11 t</td>
<td>≥ 3</td>
<td>300 (for 3 t)</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>11–17 t</td>
<td></td>
<td>1,520 (for 11 t)</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>17–25 t</td>
<td></td>
<td>3,220 (for 17 t)</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>≥ 25 t</td>
<td></td>
<td>7,220 (for 25 t)</td>
<td>65</td>
</tr>
</tbody>
</table>

Table 43: Vehicle tax for selected trucks and trailers for October 1996, 100 SEK ≅ 10.54 EURO (Source: Atkins W.S.)

The tax weight is:

a) the **kerb weight** for passenger cars, motorcycles, tractors and motor implements and

b) the **gross weight** (allowable total weight) for other vehicles.

Sweden promotes the sale of environmental class 1 cars (US TLEV standard) by a five year exemption from annual tax.

In the northern part of Sweden the annual vehicle tax is reduced (by 384 SEK/yr = approx. 40 EURO). This should partly compensate for the generally higher energy and fuel prices. Less than one fourth of the population can profit from this tax reduction.124

**Success of the measure:**

During the past years, a considerable share of the new cars sold in Sweden have been EC1-cars. Taking into account the fact that the technical standard is rather advanced, a sales figure between 5% and 10% is a rather high one.125 The success of the current incentive, as compared to a sales tax incentive, has not been evaluated.126 An indica-

---

124 A new proposal suggests that the tax reduction in these northern remote areas should be abolished.

125 EC1 is meant to be an elite class, for testing advanced technology in often the most expensive cars. The major benefits will occur when this technology is used in all cars. In this respect, the five-year exemption measure has been successful.

126 Marketing experts used to say (according to the Ministry of Environment) that a lower annual tax is a stronger incentive than a lower sales tax.
tion of the success is that the five-year exemption is frequently used as a sales argument.

**Implementation and administration:**

**Administration:** The tax is to be paid in advance for a year. The final figure of the vehicle registration number determines the payment date. If the tax due exceeds 3,600 SEK/yr (380 EURO), payment is made over three periods. The Motor Vehicle Registry sends out paying-in slips to those liable for tax, who receive a tax sticker when they have paid on the assumption that the vehicle is taxed, inspected and insured. For late payment a penalty of at least 100 SEK (approx. 10 EURO) is charged.

**Use of revenue:**

The revenue goes to the general budget.

**Restrictions:**

To adjust the annual vehicle tax for HGVs to the tax level within the EU, the vehicle tax had been adjusted downwards since 1993 (see Table 43 for the 1996 tax rates).

**Political framework conditions:**

In the spring of 1999, a proposal of the “Traffic tax investigation” was published and is still under discussion. It suggests that the annual vehicle tax will be fixed at a certain level. The adjustments would lower somewhat the tax burden for the vehicles’ owner. The proposed annual vehicle taxes are:

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Fuel</th>
<th>Tax weight [t]</th>
<th>Vehicle tax [SEK/yr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger cars, trucks, motorbikes</td>
<td>petrol</td>
<td>≤ 3.5</td>
<td>1,200*</td>
</tr>
<tr>
<td>Passenger cars, trucks, motorbikes</td>
<td>diesel</td>
<td>≤ 3.5</td>
<td>4,200*</td>
</tr>
<tr>
<td>HGVs, buses</td>
<td>petrol</td>
<td>≥ 3.5</td>
<td>984**</td>
</tr>
<tr>
<td>Buses</td>
<td>diesel</td>
<td>≥ 3.5</td>
<td>1,545**</td>
</tr>
<tr>
<td>Trucks</td>
<td>diesel</td>
<td>≥ 3.5</td>
<td>no tax change**</td>
</tr>
</tbody>
</table>

Table 44: Proposed annual motor vehicle tax varying according to vehicle and fuel type, and tax weight. Diesel trucks are supposed to deduct the Eurovignette tax from the annual vehicle tax. (Source: Discussion with the Ministry of Finance, Jan. 1999)

As a consequence of EU adaptation, the technical standard will be replaced by the EU 2005 requirements from 1 January 2000. Cars approved according to the Califor-
nian TLEV-standard will be accepted as environmental class 1 if they are sold not later than 31 December 1999\textsuperscript{127}. They will be exempted from annual tax for five years. Thereafter, the EU 2005 standard will be the new standard for EC1. An incentive will be provided in the form of a reduction in the annual tax, the exact details still to be decided by the Swedish Parliament. Electric and hybrid cars will continue to be promoted by a five-year exemption from annual tax. According to the Ministry of Environment, the incentive is currently being discussed, but a few things might be revealed:

\begin{itemize}
\item The sales tax will not be reintroduced. An annual tax is preferred.
\item It is likely that the incentive will be given as a fixed initial sum\textsuperscript{128}. The time limit will be gone. The sum is not fixed yet, but according to EC legislation it should be less than the cost of better technology.
\end{itemize}

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{127} The incentive will affect cars sold after 1 January 2000 (a limit set by the EU).
\item \textsuperscript{128} “No tax shall be paid until a sum of ... should have been paid.”
\end{itemize}
\end{footnotesize}
Vehicle scrapping charge and premium

Description of the charge:
The vehicle scrapping premium was one of the first environmentally related economic instruments introduced in Sweden. A vehicle scrapping charge was introduced in October 1975 and the premium was introduced in January 1976.

Objective of the measure:
The environmental purpose of the scrapping premium was to prevent the abandonment of motor vehicles. Furthermore, Parliament wished to accelerate the scrapping of old vehicles with inferior exhaust gas treatment in order to reduce emissions of air pollutants from road traffic.

