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The effects of fuel price changes on the transport sector and its emissions – simulations with TREMOVE

by
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Abstract

When fuel prices increased in 2000, there were concerns about the impact on the transport sector. Therefore, it was considered worthwhile to simulate the effects of a significant and durable change in oil prices on transport cost, transport demand, and transport externalities.

After reviewing the evolution of fuel prices and of its components over the last four years, this paper comes to the conclusion that the volatility of crude oil prices in this period resulted in a large variation in fuel prices for the transport sector across Member States. On the one hand, additional effects from exchange rate developments dampened the effects of the oil price decline in the first period and exacerbated it in the second period: the UK was an exception to this. On the other hand, divergent policies on excise duties were pursued in Member States, with some (DK, DE, FR, NL, FI, SE, UK) using the opportunity of low oil prices to embark on a strategy of tax shifting, while others (PT, GR, IT) used excise duties actively to absorb parts of the shock coming from rising oil prices.

Using TREMOVE, the partial equilibrium model on the transport sector, which was developed in the context of the European Auto-Oil II Programme, this paper simulates what could happen to transport costs, transport demand and transport emissions if the low oil price ($10/barrel) or the high oil price ($30/barrel) were maintained in the long run. It shows that according to these simulations, price signals do work. However, as fuel prices only constitute a fraction (about 23%) of total transport costs, the effects are small. Indeed, the recent oil price hike, which increased net fuel prices by 86% compared to the base case, would increase total transport costs by less than 7%, triggering a reduction in transport demand, fuel consumption and emissions by 2 to 3 per cent each. The effects of the second scenario are compared to those of an increase in excise duties that would lead to a similar increase in the final price. The overall cost to society of this second scenario could be lower, although the decrease in pollutant emissions would be smaller. The absence of a negative income effect should smoothen the impact on transport demand. However, the environmental benefits could be increased by adding complementary measures of fuel quality, inspection and maintenance, and urban road pricing.

This work is the first use of TREMOVE in the European Commission outside its initial purpose, which was to provide cost-effectiveness analysis for the measures defined in the Auto-Oil II Programme. As the model is currently being reviewed, both the outcomes of the simulation and the problems or limits encountered, constitute valuable input for the definition of an improved version of the model.

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THE EFFECTS OF FUEL PRICE CHANGES ON THE TRANSPORT SECTOR AND ITS EMISSIONS - SIMULATIONS WITH TREMOVE

1. INTRODUCTION

Macroeconomic models have estimated that the volatility in oil prices since 1996 can still trigger measurable consequences for overall macroeconomic aggregates like output and inflation. This holds despite the significant improvements in energy efficiency and a sharp reduction in the dependence of the European economy on oil. In the Euro zone, these effects have been exacerbated by fluctuations in the $/€ exchange rate. The range of volatility measured in US$ since mid-1996 is +/-50% (Figure 1). When measured in ECU and €, volatility reaches -40%/+108%.

The sector most seriously and most immediately affected by these volatile oil prices has been the transport sector. Therefore, it might be worthwhile to simulate the effects of a significant and durable change in oil price on transport cost, transport demand, and transport externalities.

In the first section of the note, the four basic components of fuel price variation at the pump level (i.e. crude oil price, exchange rate, profit margins and taxes) are identified for the 15 EU countries, showing how the same variation in crude oil price results in a broad range of final fuel price variation between Member States and fuels.

In the second section, the results of two simulations of fuel price levels are described. They are performed with TREMOVE, the partial equilibrium model on the transport sector, developed in the context of the European Auto-Oil II Programme, for nine Member States (D, EL, E, F, IRL, I, NL, FIN, UK) and also use its base case as reference. In the end, the resulting cost to society variation (compared with total transportation cost) is small. The fuel taxation level acts as the main shock absorber, and the final impact in monetary cost is partially offset by adjustments in demand, variations in travel time, pollutant emissions, and other side effects and in taxation revenues for public budget (these four latter elements together represent 25% of the change in monetary transport cost).

The third section compares the second scenario (increase of 85.9% in fuel price before tax) with an increase in the fuel taxation level, as proposed by the European Commission in 1997[1]. In the context of the debate on this energy tax proposal, it is worthwhile to show that the effect on the final fuel price of this proposal would have been lower than the effects of non fiscal components of the fuel price variation in the period 1999-2000. The latter included a sharp reduction in mark-ups of fuel prices provided in the light of soaring input prices. A third scenario, where a increase in excise duties leads to a similar increase in the final fuel price shows that the overall cost to society of the latter would be lower, and the impact on transport demand smoother than in the second scenario. This is

[1] Commission proposal COM(97)30

mainly due to the recycling of the revenue raised by the excise duties in the economy of the Member States, while the oil-price increase triggered a negative terms-of-trade shock.

2. DETERMINANTS OF FUEL PRICE VARIATION

2.1. The components of fuel price

In this first part of this note, the objective is to identify, for each Member State, the four domestic components[2] of the fuel price variation at the pump that would aggravate or moderate the effect of the variation in crude oil price, in US$: (1) the variation in US$/national currency exchange rate, (2) Excise duty variation, (3) Value Added Tax with, in some cases, changes in VAT rates, and in any case an automatic effect due to changes in the tax base (net fuel price + excise duties), and finally (4) a mark-up component that can be seen as a 'proxy' for the profit margins of the fuel production and distribution companies. The note focuses on three periods, using half-yearly data: 1st half-year 1996, 1st half-year 1999, 2nd half-year 2000

(1) Evolution of exchange rates: in all countries except the UK, the exchange rate of the US$ has been appreciating, between 28% (Italy) and 50% (Greece) in the five year period. Since January 1999, the US$ exchange rate for the 11 Euro-zone currencies has evolved proportionally to the €/$ exchange rate. The Danish currency maintained a close relationship, while the currency depreciation was lower than for the € for Sweden, and higher for Greece. The behaviour of the British pound diverged from the remaining 14 currencies of the EU, as the exchange rate remained in a band -9% - +3%, an important factor for the divergent evolution of fuel prices in the UK, compared to the other EU countries.

(2) Excise duties: levels of fuel taxation through excise duties are substantially different, both between countries, and within countries between gasoline and diesel (Figure 2 and Figure 3). While some countries are doing just the minimum to comply with directive 92/82/EEC, others use excise duties to restructure the quality of public finances, or gradually increase excise duties on fossil fuels in order to be able to reduce labour taxes or to stimulate environmentally benign activities. A example of the latter is the ‘fuel escalator’ in the UK. The policy of tax shifting was facilitated by the fall in oil prices over the course of 1998. However, the sharp rebound in oil prices led to a moratorium on tax shifting in some countries, and Portugal has actually used its excise duties as a buffer to stabilise end-user prices.

(3) Value added tax: VAT taxation level is broadly divergent in the EU, ranging from 12% in Luxembourg to 25% in Sweden and Denmark (Eurosuper). Three countries have modified their VAT rate, + 1% in Germany and Italy, and -1% in France. Portugal has modified its diesel rate, setting it at the same level as gasoline, but compensating with a decrease in excise duties. Luxembourg was, in the year 2000, the only Member State with a different VAT rate for gasoline (12%) and diesel (15%).

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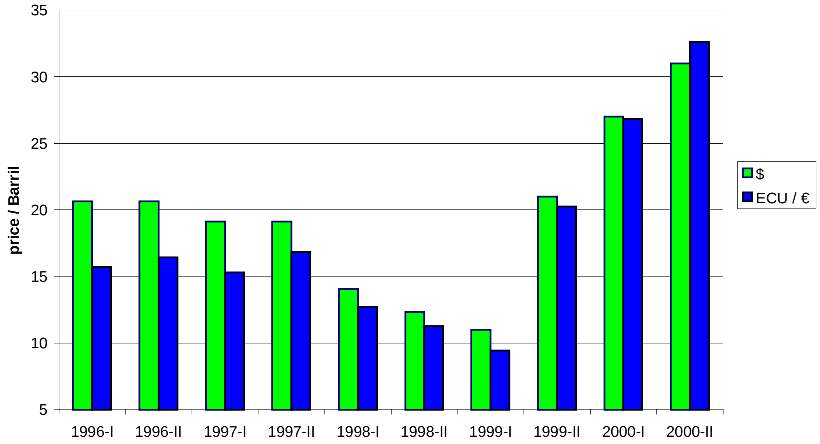
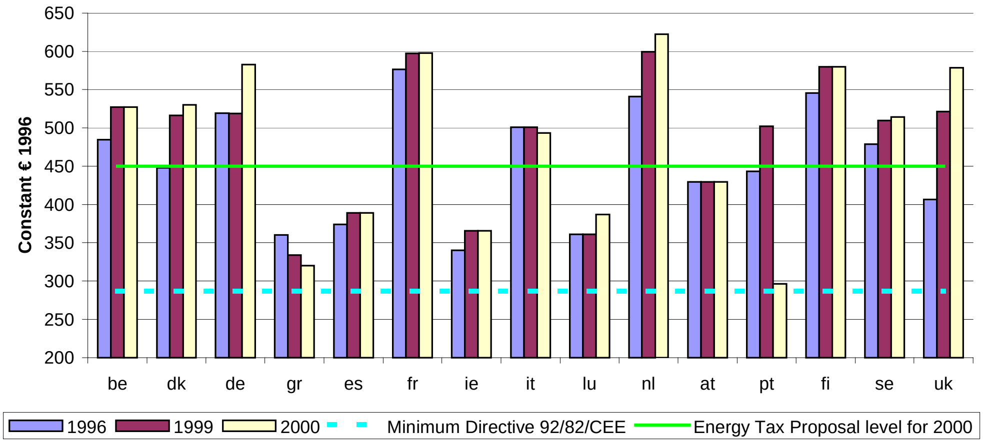
2 The analysis is restricted to the period 1996-2000.

Figure 1 : Crude Oil Price 1996-2000, in US$ and ECU/



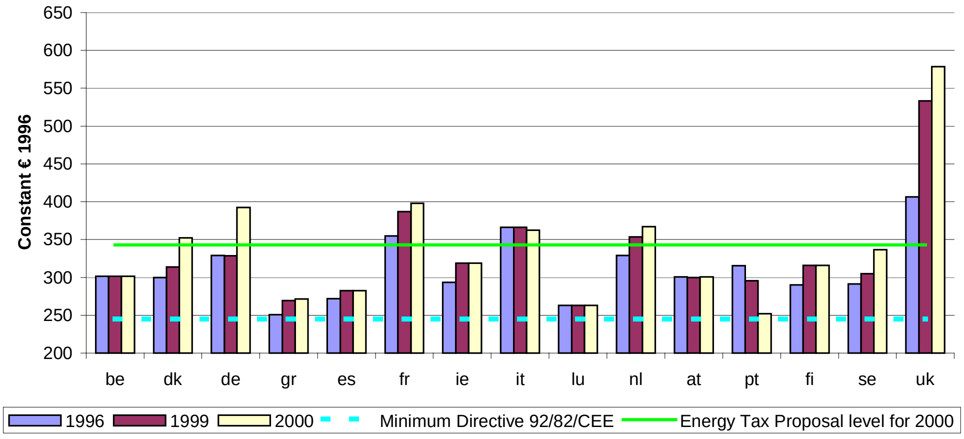
Source: International Energy Agency, European Commission.

Figure 2 : Eurosuper 98 Excise Duties in EU Member States (1996-2000)



Source : European Commission (Eurostat, Directive 92/82/CEE, Commission Proposal COM(97) 30 final).

Figure 3 : Diesel Excise Duties in EU Member States (1996-2000)



Source : European Commission (Eurostat, Directive 92/82/CEE, Commission Proposal COM(97) 30 final).

2.2. Analysis of the period 1996-I to 1999-I

In the period 1996-I to 1999-I, the crude oil price decreased by 46.7% in $/barrel. However (Figure 4 and Figure 5) the changes in pump prices do not come close to this decline in any country. There are several reasons for this:

- First of all, the oil price constitutes only a part of the variation in the price for crude oil of total price. Therefore, the percentage increase in the final price that is due to the variation in the crude oil price will depend on the level of taxation: the average decrease in TTC price that would result only from crude oil prices (in $) is 12.7% for Eurosuper, and 16.4% for diesel.

- Second, this period was characterised by an appreciation of US$ vis-à-vis EU currencies, except for the UK. This has mitigated the effect of the decrease/decline in the price for crude oil by about four percentage points.

- Third, during this period, several EU countries raised their fuel taxation, mainly through excise duties, sometimes drastically as in the UK, where excise duties have increased ('escalator' system) by approximately 30% in the period. Only Greece has decreased its excise duties for Eurosuper, and Portugal for diesel (to compensate for an increase in the VAT rate from 5% to 17%). The average effect of changes in fuel taxation on the final fuel price is about +4.0%.[3]

- Fourth, in all EU countries, oil companies used falling oil prices to increase their mark-up.

Taking all these elements together, the overall picture of a period of sharply falling oil prices is quite mixed, ranging from price reductions of up to 10% for diesel and 4% for Eurosuper in Germany, to price increases of more than 10% for both fuels in the UK.

Table 1 : Fuel price variation components for the period 1996-I to 1999-I

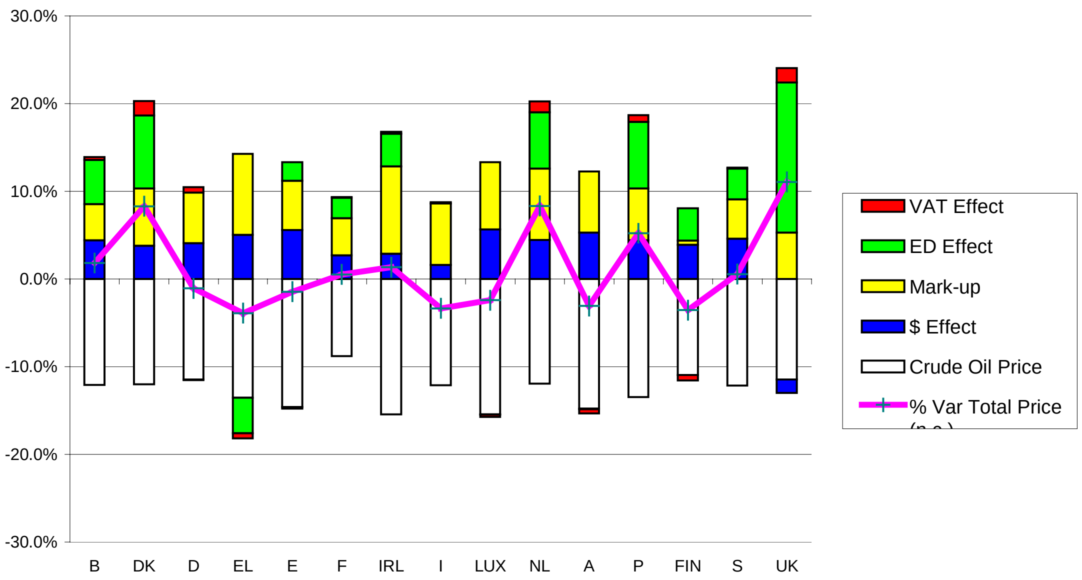
		% Var Total Price (n.c.)	**(1)** Crude Oil Price Effect	**(2)** $ Effect	**(3)** Mark-up	**(4)** ED Effect	**(5)** VAT Effect
	Min	-3.9%	-15.4%	-1.5%	0.5%	-4.1%	-0.6%
Eurosuper	**Average**	**1.2%**	**-12.7%**	**3.8%**	**6.1%**	**3.7%**	**0.3%**
	Max	11.1%	-8.8%	5.6%	10.0%	17.1%	1.7%
	Min	-10.2%	-19.5%	-1.6%	1.1%	-3.6%	-1.7%
Diesel	**Average**	**-2.1%**	**-16.4%**	**5.0%**	**6.2%**	**2.7%**	**0.4%**

Source: own calculations[4] from International Energy Agency and European Commission.

[3] It has to be noted that, without any variation of the VAT rate, there is an "automatic" impact on final price at the pump if the tax base (net price or excise duties) changes.

