JRC Technical Notes

Impacts of the proposal for amending Directive 1999/62/EC on road infrastructure charging

An analysis on selected corridors and main impacts

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Table of Contents

Executive Summary

The internalization of external costs is a main priority of the transport policy at EU level. Charging heavy duty vehicles according to the "polluter pays" principle is one of the main policy options in an effort to reduce the negative impacts of transport on the environment. In parallel, the need to optimize the use of infrastructure, reduce congestion and increase the efficiency of the transport system can be met by the "user pays" principle. In this context, the European Commission is proposing the amendment of Directive 1999/62/EC on road infrastructure charging. The proposal foresees the application of charges on heavy duty vehicles that are proportional to the damage they generate in terms of pollution, noise and congestion. The Commission's proposal establishes the methodology to be followed for the estimation of external cost charges as well as the areas of their application.

The proposed amendment is currently being discussed between the European Commission, the European Parliament and the Council in order to ensure that the proposed measure meets the policy objective of reducing the external cost of freight transport while minimizing the negative impacts for the freight transport sector and economy as a whole. As part of the process, the Council requested additional information on the possible impacts through case studies. The European Commission, DG TREN, presented preliminary calculations to the Land Transport Working Party of the Council on 12th March 2009 and an analysis of three case studies was discussed with experts from the Member States on 26th June 2009. As a result, it was requested that additional corridors and indicators were analysed. The European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) took the responsibility for the additional analysis.

The European Commission services involved (DG TREN and JRC) developed a transparent methodology that combined data from actual operations with models that simulate the level of charges under different assumptions. A first draft of the report was distributed and discussed in the Land Transport Working Party of Council on 11 December 2009. Following questions and comments received the present second version has been issued.

The aim of the analysis was to deliver a general but comprehensive picture of the cost of the directive for typical international transport operations which are of particular interest for the Council negotiation by simulating as far as possible the details of real life behaviour in actual transport operations while at the same time putting into perspective the general net benefits of a comprehensive road pricing strategy.

The external cost charges for the base case scenario were estimated assuming:

- Vehicle standard: Euro IV
- Congestion patterns: based on actual traffic speed from GPS traces
- Maximum allowable charges (caps) according to original proposal
- Low correction for mountain areas (1.5 for air pollution and 2.5 for noise)

Various possible combinations of departure time and rest periods were tested using a Monte Carlo[1] approach in order to analyse how external cost charges vary according to trip planning. The base scenario (Scenario I) follows the contents of the Commission Proposal while additional scenarios were simulated in order to analyse the impact of various alternative assumptions and

[1] The Monte Carlo approach is an application of computational algorithms using repeated random sampling. Such an approach is suitable for the simulation of complex systems when it is unfeasible to compute an exact result with a deterministic algorithm.

charging schemes. Scenario II is based on Scenario I and adds higher correction factors for mountain areas (2 for pollution and 5 for noise), although these values are still within the range of values suggested in the Commission Proposal. Scenario III it is assumed that Member States always apply the maximum possible congestion charge during peak time periods on all congested corridor segments, even if not justified by the actual congestion levels[2] (Scenario III corresponds to Scenario I with higher congestion charges). Scenario IV is based on an alternative set of maximum permissible charges (caps) as proposed by the European Parliament (ie. it uses all other assumptions of Scenario I except the caps), while scenario V assumes that no maximum permissible charges are observed. Scenario VI, finally, assumes that the freight vehicle conforms to the EURO V rather than EURO IV emission standard (keeping all other assumption as in Scenario I). The comparison of the scenario results is summarised in Table i.

The range of external cost charges that is expected for each corridor depends to a large extent on the length of the corridor and the specific characteristics of the zones it crosses. The six corridors have an average charge of between 2.5 and 5.3 €cents/vehicle*km for EURO IV (for scenarios I to IV). The use of EURO V would reduce average charges from between 2.6 and 5.3 €/vehicle*km (scenario I) to between 1.8 and 3.4 €cents/vehicle*km (scenario VI). The alternative set of maximum allowable charges proposed by the European Parliament (scenario IV) would in most cases reduce charges considerably compared to the base scenario I.