Differentiation criteria:
The charge and premium were raised according to the following table:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10/75</td>
<td>250 / 26</td>
<td>-</td>
</tr>
<tr>
<td>1/76</td>
<td>250 / 26</td>
<td>300 / 32</td>
</tr>
<tr>
<td>4/88</td>
<td>250 / 26</td>
<td>500 / 53</td>
</tr>
<tr>
<td>7/88</td>
<td>300 / 32</td>
<td>500 / 53</td>
</tr>
<tr>
<td>1/92</td>
<td>850 / 90</td>
<td>500 / 53 / 500 / 1,500 / 53 / 158 / 53/ 158</td>
</tr>
<tr>
<td>11/93</td>
<td>1,300 / 137</td>
<td>500 / 500 / 1,500 / 53 / 158 / 53 / 158</td>
</tr>
</tbody>
</table>

1) Higher premium for vehicles having passed a roadworthiness test not later than 14 months prior to payment of the premium

Table 45: Scrapping charge and premium

A higher premium is paid for vehicles having passed a roadworthiness test not later than 14 months prior to the payment of the premium. This is an incentive against car abandonment over a longer period.

Success of the measure:
The number of vehicles scrapped increased markedly with the introduction of the charge. The vehicle scrapping premium probably only has a minor impact on the rate at which people replace their cars in comparison with the rise in real salaries. Yet, the original purpose - to prevent scrap cars from being abandoned - has been achieved, even though the premium is not a cost-effective means of achieving this due to relatively high administrative costs. But it is doubtful whether people would bring their
cars to be scrapped earlier than they would do without the premium. The annual road worthiness test serves as an incentive to scrap older vehicles not fitted with catalytic converters.

Implementation and administration:

Administration: The scrapping charge has to be paid (in combination with the sales tax) when private passenger vehicles, buses and vans with a kerb weight not exceeding 3.5 tons are registered. The charge is paid by the manufacturer or importer to the National Road Administration which administers the vehicle disposal fund.

Like the scrapping charge, the premium is also for vehicles with a kerb weight of less than 3.5 tons. If a vehicle of less than 3.5 tons is de-registered because it was scrapped, a scrapping certificate is compulsory. The vehicle scrapping premium is paid to anyone who has received a vehicle disposal certificate from an authorised vehicle scrap enterprise and has in this way received a vehicle de-registration certificate. Only car owners with a vehicle disposal certificate from an authorised vehicle scrap enterprise are allowed to have their vehicles de-registered and thus exempted from vehicle tax (vehicle registration charge and the compulsory road traffic insurance).

In the case of other vehicles (weight > 3.5 tons), a scrapping certificate can be replaced by a report stating that the vehicle was scrapped or otherwise destroyed. For cars with a payload in excess of 400 kg, buses with a total weight of more than 3.5 tons and vans with a total weight of no more than 3.5 tons, a scrapping premium is payable at the time of scrapping.

Implementation costs: The total administrative cost of the vehicle scrapping premium and charge may be estimated at 1–2% of the system’s total revenues.

The organisation for central administration is small (maybe a few hours’ work each year).

Use of revenues

The purpose of the vehicle scrapping charge is to finance payment of the premium. The money received is placed in the vehicle disposal fund.

Revenue 1995: 210 million SEK (22 million EURO) from the charge.

Expenditures: 93 million SEK (9.8 million EURO) for premium payments

1 million SEK for municipal campaigns and specific projects
Overall appraisal of the measure:
The Swedish scrapping payment system is generally not thought of as a very successful measure for disposing of old cars. The Swedish car stock has still a relatively high share of old cars, often imported from Germany.

Recommendation for differentiation and variabilisation policies:
In order to succeed with the system of a scrapping charge and premium for disposing of old vehicles, one major aspect should not be neglected:

The incentive for people to scrap their old vehicles should be high enough. If this is not the case, it does not really matter when the vehicle is given to be scrapped – on the spot or some years later. Suggestions for increasing the scrap incentives could be:

- The scrapping premium could be differentiated according to the age of a vehicle or the duration since abeyance. The older the vehicle (or the longer the time span since abeyance), the smaller the scrapping premium will be. Finally, it will be set at zero. This system with a time limitation for receiving a premium – as it exists, e.g. in Denmark – has proved to be more successful than the applied Swedish system.

- Higher incentives could also be given, if the scrapping premium is only due whenever an old car is sent for scrapping upon buying a new car. In that way, each car purchase could lead to a substitution of an old car.
Information sheet for Switzerland

Information

- Botschaft zu einem Bundesgesetz über die leistungsabhängige Schwerverkehrsabgabe, September 1996

Overall framework conditions

Political and international framework conditions:
The political framework conditions in Switzerland are quite different from those in other European countries. In particular, not being an EU member state, the direct democracy as well as the pronounced federal system are features which characterise Switzerland. In bilateral negotiations with the EU, one important field is transport. The most crucial points are:
- the level of the road user charge necessary for shifting freight transport from road to rail;
- the market access to rail and road;
- the harmonisation of the standards, especially the harmonisation of the weight limits for freight transport.

Environmental framework conditions:
In large parts of the country, people are sensitive to environmental questions. Being an important country for transit, its population is particularly concerned about the increase in freight transport which has been forecasted for the future and which already is a problem along the transit routes. In 1994, the people accepted in a public consultation a constitutional article for the protection of the Alpine area. This article prescribes that up to the year 2004 the transiting freight transport has to be considerably shifted from road to rail transport. The Parliament has decided to realise the shift from road to rail with fiscal instruments, i.e. the km charge for freight transport and an additional Alpine transit charge. As an important flanking measure, the new transalpine railway axis will be constructed.
Variable charges for road transport:

Road pricing for lorries: distance- and weight-referred kilometre tax

Description of the charge:
The charge is defined as a km- and weight-related charge levied on HGVs with a weight of over 3.5 tons. The weight is defined as the allowed total maximum weight of the vehicle. The charge is levied on the whole Swiss road network. Swiss HGVs have to install an electronic km-measuring device in the vehicle (a foreign HGV has the option to install this device). The mileage will be checked at least once a year. The km counting of foreign vehicles will be read at the borders (comparison of mileage at the entry and exit of the country). It is intended to introduce a simple electronic system for foreign lorries also, which would allow the reduction of border formalities to a minimum. If possible, the Swiss electronic system will be harmonised with the systems introduced in other European countries (for example in Austria). The variable charge for lorries will be gradually introduced, starting in 2001.
The introduction of the variable charge will be accompanied by a stepwise increase of the weight limit for lorries. The up-to-date 28 tons weight limit will be raised to 34 tons in 2001 and to 40 tons in 2005. This allows for significant productivity effects.