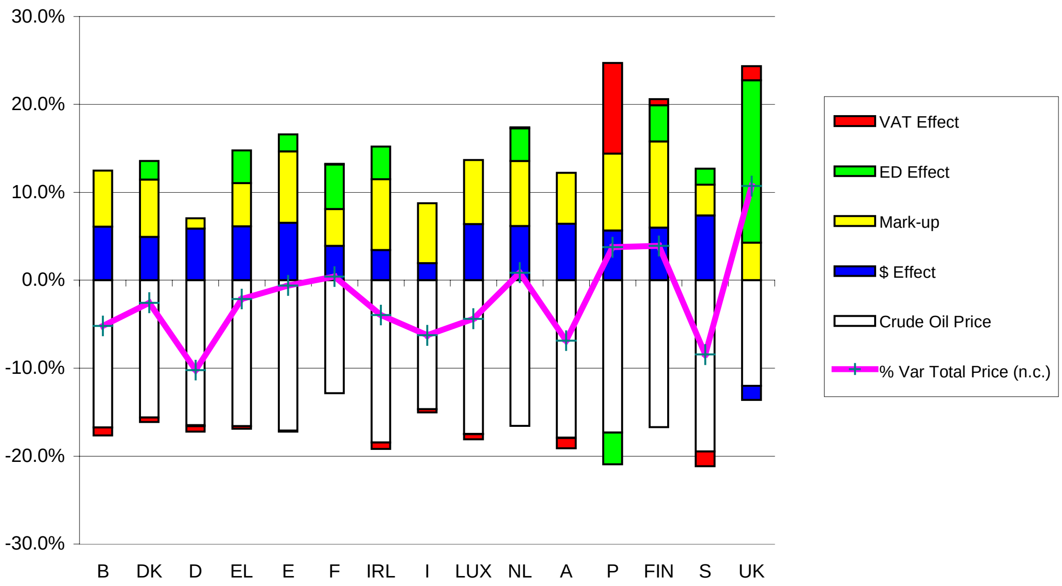
[4] The minimum and maximum values are presented for each component, and do not automatically belong to the same country. Only the average data can be added.

Figure 4 : Fuel price variation components - Eurosuper 1996-99



Source : own calculations from International Energy Agency and European Commission.

Figure 5 : Fuel price variation components - Diesel 1996-99



Source: own calculations from International Energy Agency and European Commission.

2.3. Analysis of the period 1999-I - 2000 II

During the period 1999-I to 2000-II, the crude oil price climbed by 182% in $/barrel. Logically, the level of taxation has smoothed the effects of the increase (Figure 6 and Figure 7), but some of the remaining components have also played an important role in this period:

- The average increase in the final price that would result only from the increase of the oil price (in $) would have been 43.9% for Eurosuper, and 55.8% for diesel. The much lower level of excise duties on diesel explains the difference.

- Second, all currencies have depreciated vis-à-vis US$ during the period, contributing to an additional increase in the final price (+5.3% for Eurosuper, +6.7% for diesel).

- Third, during this period, although some EU countries continued raising their fuel taxation, others tried to alleviate the net price increase through a reduction in excise duties, reaching, in some cases, the minimum set by European legislation. In Portugal, the decrease in excise duties has in purely technical terms triggered a reduction of 25% in the final price.

- Fourth, in all EU countries, oil companies were forced to reduce their mark-up, but with significant differences between countries. In the UK, this element absorbed 10% of the final price variation while in Austria it absorbed about 40%

Taking all these elements together, the final increase in fuel prices ranges from 43% in Greece for both fuels, to 10.6% for Eurosuper and 13.6% for diesel in Portugal.

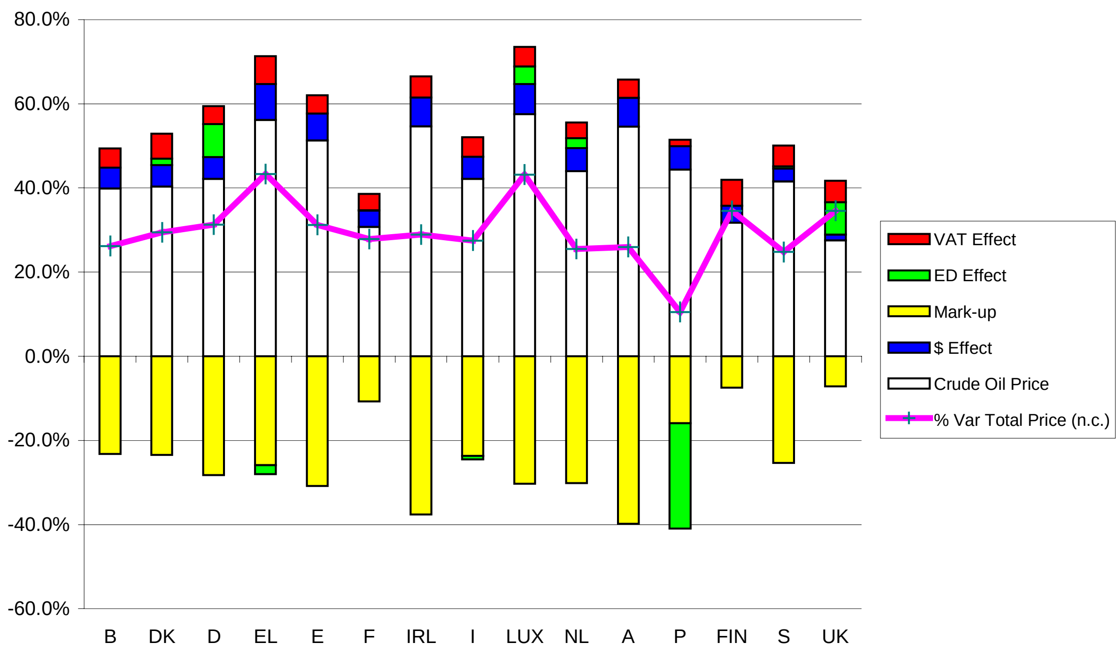
Table 2 : Fuel price variation components for the period 1999-I to 2000-II

		% Var Total Price (n.c.)	**(1)** Crude Oil Price Effect	**(2)** $ Effect	**(3)** Mark-up	**(4)** ED Effect	**(5)** VAT Effect
Eurosuper	Min	10.6%	27.6%	1.3%	-39.8%	-25.0%	1.5%
	Average	**29.7%**	**43.9%**	**5.3%**	**-24.0%**	**-0.3%**	**4.7%**
	Max	43.3%	57.5%	8.6%	-7.2%	7.8%	6.6%
Diesel	Min	13.6%	26.9%	1.3%	-60.1%	-7.8%	2.0%
	Average	**29.3%**	**55.8%**	**6.7%**	**-39.5%**	**1.6%**	**4.6%**
	Max	43.4%	65.7%	8.5%	-8.6%	11.1%	7.5%

Source: own calculations[5] from International Energy Agency and European Commission.

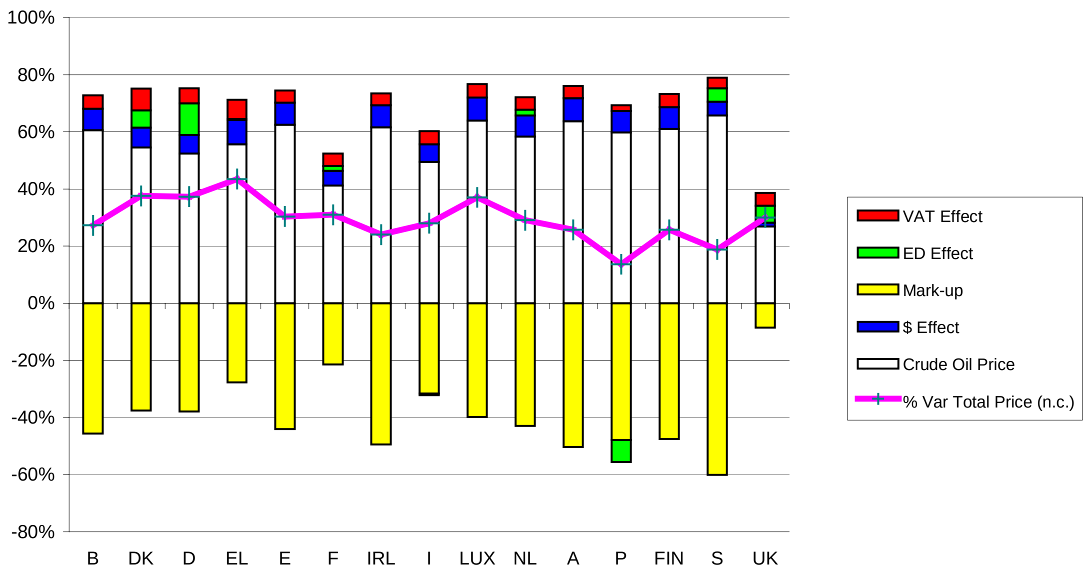
[5] As for table 1, the minimum and maximum values are presented for each component, and do not automatically belong to the same country. Only the average data can be added

Figure 6 : Fuel price variation components - Eurosuper 1999-2000



Source : own calculations from International Energy Agency and European Commission.

Figure 7 : Fuel price variation components - Diesel 1999-2000



Source : own calculations from International Energy Agency and European Commission.

3. SIMULATION OF THE EFFECT OF FUEL PRICE VARIATIONS

3.1. Description of the model and the base case

The TREMOVE model was developed for the Auto-Oil II Programme. It is a partial equilibrium model for the transportation sector, which includes ten sample cities (Berlin, Cologne, Athens, Madrid, Lyons, Dublin, Milan, Utrecht, Helsinki and London) in nine Member States. TREMOVE is used to simulate the effects of various types of policy measures on the key factors driving transport emissions. The model also determines the costs to society (see below) of transportation at a new equilibrium point and calculates direct and induced emissions reduction effects. The latter may occur when policy options significantly upset the price structure of currently used transport modes (including road, rail and waterway transport for passengers and/or freight).

It may be worthwhile at this stage to highlight the limits of such a model that have to be taken into account in the analysis of the results: On the one hand, elasticities used here are 10-yearelasticities, assuming no important change in behaviour patterns. On the other hand, the model is static: it represents the equilibrium for a given year and assumes that the stock of all means of transport (private and public) is perfectly adapted to the demand for transport.

Box 1 - The calculation of cost to society in TREMOVE

In the Auto-Oil II Programme, the evaluation of the cost-effectiveness of pollutant abatement measures was based on a calculation of the welfare change, or cost to society, calculated with the TREMOVE model.

The concept is measured by changes in consumer surplus (for passenger and freight transport), net changes in tax revenue ("Government") and the Marginal Cost of Public Fund (MCPF).

Consumer surplus is the difference between the willingness to pay of the consumer and what he actually pays. For each change in the demand or supply curve of a transport market, the equilibrium point will be changed, and the welfare cost will be the sum of changes in monetary cost and time cost (that vary in opposite direction) for remaining users, and the lost welfare of the diverted users.

Basically, for the passenger car market, the welfare cost will depend on the slope of the demand function and the speed-flow relationship. The less price-elastic the demand curve is, the less car users can switch to other options and the higher will be the welfare cost. Relative prices in the different transport market (i.e. private/public passenger transport) will be transferred to the demand functions, using 'utility trees', with elasticities of substitution between modes.

The Marginal Cost of Public Fund (MCPF) takes into account the fact that, for instance, an increase in transport taxes is not used to reduce labour taxes. That means that the real wage has been reduced and that implicitly the labour tax has been increased, causing an efficiency loss.

Finally, the monetary value of noise and accident, produced by the new levels of traffic, can be computed as 'side-effects', and used to lessen the absolute value of the changes in the cost to society. The TREMOVE simulation does not provide the monetary value of the impact in air pollutant emission. It is possible anyway, using data from other sources, to estimate the value of the increase in NOX, VOCs, PM and CO_2 emissions.

To conclude, we should remember the geographical scope of the calculation of cost to society is limited to the EU: welfare variations in external countries (e.g. OPEC countries) are not taken into account.

The TREMOVE base case (See Annexe 1 for detailed information and references) describes, in qualitative and quantitative terms, annual changes in transport demand, vehicle stocks, generalised price components and road transport emissions from 1990 to 2020. This base case will be used as a reference to which two opposite scenarios of variations in oil prices will be compared, in terms of environmental impact and cost to society. The main assumptions/criteria taken into account in the base case are:

- A medium term growth rate of GDP around 2.4%

- Changes in vehicle technology and fuel specification due to the enforcement of the first Auto-Oil Programme and the voluntary agreement with passenger car makers to reduce CO_2 emissions by 2008 (e.g. improvements of fuel efficiency of 1.3% per year until 2003, 3.5% per year between 2003 and 2008 and 1% per year thereafter, very low sulphur fuels to be mandatory from 2005, etc.)

- Stability of the net fuel prices at their September 1996 level (ca. 20$/barrel), and some changes in fuel taxation (mainly in the United Kingdom with an annual increase of fuel excise duties).

3.2. Simulation of the effects of a permanently lower oil price

To reflect the situation where the oil market price was around 10$/barrel (March 1999) and the exchange rate $/€ was around 1.16, a decrease of 35% in the fuel price at the pump level (without VAT and excise duties) was chosen as compared to the base case of the Auto-Oil II Programme. This decrease corresponds to a decrease in the price of crude oil by about 47%, and an appreciation of the exchange rate of the US$ by about 13%, as described previously. It is supposed that there is no additional domestic component contributing to a variation in fuel price, except the automatic VAT effect.

Keeping excise duties, VAT rates and the mark-up component unchanged, this gives an average variation of the final fuel price at the pump of -11.7% for Eurosuper and -14.3% for diesel, due to the different taxation levels. Using the TREMOVE model, a scenario has been simulated, that was based on this new net price (identical for the nine countries studied) maintained during the 2000-2020 period, and on the corresponding decrease in the final fuel prices. The impacts presented here are calculated for the year 2010, compared with the base case situation.

Firstly, for the nine countries taken all together, the average transportation cost would decrease by 2.8%, given that fuel prices, net of taxes, constitute only around 6.0% of the total transportation cost. Total fuel costs, however, on average account for 22.6% of total transportation cost. The percentages vary widely according to the vehicle type and the country. For the same net fuel price variation there is a relatively wide range of different country impacts in transportation cost, ranging from -2.1% in the UK to -3.7% in Ireland (Figure 8). The difference in the level of fuel taxation partly explains such divergence. However, there are also other structural factors such as the resource cost (vehicle purchase, maintenance, insurance) and the composition of the fleet (vehicle type and fuel). These structural factors will be identified for each country in the last chapter of this section.

According to the model, this decrease in transport cost would trigger a 0.6% increase in road transport demand, for the nine countries taken as a whole. Ireland is the most sensitive (+0.9%) to the variation of oil prices, whereas demand in France and the United Kingdom would react less sensitively (+0.5% and +0.4% respectively).

The different changes in transport demand between modes respond to the combination of price elasticities and elasticities of substitution. For passenger transport, the high price elasticity for passenger cars adds to the also high substitution elasticity in public transport modes, leading to a decrease in demand for public transport (buses). In freight transport, the price elasticity of demand for light trucks is combined with the elasticity of substitution towards heavy trucks, leading to an apparent price inelasticity in the demand for light trucks to the transportation cost. This effect will also be observed for the second scenario (increase of fuel prices).

Overall fuel consumption increases by 1.03%, more than the increase in transport demand. There is a switch towards less fuel-efficient vehicles as the decrease in oil prices reduces demand for more fuel-efficient vehicles (small cars, diesel, LPG). Moreover, the lower the taxation level, the more important will be the variation in net fuel prices in the decision to scrap an old vehicle and buy a new vehicle.

Logically, such transformation in transport demand increases air pollutant emissions which are higher than the increase in road transport demand for eight of the nine pollutants analysed (Table 3): it is worth mentioning CO_2 emissions, which are strongly correlated with fuel consumption. The growth in both variables is superior to the growth in transport demand, as fuel efficiency decreases over the period, due to a combination of factors: increase of less fuel efficient urban road transport demand, decrease in the share of diesel passenger cars, etc. This decrease in the share of diesel passenger cars is the key explanation for the low increase of the emissions of PM (+0.5%)

The results of the simulation on cost/benefit to society (Figure 9) show how the variation of its main component, the monetary cost of transport (fuel cost and tax, and resource cost and tax), is partially offset by other components, mainly changes in travel time cost, impact in revenue for public finance and side effects (noise and accidents). The average decrease in the monetary cost of transport is about 2.7%, ranging from -1.9% (UK) to -3.6 (Spain). The inclusion of all the other components of the cost to society reduces the welfare gain by more than 25%.