The highest external cost would be generated in the Rotterdam- Köln- Rotterdam corridor for a EURO IV vehicle during congestion, 14.9 € cents/vehicle*km (maximum value for scenario V). Depending on the caps used in that case, charges would range between 8 €cents/vehicle*km (maximum for scenario IV) and 12.2 € cents/vehicle*km (maximum for scenario III), while for the base scenario the charge would be 8.8 €cents/vehicle*km. On average though, external cost charges for this corridor would be 11.4 €cents/vehicle*km and charges would range from 4.4 to 6.0 €cents/vehicle*km. The shift to EURO V would reduce both costs and charges significantly though, since air pollution would decrease.

*Table i: Average total charges per vehicle*km (€cents), mean value (min, max)*

Corridor	I. Base scenario	II. Higher mountain area charges	III. Higher congestion charges	IV. Alternative set of caps	V. No caps	VI. Euro V standard
1. Sines – Paris	2.9 (2.8–3.4)	2.9 (2.8–3.4)	3.3 (2.7-4.9)	2.6 (2.3-3.0)	5.7 (5.5-6.1)	1.8 (1.6-2.2)
2. Lyon – Bratislava	4.8 (4.3-5.9)	4.9 (4.3-5.9)	5.2 (4.3-6.8)	3.9 (3.4-4.9)	7.5 (7.0-8.6)	2.9 (2.4-3.8)
3. Catania – Holyhead	4.9 (4.1-7.0)	4.9 (4.2-6.9)	5.0 (4.1-7.4)	4.0 (3.3-6.0)	8.4 (7.6-10.8)	3.0 (2.2-4.7)
4. Milano – Lübeck	4.9 (4.2-6.1)	5.0 (4.3-6.2)	5.2 (4.2-7.4)	4.1 (3.3-5.4)	12.3 (11.5-14.0)	3.0 (2.3-4.5)
5. Rotterdam – Köln – Rotterdam	5.3 (4.2-8.8)	5.3 (4.2-8.8)	6.0 (4.2-12.2)	4.4 (3.3-8.0)	11.4 (10.4-14.9)	3.4 (2.3-7.0)
6a. Stockholm – Odense (bridge)	2.6 (2.1-3.7)	2.6 (2.1-3.7)	3.2 (2.1-6.4)	2.5 (2.1-3.7)	3.7 (3.2-4.8)	1.9 (1.4-3.0)
6b. Stockholm – Odense (ferry)	2.7 (2.1-4.0)	2.7 (2.1-4.0)	3.2 (2.1-5.5)	2.7 (2.1-4.1)	3.9 (3.3-5.2)	2.0 (1.4-3.3)

[2] Note that such charges would normally not be permissible under the Commission proposal as Member States would always have to justify the charge levels.

The lowest increase in average transport costs is expected in the Stockholm – Odense corridor (less than 2%) and the highest in the congested Rotterdam – Köln – Rotterdam corridor (5.2%). If the highest charges for scenario I are taken into account (corresponding to trips encountering the highest levels of congestion), the range of cost increases becomes 2.7% to 8.6% (Table ii).

Table ii: Impact of external cost charges on operational costs, base scenario

Corridor	**Operating costs** Average (min, max) €/trip	**Total external cost charges** Average (min, max) €/trip	**Average external cost charges / tolls or vignettes** (for sections with an existing user charge)	**Average increase % (av. external cost charges / av. operational costs)**
1. Sines – Paris	2038	54.38 (50.74-62.06)	16.2%	**2.7 %**
2. Lyon – Bratislava	1580	67.24 (60.49-82.48)	23.7%	**4.3 %**
3. Catania – Holyhead	3438	145.96 (123.25-209.96)	47.9%	**4.2 %**
4. Milano – Lübeck	2100	64.37 (55.04-79.08)	47.6%	**3.1 %**
5. Rotterdam – Köln – Rotterdam	497	25.72 (20.37-42.58)	40.3%	**5.2 %**
6a. Stockholm – Odense (bridge)	1097	20.73 (16.48-29.28)	0.7%	**1.9 %**
6b. Stockholm – Odense (ferry)	1126	20.53 (15.98-30.61)	1.5%	**1.8 %**
Average for all corridors			25.4%	**3.3%**

Assuming that a part of the external cost charges will be passed on to the users, a still considerable part, 20% to 30% of the total, can be absorbed by the operators in the form of improved efficiency and/or technology. Even if the entire charges for external costs are passed on to the user of the transport services though, they would still have a very limited repercussion on final prices. In principle, the impact on final product prices is negligible and only in some extreme situations of low weight-to-volume and low price-to-weight products and during high congestion periods would it be visible, though still marginal. If any, the main impacts would be concentrated in areas producing or consuming agricultural products or raw materials that are transported in bulk. Fresh products may be less susceptible to changing their shipment strategy because of delivery speed requirements, but other non-perishable goods of low value or high volume would probably turn to more efficient shipments or other transport modes, if available. Table iii gives an overview of the impact on final product prices for the corridor Rotterdam-Köln- Rotterdam, where the highest increases in charges are expected.