Objective of the measure:
The official reason for the change from a fixed annual tax to a variable, mileage-dependent charge lies in the covering of all costs incurred by HGVs. These costs involve the infrastructure costs (which are already covered with the existing taxes) and the external costs (external costs of accidents, health costs and environmental costs) and are estimated to amount to 1 billion CHF. The damages to the ecosystem and external costs of climate change are not included in this amount.
The design of the tax should give an incentive to increase the load factor (decrease of (half-)empty travels) of the lorries.

Criteria for the tax level:
The tax level is based on the external costs of HGVs. It was decided to fix a range of 0.016–0.03 CHF per ton kilometre in order to have a greater flexibility in the adjustment of the charge to changing framework conditions (inflation, changes in the magnitude of external effects). The stepwise introduction foresees at first a low charge (0.016 CHF
per ton kilometre) for the year 2001. The gradual increase will lead to 0.027 CHF per ton kilometre.

**Success of the measure:**
It has been estimated, that in 2015, the transport services provided (tkm) will increase by around 3–5%, because of the productivity effects induced by the increase in weight limits. This would lead to a significant decrease in mileage of about 29–33% by the year 2015 in comparison to the reference scenario. A significant shift of transiting vehicles from the French and Austrian Alps towards the Swiss alpine transit routes is expected. Rail transportation could profit by this regional and modal shift with an estimated increase of transports through the Alps of 22–45%. This increase can only be achieved if the price for cross Alpine transportation does not exceed 5,000 CHF per route.

**Possible problems:**
One possible negative side effect of the increase in maximum weight limits would be a worsening competitiveness of rail transport. This problem will be minimised with an improvement in the quality of rail transportation (through additional investments in the infrastructure). A share of the productivity gains of HGV transport is compensated by introducing the km-referred charge. The charge should also guarantee that the share of vehicles in transit in Switzerland does not increase too much.

**Implementation and administration**

**Implementation costs:** The costs of the electronic system for measuring the kilometres driven are estimated to be around 1,000-1,500 CHF per vehicle. The overall implementation costs for the Government are estimated at 4.6–6.5% of the revenue (for revenue of about 740 million CHF), or at 3.0–4.2% for revenue of 1,150 million CHF respectively (without the implementation costs of the cantons).

**Use of revenue:**
The variabilisation is linked to additional state revenue. Two-thirds of the revenue will be used to finance large Swiss infrastructure projects (new transalpine railway axes, improvement of the existing infrastructure in the context of the project “Rail 2000”, connection of the western part of Switzerland to the TGV-network, noise protection measures).

One-third of the revenue will be distributed to the cantons. The criteria relevant to the distribution of revenue are:
– the amount of the cantons’ annual vehicle tax for lorries,
– population,
– financial burden due to the road network, and
– length of road network.

Exemptions/Restrictions: Buses used for public transport will be exempt from tax payment. The same is valid for off-road vehicles used in agriculture and for the military. Tax exemption could also be applied for electric vehicles as well as for transportation with humanitarian aims. The reason for providing tax exemption lies in the negative side effects a tax could imply on the use of public means of transport and on the infrequent use of road infrastructure by agricultural vehicles. The costs of the installation of electronic devices in all military vehicles is the major reason for the exemption of these kinds of vehicles from tax payment.

Overall Appraisal of the measure
The introduction of a km-related tax for lorries, which increases transport costs considerably, was possible because of the link between environmental and financial goals. A large part of the population is sensitive to environmental topics. A tax based on the polluter-pays-principle is therefore well accepted. Furthermore, the construction of two new transalpine railway axes for the transport of goods through Switzerland requires a significant amount of capital which will be paid by the transport sector.
Differentiated taxes for road transport:

Differentiated annual vehicle tax

Description of the tax:
In Switzerland, the cantons are responsible for the design and collection of the annual registration tax of vehicles. Therefore, there is no uniform tax design. The tax basis as well as the tax rate vary between jurisdictions. The tax is based on the weight of the vehicle, on its cubic capacity, on an engine power index or on combinations of these criteria. Recently, some attempts have been made in order to standardise the tax. In past years, some of the cantons have differentiated the tax according to the emissions of the vehicles. Particularly in the late 1980s, the tax was decreased for vehicles with catalytic converters in order to give an incentive for the purchase of vehicles with this technology. In 1996, the canton Lucerne differentiated its annual vehicles’ tax. Vehicles with a low fuel consumption benefit from a 50% reduction in the annual vehicle tax. The amount of the tax varies between the vehicle categories, being between 250 and 400 CHF (155–250 EURO). This reduction is limited to a maximum of 7 years. The maximum tax reduction for an environmentally sound car amounts to 1,060 CHF (660 EURO) for the whole period with the tax rebate. A rebate of annual vehicle tax has been introduced also for lorries (valid till the end of 1999). An increase by 30% of the tax is foreseen for vehicles which do not fulfil the emissions’ criteria in force. The extra charge is levied first when ownership changes.

Differentiation criteria:
The differentiation of the annual vehicle tax for cars is based on the following criteria:
– the vehicles have to fulfil the emissions criteria fixed by the Federal Government
– they have a low fuel consumption (defined for the “city cycle”, for a mixed cycle according to the EU guideline 93/116 respectively).