The inclusion of the cost of the increase in pollutants emissions[6] would represent an added cost to society of €481 million, that would have been higher if all the pollutants had been computed: this represents 1.5% of the variation of cost to society.

Two-thirds of the welfare gain due to the decrease in fuel price come from passenger transport. The changes in the cost to society are not distributed between agents in the same way in the nine countries: in Germany and Italy, 80% of the variation of the cost to society is related to passenger transport, whereas in Greece and Spain the weight of freight transport in the welfare increase is 45% and 38% respectively.

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[6] Only four of the nine pollutants included in Auto-Oil II Programme are included in the monetary valuation. For NOx, VOCs and PM emissions the values provided by ExternE research project (European Commission - DG Research (1999)) were used, and for CO_2 emissions, the price of permit in an intra-EU trade for CO_2 was used, which, according to the sector objectives study (European Commission - DG Environment (2001)), is €20 per tonne of CO_2.

Note: All the graphs and tables below are based on own calculation resulting of TREMOVE simulations

Figure 8: Changes in total transport cost - First Scenario

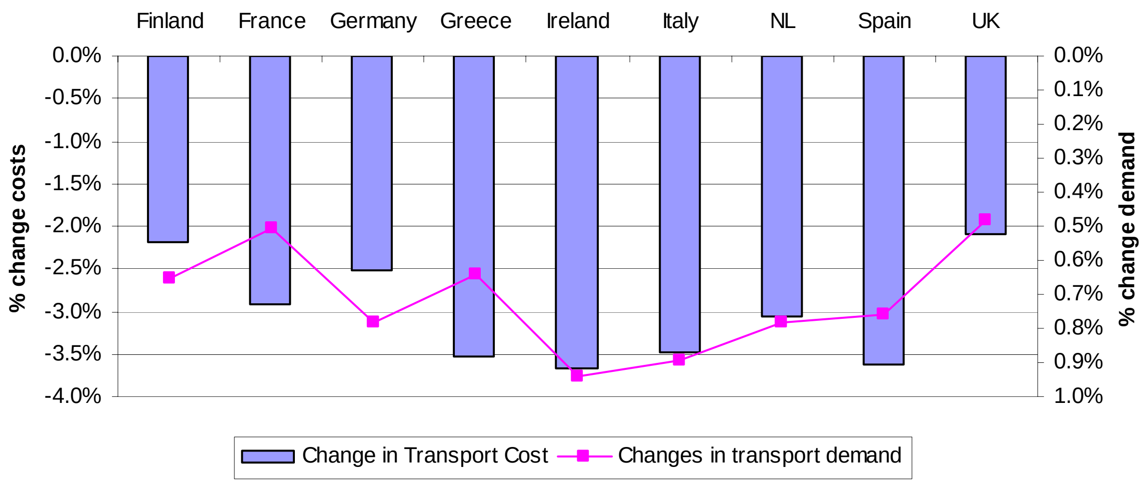
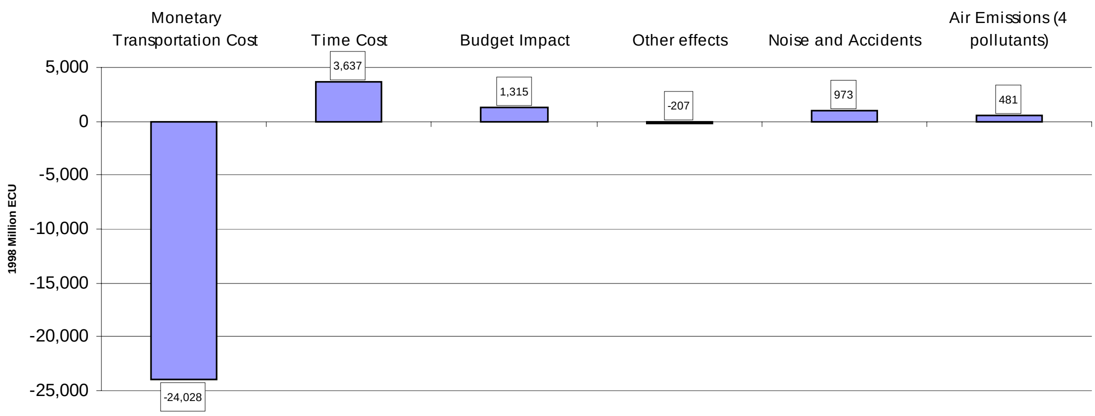


Table 3: Changes in air pollutant emissions (% change from base case - First Scenario)

Impact on emissions	FIN	F	D	EL	IRL	I	NL	E	UK	Total
CO	1.1%	1.6%	1.7%	1.4%	2.3%	1.4%	1.5%	1.8%	1.5%	1.5%
NOx	1.0%	1.3%	1.2%	1.2%	1.5%	1.4%	1.4%	1.5%	0.8%	1.2%
PM	0.8%	0.4%	0.2%	1.0%	0.6%	0.7%	0.5%	1.1%	0.2%	0.5%
Benzene	1.1%	1.2%	1.5%	0.9%	2.2%	1.1%	1.5%	1.4%	1.4%	1.3%
VOC	1.1%	1.2%	1.5%	0.9%	2.0%	1.1%	1.4%	1.5%	1.2%	1.3%
NMVOC	1.1%	1.2%	1.5%	0.9%	2.1%	1.1%	1.4%	1.5%	1.3%	1.3%
Methane	1.3%	1.2%	1.1%	0.9%	1.3%	0.8%	1.2%	1.3%	0.9%	1.0%
SO2	1.1%	0.9%	1.1%	1.2%	1.3%	1.3%	1.5%	1.4%	0.8%	1.1%
CO2	1.1%	0.9%	1.1%	1.1%	1.3%	1.1%	1.2%	1.3%	0.8%	1.0%
Fuel Consumption	**1.1%**	**0.9%**	**1.1%**	**1.1%**	**1.3%**	**1.1%**	**1.2%**	**1.3%**	**0.8%**	**1.0%**

Figure 9: Components of the cost to society (Total 9 Countries - First Scenario)



3.3. Simulation of the effects[7] of a permanently higher oil price

To reflect the situation in autumn 2000 with a market price of oil of about 30$/barrel, and a € being worth 0.95$, an increase of 86% of the net fuel price at the pump level was simulated, as compared to the Auto-Oil II Programme base case scenario. As in the previous scenario, the variation relates to the crude oil price component, and the average value of the US$ exchange rate component as described in the first section of this note. As in the previous scenario, there is no variation in domestic fuel price components, except the automatic VAT effect. The main results are presented below, thus allowing comparisons with the first scenario.

According to these assumptions, the final fuel price increases by 29.5%. The lowest variation is registered in the UK (+19.5%), and the highest in Spain (+37.5%). For the nine countries taken together, the transportation cost would increase by 6.8%, with (Figure 10) a broad range of variation between +5.1% (UK) and +9.0% (Spain).

As a consequence of higher transport costs, road transport demand would be 1.4% lower on average. Ireland is the most sensitive (-2.0%) to the oil price variation, whereas the UK registers the smallest decrease in total road transport demand (-0.9%)

Higher prices result in a significant reduction in the size of the car fleet (-1.9%), mainly at the expense of gasoline cars and heavy trucks, while the number of light trucks remains almost stable and the share of more fuel efficient diesel cars grows significantly. As a result of this process, the overall fuel consumption is simulated to be 2.4% lower. This indicates an increase of apparent fuel efficiency, as the reduction of road transport demand would be only -1.4%. This is due to several factors, like the increased use of more fuel-efficient diesel and LPG vehicles, the reduction in private urban transport demand, the decrease in the congestion level, etc.

As expected, the transformation of the transport demand structure induced a decrease in pollutants emissions (Table 4). As commented on in the previous scenario, the variation is higher (in absolute value) than the decrease in transport demand, with the exception of PM, because of the growing diesel share.

Symmetrically to the first scenario, three components of the cost to society (the decrease in travel time cost due to less road congestion, the increase of taxation resources, and the decrease of external effects such as noise and accidents) offset almost 27% of the increase of the monetary cost of transport (Figure 11).

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7 Detailed results of the TREMOVE simulations performed are included in Annexe 3.

Figure 10: Changes in total transport cost - Second Scenario

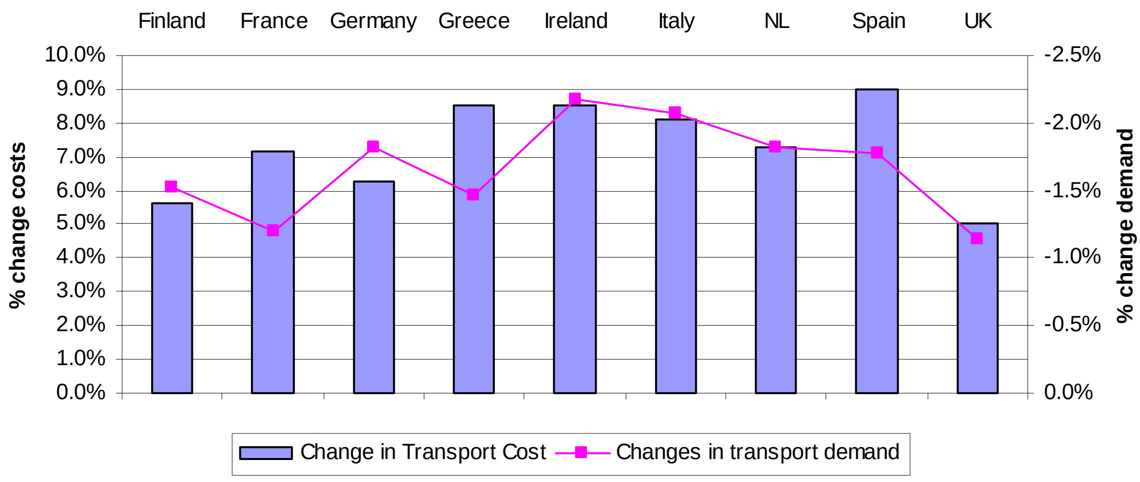
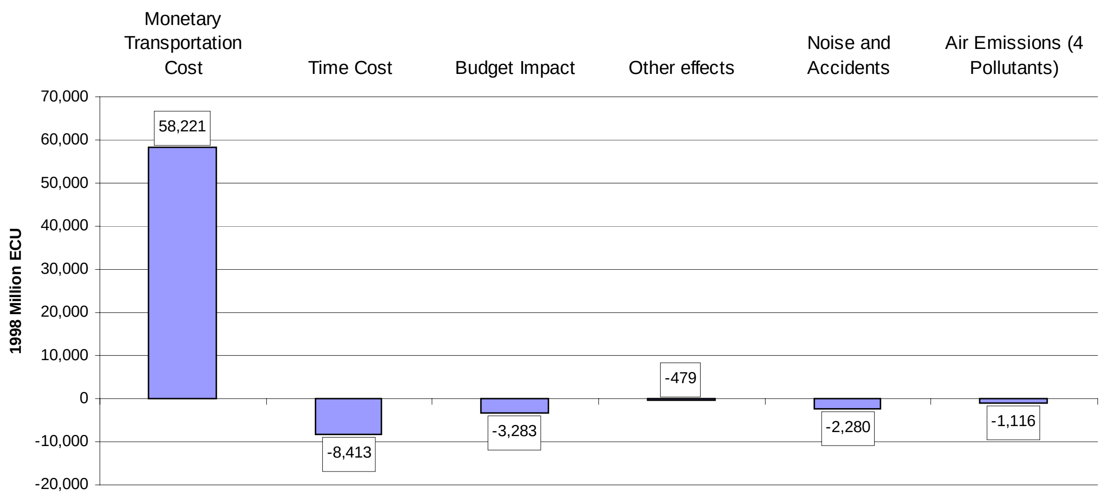


Table 4: Changes in air pollutant emissions (% change from base case - Second Scenario)

Impact on emissions	FIN	F	D	EL	IRL	I	NL	E	UK	Total
CO	-2.5%	-3.7%	-3.9%	-3.2%	-5.2%	-3.2%	-3.5%	-4.2%	-3.4%	-3.6%
NOx	-2.6%	-3.0%	-2.7%	-2.8%	-3.3%	-3.1%	-3.0%	-3.5%	-1.9%	-2.8%
PM	-1.4%	-1.0%	-0.3%	-2.3%	-1.3%	-1.5%	-1.0%	-2.4%	-0.3%	-1.0%
Benzene	-2.4%	-2.9%	-3.6%	-2.0%	-4.9%	-2.6%	-3.4%	-3.3%	-3.2%	-3.0%
VOC	-2.2%	-2.8%	-3.4%	-2.1%	-4.6%	-2.6%	-3.1%	-3.4%	-2.9%	-2.9%
NMVOC	-2.3%	-2.8%	-3.5%	-2.0%	-4.7%	-2.6%	-3.2%	-3.4%	-2.9%	-3.0%
Methane	-3.1%	-2.8%	-2.4%	-2.2%	-2.8%	-1.8%	-2.7%	-2.8%	-2.1%	-2.4%
SO2	-2.7%	-2.2%	-2.6%	-2.7%	-3.1%	-3.0%	-3.4%	-3.3%	-2.0%	-2.6%
CO2	-2.6%	-2.1%	-2.5%	-2.5%	-3.0%	-2.6%	-2.9%	-3.0%	-1.8%	-2.4%
Fuel Consumption	**-2.5%**	**-2.1%**	**-2.5%**	**-2.4%**	**-2.9%**	**-2.6%**	**-2.8%**	**-3.0%**	**-1.8%**	**-2.4%**

Figure 11: Changes in cost to society (including side effects - Second Scenario)



3.4. Factors explaining the differing results between countries

As the above simulations show, the variations in emissions caused by identical absolute price shocks are slightly divergent for the nine Member States analysed. This difference can be explained by five factors: (1) the taxation level, (2) the fuel mix of the vehicle stock, (3) a different impact of fuel prices on transport cost and on transport demand, (4) changes in fuel efficiency and (5) the impact of transport demand on emissions

(1) Different levels of fuel taxation will induce divergences in increases of fuel price at the pump, which further explains a large part of costs variation and behaviour changes. The same absolute variation in the fuel price exclusive of tax is translated into a broad range (see Table 5) of final consumer prices, ranging from 8% for the UK to –15.4% for Spain in the first scenario, and from +19.5% for the UK and +37.5% for Spain in the second scenario.

(2) The differences in fuel mix an additional factor for explaining the differing results between countries. The fuel mix in the vehicle stock will act as relevant smoother of the price shock when the stock is biased toward gasoline and the taxation gap between fuels is low. This is the case, for instance, for the UK. The opposite is the case in France, where the diesel share is 63.2%, and the taxation level of diesel is 8.4 percentage points below that of gasoline.

(3) Changes in monetary transport cost and transport demand are calculated by TREMOVE. The process is a combination of the definition of an equilibrium point in the transport market, through changes in the generalised cost[8] of each mode, and a progressive adjustment of the vehicle stock (growth of motorization, choice between fuels and vehicle types, etc.). For the same variation in monetary cost, the transport demand variation can be up to 60% higher in one country than in another (Netherlands vs. France, Italy vs. Greece) (Figure 12 for the 2nd scenario). This is the result of a complex process, whose main elements are the following:

    (a) The fuel component for monetary cost of road transport (Table 6) is not of equal relevance in all the countries analysed, nor between passenger and freight transport. While the range of variation is quite narrow for passenger cars (from 19.0% in Finland to 24.4% in Italy), it is very wide for trucks, ranging from 14.5% in Finland to 42.7% in Italy. In the case of Finland, Spain and Greece, the effect of fuel price variation is amortised by other components of transport cost, like purchase, maintenance and insurance.

    (b) The model calculates, using a utility tree for passenger transport, and a production function for freight transport, the price elasticity of each mode, using substitution elasticities between modes or between transport and other goods and services, and the demand and prices in the new situation. As the elasticities used in the model are the same for the nine countries, the structure of the road transport demand will be a relevant factor

[8] Sum of the monetary cost of transport and other components like travel time, quality of service, etc. using monetary values.

explaining the differing results between countries. The apparent relationship (Figure 13) between transport cost and demand variations is stronger for small cars and motorbikes than for small and big trucks. In countries where the freight component of the road transport demand is higher (Figure 14), this will lead to a rigidity of the reaction of transport demand to the variation in fuel costs exacerbating the positive or negative welfare impacts of price shock. This is the case for Greece, France and Spain.