The increase in transport costs due to external cost charges can stimulate reactions across the whole transport chain. The direct impacts are expected at operator or shipper level who can limit the increase in costs by selecting alternative routes, trip schedules and modes or through improvements in technologies and efficiency gains. Additional savings can be expected from indirect savings and the longer term changes in user behaviour.

Assuming that the corridors analysed in this study are characteristic of the range of transport services across the EU, the overall costs and benefits of the application of external cost charges throughout the EU can be extrapolated by using the estimated transport cost increases in the TRANSTOOLS model simulating interregional transport flows. If an average increase in transport costs of 3% is assumed, a decrease of 13.5 billion tonne*kms in road transport volumes would be expected, mainly on those corridors that include congested areas and in which the price signal conveyed by the external cost charges would be more marked. Such volume would represent a decrease of 0.7% of the year 2007 total road freight volume, which would be shifted mainly to those modes where scarcity and congestion avoidance can be better managed.

Table iii: Impact of external cost charges on final product price, various products (Rotterdam-Köln-Rotterdam corridor)

Increase of price	100% of cost increase passed on to the final customers (no efficiency gain in the road sector)	70% of cost increase passed on to the final customers (30% of cost saved through efficiency gains in the road sector)
Biscuit	0.37%	0.26%
Tuna	0.49%	0.34%
Tomato	0.29%	0.21%
Blouse	0.06%	0.04%
Jeans	0.05%	0.03%
Suit	0.14%	0.10%
Coffee pack	0.21%	0.14%
Coffee pods	0.08%	0.05%
Passenger car	0.20%	0.14%
Mobile phone	0.05%	0.04%
Pharmaceuticals	0.04%	0.03%

The impacts on transport volumes would have a clear impact on the external costs that the transport sector as a whole generates. The charges are expected to stimulate technological renewal and organisational changes that would lead to efficiency gains in the road sector. Alternative transport modes may also become competitive for some market segments and – since in most cases they generate lower levels of externalities- reduce external costs through modal shift. It is worth noting that significant savings are also expected for externalities not directly included in the charges used in this analysis, most notably climate change costs and accidents. The collected charges re-enter the economy through additional transport investment, tax cuts or debt reduction..

The results from the previously carried out impact assessment of the internalisation of external costs (EC 2008b) suggest that the internalization of road freight transport costs at the EU-level on the main EU roads would result in a total net welfare gain of € 1.8 billion per year. Extension of congestion charging to passenger cars would increase the net welfare gain to € 2.3 billion a year. However, these modelling results exclude the benefits for local traffic due to reduced local congestion.. Various national and international studies suggest that the welfare gain of a general internalisation scheme including urban roads would be many times more than the above figure.

According to the congestion indicator used in EC2008b, congestion on the interurban road network would decrease by more than 4% and by more than 7% if congestion charging applied to cars as well in addition to trucks (EC2008b). Empirical evidence from actual congestion charging schemes and local studies suggest a much higher potential to reduce local congestion; between 10-30% in congested areas.

CO_2 emissions from road freight transport and fuel consumption would be reduced by 8%. The total CO_2 emissions of the whole road transport sector could also reduced by a similar extent if congestion charging applied to all road users and not only to trucks. Similar reductions would be achieved for the emissions of other pollutants as well. As 10-30% of fuel consumption and CO2 emissions are usually considered as caused by congestion, there would be additional important benefits in terms of climate change if congestion decreases are higher, as suggested by the local studies.

To conclude, the overall benefits of charging for external costs outweigh the limited negative price impacts on individual transport operators. External cost charges can stimulate a change in the behaviour of the users of the transport system without increasing transport and product costs significantly. In the long term, they can induce a reorganisation of transport activities and contribute to a change in business processes and industrial productions locations towards more sustainable patterns. Such policy can yield much higher benefits for society as a whole if applied more widely to all vehicles including passenger transport. Applying it to other transport modes following the same principles of internalisation would provide a level playing field and stimulate sustainable solutions for the whole transport system.