The maximum fuel consumption is defined as shown in the following table:
<table>
<thead>
<tr>
<th>KWh/100 km</th>
<th>Litre petrol/100 km</th>
<th>Litre diesel/100 km</th>
<th>Tax reduction until</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.5</td>
<td>4.8</td>
<td>4.3</td>
<td>2002</td>
</tr>
<tr>
<td>44.1</td>
<td>5.1</td>
<td>4.5</td>
<td>2001</td>
</tr>
<tr>
<td>46.7</td>
<td>5.4</td>
<td>4.8</td>
<td>2000</td>
</tr>
<tr>
<td>49.3</td>
<td>5.7</td>
<td>5.1</td>
<td>1999</td>
</tr>
<tr>
<td>51.9</td>
<td>6.0</td>
<td>5.4</td>
<td>1998</td>
</tr>
<tr>
<td>54.5</td>
<td>6.3</td>
<td>5.6</td>
<td>1997</td>
</tr>
</tbody>
</table>

Lorries have to fulfil the following criteria in order to benefit from the tax reduction:  
– less than 1 g emissions of particles per 1 kWh,  
– fulfilment of the EURO 2 emission levels,  
– fall below the present noise emission regulations by 3 dB(A).

The canton publishes a list of the vehicles once a year which fulfil the requirements.

The data for the fuel consumption are based on the information of car producers. To determine noise emissions, the type of transmission is relevant. Four categories are distinguished: lorries with mechanical transmission, automatic transmission, hydrostatic transmission and continuously regulated transmission.

**Criteria for the tax level:**
There were no fixed criteria for the magnitude of the tax decrease. In order to limit the drop in revenue, it has been decided to increment the tax for vehicles with a high emission level.

**Objective of the measure:**
The objective was to give an incentive for the purchase of environmentally sound vehicles. The measure was introduced in 1996 and for a limited period. It was planned that around 10% of the registered vehicles could benefit from the tax reduction. In Switzerland, about 18% of the new vehicles sold fulfilled the requirements for the tax rebate in 1993, about 6,500 vehicles (out of a total of about 133,000 vehicles).

**Success of the measure:**
A first evaluation of the measure did not indicate a particular effect of the differentiation. Whereas for 1996, the share of environmentally sound vehicles fulfilling the rebate requirement in the canton Lucerne was twice as high as in the rest of Switzerland, for 1997 no significant differences could be recognised. The incentive for buying envi-
ronmentally sound vehicles was effective only in the year of introduction of the tax rebate.

**Possible improvements of the measure:** The tax reduction can be interpreted as a rebate only as long as the requirement for the tax decrease does not correspond to the compulsory technology (in this case it would be a subsidy). In 2003, it is foreseen to adapt the requirements to the intensified emission limits.

With regard to lorries, the requirements “1 g particle emissions per kWh” and “EURO 2 emission regulations” were abolished in the beginning of 1999 (as they became compulsory) and replaced by the EURO 3 requirements and the additional HGV equipment including a particle filter. HGVs driven with natural gas also benefit from the rebate.

**Implementation and administration**

The **implementation costs** amount to around 180,000 CHF (for the development of a computer programme and for data collection). Additionally, every year running costs arise in the magnitude of 2–3 working days for the adjustment of data and for information purposes.

The drop in the fiscal revenues caused by the tax rebate for cars amounted in the first year to 0.7% and in the second year to 0.5% of the total revenue. It was estimated that the drop in 1998, the third year after introduction, would be around 0.4%. The tax increase for vehicles with high emission levels has lead to additional revenue which exceeded – at least in 1997 and probably also in 1998 – the drop in revenue. The rebate for lorries with low noise and particles emissions has lead to a decrease in revenue of around 0.4% of total revenue in 1996 and 0.6% in 1997. The estimated drop for 1998 amounted to 0.7%.

**Use of revenue:**

70% of the revenue is used for financing the expenditures and running costs of road infrastructure. 15% of the revenue is allocated to the police, and 10% is used for financing road infrastructure expenditures of municipalities. 5% of the total revenue is used for the construction of park & ride facilities and for other measures able to link public transport with individual road transport needs.

One objective of the increase in the tax for vehicles with a high emission level lies in the financing of the tax reduction for environmentally sound vehicles.
Overall appraisal of the measure:

It has been argued that the tax differentiation would have been more successful if its introduction was linked to a more intensive information campaign in favour of environmentally sound vehicles. In fact, it could be noticed that in the first year of introduction of the tax rebate, when the publicity was greatest, the measure had also a significant impact on the composition of the car stock. Apparently the economic incentive is not big enough to induce – without flanking measures – an important change in purchase behaviour.

Furthermore, there is the problem that tests for fuel consumption of HGVs in different driving situations – similar to those of passenger cars – are lacking. Therefore, it was necessary to base the differentiation on technical features such as the type of transmission. In spite of the data situation, it was an important objective to differentiate also HGV taxes – at least before the Federal introduction of the ton kilometre-referred tax for HGVs.
Information sheet for the United Kingdom (UK)

Literature and data sources


Overall framework conditions

Overview of the history of the taxes:
The Government does not have a long tradition of using taxes and charges for environmental purposes. However, the reduction of emissions of greenhouse gases and the improvement of local air quality have become more and more important:

• UK policy on climate change is driven by two targets: a legally-binding greenhouse gas emission reduction target of 12.5% on 1990 levels by 2008-12 arising from the Kyoto Protocol; and a domestic goal of reducing CO₂ emissions to 20% below 1990 levels by 2010. Transport has been the fastest growing major source of emissions of CO₂, the most important of the gases associated with climate change.¹²⁹ All sectors of the economy will need to play their part in tackling the problem of climate change.

• In response to the growing scientific evidence and increasing public concern about the adverse effects of air pollution, the Government began in July 1997 to implement the National Air Quality Strategy, published by the last administration following the 1995 Environment Act. It sets standards and objectives for eight major air pollutants, which represent levels at which no significant health effects should occur. One of the major tools to achieve the Strategy’s aims is through local air quality management.

The Government is pursuing a mixture of policy instruments in addressing the environmental problems. In July 1997, it declared environmental taxes as key instruments to achieve environmental objectives (Government’s Statement of Intent on Environmental Taxation). In July 1998, the Government published its White Paper on the Future of Transport, which sets out the framework for an integrated transport strategy which aims to reduce traffic growth and to tackle the adverse impacts transport can have on people and the environment. The White Paper proposed a number of new measures affecting road traffic, such as powers for local authorities to introduce road user charges and workplace parking charges to reduce congestion and to generate revenue to fund complementary local transport projects. The White Paper also recog-

¹²⁹ In 1997, road transport produced around 32 million tons of carbon (MtC) – a fifth of the total emissions from all sources.
nised that fiscal measures and economic instruments will have a major role to play in influencing travel choice and encouraging sustainable development.