(c) The changes in fuel prices do not lead to significant changes in the modal split. On average, the share of passenger cars increases by 0.14% in the 1st scenario, and decreases by 0.35% in the 2nd scenario. For freight transport, the effect is greater, +0.36% and -0.86% respectively. In countries where the modal split is less biased towards road transport, the modal shift is higher. This is the case in Greece for passenger transport, and in Finland and the Netherlands for freight.

(4) Changes in the vehicle stock, improvements in the loading factor and reductions in congestion lead to an improvement in fuel efficiency, calculated as the ratio total fuel consumption to total transport demand in vehicle.km in the second and vice versa on the first scenario. In the second scenario, for example, the apparent fuel efficiency improves by 0.87% in Spain, while in Greece the improvement is only about 0.28% (Figure 15).

(5) Finally, emissions are calculated in the TREMOVE model with the COPERT module. The changes in emissions differ broadly between countries and between pollutants (see above Tables 5 and 8): CO_2 emissions are considered in the model as strictly proportional to fuel consumption, while the emissions variation for particulate matter (PM) is higher - in absolute terms - than the fuel consumption variation. This is due to the shift towards diesel observed in the case of a fuel price increase, and to the symmetrical process in the first scenario. Conversely, the variation of CO, C_6H_6, VOC and NMVOC is lower - in absolute terms - than the fuel consumption variation, and also strongly correlated with the shift towards/from diesel.

Table 5 : Variation of the customer fuel prices at the pump level due to the same variation in the price exclusive of tax[9]

Variation of the net fuel price	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK
-35.2% Average	**-13.0%**	**-11.4%**	**-12.9%**	**-14.9%**	**-15.1%**	**-12.9%**	**-13.4%**	**-15.4%**	**-8.0%**
Eurosuper	-10.9%	-9.1%	-11.5%	-14.1%	-14.2%	-11.7%	-11.6%	-14.2%	-7.9%
Diesel	-16.4%	-12.7%	-15.1%	-15.5%	-16.1%	-13.5%	-15.3%	-16.2%	-8.1%
+85.8% Average	**31.7%**	**27.7%**	**31.3%**	**36.4%**	**36.8%**	**31.5%**	**32.5%**	**37.5%**	**19.5%**
Eurosuper	26.6%	22.2%	27.9%	34.4%	34.5%	28.6%	28.2%	34.6%	19.2%
Diesel	40.0%	30.9%	36.8%	37.8%	39.3%	32.9%	37.3%	39.6%	19.8%

Figure 12: Impact of the Fuel price Variation in Transport Cost and Demand

Second Scenario (86% Increase in net fuel price)

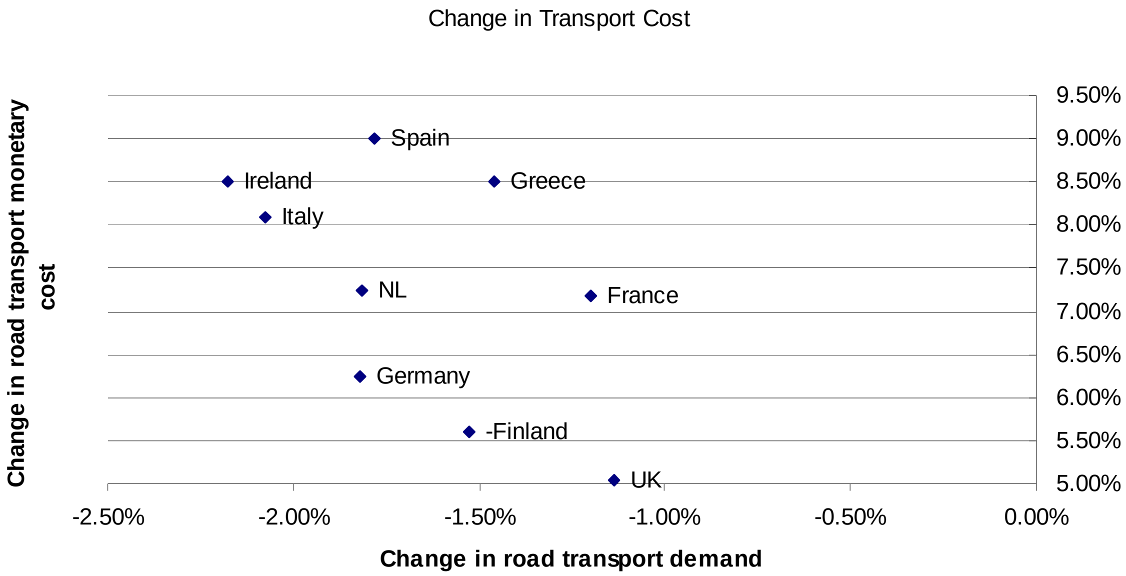


Table 6: Fuel price component in the road transport monetary cost

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK
Passenger Car (Average)									
Fuel Cost	4.9%	5.3%	5.7%	7.6%	6.7%	7.0%	5.7%	7.4%	4.1%
Fuel Tax	14.1%	17.6%	14.1%	14.6%	13.2%	17.5%	13.5%	13.4%	19.7%
Total Fuel	***19.0%***	***22.9%***	***19.7%***	***22.2%***	***19.8%***	***24.4%***	***19.2%***	***20.8%***	***23.8%***
Resource Cost	53.5%	67.7%	71.0%	61.2%	58.3%	64.5%	53.8%	67.4%	65.7%
Resource Tax	27.5%	9.4%	9.2%	16.7%	21.9%	11.1%	26.9%	11.8%	10.5%
Truck (Average)									
Fuel Cost	5.2%	9.3%	10.5%	8.3%	13.8%	13.4%	10.3%	6.0%	6.8%
Fuel Tax	9.3%	22.5%	18.4%	15.5%	22.9%	29.3%	18.8%	9.6%	32.7%
Total Fuel	***14.5%***	***31.8%***	***29.0%***	***23.9%***	***36.7%***	***42.7%***	***29.1%***	***15.7%***	***39.6%***
Resource Cost	75.4%	65.4%	68.9%	66.0%	50.3%	56.4%	64.5%	81.9%	56.2%
Resource Tax	10.2%	2.7%	2.1%	10.1%	13.0%	0.9%	6.4%	2.5%	4.2%

[9] Weighted average, calculated with the mix in the vehicle stock (see 3.4.(2))

Figure 13: Variation in transport cost and demand by modes (Second Scenario)

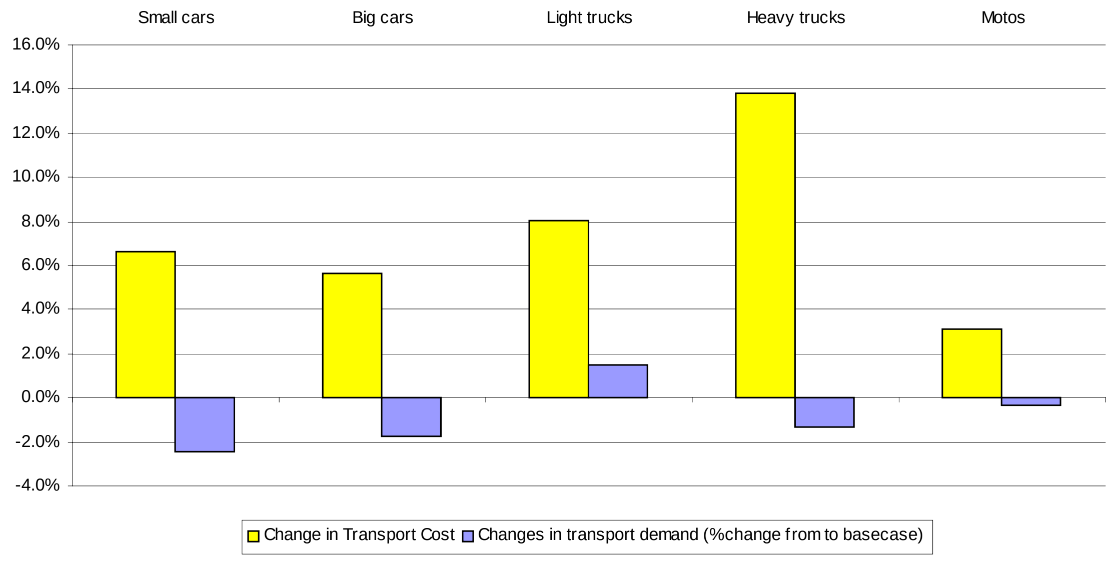


Figure 14: Composition of Road Transport Demand (Base Case)

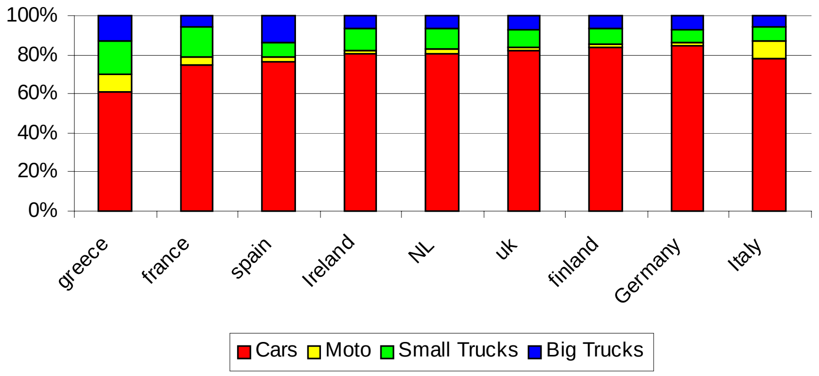
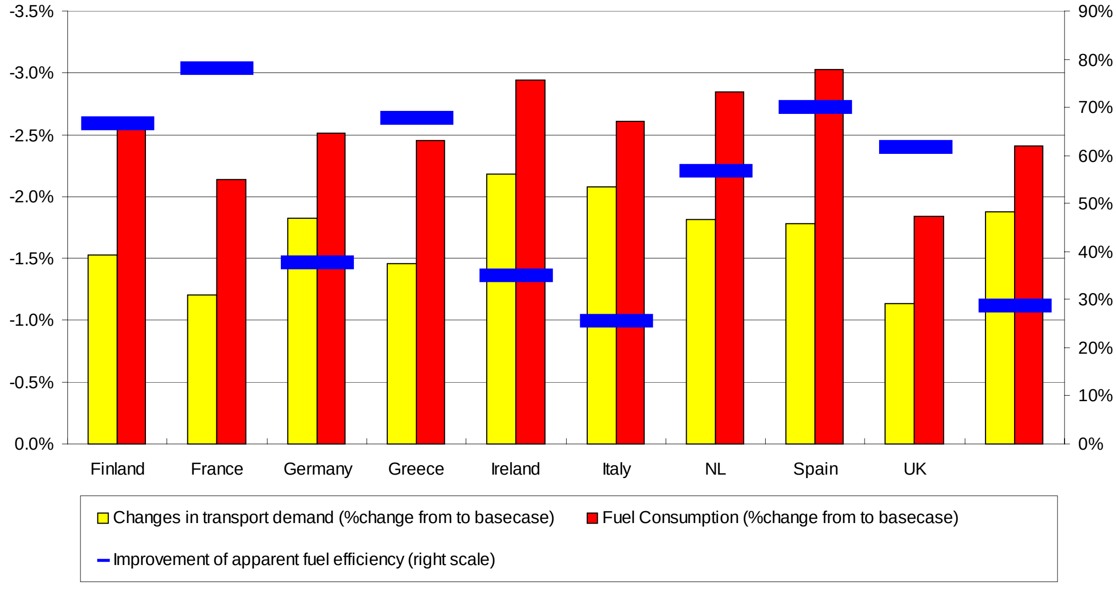


Figure 15: Improvement in the apparent fuel efficiency (Second Scenario)



4. COMPARISON WITH A FUEL PRICE INCREASE DUE TO TAXATION

4.1. Comparison of fuel price increase with the Energy Tax proposal

Using the period of price increase 1999-I to 2000-II, it is interesting to compare the effect of the increase in crude oil price (combined with the other fuel price variation components as explained above), with the increase in the final fuel price that would have been produced, *mechanically*, by the implementation of minimum excise duties proposed in the European Commission Energy Tax Proposal (COM(97)30).

The Commission Proposal foresaw for 1998 an increase in minimum excise duties[10] to €417/1000l for unleaded petrol, and to €310/1000l for diesel, followed by a second rise in 2000 to €450/1000l for unleaded petrol and €343/1000l for diesel, and a third rise in 2002 to €500/1000l for unleaded petrol and €393/1000l for diesel.

Supposing no change in the other fuel price variation component occurs in the same period, Figure 16 and Figure 17 show that for both fuels and for every country, the mechanical effect of the energy tax proposal on the final fuel price at the pump would have been less than the effective increase registered in the last two years. This is true for both 2000 and 2002 levels.

The only exception is for diesel in Portugal, where - for 2002 levels - the effect of the energy tax proposal would have been higher than the effective increase registered. But it is worthwhile to remember that for this period, Portugal significantly reduced its excise duties. It is therefore possible to conclude that the effect of the implementation of minimum excise duties (at both 2000 and 2002 levels) of the energy tax proposal would have been lower than the effects of non fiscal components of the fuel price variation in the period 1999-2000, which included a sharp reduction in mark-ups of fuel prices provided in the light of soaring input prices.

Moreover, it can be added that the revenue raised by the excise duties would stay and be recycled into the economy of the Member States, while part of the increase in the monetary cost of transport due to the increase in crude oil price goes outside of the EU-15 economy.

[10] Council Directive 92/82/EEC of 19 October 1992 on the approximation of the rates of excise duty on mineral oils sets the minimum rates to be applied on 1 January 1993 as follows (ECU/1 000 litres): unleaded petrol: ECU 287, diesel: used as a propellant: ECU 245

Figure 16: Fuel price variation components - Eurosuper 1999-2000 - Comparison with Energy tax proposal effects