Chapter 1. Introduction

The proposed amendment of Directive 1999/62/EC allows for the introduction of charges to freight vehicles proportional to the damages they cause in terms of air pollution, noise damages and congestion. The amendment proposal outlines the areas of application, the methods for the calculation of the charges and the maximum charges to be applied on a specific road segment. The approach and the levels of charges to be applied are being discussed between the European Commission, the European Parliament and the Council of Ministers in order to ensure that the proposed measure meets the policy objective of reducing the external cost of freight transport while minimizing the negative impacts for the freight transport sector and economy as a whole.

During the preparatory phases of the proposed amendment, the Council of Ministers requested additional information on the possible impacts through case studies of three specific corridors across the EU. The European Commission, DG TREN, presented preliminary calculations to the Land Transport Working Party of the Council on 12th March 2009 and an analysis of the case studies was discussed with experts from the Member States on 26th June 2009. As a result, it was requested that additional corridors and indicators were analysed. The European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) took the responsibility for the additional analysis.

The goal of the analysis is to provide easy-to-understand and realistic real life examples to illustrate the likely impact of the proposed Directive on road haulers and society at large. The European Commission services involved (DG TREN and JRC) developed a transparent methodology that combined data from actual operations with models that simulate the level of charges under different assumptions.

As a first step, the analysis estimates the external costs of road haulage for a representative set of six corridors in the EU in order to derive the permissible external cost charges for each of the corridors and corridor sections. In the subsequent steps, it explores the impact of other main factors, a series of sensitivity analyses is carried out on the impact of (i) various aspects of trip optimization, (ii) different assumptions on the calculation and implementation of external cost charges and (iii) road section classification criteria, on the estimated external costs.

Finally, a number of analyses are carried out that focus on the impact that the implementation of the external cost charges would have on: (i) total transport costs and mode competitiveness, (iii) price of the transported goods and regional competitiveness and (iii) the benefits for society and haulers in terms of emissions and congestion levels.

In addition, the analysis used six different scenarios of implementation of the charges and examined different option of charge levels and coverage, as well the impact of improving the technology of heavy duty vehicles in freight transport.

The overall goal was to quantify the impacts both at operator level and at aggregate level. The results of the analysis in terms of costs and reduction of environmental impacts will allow the evaluation of the efficacy of the proposed measures and of the distribution of its costs.

The main modifications of this analysis compared to the preliminary calculations as presented to the Land Transport Working Party of the Council on 12th March 2009 are as follows:

- The analysis is carried out for three additional corridors, i.e., Milano- Lübeck, Rotterdam-Köln-Rotterdam and Stockholm-Odense. For the latter corridor, both the route using the Øresund bridge and the route using the Helsingør-Helsingborg ferry were analysed. The rationale behind their choice was the need to cover different geographic areas and trip lengths

- The optimal route for each corridor is identified by the route assignment model of TRANSTOOLS, instead of the ViaMichelin on-line tool.
- The analysis for each corridor is based on 1000 randomly chosen departure times, rather than two, so as to avoid the results to depend on an arbitrarily chosen departure times, and to obtain more detailed information on the impact of departure time on the external costs.
- The analysis for each corridor is based on 1000 randomly chosen break lengths, rather than fixed assumptions on break and resting time, so as to obtain information on the impact of break length on the external costs. Additionally, a case study has been carried out in order to analyse the impact of the timing of breaks in more detail.
- The speed figures used in the analysis are obtained by introducing real speed data from the TeleAtlas speed profiles database (from GPS traces) into the road network of TRANSTOOLS, rather than based on the simplified assumptions used in the non-paper.
- Congestion charges are based on the value of time lost due to congestion for each segment and time period, using TRANSTOOLS results after calibration of the model against real measured traffic data. The charges estimated this way depend on the level of congestion and the level of time of the specific zone
- The analysis has been carried out for six different scenarios, i.e., (i) the base scenario, (ii) a scenario based on the application of an alternative set of mountain correction factors, (iii) a scenario in which the congestion charge for congested sections is always equal to the peak-hour charge, even if the actual congestion levels do not justify the charges. (iv) a scenario based on the application of an alternative set of caps, (v) a scenario in which no caps are applied (vi) a scenario in which the vehicle complies with the Euro V standard.
- The definition of urban and non-urban segments follows that of the road network of the TRANSTOOLS[3] model v2.1.7. Analyses have been carried out on the impact of different sets of (sub)urban classification criteria on the external costs and on the impact of different sets of mountain classification criteria on the share of mountain segments in the total length of the route.
- An analysis has been carried out that compares the external costs with tolls, haulage costs and the haulage costs of competing modes, in order to assess the competiveness of the road freight mode, following the application of the external cost charges.
- An analysis has been carried out on the impact of the application of the external cost charges on the total haulage cost and final product price of nine different product types.
- An analysis of the benefits of the application of the external cost charges has been carried out.