**Political framework conditions:**
The Government is reinforcing the integrated transport strategy by a fuel duty strategy and a reform of the vehicle excise duty (VED) and the company car taxation.

The fuel duty strategy aims at reducing emission of greenhouse gases and encouraging cleaner fuels. It consists of a fuel duty escalator up to 6% a year and several duty differentials:

- Duty differential between leaded and unleaded petrol.
- Reduction of the duty on road fuel gases (LPG and CNG) relative to the increase of the duty of diesel and petrol due to the duty escalator.
- Duty differential between ordinary diesel and ultra low sulphur diesel (ULSD).
- Duty differential between standard diesel relative to unleaded petrol.

With the reform of the VED for cars, buses and lorries (graduated VED) and company car taxation, the Government intends to encourage cleaner vehicles and technologies. The following measures have been realised:

<table>
<thead>
<tr>
<th>Realised measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VED</strong></td>
</tr>
<tr>
<td>Reduction of the VED for buses and lorries with very low particulate emissions</td>
</tr>
<tr>
<td>Increasing of the VED for new classes of lorries with 11.5 ton axle weights</td>
</tr>
<tr>
<td>Freeze of the VED of other lorries</td>
</tr>
<tr>
<td>Reduction of the VED for cars with engines up to 1,100 cc</td>
</tr>
<tr>
<td><strong>Company car taxation</strong></td>
</tr>
<tr>
<td>Reduction in business mileage discounts and older car discounts.</td>
</tr>
<tr>
<td>Reform of the employee benefits tax charge to encourage the use of public service and cycling</td>
</tr>
</tbody>
</table>

*Table 46: Realised measures concerning the reform of the Vehicle Excise duty (VED) and the company car taxation*

Table 47 gives an overview of the planned measures:
Planned measures

<table>
<thead>
<tr>
<th></th>
<th>Planned measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VED</strong></td>
<td>Graduated VED for new cars, determined primarily by their CO₂ emissions</td>
</tr>
<tr>
<td></td>
<td>New graduated VED system for lorries to consider the environmental damage they cause</td>
</tr>
<tr>
<td><strong>Company car taxation</strong></td>
<td>Tax measures to encourage green transport plans</td>
</tr>
<tr>
<td></td>
<td>Reform of company car taxes: Replace incentives to drive extra miles with an incentive to use more fuel efficient cars.</td>
</tr>
</tbody>
</table>

*Table 47: Planned measures concerning the reform of the Vehicle Excise duty (VED) and the company car taxation*

**Additional measures in transport**

Besides the economic instruments mentioned above there are the following additional measures in transport:

- **Local Transport Plans**: Local transport plans are the core of the New Deal for Transport. They will cover all forms of local transport and establish coherent strategies to tackle transport problems, including congestion, air quality and other adverse impacts of road traffic. Local transport plans will be introduced in 2000-2001.

- **Road user charging**: The White Paper contains the commitment to introduce legislation which would allow local authorities to charge vehicles to drive within designated areas or on designated roads, as part of a package of measures to tackle congestion in a local transport plan.

- **Workplace Parking**: The White Paper committed the Government to introduce legislation to give local authorities discretionary powers to impose a levy on the provision of workplace parking. The aim is to reduce the amount of parking space available as a means of reducing car journeys and increasing the use of public transport, walking and cycling. In practical terms, it looks unlikely that any pilot schemes will be on the ground before 2001.

- The **Cleaner Vehicles Task Force (CVTF)** is a partnership between senior representatives of the motor and oil industries, environmentalists and other organisations, which aims to see what more can be done to accelerate the pace of change in vehicle and fuel technology. Examples of the work of the Task Force include the production of recommendations regarding the cost effective introduction of alternative fuelled vehicles into the vehicle fleet and an environmental labelling scheme.
- **Low emission zones:** A number of local authorities are considering the establishment of low emission zones which only certain types of vehicle could enter, for example, those which conform to stringent emission standards.

- **Education and Publicity:** Raising public awareness of environmental issues, such as the need to improve air quality, is an essential part of any strategy to address them. The ‘Are you doing your bit?’ campaign, focused on the fact that everybody can play a part in reducing pollution through small changes in their behaviour.

**Overall appraisal of the measures**

Government guidance makes clear that arrangements for effective monitoring and evaluation are a key component of the environmental appraisal process. The Government expects to publish an environmental appraisal of its environmental tax measures on an annual basis. The 1998 Financial Statement and Budget Report contained, for the first time, a table showing the environmental appraisal of Budget measures. This policy was continued in 1999. The Government estimates the impacts of its measures mainly with a number of economic models which are designed to capture long-term trends and which are continuously reviewed. As the environmental tax measures are long-term policies and in force only for a few years (fuel tax escalator, fuel duty differentials) or not yet introduced (graduated VED for cars), it is too early to say definitely what the impacts have been.