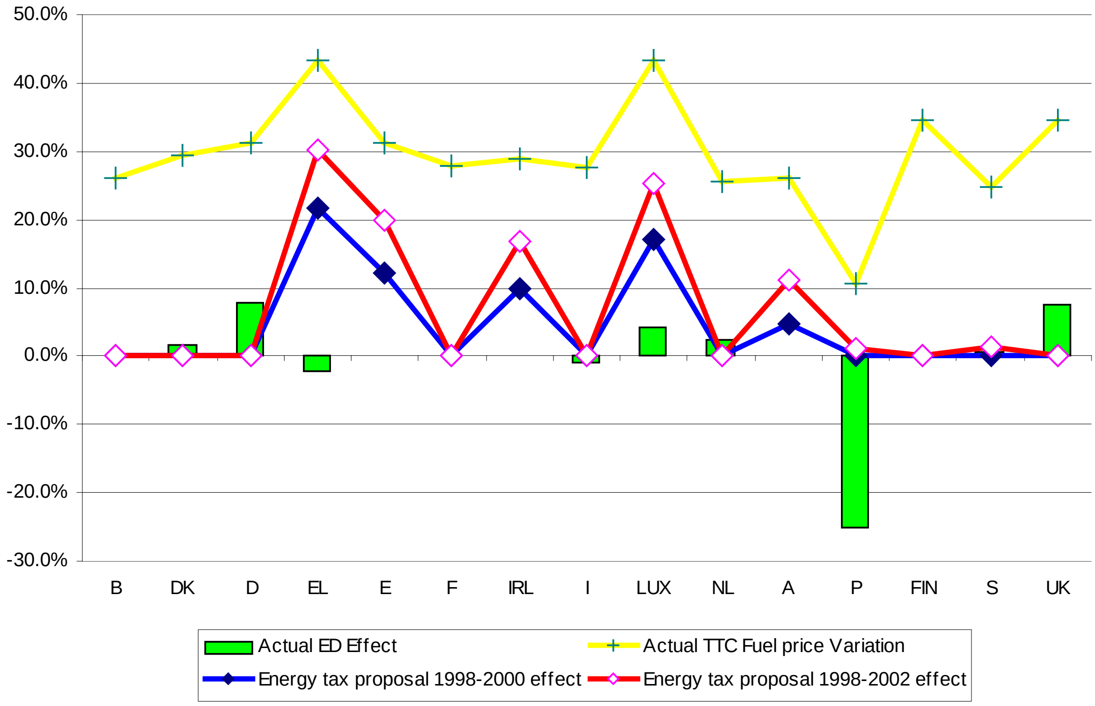
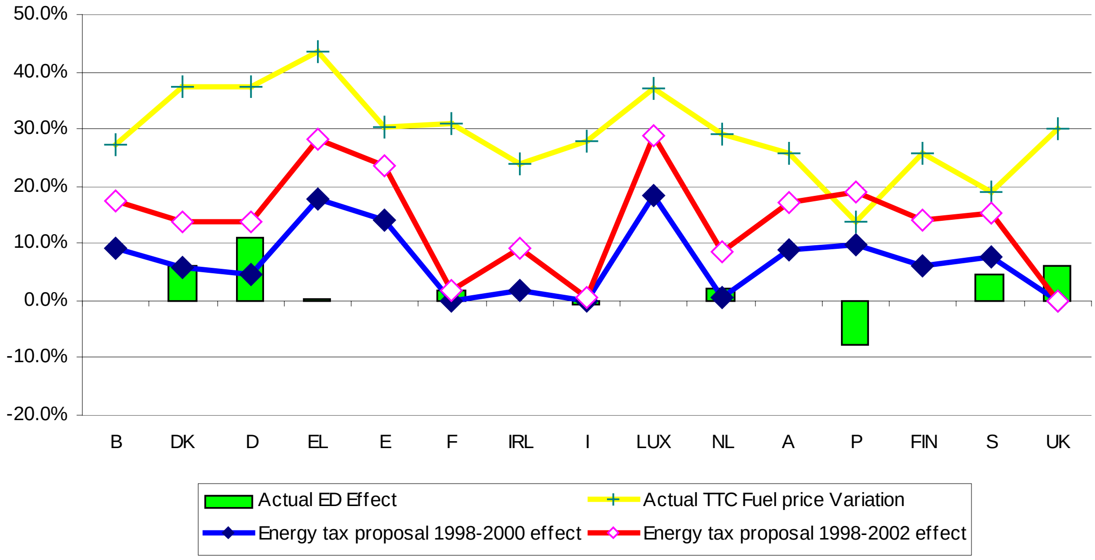


Figure 17: Fuel price variation components - Diesel 1999-2000 - Comparison with Energy tax proposal effects



4.2. Comparison with the effects of an equivalent increase in excise duties

In the context of the debate on the energy tax proposal, it could be worthwhile to compare the second scenario (increase in 85.9% of the fuel price before tax) with an increase in the excise duties that would lead to a similar increase in the fuel price at the pump level.

We present here the assumptions of the new scenario and the main results in terms of impact in transport demand, cost to society and pollutant emissions, compared with the scenario "+85.9% in fuel price before tax".

The strong difference between the two scenarios is due to the existence of an 'income effect', based on fiscal revenues from the increase in excise duties, that are partially recycled in transport demand, boosting road transport demand and leading to a smaller decrease in pollutant emissions.

The scenario, called "T3" in reference to the "T2" scenario of the Auto-Oil II Programme11, includes an increase in excise duties, that would lead to the same price increase (for gasoline and diesel) as an increase of 85.9% in the fuel price before tax (due to external factors like crude oil price or exchange rate). The simulation leads to very different results compared with the 'exogeneous' fuel price increase.

On the side of passenger demand, the decrease is lower, and complemented by a strong increase in bus transport (Figure 18). Conversely, the increase in excise duties leads to stronger performance by freight transport, 2 percentage points below the 'exogeneous' scenario.

The examination of the cost to society and its decomposition provides essential information for understanding this difference between the scenarios. The increase in excise duties leads to a substantial increase in fiscal revenues (Figure 19). This 'benefit to society' is partially, by model assumption, returned to households and taxes cannot be fully counted as costs. This relies on a strong hypothesis that the revenue is recycled into a reduction in labour taxes. However, the model takes into account the 'marginal cost of public funding (MCPF), i.e. the proportion of the increase in transport taxes that is not used to reduce labour taxes and means that the real wage has been reduced and that implicitly the labour tax has been increased.

Due to the increase in household income, the demand for passenger transport is boosted, and the final decrease in demand, expressed in passenger.km, is lower than for the 'exogenous' scenario (-0.69% instead of -0.93%)

This leads to a lower improvement in the external costs of transport: the decrease in pollutant emissions (Figure 20) is lower than for the exogenous scenario (except for PM, due to the stronger decrease in road freight demand). The cost for consumers and freight transport is also higher than for the 1st scenario, due to higher travel times.

The comparison between the two scenarios must however take into account that the results rely on some assumptions or structural features in the TREMOVE model, relative

11 That included the implementation in 2005 of the Energy Tax proposal at its 2002 level, +50%

to the welfare impact of the revenues raised through excise duties, compared with an 'exogenous' shock:

- The income effect from the tax revenue depends essentially on the ways of recycling excise duties revenues. This could be reviewed in the light of 'real life' experiences, like the strong increase in excise duties in the UK, and testing alternative recycling policies.

- As the production level is kept constant, and therefore not influenced by the fuel price, there is no ‘activity effect’ (income effect) on freight transport. However, a drastic welfare variation would in any case affect the total production level.

- For the 'exogenous' scenario, the profits from higher fuel prices are partially recycled into the domestic economy (e.g. profits of fuel production and distribution firms), leading to a smaller income effect that should be take in account.

These issues have been submitted as a contribution to the review of the TREMOVE model, currently performed by the European Commission, DG Environment.

Box 2 - Optimal policy-mix: the LEUVEN II tools

In order to define a cost-effective package of the measures defined by the Auto-Oil II Programme, the DG Economic and Financial Affairs of the European Commission, in co-operation with KULeuven, has developed an optimisation model called LEUVEN II (Local and EUropean Vehicle Emissions Numerical). The model uses information on cost and emission reductions from TREMOVE, to determine the least-cost mix of European, national, and local measures (transport and non-transport sectors) to simultaneously reach local and regional air quality objectives.

In this optimisation process, the effects on national air emissions of a permanently higher oil price (2nd scenario) are transformed into national targets, and LEUVEN II defines a set of national and local measures, picking up in the list of policy measures defined in the Auto-Oil II Programme.

The measures are T2 (Minimum fuel excise duties are set to proposed 2002 + 50% levels by 2005) and TB (Registration tax is replaced by fuel tax duties (fiscal neutrality)), complemented on the one hand by other national measures [DQ3 (Changes in diesel specification aimed at reducing PM and PAH content), IM1 (Improved testing of Euro 1&2 vehicles), DI (Measures for Motorcycles: Direct injection (2-stroke) + oxidation catalyst (4-stroke))], and on the other hand by local measures for Lyons (parking charge and time-differentiated road charging) and for Athens (reduced public transport fares, parking charges, and scrapping schemes for HGV and buses).

The optimal policy mix selected by the LEUVEN II tool could be implemented with a total negative cost (benefit), if fines for target underachievement are not taken into account. As mentioned above, the T2 scenario generates substantial positive cash flows for the government budget, that are assumed to be recycled into the economy, thus inducing significant benefits for the global welfare of the society, benefits which in turn are not necessarily decreasing global transport demand (and consequently emissions) in all countries. However, rather small underachievement is encountered for a large number of country/pollutant couples. Therefore, the available Auto-Oil 2 policy measures/scenarios (including the tax scenario T2 which applies a 50% increase by 2005 to the 2002 levels of the Community minimum fuel excise duty rates) are not sufficient to reach the effects on national air emissions of a permanently higher oil price around 30$/barrel.

In a second optimisation process, to improve the results, the new global tax scenario “T3” has been introduced, in addition to the Auto-Oil 2 scenarios. By selecting T3 instead of T2, better results are reached: total gross benefit increases by 5% and fines decrease by 54%. For CO_2, only Ireland and Spain experienced a very slight increase in emissions. We now get over-achievement for VOC in Ireland and NOx in the United Kingdom. All the other effects, for which there was underachievement in the first scenario, increase so that the underachievement becomes negligible in the majority of the cases.

Figure 18: Comparison variation of road transport demand (9 countries)

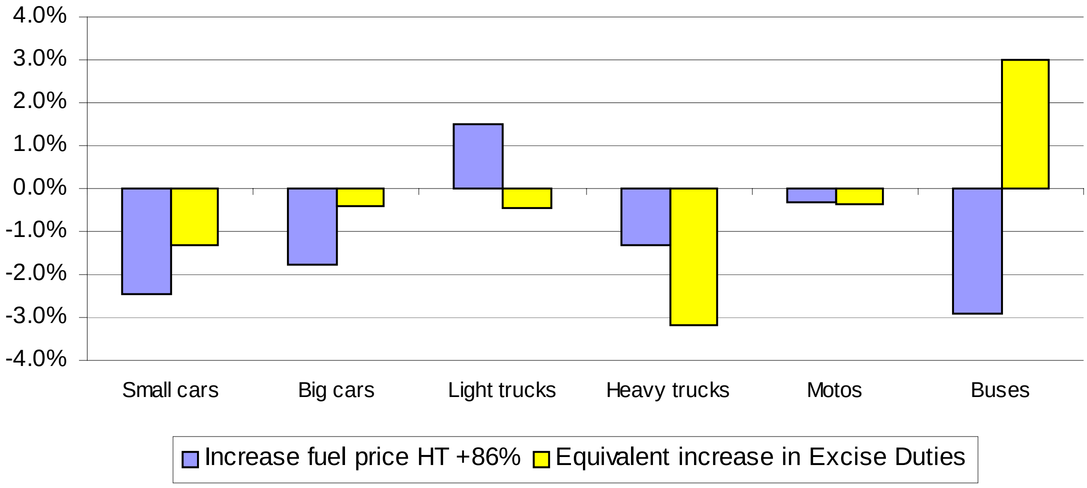


Figure 19: Comparison variation cost to society and its components (9 countries)

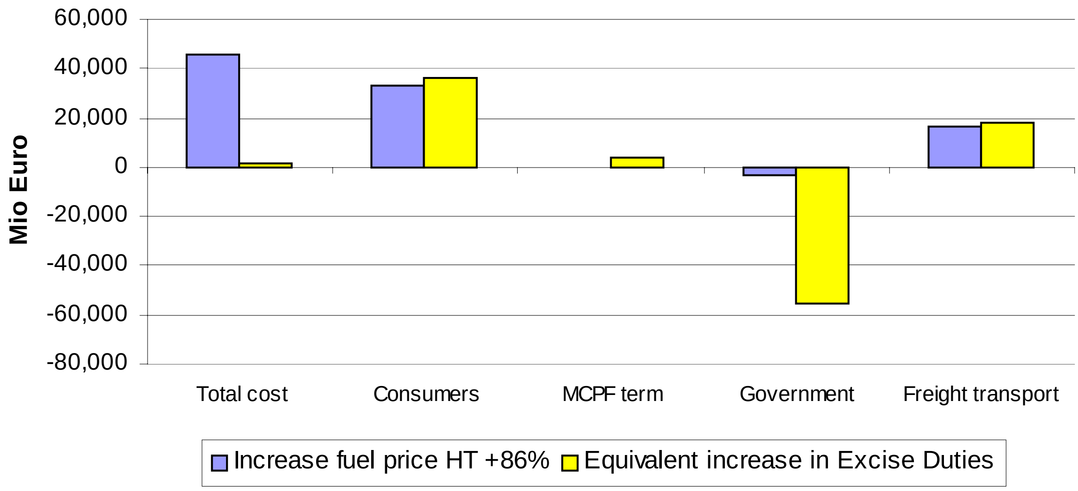
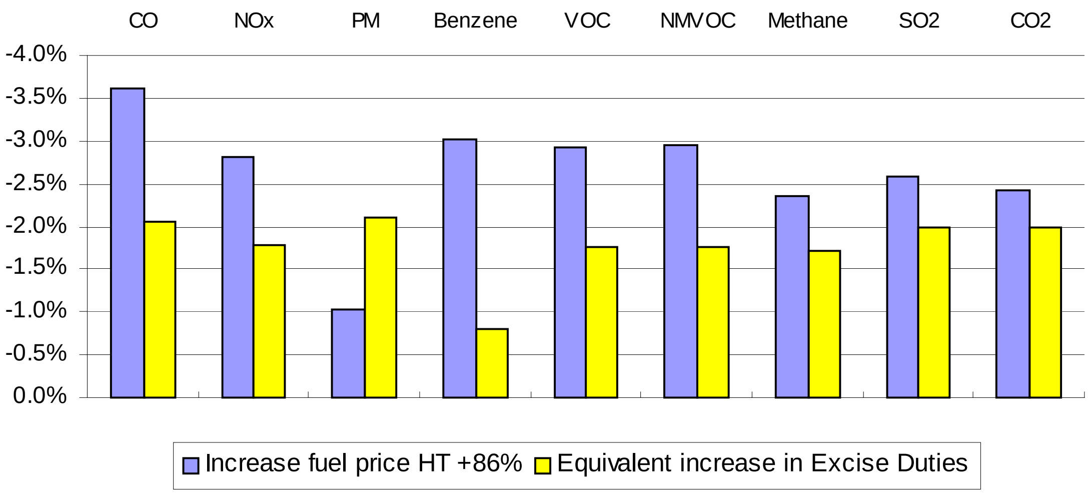


Figure 20: Comparison decrease in pollutant emissions (9 countries)



5. CONCLUSIONS

The high levels of fuel taxation in Member States can be considered as the main absorber of oil price shocks: an average 86% increase in the net fuel price translates into a 32% increase in fuel price at the pump level in Spain, and only a 18% increase in the UK, where VAT and excise duties account for 80.4% of the price at the pump. On the other hand, a decrease by 35% of net fuel price leads to a 15% decrease of final fuel price in Spain, and only an 8% decrease in the UK.

The oil price shock is not absorbed in an identical way by the national transportation systems: for the same variation in cost, the adjustment of demand is 60% lower in France than in the Netherlands, resulting in higher costs to society.

The main adjustment factors - for an increase in fuel price - are the decrease of transportation demand (in vehicle.km) and an improvement in fuel efficiency (through more fuel-efficient vehicles and the reduction of congestion).

The changes in fuel prices do not lead to important changes in the modal split. For the nine countries together, the share of passenger cars increases by 0.14% in the 1st scenario, and decreases by -0.35% in the second scenario. For freight transport, the effect is more important, respectively +0.36% and -0.86%.

In the end, the resulting cost to society variation (compared with total transportation cost) is small: for the 35% decrease in net fuel prices (see Figure 21), the monetary transport cost would decrease 2.8%, and the impact in welfare is lower, taking into account the increase in CO_2 emissions (+1.04%) and the increase in travel time, side effects and the decrease in taxation revenues for public budget (these three elements together represent 25% of the change in monetary transport cost). For the 86% increase in the net fuel prices (see Figure 22), monetary transport costs increase by 6.8%. This leads to a decrease of 2.4% in the CO_2 emissions, and the same proportional impact as in the first scenario on travel time, pollutant emissions, accidents and noise, and taxation revenues.

A third scenario introducing an increase in excise duties that would lead to a similar increase in the fuel price at the pump level as the second scenario (increase of 85.9% in fuel price before tax) provides a lower welfare cost, due to the existence of an 'income effect', based on the fiscal revenues from the increase in excise duties, which are partially recycled in the transport demand, boosting the road transport demand, mainly for road passenger transport. The latter leads to a smaller decrease in pollutant emissions, but this can be solved by adding complementary measures of fuel quality, inspection & maintenance, and urban road pricing, as optimisation processes with the tool LEUVEN II demonstrate.

Further improvements in the model TREMOVE, currently being carried out at the European Commission, will lead to a more precise evaluation of the impact of variations in components of the cost of transport, like crude oil price, and a better estimation of the costs and benefits of policy instruments like vehicle taxation and infrastructure charging.