[3] TRANSTOOLS is the EU-wide transport network model that is the reference tool for impact assessment by the European Commission. The model was developed by a multinational research team in the context of a 6th FP research project. It allows the simulation of the behaviour of the transport system for all main modes.

Chapter 2. Definition of corridors and calculation of external cost charges

Freight transport operations are very diverse across the EU. Hauliers face different cost structures depending on the geographic zone where they operate, the types of products they transport or even the size or age of their fleet. On the other hand, the external costs of transport (in this case pollution, noise and congestion) depend on both the vehicles used and the valuation of the external impacts at the location and time they are generated. In addition, new charges may lead to a change in the behaviour of operators, stimulating them to change their route, timing or even choice of vehicle or mode so that they limit a possible increase in their costs.

The aim of the analysis was to deliver a general but comprehensive picture across the EU, while at the same time simulating as far as possible the details of real life behaviour in actual transport operations. This was possible through the definition of six corridors that were considered as characteristic, the use of real data to the extent possible and the detailed simulation of different operator strategies for the specific corridors.

2.1 Route choice

The six corridors to be analyzed were defined by the experts from the Member States. The rationale behind their choice was the need to cover different geographic areas and trip lengths, so that the corresponding transport and external costs and driving times[4] would be analysed. Since the corridors were pre-defined based on geographic criteria, it is not always the case that they correspond to frequently used choices of route or even mode. The corridors that were analyzed are the following:

1. Sines (P) – Paris (F)
2. Lyon (F) – Bratislava (SL), via Italy, Slovenia and Hungary[5]
3. Catania (I) – Holyhead (UK)
4. Milano (I) – München (D) – Lübeck (D)[6]
5. Rotterdam (NL) – Köln (D) – Rotterdam (NL)[7]
6. Stockholm (S) – Odense (DK)

In order to determine the route for each corridor, the route assignment module of TRANSTOOLS[8] v2.1.7 was used to assign a hypothetical quantity of freight between the origin and destination zones coinciding with the corridors. The part of the route that lies within or on the ring of the departure and arrival city is not included in the analysis, i.e., the analysis covers only the part ‘from ring to ring’. In most cases, the assignment algorithm produced a single route that attracted the majority of the trips, since other possible route variants had a noticeably higher generalised cost (the combined distance and time cost). For the corridors where intermediate points were defined (2 and 5), individual simulations of route choice were carried out for each segment in order for the resulting route choice of the model to follow the corridor that had been selected.

[4] The different driving times would allow the comparison of the impacts for different trip management strategies

[5] The specific itinerary for this corridor was a requirement for the analysis. It does not correspond to the optimal route between Lyon and Bratislava.

[6] The corridor selected by the Member States experts deliberately passed through München, instead of a more direct trip from Milano to Lübeck.

[7] The roundtrip was specifically selected to analyze the impact on frequent/shuttle operations.

[8] TRANSTOOLS is the EU-wide transport network model that is the reference tool for impact assessment by the European Commission. The model was developed by a multinational research team in the context of a 6th FP research project. It allows the simulation of the behaviour of the transport system for all main modes.

For corridor 6 two different options were identified, depending on the assumptions concerning the value of time and transported goods. We therefore analyse two different routes, i.e., (i) the route crossing the Øresund bridge between Malmö and Copenhagen, and (ii) the route using the ferry crossing between Helsingborg and Helsingør.

In order to check the consistency of the results, the route choices calculated by TRANSTOOLS was compared to those by three online applications (ViaMichelin, Guía Repsol, Google Maps). TRANSTOOLS agreed with at least two of the online applications for at least 90% of the route length of the 6 corridors. The differences in the remaining parts can be explained by the more detailed calculation of generalised costs that TRANSTOOLS allows and are more likely to reflect the rational behaviour of professional drivers. This includes both time and distance costs, specifically for freight transport. Online applications can calculate only the shortest or fastest route for passenger cars[9].