Table 48 shows the estimated environmental impact of the Budget measures 1999. The key instrument for reducing emissions of greenhouse gas emissions is the **fuel duty escalator**. The key instrument for improving air quality (emissions of particulates and NO\textsubscript{x}) is the duty differential for ultra low sulphur diesel (USLD) compared to conventional diesel:
<table>
<thead>
<tr>
<th>Budget measures March 1999</th>
<th>Estimated environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel duty escalator</td>
<td>The escalator over the period 1996 to 2002 estimated to produce CO₂ emission savings of 2–5 million tons by 2010; some 5–12% of CO₂ emissions from transport in 2010; and a reduction of 1% in NOₓ emissions and 1.2% in particulate emissions</td>
</tr>
<tr>
<td>Increase duty on standard diesel relative to unleaded petrol</td>
<td>Reduction of 1 to 3% of particulates and NOₓ; Very small increase in emission of CO₂</td>
</tr>
<tr>
<td>Increase duty differential for ultra sulphur low diesel (USLD)</td>
<td>Reduction of 21% of particulates and up to 2% of NOₓ emissions</td>
</tr>
<tr>
<td>Reduction in duty on road fuel gases</td>
<td>Reduction in emissions of particulates and NOₓ</td>
</tr>
<tr>
<td>Graduated VED for cars</td>
<td>Reduction of emissions of CO₂, NOₓ and particulates</td>
</tr>
<tr>
<td>New rates of VED reduction for clean lorries and buses up to £1000</td>
<td>Reduction in emission of particulates and NOₓ</td>
</tr>
<tr>
<td>Company car tax reform</td>
<td>Estimated to produce savings of around 0.5 to 1 million tons of CO₂ emissions</td>
</tr>
</tbody>
</table>

Variable charges for road transport:

Fuel taxes

Description of the charge:
The fuel tax consists of an excise duty and VAT (17.5%). Justified by environmental reasons, the Government introduced a fuel duty strategy which consists of a fuel duty escalator and several fuel duty differentials:

1) In 1993, the Government introduced an annual increase in the real level of motor fuel duty (fuel duty escalator) by 3% per annum. The escalator was increased to 5% in November 1993. The July 1997 budget included a commitment to annual increases of 6% in real terms in the duty on road fuels, except road fuel gases.

2) In 1989, the fuel duty was differentiated in favour of unleaded petrol. The price differential made unleaded petrol 12p per gallon cheaper than leaded petrol. In October 1999, the duty on higher octane unleaded petrol was cut to 2p per litre above unleaded petrol.

3) In 1994, the excise duty of road fuel gases (liquid petroleum gas (LPG) and compressed natural gas (CNG)) was frozen. In November 1995, the duty on road fuel gases was cut by 15%, in 1996 by a further 25% and in 1999 by an additional 29%.

4) In August 1997 the Government introduced a duty differential between ordinary diesel and ultra low sulphur diesel (ULSD) of 1p a litre. This differential was increased in the following years to 3p a litre. In addition, the specification of ULSD was tightened to ensure only the cleanest diesels could qualify for the reduced rate.

5) In March 1998, the Government introduced a duty differential between standard diesel relative to unleaded petrol of 1p. In March 1999, this differential was widened to 3p per litre.

Objective of the measure:
The main purpose of fuel taxation is fiscal. The fuel escalator and the fuel duty differentials are important policies to reduce emissions of greenhouse gases and to tackle local air pollution. According to the Government, the fuel escalator is the key policy instrument for reducing emission of CO₂ from the transport sector. Fuel duty differen-
tials have become an increasingly significant way of encouraging cleaner fuels. The Government intends to continue to change the structure of road fuel duties over time:

1) The aim of the **annual increase in the duty on road fuel** is primarily to reduce CO$_2$-emissions from the transport sector through encouraging the purchase of more fuel efficient vehicles, promoting greener driving styles and less vehicle use. Additionally, this measure has a beneficial impact on air quality and encourages the use of non-renewable natural resources within the transport sector. The fuel duty escalator is also significant in revenue terms.

2) The differentiation in favour of **unleaded petrol** aims to encourage the use of cleaner fuels. From January 2000, the higher unleaded petrol will no longer contain benzene, a known carcinogen. The price reduction of this fuel aims at facilitating the introduction of Lead Replacement Petrol.

3) The differentiation in favour of **road fuel gases** reflect the fact that they produce much lower emissions, especially particulates, than diesel. Road fuel gases are more expensive than petrol and diesel, chiefly because of the cost of compressing the gases for on-board storage. Their excise duty was reduced to bring the price of the fuel broadly into line with petrol and diesel and to compensate the conversion cost. The Government intends to provide incentives for potential investors in these new technologies and cleaner fuels.

4) The aim of the duty **differential favouring ultra low sulphur diesel (USLD)** over conventional diesel is to encourage the manufacture and use of the ULSD which offers substantial benefits to urban air quality by reducing the amount of particulates, nitrogen oxides and black smoke produced during combustion. The use of cleaner diesel is generally needed for the introduction of emission reduction technologies, such as oxidation catalysts and particulate traps. The favouring of USLD is an essential element in the strategy to improve air quality, particularly in urban areas.

5) The **higher duty increase for diesel** relative to petrol is partially to offset the higher energy and carbon content and also reflects the fact that using diesel is worse than petrol for urban air quality.
Differentiation criteria:
The fuel duty strategy consists of a variable charge (fuel duty escalator) and an additional differentiation of the fuel prices. The base for the charges are shown in the following table:

<table>
<thead>
<tr>
<th>Charges</th>
<th>Differentiation criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel duty escalator</td>
<td>Fuel price in real terms (increase of 6%)</td>
</tr>
<tr>
<td>Fuel duty differentials</td>
<td>Different type of fuels</td>
</tr>
<tr>
<td></td>
<td>• leaded/unleaded</td>
</tr>
<tr>
<td></td>
<td>• petrol/diesel/road fuel gas</td>
</tr>
<tr>
<td></td>
<td>• sulphur content of diesel</td>
</tr>
</tbody>
</table>

Table 49: Differentiation criteria of the fuel duty escalator and the fuel duty differentials

Table 50 shows the actual duty fuel rates:

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Duty rate (pence) per litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaded petrol</td>
<td>52.88</td>
</tr>
<tr>
<td>Unleaded petrol</td>
<td>47.21</td>
</tr>
<tr>
<td>Higher Octane Unleaded Petrol</td>
<td>52.33</td>
</tr>
<tr>
<td>Ordinary diesel</td>
<td>50.21</td>
</tr>
<tr>
<td>Ultra Low Sulphur Diesel</td>
<td>47.21</td>
</tr>
<tr>
<td>Road fuel gas</td>
<td>15 (per kg.)</td>
</tr>
</tbody>
</table>


Success of the measure:
1) The escalator is a long-term policy with cumulative impacts: it is intended to encourage vehicle users to reduce their fuel consumption either through the vehicle they drive or the way they use their vehicle. Additionally, the escalator also acts as a signal to manufacturers about likely demand for more fuel efficient vehicles. Because of the long-term and complex nature of the escalator it is too early to estimate the actual environmental performance with a modelling framework. However, the Government points out that there is increasing evidence available on the actual impacts of the escalator:
   - The fuel consumption from the road transport sector has gone down as a result of the escalator.
– There has been a marked improvement in the average fuel consumption of lorries since the escalator was introduced, increasing by 13% between 1993 and 1998.