Figure 21: Main results of the Simulation - First Scenario

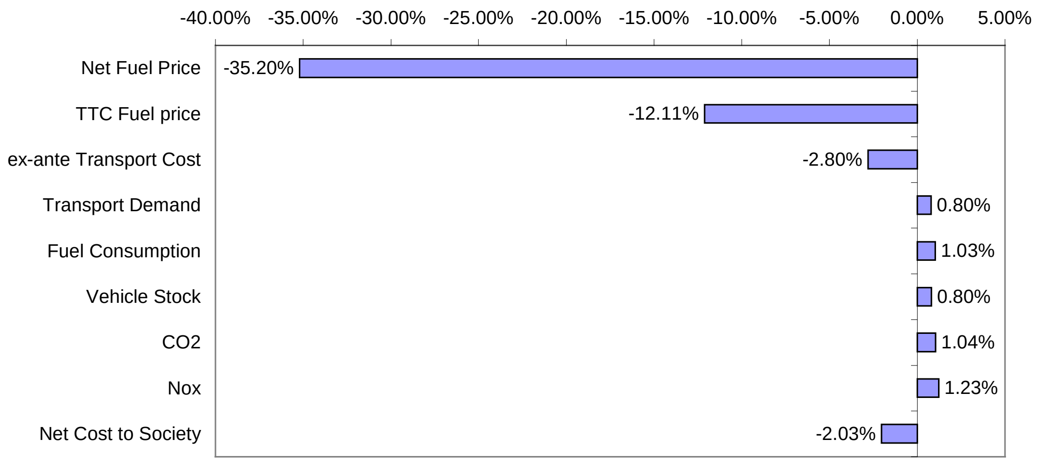
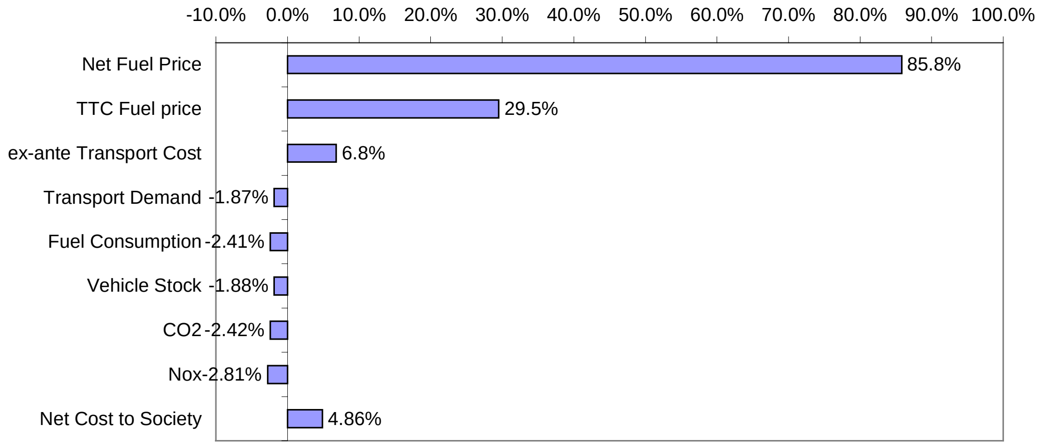


Figure 22: Main results of the Simulation - Second Scenario



6. DATA SOURCES

- Data for crude oil prices: International Energy Agency, Monthly Oil Market Report, available at www.iea.org

- Data for final fuel prices, VAT and excise duties : European Commission, Eurostat, database "sirene" (Energy)

- Data for exchange rates : European Commission, DG Budget - Inforeuro Monthly Files available at http://europa.eu.int/comm/budget/inforeuro/files.htm

- Data for price variation components and for simulation of the effects of fuel price changes are calculated by the author, using the TREMOVE model.

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8. ANNEXES

1. The TREMOVE base case

The TREMOVE[12] model was developed for the Auto-Oil II Programme. It is a general equilibrium model for the transportation sector that includes ten sample cities (Berlin, Cologne, Athens, Madrid, Lyons, Dublin, Milan, Utrecht, Helsinki and London) in nine Member States. TREMOVE is used to simulate the effects of various types of policy measures on the key factors driving transport emissions. The model also determines the costs to society (i.e. the transport users, service providers and government) from transportation at a new equilibrium point and calculates direct and induced emissions reduction effects. The latter may occur when policy options significantly upset the price structure of currently used transport modes (including road, rail and waterway transport for passengers and/or freight).

The Auto-Oil II Programme transport base case is a year-by-year qualitative and quantitative description of transport demand, vehicle stocks, generalised price components and road transport emissions from 1990 to 2020. This base case will be used here as a reference, to which two opposite oil price variation scenarios will be compared, in terms of environmental impact and cost to society. The main assumptions/criteria taken into account in the base case[13] are:

- The macroeconomic framework contained in the Energy 2020 Forecast (produced by DG TREN), namely the historical and assumed growth rates of GDP in selected periods, as follows:

Table 7: GDP Growth rate - Base Case

GDP per country average annual compound growth rate	1990-95	1995-00	2000-05	2005-10	2010-15	2015-20
Finland	-0.5%	3.2%	2.4%	2.3%	1.8%	1.6%
France	1.1%	2.4%	2.3%	2.2%	1.9%	1.7%
Germany	2.0%	2.5%	2.5%	2.3%	1.8%	1.7%
Greece	1.2%	2.9%	3.4%	3.3%	3.0%	3.0%
Ireland	5.6%	5.6%	3.8%	2.7%	2.2%	2.0%
Italy	1.1%	2.1%	2.2%	2.1%	1.8%	1.7%
Netherlands	2.1%	2.9%	2.6%	2.6%	2.1%	1.9%
Spain	1.3%	3.1%	2.9%	2.8%	2.4%	2.2%
UK	1.3%	2.9%	2.6%	2.5%	2.0%	1.7%

- Changes in vehicle technology and fuel specification due to the enforcement of the first Auto-Oil Programme and the voluntary agreement with passenger car makers to reduce CO_2 emissions by 2008 (e.g. improvements of fuel efficiency of 1.3% per year until 2003, 3.5% per year between 2003 and 2008 and 1% per year thereafter, very low sulphur fuels to be mandatory from 2005, etc.);

[12] see AOP II Cost effectiveness Study, Part II: The TREMOVE Model 1.3 (http://forum.europa.eu.int/Public/irc/env/aop2wg7)

[13] see AOP II Cost effectiveness Study, Part III: The Transport Base Case http://forum.europa.eu.int/Public/irc/env/aop2wg7/home

- Stability of the net fuel prices at their September 1996 level (ca. 20$/barrel), and some changes in fuel taxation (mainly in the United Kingdom with an annual increase of fuel excise duties).

The tables below show some key features of assumed transport demand, namely trends in vehicle.km, modal split evolution and fleet composition.

The trend of rapid increase of transport demand (see Table 8) is expected to continue albeit at a slower pace due to the gradual saturation of the infrastructure. The average growth rate is still expected to reach about 1.2% per year until 2020. Higher growth rates are expected in countries with currently lower GDP/capita.

Table 8: Growth of total transport demand - Base Case

Total transport demand (in vkm) per country average annual compound growth rate						
	1990-95	**1995-00**	**2000-05**	**2005-10**	**2010-15**	**2015-20**
Finland	1.2%	2.8%	1.6%	1.2%	0.9%	0.6%
France	2.5%	2.3%	2.1%	1.8%	1.6%	1.5%
Germany	1.5%	1.7%	1.6%	1.0%	0.5%	0.5%
Greece	3.9%	2.6%	2.6%	2.7%	2.5%	2.6%
Ireland	4.8%	3.5%	2.4%	1.2%	0.9%	0.9%
Italy	3.5%	1.6%	1.6%	1.6%	1.6%	1.6%
Netherlands	2.3%	1.7%	1.3%	1.2%	1.1%	1.0%
Spain	3.3%	3.0%	2.6%	2.3%	1.8%	1.6%
UK	1.0%	1.9%	1.7%	1.6%	1.5%	1.2%

Table 9 below shows that growth in traffic demand for private passenger cars should follow a gradual slowing down. Truck use is expected to closely follow underlying GDP growth rates.

Table 9: Growth of road transport demand - Base Case

Total traffic demand (in vkm) in Europe-9 average annual compound growth rate						
	1990-95	**1995-00**	**2000-05**	**2005-10**	**2010-15**	**2015-20**
Total	2.2%	2.0%	1.8%	1.6%	1.3%	1.2%
Buses & coaches	1.8%	1.1%	1.6%	1.7%	1.4%	1.4%
Cars	2.1%	2.0%	1.8%	1.5%	1.3%	1.2%
Train & metro	4.0%	3.2%	2.0%	1.9%	1.5%	1.7%
Trucks	2.9%	2.2%	1.9%	1.7%	1.6%	1.5%
Motorcycles	1.8%	1.8%	1.8%	1.8%	1.4%	1.4%
Non-motorised	0.4%	1.1%	1.1%	0.9%	0.6%	0.6%

For vehicle stocks (see Table 10), the market shares (for new car sales) of various categories will primarily depend on the changes in the relative driving cost between gasoline and diesel cars.

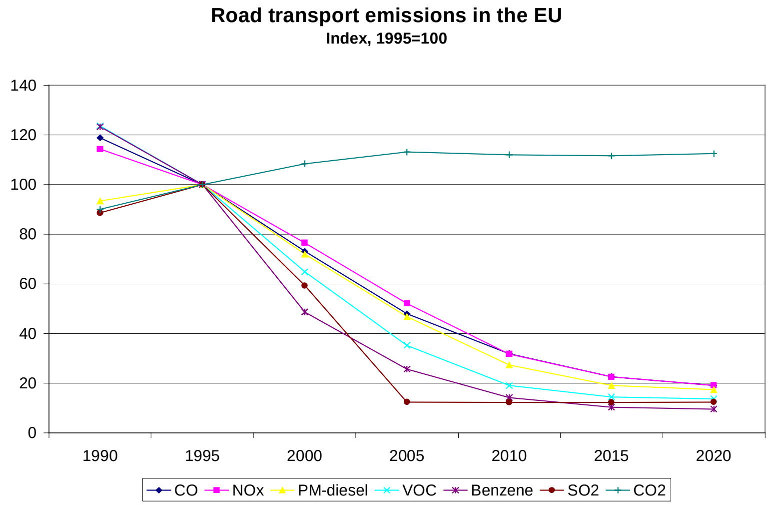
Table 10: Changes in Vehicle Stock - Base Case

	Vehicle stocks in Europe-9 (thousands)						
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Buses & coaches	367	398	419	450	487	520	557
Cars, gasoline	107,815	116,063	122,381	129,691	137,906	145,023	151,784
Cars, diesel	16,708	21,145	25,400	28,643	29,997	30,344	30,643
Cars, LPG	1,666	1,564	1,649	1,744	1,804	1,826	1,834
LGV	10,048	11,618	13,191	14,532	15,804	17,282	18,817
HGV	2,726	2,965	3,170	3,409	3,638	3,933	4,246
Motorcycles	16,106	17,835	19,562	20,776	22,121	22,923	23,722

Note: LGV = Light Goods Vehicles - HGV = Heavy Goods Vehicle

The TREMOVE base case simulation also allowed the trends in pollutants emissions to be estimated. Figure 23 below shows that most of these emissions are expected to fall below 20% of their 1995 levels by 2020. These important improvements can be attributed to the significant tightening of emission limit values for vehicles and higher standards for fuel quality. However, CO_2 emissions from road transport are expected to continue to increase until ca. 115% of their 1995 level by 2020. This trend closely follows the expected total fuel consumption. It's worth noting that this trend takes account of the voluntary agreement with passenger carmakers to reduce CO_2 emissions for new passenger cars by 25% by 2008.

Figure 23 : Evolution of road transport pollutant emissions - base case



2. Analysis of Fuel Price Variation Components

	% Var Total Price (n.c.)	Crude Oil Price	$ Effect	Mark-up	ED Effect	VAT Effect
Eurosuper						
Simulation Price 1999-1						
Be	1.8%	-12.1%	4.4%	4.1%	5.0%	0.3%
Dk	8.3%	-12.0%	3.8%	6.5%	8.3%	1.7%
De	-1.1%	-11.5%	4.1%	5.8%	-0.1%	0.6%
Gr	-3.9%	-13.5%	5.0%	9.3%	-4.1%	-0.6%
Es	-1.4%	-14.6%	5.6%	5.6%	2.2%	-0.2%
Fr	0.5%	-8.8%	2.7%	4.3%	2.3%	0.1%
Ie	1.4%	-15.4%	2.9%	10.0%	3.7%	0.2%
It	-3.4%	-12.1%	1.6%	7.0%	0.0%	0.1%
Lu	-2.4%	-15.4%	5.6%	7.7%	0.0%	-0.3%
Nl	8.3%	-11.9%	4.4%	8.2%	6.4%	1.2%
At	-3.1%	-14.8%	5.3%	7.0%	-0.1%	-0.5%
Pt	5.2%	-13.5%	4.4%	5.9%	7.6%	0.8%
Fi	-3.6%	-11.0%	3.9%	0.5%	3.7%	-0.6%
Se	0.5%	-12.2%	4.6%	4.5%	3.5%	0.1%
Uk	11.1%	-11.5%	-1.5%	5.3%	17.1%	1.6%
Simulation Price 1999-1						
Be	26.2%	39.9%	5.0%	-23.2%	0.0%	4.5%
Dk	29.4%	40.3%	5.1%	-23.4%	1.5%	5.9%
De	31.3%	42.1%	5.3%	-28.2%	7.8%	4.3%
Gr	43.3%	56.2%	8.6%	-25.8%	-2.2%	6.6%
Es	31.2%	51.3%	6.4%	-30.8%	0.0%	4.3%
Fr	27.9%	30.8%	3.9%	-10.7%	0.1%	3.9%
Ie	28.9%	54.6%	6.8%	-37.6%	0.0%	5.0%
It	27.5%	42.2%	5.3%	-23.7%	-0.9%	4.6%
Lu	43.2%	57.5%	7.2%	-30.3%	4.1%	4.6%
Nl	25.5%	44.0%	5.5%	-30.1%	2.3%	3.8%
At	26.0%	54.6%	6.8%	-39.8%	0.0%	4.3%
pt	10.6%	44.4%	5.6%	-15.9%	-25.0%	1.5%
fi	34.5%	31.8%	4.0%	-7.5%	0.0%	6.2%
se	24.8%	41.5%	3.1%	-25.3%	0.5%	5.0%
uk	34.6%	27.6%	1.3%	-7.2%	7.7%	5.1%
Diesel						
Simulation Price 1999-1						
be	-5.2%	-16.8%	6.1%	6.3%	0.0%	-0.9%
dk	-2.6%	-15.6%	4.9%	6.5%	2.1%	-0.5%
de	-10.2%	-16.5%	5.9%	1.1%	-0.1%	-0.7%
gr	-2.1%	-16.6%	6.2%	4.9%	3.7%	-0.3%
es	-0.6%	-17.1%	6.5%	8.1%	2.0%	-0.1%
fr	0.4%	-12.8%	3.9%	4.2%	5.1%	0.1%
ie	-4.0%	-18.5%	3.4%	8.0%	3.7%	-0.7%
it	-6.3%	-14.7%	1.9%	6.8%	0.0%	-0.3%
lu	-4.4%	-17.5%	6.4%	7.3%	0.0%	-0.6%
nl	0.9%	-16.5%	6.2%	7.4%	3.7%	0.1%
at	-6.9%	-17.9%	6.4%	5.8%	-0.1%	-1.1%
pt	3.8%	-17.3%	5.7%	8.7%	-3.6%	10.3%
fi	3.9%	-16.7%	6.0%	9.8%	4.1%	0.7%
se	-8.5%	-19.5%	7.4%	3.5%	1.8%	-1.7%
uk	10.7%	-12.0%	-1.6%	4.3%	18.5%	1.6%
Simulation Price 2000-2						
be	27.2%	61%	8%	-46%	0%	5%
dk	37.6%	55%	7%	-38%	6%	8%
de	37.3%	52%	7%	-38%	11%	5%
gr	43.4%	56%	8%	-28%	0%	7%
es	30.4%	62%	8%	-44%	0%	4%
fr	31.0%	41%	5%	-21%	2%	4%
ie	24.0%	62%	8%	-49%	0%	4%
it	28.0%	49%	6%	-32%	-1%	5%
lu	37.1%	64%	8%	-40%	0%	5%
nl	29.1%	58%	7%	-43%	2%	4%
at	25.7%	64%	8%	-50%	0%	4%
pt	13.6%	60%	7%	-48%	-8%	2%
fi	25.7%	61%	8%	-48%	0%	5%
Se	18.9%	66%	5%	-60%	5%	4%
Uk	30.1%	27%	1%	-9%	6%	4%