2.2 Division of route into sections

The per kilometre value of the external costs depend on certain characteristics of the corridor. In order to account for this, the routes are broken into sections according to three criteria, i.e., (i) country, (ii) road classification, and (iii) time period.

First, routes are broken down by country. Next, the resulting route segments are further broken down by road classification. Road sections are classified as either "interurban", "(sub)urban" or "mountain section". The definition of urban and non-urban segments follows that of the road network of the TRANSTOOLS model, which in turn is based on data by ESRI (a provider of Geographic Information Systems software and data) using the definition of urban areas used in each Member State.

The amendment proposal foresees that higher external cost charges may be charged for high altitude or steep road segments, the reason for this being the higher level of pollution and noise generated by vehicles under such conditions. The division of the route into sections takes into account whether the segment can be considered as mountainous or steep: road sections are classified as "mountain sections" either if they are at an altitude of over 1000 m (to cover high altitude areas) or if the difference in the average free-flow speed of the two directions of the segments exceeds 20% (regardless of the altitude, to identify segments that would be considered steep[10]).

The impact of a number of alternative criteria for (sub)urban and mountain sections are explored in the sensitivity analysis in Chapter 4.

Finally, the information on the resulting sections includes the time period it is crossed by the vehicle and its corresponding charges, i.e., "high peak", "medium peak", "off peak" and "night". "High Peak" periods correspond to the time slots 7-9 am and 6-8 pm, while "Medium Peak" periods are those immediately before and after High Peak: 6-7 and 9-10 am, 5-6 and 8-9 pm. "Off Peak" periods are between 10-17 and 21-24. Night is between 0-6 (see Figure 1).

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[9] JRC also consulted the developer of a specialized software package for truck operators on the possibility of acquiring in order to use it as an additional tool for the analysis. No feedback was however received by the developer on whether the software would be suitable to carry out a similar analysis.

[10] Since all routes identified in this analysis use roads that are considered either European or National highways, virtually no segment was identified as steep (since standards for highways would not allow such levels of steepness). The steepness criterion is though still valid and a considerable share of the secondary road network in Europe would be covered by it, even at low altitudes.

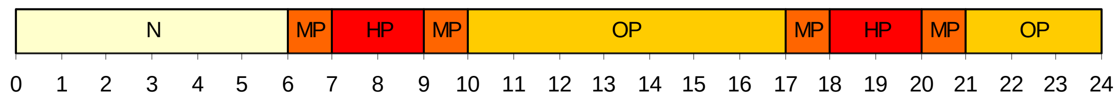

Figure 1: Time periods of the day
N= normal, MP= medium peak, OP= off peak, HP = high peak

The definition of the time periods was done based on statistics on traffic and congestion levels across EU. Congestion profiles for all inter-urban roads across the EU were derived from the TeleAtlas[11] speed profiles database. These profiles allow the identification of peak periods during the day, when average speeds on a segment are a low share of free flow speed (corresponding to a situation where traffic on a link is high compared to its capacity, i.e., the link is congested).

Even though data on average speeds for all segments of the corridors analysed and for all time periods was available, there were operational limitations in model that was used for the sensitivity analysis that did not allow a "dynamic" definition of the peak periods for every segment. The peak periods used in the analysis and shown in Figure 1 are fixed, and were defined through a generalisation of the profiles derived from TeleAtlas data. The latter suggest that although there is diversity in the congestion profiles, morning and afternoon peaks can be clearly identified for links in the vicinity of urban areas. An exception can be found in areas where an additional medium or high peak can be expected between 14:00 and 16:00, normally in southern parts of Europe that follow a discontinuous schedule for shops and businesses. The manual check of the corridors selected for the analysis though revealed that, for the links analysed, there are no significant differences in congestion profiles. The derived peak periods can be considered therefore as sufficiently reliable for the level of detail necessary in this analysis.