– As a result of higher prices, more fleets are beginning to introduce more fuel saving measures.

The Government has estimated the impact of the fuel duty escalator with a modelling framework over the period from 1996 to 2010. It estimates that the escalator over the period 1996 to 2002 will produce CO₂ emission savings of 2 to 5 million tons by 2010, representing 5% to 12% of CO₂ emissions from transport in 2010 and a reduction of 1% in NOₓ and 1.2% in particulate emissions.

2) When the price differential was introduced, making **unleaded petrol** 12p per gallon cheaper than leaded petrol, the market share rose from about 2% in 1989 to 30% per year in 1990. It has now stabilised at about 70% of the market and is gradually increasing as the old vehicle stock is replaced.

3) The reduction in duty on road fuel gases is expected to reduce the emissions of particulates and NOₓ.

4) The duty **differential favouring ultra low sulphur diesel** (USLD) has had effects on the use of ULSD. The Government is pleased that this policy has resulted in the rapidly increasing UK production of this quality of diesel. The proportion of diesel sold which meets this specification had increased to 43% by February 1999. The further increase in the duty differential is expected to turn almost the whole diesel market to ULSD by the end of 1999, leading to significant reductions in emissions from diesel-fuelled vehicles, and contributing to improved air quality for everyone, especially in congested areas.

---

130 The two main models used by the Department of Environment, Transport and the Regions (DETR) are the National Road Forecasting model (NRTF) and the Vehicle Market model (VMM). The two models interact: The Vehicle Market model estimates the impact of the fuel price changes on the vehicle fleet into the second model to forecast the overall impact of the policy on traffic levels and emissions. Elasticities are estimated by looking at historic trends in fuel prices and consumption. The CO₂ elasticities as a result of annual 6% real fuel duty increases between 1996 and 2002 implicit in the VMM/NRTF model taking into account the efficiency, traffic congestion and speed effects are as follows: 1996: 0; 2001: -0.13; 2006: -0.17; 2011: -0.25; 2016: -0.32. Similar forecasts are being undertaken with an energy model. This model used an estimate of long run elasticity of fuel demand with respect to changes in fuel price of -0.41.
Use of revenue:

Revenue is used for general budget purposes and for compensating the extra production cost. Table 51 shows the revenue of the fuel duties for three periods.

<table>
<thead>
<tr>
<th></th>
<th>1997-98</th>
<th></th>
<th>1998-99</th>
<th></th>
<th>1999-00</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£ billion (billion EURO)</td>
<td>% of GDP</td>
<td>£ billion (billion EURO)</td>
<td>% of GDP</td>
<td>£ billion (billion EURO)</td>
<td>% of GDP</td>
</tr>
<tr>
<td>Fuel duty</td>
<td>19.4 (27.5)</td>
<td>2.4</td>
<td>21.5 (30.5)</td>
<td>2.5</td>
<td>23.1 (32.7)</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Table 51: Revenue of the fuel duties (HM Treasury: Financial Statement and Budget Report March 1999)

The fuel duty escalator will raise some £1.5 billion (2.1 billion EURO) in 1999–2000.

Overall appraisal of the measures:

The fuel duty escalator is a key element in meeting the Government’s climate change targets. As noted above, there is increasing evidence that the escalator is reducing emissions from road transport. However, the escalator is a long-term policy and determining the effects of increases in fuel duty will only be possible in the longer term.

Concerning the air quality, the Government is pleased that the duty differential favouring ultra low sulphur diesel (USLD) has resulted in the rapidly increasing UK production and use of this quality of diesel, leading to significant reductions in emissions from diesel-fuelled vehicles.
Differentiated taxes for road transport:

Annual motor vehicle tax

Since the reform of the Vehicle Excise Duty (VED) is not yet fully implemented, it can not be evaluated.

Description of the charge:
The Vehicle Excise Duty (VED) is an annual vehicle ownership tax introduced in 1985. The VED is applied for cars, lorries and buses. From 1985 to 1992, the level of VED for cars remained constant at £100, and than successively increased in subsequent years. It currently stands at £155.

Until 1999, the UK was unique in Europe in not charging VED on cars by reference to some characteristics of the vehicle like engine capacity, power output, weight, age or fuel type. The single-rate structure for cars offered no incentives for purchasers to buy, or manufacturers to produce, cleaner vehicles. The Government is reforming the VED for cars, lorries and buses to encourage cleaner vehicles and technologies (Graduated VED):

1) From 1 June 1999, cars with engines of up to 1,100 cc are entitled to a reduced rate of VED of £100.

2) In March 1998, the VED rates for lorries were frozen.

3) In January 1999, a VED concession of up to £500 for buses and lorries with very low particulate emissions was introduced. This reduction has been increased to a maximum of £1,000 from March 1999. The incentive will continue to apply to commercially operated lorries and buses with cleaner engines.

4) In March 1999, the Government increased the VED for new classes of lorries with 11.5 ton axle weights.

Objective of the measure:
The main objective of the VED is fiscal. Additionally, the graduated VED for cars, buses and lorries aims at reducing the emissions of CO₂ and improving the air quality by encouraging cleaner vehicles and technologies:
1) The aim of the **graduated VED for cars** is to develop a system which gives clear signals to encourage motorists to consider environmental criteria when buying new or second-hand cars.