3. Results of TREMOVE Simulations

First Scenario (-35% in net fuel price)

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK	Average
Increase Net Price	-35%	-35%	-35%	-35%	-35%	-35%	-35%	-35%	-35.2%	-35.2%
Increase TTC Price	-13%	-11%	-13%	-15%	-15%	-13%	-13%	-15%	-8.0%	-12.1%
Change in Transport Cost	-2.2%	-2.9%	-2.5%	-3.5%	-3.7%	-3.5%	-3.1%	-3.6%	-2.1%	-2.8%
Transport Cost (ex ante)										
Base Case	21,121	164,689	253,154	20,292	6,976	136,973	43,505	75,631	169,735	892,075
SC	3,795	38,754	31,384	5,878	2,574	52,741	10,170	20,314	40,517	206,127
BC	11,789	83,518	179,826	4,714	2,927	58,030	23,827	34,766	94,024	493,421
MC	270	3,490	6,116	804	97	8,773	863	609	1,388	22,410
ST	3,010	25,816	11,877	4,387	656	7,727	4,861	10,869	15,898	85,101
BT	2,258	13,110	23,951	4,510	721	9,702	3,784	9,073	17,908	85,017
										0
Scenario	20,657	159,878	246,790	19,575	6,719	132,218	42,173	72,886	166,188	867,082
SC	3,708	37,832	30,579	5,677	2,487	51,011	9,924	19,613	39,601	200,432
BC	11,569	81,517	175,811	4,545	2,840	56,189	23,157	33,814	92,490	481,932
MC	270	3,446	6,080	786	96	8,606	865	595	1,378	22,122
ST	2,961	24,958	11,437	4,255	623	7,341	4,660	10,657	15,501	82,392
BT	2,149	12,126	22,883	4,312	673	9,069	3,567	8,207	17,218	80,203
% change										
Total	-2.2%	-2.9%	-2.5%	-3.5%	-3.7%	-3.5%	-3.1%	-3.6%	-2.1%	-2.8%
SC	-2.3%	-2.4%	-2.6%	-3.4%	-3.4%	-3.3%	-2.4%	-3.4%	-2.3%	-2.8%
BC	-1.9%	-2.4%	-2.2%	-3.6%	-3.0%	-3.2%	-2.8%	-2.7%	-1.6%	-2.3%
MC	0.0%	-1.3%	-0.6%	-2.2%	-0.9%	-1.9%	0.3%	-2.4%	-0.7%	-1.3%
ST	-1.6%	-3.3%	-3.7%	-3.0%	-5.1%	-5.0%	-4.1%	-2.0%	-2.5%	-3.2%
BT	-4.8%	-7.5%	-4.5%	-4.4%	-6.7%	-6.5%	-5.7%	-9.5%	-3.8%	-5.7%
Fuel Consumption	1.1%	0.9%	1.1%	1.1%	1.3%	1.1%	1.2%	1.3%	0.8%	1.0%
Changes in transport demand (%change from to basecase)										
	0.7%	0.5%	0.8%	0.6%	0.9%	0.9%	0.8%	0.8%	0.5%	0.8%
Small cars	1.0%	**1.0%**	**1.0%**	1.3%	**1.4%**	**1.1%**	1.2%	1.2%	0.9%	1.0%
Big cars	0.9%	**0.5%**	**0.9%**	1.3%	**0.9%**	**0.9%**	1.0%	0.8%	0.6%	0.8%
Light trucks	0.1%	0.2%	0.0%	0.1%	0.3%	0.2%	0.3%	-0.2%	0.1%	0.1%
Heavy trucks	1.3%	**1.6%**	**1.2%**	0.9%	**1.4%**	1.3%	1.7%	**1.3%**	0.9%	1.3%
Motos	0.3%	0.4%	0.6%	0.6%	0.6%	0.7%	0.2%	0.7%	0.4%	0.6%
Buses	**-1.1%**	-0.6%	-0.6%	-0.8%	-0.6%	-0.6%	-1.0%	**-0.4%**	-0.8%	-0.6%
Changes on average speed										
Urban	-0.3%	-0.2%	-0.2%	-0.3%	-0.3%	-0.2%	-0.4%	-0.3%	-0.3%	
Motorways	-0.2%	-0.3%	-0.4%	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%	-0.3%	
Other roads	-0.3%	-0.1%	-0.2%	-0.2%	-0.3%	-0.2%	-0.2%	-0.4%	-0.1%	
Changes in vehicle stocks (% change from basecase)										
	0.8%	0.6%	0.9%	0.9%	1.1%	0.9%	0.9%	0.8%	0.6%	0.8%
Gasoline cars	1.1%	1.5%	1.5%	1.3%	1.7%	1.4%	1.8%	1.6%	1.0%	1.4%
Diesel cars	-1.8%	-0.8%	-2.1%	-4.6%	-1.5%	-1.6%	-2.5%	-1.9%	-1.5%	-1.5%
LPG cars				-2.7%	6.0%	-1.3%	-1.5%	-1.0%		-1.3%
Light trucks	0.1%	0.2%	0.0%	0.1%	0.3%	0.2%	0.3%	-0.2%	0.1%	0.1%
Heavy trucks	1.3%	1.6%	1.2%	0.7%	1.1%	1.1%	1.5%	1.1%	0.9%	1.1%
Motos	0.3%	0.4%	0.6%	0.7%	0.7%	0.7%	0.3%	0.7%	0.4%	0.6%
Impact on emissions										
CO	1.1%	1.6%	1.7%	1.4%	2.3%	1.4%	1.5%	1.8%	1.5%	1.5%
NOx	1.0%	1.3%	1.2%	1.2%	1.5%	1.4%	1.4%	1.5%	0.8%	1.2%
PM	0.8%	0.4%	0.2%	1.0%	0.6%	0.7%	0.5%	1.1%	0.2%	0.5%
Benzene	1.1%	1.2%	1.5%	0.9%	2.2%	1.1%	1.5%	1.4%	1.4%	1.3%
VOC	1.1%	1.2%	1.5%	0.9%	2.0%	1.1%	1.4%	1.5%	1.2%	1.3%
NMVOC	1.1%	1.2%	1.5%	0.9%	2.1%	1.1%	1.4%	1.5%	1.3%	1.3%
Methane	1.3%	1.2%	1.1%	0.9%	1.3%	0.8%	1.2%	1.3%	0.9%	1.0%
SO_2	1.1%	0.9%	1.1%	1.2%	1.3%	1.3%	1.5%	1.4%	0.8%	1.1%
CO_2	1.1%	0.9%	1.1%	1.1%	1.3%	1.1%	1.2%	1.3%	0.8%	1.0%

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK	Average
Impact on emissions (tonnes)										
CO	1,764	20,896	27,268	2,873	1,634	22,670	4,581	14,876	19,452	116,013
NOx	297	3,792	3,862	573	191	3,093	762	3,395	1,993	17,959
PM	8	85	17	11	3	46	10	82	18	282
Benzene	4	51	62	8	3	55	10	43	39	275
VOC	163	1,821	2,188	310	114	2,048	358	1,657	1,336	9,995
NMVOC	145	1,657	2,073	286	106	1,912	336	1,586	1,269	9,370
Methane	18	163	114	23	6	121	22	70	64	602
SO2	2	31	46	5	2	32	9	26	24	177
CO2	123,968	1,219,260	1,807,920	195,726	67,780	1,186,390	327,237	1,018,822	900,980	6,848,082
Valuation Pollutant variation (MECU)	6.4	104.5	136.1	10.3	3.8	74.3	20.6	67.4	57.2	481
Total cost to society	-391	-3,350	-5,368	-517	-191	-3,455	-985	-2,157	-2,694	-19,109
	-1.77%	-1.94%	-2.02%	-2.42%	-2.56%	-2.39%	-2.15%	-2.68%	-1.51%	-2.03%
Side-effects										
Impact on noise cost	1	6	11	2	0	10	2	7	7	45
Impact on accident cost	18	149	254	25	12	171	49	122	128	927
Total with side-effects	-373	-3,194	-5,104	-491	-179	-3,274	-935	-2,028	-2,559	-18,136
										0
Decomposition of cost to society - Country										0
Total cost	-391	-3,350	-5,368	-517	-191	-3,455	-985	-2,157	-2,694	-19,109
Consumers	-276	-2,152	-4,269	-288	-131	-2,841	-636	-1,289	-1,942	-13,823
MCPF term	-1	-23	-23	-3	0	-19	0	-10	-8	-87
Government	11	348	346	42	7	289	-4	153	122	1,315
Freight transport	-128	-1,569	-1,468	-275	-67	-922	-345	-1,032	-882	-6,688
										0
										0
Decomposition of change in cost to consumers - Country										0
Total	-276	-2,152	-4,269	-288	-131	-2,841	-636	-1,289	-1,942	-13,823
Fuel cost & tax	-317	-2,542	-4,842	-331	-152	-3,257	-731	-1,565	-2,210	-15,947
Non-fuel cost & tax	0	34	-43	1	5	-2	0	36	38	69
Time cost	43	366	648	45	18	437	100	251	238	2,145
Interactions	-2	-10	-32	-2	-1	-19	-5	-10	-9	-90
										0
%Total										0
Fuel cost & tax	115%	118%	113%	115%	116%	115%	115%	121%	114%	10
Non-fuel cost & tax	0%	-2%	1%	0%	-3%	0%	0%	-3%	-2%	0
Time cost	-16%	-17%	-15%	-16%	-13%	-15%	-16%	-19%	-12%	-1
Interactions	1%	0%	1%	1%	1%	1%	1%	1%	0%	0
										0
Decomposition of change in cost to freight transport - Country										0
Total	-128	-1,569	-1,468	-275	-67	-922	-345	-1,032	-882	-6,688
Fuel cost & tax	-162	-1,861	-1,876	-358	-82	-1,132	-429	-1,258	-1,076	-8,235
Non-fuel cost & tax	3	3	15	10	2	16	8	7	21	84
Time cost	32	296	400	74	14	198	78	225	176	1,492
Interactions	-1	-7	-7	-1	0	-4	-2	-5	-3	-30
Impact on government budget (1998 million ECU)										
Budget impact	-11	-348	-346	-42	-7	-289	4	-153	-122	

Second Scenario (+86% in net fuel price)

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK	Average
Increase Net Price	86%	86%	86%	86%	86%	86%	86%	86%	86%	85.8%
Increase TTC Price	32%	28%	31%	36%	37%	31%	33%	37%	19%	29.5%
Change in Transport Cost										
Total	21,121	164,689	253,154	20,292	6,976	136,973	43,505	75,631	169,735	892,075
SC	3,795	38,754	31,384	5,878	2,574	52,741	10,170	20,314	40,517	206,127
BC	11,789	83,518	179,826	4,714	2,927	58,030	23,827	34,766	94,024	493,421
MC	270	3,490	6,116	804	97	8,773	863	609	1,388	22,410
ST	3,010	25,816	11,877	4,387	656	7,727	4,861	10,869	15,898	85,101
BT	2,258	13,110	23,951	4,510	721	9,702	3,784	9,073	17,908	85,017
										0
Total	22,305	176,510	268,981	22,016	7,568	148,049	46,658	82,432	178,307	952,827
SC	4,013	41,338	33,529	6,336	2,761	56,415	10,769	22,065	42,534	219,760
BC	12,374	88,040	189,663	5,128	3,125	62,578	25,416	37,106	97,870	521,301
MC	270	3,605	6,221	847	99	9,124	863	653	1,418	23,100
ST	3,129	28,035	12,987	4,715	743	8,684	5,300	11,414	16,920	91,926
BT	2,519	15,493	26,581	4,989	840	11,248	4,311	11,195	19,566	96,740
Total	5.6%	7.2%	6.3%	8.5%	8.5%	8.1%	7.2%	9.0%	5.1%	6.8%
SC	5.7%	6.7%	6.8%	7.8%	7.2%	7.0%	5.9%	8.6%	5.0%	6.6%
BC	5.0%	5.4%	5.5%	8.8%	6.8%	7.8%	6.7%	6.7%	4.1%	5.7%
MC	-0.1%	3.3%	1.7%	5.4%	2.1%	4.0%	0.0%	7.1%	2.2%	3.1%
ST	4.0%	8.6%	9.3%	7.5%	13.2%	12.4%	9.0%	5.0%	6.4%	8.0%
BT	11.6%	18.2%	11.0%	10.6%	16.5%	15.9%	13.9%	23.4%	9.3%	13.8%
Fuel Consumption	-2.5%	-2.1%	-2.5%	-2.4%	-2.9%	-2.6%	-2.8%	-3.0%	-1.8%	-2.4%
Changes in transport demand (%change from to basecase)										
	-1.5%	-1.2%	-1.8%	-1.5%	-2.2%	-2.1%	-1.8%	-1.8%	-1.1%	-1.9%
Small cars	-2.4%	**-2.3%**	**-2.4%**	-3.0%	**-3.4%**	**-2.5%**	-2.8%	-3.0%	-2.0%	-2.5%
Big cars	-2.2%	**-1.1%**	**-2.2%**	-2.9%	**-2.2%**	**-2.2%**	-2.2%	-1.8%	-1.3%	-1.8%
Light trucks	-0.2%	-0.4%	-0.1%	-0.3%	-0.9%	-0.5%	-0.8%	0.4%	-0.3%	1.5%
Heavy trucks	-3.0%	**-3.7%**	**-2.8%**	-2.1%	**-3.2%**	-3.1%	-3.8%	**-3.0%**	-2.1%	-1.3%
Motos	-0.8%	-1.0%	-1.3%	-1.4%	-1.5%	-1.6%	-0.6%	-1.6%	-1.0%	-0.3%
Buses	**2.8%**	1.5%	1.5%	2.0%	1.5%	1.4%	2.4%	**0.9%**	1.9%	-2.9%
Changes on average speed										
Urban	0.7%	0.5%	0.5%	0.6%	0.6%	0.5%	0.8%	0.6%	0.7%	
Motorways	0.6%	0.7%	0.9%	0.6%	0.6%	0.6%	0.9%	1.1%	0.7%	
Other roads	0.6%	0.3%	0.5%	0.5%	0.6%	0.6%	0.4%	0.9%	0.4%	
Changes in vehicle stocks (% change from basecase)										
	-2.0%	-1.4%	-2.1%	-2.1%	-2.6%	-2.2%	-2.2%	-2.0%	-1.5%	-1.9%
Gasoline cars	-2.6%	-3.6%	-3.7%	-3.0%	-3.9%	-3.3%	-4.2%	-3.9%	-2.5%	-3.4%
Diesel cars	4.8%	1.8%	5.0%	12.3%	3.8%	4.0%	6.3%	4.9%	3.7%	3.6%
LPG cars				6.7%	-13.0%	2.9%	3.5%	2.6%		3.1%
Light trucks	-0.2%	-0.4%	-0.1%	-0.3%	-0.9%	-0.5%	-0.8%	0.4%	-0.3%	-0.2%
Heavy trucks	-3.0%	-3.7%	-2.8%	-1.6%	-2.6%	-2.5%	-3.4%	-2.6%	-2.1%	-2.6%
Motos	-0.8%	-1.0%	-1.3%	-1.5%	-1.7%	-1.7%	-0.8%	-1.7%	-1.0%	-1.4%
Impact on emissions										
CO	-2.5%	-3.7%	-3.9%	-3.2%	-5.2%	-3.2%	-3.5%	-4.2%	-3.4%	-3.6%
NOx	-2.6%	-3.0%	-2.7%	-2.8%	-3.3%	-3.1%	-3.0%	-3.5%	-1.9%	-2.8%
PM	-1.4%	-1.0%	-0.3%	-2.3%	-1.3%	-1.5%	-1.0%	-2.4%	-0.3%	-1.0%
Benzene	-2.4%	-2.9%	-3.6%	-2.0%	-4.9%	-2.6%	-3.4%	-3.3%	-3.2%	-3.0%
VOC	-2.2%	-2.8%	-3.4%	-2.1%	-4.6%	-2.6%	-3.1%	-3.4%	-2.9%	-2.9%
NMVOC	-2.3%	-2.8%	-3.5%	-2.0%	-4.7%	-2.6%	-3.2%	-3.4%	-2.9%	-3.0%
Methane	-3.1%	-2.8%	-2.4%	-2.2%	-2.8%	-1.8%	-2.7%	-2.8%	-2.1%	-2.4%
SO2	-2.7%	-2.2%	-2.6%	-2.7%	-3.1%	-3.0%	-3.4%	-3.3%	-2.0%	-2.6%
CO2	-2.6%	-2.1%	-2.5%	-2.5%	-3.0%	-2.6%	-2.9%	-3.0%	-1.8%	-2.4%

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK	Average
Impact on emissions (tonnes)										
CO	-4,202	-48,625	-63,163	-6,602	-3,750	-52,971	-10,743	-34,665	-45,932	-270,653
NOx	-794	-8,736	-8,852	-1,308	-433	-7,077	-1,681	-7,682	-4,585	-41,148
PM	-16	-201	-34	-26	-8	-103	-22	-181	-36	-626
Benzene	-9	-118	-143	-19	-7	-128	-23	-99	-91	-636
VOC	-326	-4,219	-5,032	-715	-258	-4,739	-819	-3,815	-3,119	-23,042
NMVOC	-303	-3,841	-4,765	-657	-241	-4,423	-769	-3,655	-2,964	-21,619
Methane	-40	-378	-264	-52	-14	-282	-51	-159	-147	-1,387
SO2	-6	-73	-108	-12	-4	-73	-21	-60	-55	-412
CO2	-298,440	-2,851,490	-4,239,000	-451,503	-156,558	-2,758,860	-760,264	-2,356,931	-2,121,270	-15,994,316
Valuation of pollutant variation (MECU)	-15.4	-242.8	-316.5	-23.8	-8.9	-172.3	-47.4	-155.1	-133.9	-1,116
Total cost to society	942	8,064	12,792	1,238	458	8,202	2,348	5,152	6,416	45,613
	4.46%	4.90%	5.05%	6.10%	6.56%	5.99%	5.40%	6.81%	3.78%	5.11%
Side-effects										
Impact on noise cost	-2	-15	-25	-4	-1	-22	-5	-15	-16	-105
Impact on accident cost	-42	-354	-595	-58	-28	-399	-113	-285	-301	-2,175
Total with side-effects	898	7,696	12,172	1,176	429	7,781	2,230	4,852	6,099	43,333
										0
Decomposition of cost to society - Country										0
Total cost	942	8,064	12,792	1,238	458	8,202	2,348	5,152	6,416	45,612
Consumers	660	5,196	10,135	677	312	6,767	1,505	3,071	4,638	32,961
MCPF term	2	59	57	6	1	49	-1	24	20	217
Government	-24	-898	-865	-96	-16	-741	16	-357	-302	-3,283
Freight transport	307	3,826	3,579	663	163	2,226	826	2,462	2,100	16,151
										0
										0
Decomposition of change in cost to consumers - Country										0
Total	660	5,196	10,135	677	312	6,767	1,505	3,071	4,638	32,961
Fuel cost & tax	772	6,189	11,715	793	369	7,881	1,760	3,794	5,339	38,612
Non-fuel cost & tax	0	-81	107	-1	-11	-1	0	-89	-96	-172
Time cost	-99	-856	-1,505	-102	-40	-1,005	-226	-578	-553	-4,963
Interactions	-12	-57	-183	-13	-7	-108	-29	-56	-52	-516
										0
%Total										0
Fuel cost & tax	117%	119%	116%	117%	118%	116%	117%	124%	115%	11
Non-fuel cost & tax	0%	-2%	1%	0%	-4%	0%	0%	-3%	-2%	0
Time cost	-15%	-16%	-15%	-15%	-13%	-15%	-15%	-19%	-12%	-1
Interactions	-2%	-1%	-2%	-2%	-2%	-2%	-2%	-2%	-1%	0
										0
Decomposition of change in cost to freight transport - Country										0
Total	307	3,826	3,579	663	163	2,226	826	2,462	2,100	16,151
Fuel cost & tax	391	4,567	4,589	860	200	2,743	1,032	3,027	2,572	19,979
Non-fuel cost & tax	-6	-7	-36	-24	-4	-37	-19	-16	-50	-199
Time cost	-74	-691	-930	-167	-32	-455	-176	-518	-407	-3,450
Interactions	-4	-43	-44	-5	-2	-25	-11	-31	-15	-179
										0
Impact on government budget (1998 million ECU)										0
Budget impact	24	898	865	96	16	741	-16	357	302	3,283

4. Composition of the transport monetary cost per Vehicle Category

MOVE Categories:

SC:	
PCGS	cars - gasoline - small <1.4l
BC:	
PCGM	cars - gasoline - medium 1.4-2.0l
PCGB	cars - gasoline - big >2.0l
PCDM	cars - diesel - medium 1.4-2.0l
PCDB	cars - diesel - big >2.0l
PCL	cars - lpg
PCG2	cars - gasoline - 2strokes
ST:	
LTG	light duty trucks - gasoline
LTD	light duty trucks - diesel
BT:	
HTG	heavy duty trucks - gasoline
HTD1	heavy duty trucks - diesel - <7.5t
HTD2	heavy duty trucks - diesel - 7.5-16t
HTD3	heavy duty trucks - diesel - 16-32t
HTD4	heavy duty trucks - diesel - >32t
M:	
MP	mopeds <50cm3
MC1	motorcycles - 2-stroke >50cm3
MC2	motorcycles - 4-stroke 50-250cm3
MC3	motorcycles - 4-stroke 250-750cm3
MC4	motorcycles - 4-stroke >750cm3

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK
MONETARY COST PER MOVE CATEGORY									
PCGS	0.262	0.21	0.234	0.205	0.207	0.244	0.289	0.174	0.221
PCGM	0.38	0.333	0.335	0.308	0.304	0.299	0.399	0.277	0.373
PCGB	0.399	0.393	0.38	0.422	0.418	0.333	0.441	0.336	0.468
PCDM	0.255	0.172	0.276	0.052	0.156	0.189	0.19	0.163	0.213
PCDB	0.385	0.304	0.395	0.092	0.297	0.328	0.342	0.306	0.385
PCL				0.065	0.231	0.156	0.23	0.154	
LTG	0.699	0.347	0.382	0.334	0.17	0.181	0.262	0.394	0.246
LTD	0.533	0.233	0.227	0.28	0.197	0.192	0.266	0.496	0.283
HTG	0.185						0.358	0.277	
HTD1	0.247	0.206	0.45	0.288	0.177	0.231	0.275	0.144	0.221
HTD2	0.487	0.318	0.671	0.408	0.305	0.362	0.431	0.237	0.363
HTD3	0.633	0.294	0.318	0.469	0.46	0.391	0.495	0.293	0.568
HTD4	0.888	0.392	0.424	0.645	0.618	0.503	0.635	0.395	0.74
MP	0.158	0.118	0.211	0.055	0.232	0.127	0.183	0.059	0.138
MC1			0.298	0.129				0.082	
MC2	0.137	0.103	0.307	0.138	0.203	0.159	0.296	0.089	0.186
MC3	0.298	0.15	0.49	0.208	0.265	0.235	0.459	0.131	0.246
MC4	0.564	0.239	0.84	0.362	0.421	0.384	0.903	0.212	0.379

RESOURCE COST PER MOVE CATEGORY

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK
PCGS	53.8%	62.9%	68.4%	62.0%	57.5%	64.8%	53.3%	64.4%	59.7%
PCGM	53.7%	67.3%	70.7%	60.1%	59.2%	62.9%	53.9%	68.2%	67.8%
PCGB	51.1%	65.4%	68.2%	55.7%	57.4%	58.6%	51.5%	67.6%	69.9%
PCDM	55.3%	72.1%	76.4%	36.5%	59.0%	66.1%	49.5%	73.6%	67.6%
PCDB	56.1%	78.0%	75.4%	48.9%	63.3%	69.8%	55.0%	76.8%	78.2%
PCL	n.a.	n.a.	n.a.	40.0%	57.6%	67.9%	62.2%	69.5%	n.a.
LTG	78.7%	68.3%	75.4%	67.1%	50.6%	49.7%	58.0%	77.9%	55.7%
LTD	77.1%	69.1%	70.9%	70.4%	56.9%	63.0%	68.4%	85.7%	61.8%
HTG	95.1%	n.a.	n.a.	n.a.	n.a.	n.a.	49.7%	26.7%	n.a.
HTD1	71.3%	68.0%	81.6%	73.3%	56.5%	63.2%	68.0%	51.4%	52.5%
HTD2	69.8%	62.6%	77.5%	65.4%	45.9%	57.7%	62.6%	39.7%	44.1%
HTD3	62.7%	36.4%	38.4%	56.7%	37.4%	41.2%	53.5%	23.2%	42.3%
HTD4	63.2%	37.5%	39.6%	56.9%	33.3%	39.6%	51.3%	23.8%	39.9%
MP	73.4%	75.4%	84.8%	69.1%	59.5%	70.1%	57.9%	72.9%	75.4%
MC1	n.a.	n.a.	83.2%	72.9%	n.a.	n.a.	n.a.	65.9%	n.a.
MC2	69.3%	62.1%	82.4%	69.6%	69.0%	67.9%	64.5%	61.8%	71.0%
MC3	62.1%	70.0%	84.9%	75.0%	73.2%	74.5%	68.2%	69.5%	75.2%
MC4	59.9%	76.6%	86.5%	75.1%	76.0%	78.6%	60.7%	74.5%	80.7%

RESOURCE TAX PER MOVE CATEGORY

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK
PCGS	24.8%	7.6%	7.3%	15.1%	20.8%	10.2%	24.9%	10.9%	10.9%
PCGM	28.2%	9.6%	8.1%	19.5%	22.7%	11.0%	26.8%	12.3%	10.5%
PCGB	27.8%	11.2%	9.5%	26.5%	26.8%	13.2%	27.7%	13.1%	9.0%
PCDM	34.1%	10.5%	13.0%	11.5%	23.1%	16.4%	35.3%	11.7%	10.8%
PCDB	36.9%	12.5%	17.5%	22.8%	27.3%	20.4%	36.5%	15.4%	10.1%
PCL	n.a.	n.a.	n.a.	12.3%	21.2%	11.5%	29.1%	11.7%	n.a.
LTG	10.9%	4.6%	2.6%	10.8%	10.6%	1.1%	7.6%	3.0%	4.1%
LTD	11.6%	2.6%	1.8%	10.4%	10.2%	1.0%	6.8%	2.4%	3.5%
HTG	4.3%	n.a.	n.a.	n.a.	n.a.	n.a.	4.2%	0.7%	n.a.
HTD1	3.2%	0.1%	2.0%	6.6%	6.2%	0.9%	5.5%	1.4%	1.8%
HTD2	3.9%	0.2%	3.3%	8.6%	12.1%	0.8%	5.8%	0.8%	3.3%
HTD3	5.4%	2.7%	2.5%	8.7%	19.6%	0.5%	4.8%	0.3%	6.3%
HTD4	6.2%	1.8%	1.9%	9.8%	23.9%	0.6%	5.7%	0.2%	7.8%
MP	26.6%	11.0%	8.5%	7.3%	34.5%	15.0%	35.0%	8.5%	13.0%
MC1	n.a.	n.a.	8.1%	10.9%	n.a.	n.a.	n.a.	9.8%	n.a.
MC2	30.7%	7.8%	8.1%	10.1%	19.2%	10.7%	28.0%	9.0%	11.3%
MC3	37.9%	9.3%	9.2%	11.1%	17.7%	11.1%	26.8%	10.7%	11.4%
MC4	40.1%	9.6%	9.9%	16.3%	18.3%	12.0%	36.8%	12.3%	10.3%

	Finland	France	Germany	Greece	Ireland	Italy	NL	Spain	UK
FUEL COST PER MOVE CATEGORY									
PCGS	5.3%	6.2%	6.8%	7.8%	7.2%	7.0%	5.9%	8.6%	5.0%
PCGM	4.7%	5.1%	6.0%	7.1%	5.9%	7.4%	5.5%	6.9%	3.8%
PCGB	5.3%	5.1%	6.3%	6.2%	5.3%	7.8%	5.9%	6.8%	3.6%
PCDM	3.9%	5.2%	3.6%	19.2%	6.4%	5.8%	5.8%	6.1%	3.8%
PCDB	2.6%	3.0%	2.5%	10.9%	3.4%	3.4%	3.2%	3.3%	2.1%
PCL	n.a.	n.a.	n.a.	21.5%	13.0%	9.6%	6.5%	8.4%	n.a.
LTG	2.7%	5.8%	6.0%	7.5%	12.9%	13.8%	9.5%	6.6%	6.9%
LTD	4.3%	8.6%	10.1%	7.1%	12.7%	11.5%	9.0%	4.6%	6.0%
HTG	0.0%	n.a.	n.a.	n.a.	n.a.	n.a.	0.0%	25.3%	n.a.
HTD1	9.7%	9.7%	6.0%	7.6%	14.1%	11.3%	9.8%	18.8%	8.1%
HTD2	10.1%	11.3%	7.2%	9.8%	16.1%	13.3%	11.6%	23.6%	9.1%
HTD3	12.2%	18.0%	22.0%	13.0%	16.3%	18.7%	15.4%	30.4%	9.0%
HTD4	11.7%	18.1%	21.7%	12.4%	16.2%	19.3%	15.9%	30.1%	9.2%
MP	0.0%	2.5%	1.9%	7.3%	2.2%	3.9%	0.0%	6.8%	2.2%
MC1	n.a.	n.a.	2.3%	5.4%	n.a.	n.a.	n.a.	8.5%	n.a.
MC2	0.0%	6.8%	2.6%	6.5%	3.9%	5.7%	0.0%	10.1%	3.2%
MC3	0.0%	4.7%	1.6%	4.8%	3.0%	3.8%	0.0%	6.9%	2.4%
MC4	0.0%	2.9%	1.0%	2.8%	1.9%	2.6%	0.0%	4.2%	1.6%
FUEL TAX PER MOVE CATEGORY									
PCGS	16.0%	22.9%	17.5%	15.1%	14.5%	18.0%	15.6%	16.1%	24.4%
PCGM	13.7%	18.3%	15.2%	13.6%	12.2%	19.1%	13.8%	12.6%	18.2%
PCGB	15.8%	18.6%	16.1%	11.8%	10.5%	20.4%	15.0%	12.8%	17.5%
PCDM	6.7%	12.2%	6.5%	32.7%	10.9%	11.6%	9.5%	9.2%	17.4%
PCDB	4.4%	6.9%	4.6%	18.5%	5.7%	6.7%	5.3%	4.9%	9.6%
PCL	n.a.	n.a.	n.a.	24.6%	8.7%	10.9%	1.7%	9.7%	n.a.
LTG	7.9%	21.0%	15.7%	14.7%	25.9%	35.4%	24.8%	12.4%	33.7%
LTD	6.9%	19.7%	17.2%	12.1%	20.8%	24.5%	15.8%	7.1%	29.0%
HTG	0.0%	n.a.	n.a.	n.a.	n.a.	n.a.	46.1%	47.3%	n.a.
HTD1	15.8%	22.3%	10.4%	12.8%	23.2%	24.2%	16.7%	28.5%	38.0%
HTD2	16.2%	26.4%	12.1%	16.4%	26.2%	28.2%	20.0%	35.9%	43.3%
HTD3	19.7%	42.5%	37.4%	21.7%	26.7%	39.6%	26.3%	46.1%	42.4%
HTD4	18.9%	42.6%	37.0%	20.9%	26.5%	40.8%	27.1%	45.8%	43.2%
MP	0.0%	10.2%	5.2%	16.4%	3.9%	11.0%	7.1%	13.6%	10.1%
MC1	n.a.	n.a.	6.0%	10.9%	n.a.	n.a.	n.a.	15.9%	n.a.
MC3	0.0%	16.7%	4.3%	9.1%	6.0%	10.6%	5.0%	13.0%	11.4%
MC4	0.0%	10.5%	2.5%	5.5%	4.0%	6.5%	2.5%	8.5%	7.4%