2) The **freeze of the VED** rates of most of the lorries should help to shift the burden of taxation from car ownership to car use. It should also help maintain the competitive position of UK hauliers.

3) The **VED concession of up to £ 1,000 for buses and lorries with very low particulate emissions** should encourage owners to achieve tough emission standards: for example, by fitting particulate traps to vehicles, fitting higher standard engines or switching to road gas fuels.

4) The **higher VED rates for the new heavy goods vehicles** are set to discourage strongly the use of such vehicles with 11.5 tons axle weight, in view of the additional road damage that they cause.

**Differentiation criteria:**
The VED has a **single-rate structure** with **graduated elements** for particular vehicles:

1) The **graduated VED for cars** is differentiated by the **engine size** (cc) of the car. There are two classes:

<table>
<thead>
<tr>
<th>Cars</th>
<th>VED rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>With engines up to 1,100 cc get a.</td>
<td>£ 100</td>
</tr>
<tr>
<td>With engines above 1,100 cc</td>
<td>£ 155</td>
</tr>
</tbody>
</table>

*Table 52 Graded rate for cars*

2) The **freezing of the VED** of lorries should partly offset the impact of higher fuel duty.

3) The **VED concession for buses and lorries** of up to £1000 is based on new and projected **Euro standards**. It aims to compensate for the additional costs of fitting particulate traps or converting to gas power.

4) The base of the **higher VED rates for the new heavy good vehicles** is the **axle weight**.

**Success of the measure:**
The Government expects the impacts of the graduated VED for cars, buses and lorries as likely to be **small**. The reasons for this are the short time since the measures were
implemented and the rather low level of differential introduced. The government expects a reduction in emissions of CO₂, NOₓ and particulates.

Use of revenue:
The VED is used for fiscal purposes. Table 53 shows the revenue of the VED for three periods.

<table>
<thead>
<tr>
<th></th>
<th>1997-98</th>
<th>% of GDP</th>
<th>1998-99</th>
<th>% of GDP</th>
<th>1999-00</th>
<th>% of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle excise duties</td>
<td>£4.5 (billion EURO)</td>
<td>0.6</td>
<td>£4.6 (billion EURO)</td>
<td>0.5</td>
<td>£4.6 (billion EURO)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 53 Revenue of the VED (HM Treasury: Financial Statement and Budget Report March 1999)

Political framework conditions:
The Government has announced that they will further reform the VED rates to encourage cleaner vehicles and technologies: From Autumn 2000, VED rates for new cars will be based primarily on their CO₂ emission rates. The aim is to encourage more fuel-efficient and cleaner cars and therefore, to help reduce emissions of green house gases and local air pollutants. It is planned that the VED rates will be set to secure a revenue neutral system. Since the information to do this will be only available for new cars, it is proposed to use engine size and possibly age, as approximations for existing cars. The Government expects the impact of the graduated VED as likely to be small. It will depend mainly on the level of the differential introduced. However, the Government is convinced that it will send an important signal to the market, supporting the fuel duty strategy and the voluntary commitment by the car industry. More work is being undertaken on a label with information on CO₂ emissions and on the feasibility of an environmental rating system for vehicles to show comparative performance.

In addition, the Government is currently conducting a review of the existing system for calculating VED rates for lorries to ensure that rates more accurately reflect the environmental impact of different lorry types. This review will take into account the wider environmental impacts of lorries as well as their physical effects on the road infrastructure.
References

Banister David, Dreborg Karl, et al, Development of transport policy scenarios for the EU: Images of the future, paper 654 for the 8th world conference on transport research, Antwerp, Belgium, July 1998

Beat Bürgenmeier, Yuko Harayama, Nicolas Wallart, Théorie et Pratique des Taxes Environnementales, Economica, Paris


Bundesamt für Statistik, Schweizerische Verkehrsstatistik 1994, Bern 1996

CEMT/CS/SOC(96)9, National Transport Expenditure, Revenues and Internalisation Policies, 1996


Dargay Joyce M., Estimation of a Dynamic Car Ownership Model for France Using a Pseudo-Panel Approach, TSU Transport Studies Unit University College of London, January 1998 (Ref. 98/03)


DIW/INFRAS/HERRY/NERA, Infrastructure capital, maintenance and road damage costs for different heavy goods vehicles in the EU, on behalf of the European Commission, DG VII, Berlin, 1998

ECOPLAN, Auswirkungen der leistungsabhängigen Schwerverkehrsabgabe (LSVA) und der Ablösung der Gewichtslimite im Strassengüterverkehr - Schlussbericht, GVF-Auftrag Nr. 287, Bern 1997 a

ECOPLAN, Kombiniertes Road-Pricing-/Parkplatzabgaben-System für die Stadt Bern - Schlussbericht, COST 616/CITAIR, Bern 1997 b

Ekins P. & Specks S., A Database of Environmental Taxes and Charges, Forum for the Future, London and Dept. of Environmental Social Sciences, Keele University, 1997


EU (1997b), Presentation of the new Community system for the taxation of energy products. Part I: Objectives and provisions, Proposal for council directive 97/30/EC restructuring the Community framework for the taxation of energy products, Working paper of the Commission services, April 1997
EU (1997c), *Presentation of the new Community system for the taxation of energy products. Part II: Assessment of the impact of the proposal*, Proposal for a directive restructuring the Community framework for the taxation of energy products, Working paper of the Commission departments, April 1997


Herry Max, Dieter Ulrike, *Voruntersuchung zum Thema Maut in Österreich*, Bundesministerium für wirtschaftliche Angelegenheiten, Strassenforschung, Heft 439, Wien 1995


Walther Klaus, *Der Preiselastizitätsfaktor im ÖPNV und seine Bestimmungsgrössen _ Kritische Analyse auf der Grundlage neuer Forschungsergebnisse*, in: Der Nahverkehr, 1-2/93, p. 33-36


Wittenbrink Paul, *Wirkung einer Internalisierung negativer externer Effekte des Straßengüterverkehrs auf die Güternachfrage*