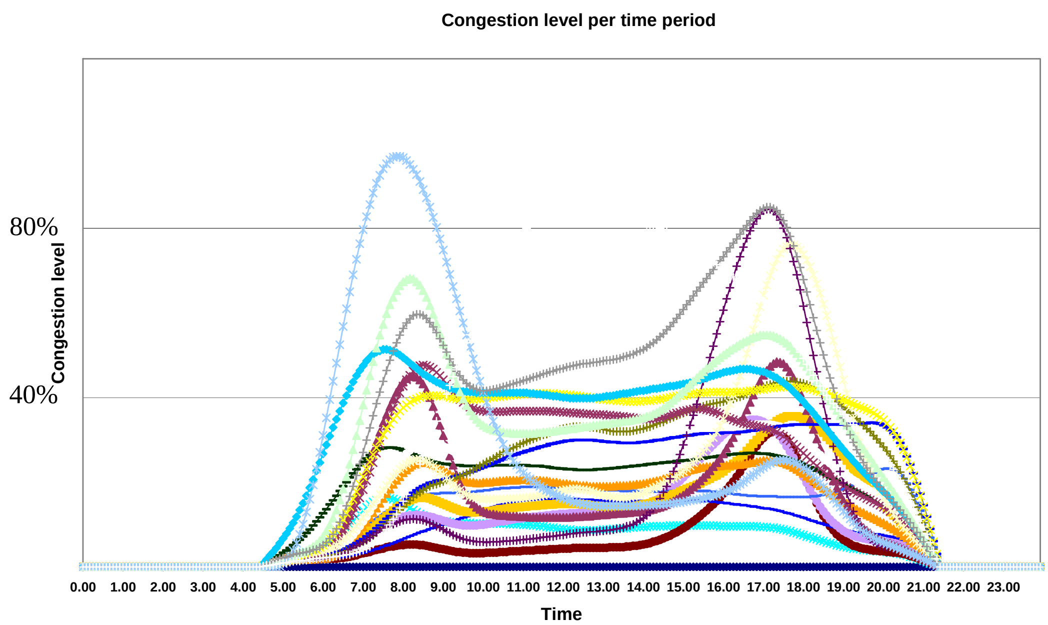

Figure 2: Examples of different congestion profiles (as % share of capacity)
Source: selected speed profiles from TeleAtlas

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[11] TeleAtlas is a major developer of maps and data used by GPS and in-vehicle navigator systems. Real vehicle speeds are collected and average speeds are estimated for 5 minute periods throughout a typical 24 hour period. This data allows the comparison between average speeds for a specific road segment at any given period of the day with the maximum speed measured for this segment (its theoretical free flow speed).

2.3 Time schedule of the route

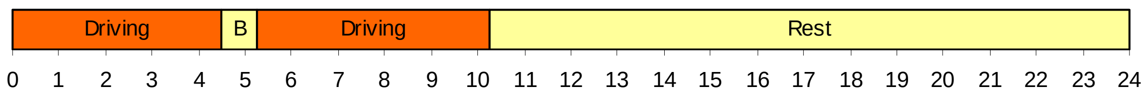
The time schedule of the route is important because it affects the timing of use of each road segment and the resulting level of charges the vehicle would need to pay. The time schedule of the route depends on (i) vehicle speed, (ii) departure time, (iii) break and rest time behaviour, and (iv) time on ferries.

The vehicle speed is section-specific. The speed used in the analysis depends on the time period (night, medium peak, high peak, off peak) in which the road section is traversed. The underlying data for average speed on each particular segment and time period was derived by introducing real speed data from the TeleAtlas speed profiles database (from GPS traces) into the road network of TRANSTOOLS. The resulting updated data of the TRANSTOOLS network allowed the estimation of free flow speed and average speed for each time period, for both passenger cars and trucks. Given that the TeleAtlas data are very recent, this is probably the most reliable approach to estimate real average speeds for specific road segments. Any other model or software would also need to rely on such a dataset and at best would provide the same level of precision.

The analysis does not assume any fixed departure time. The calculations are made for a large number of different departure times, so as to avoid the results to depend on the (arbitrary) choice of a specific departure time. A sensitivity analysis on the departure time is carried out in Chapter 3.

It is assumed that the vehicle is driven by a single driver, complying with the EU regulations on resting and driving time. The base assumption is that after departure the driver drives for 4:30 hours, takes a break/resting time, drives another 4:30 hours and then takes a second break/resting time until 24 hours after departure. Based on a first break of 0:45 hours, the driving schedule for each 24-hour period would be as in Figure 3. However, the sensitivity analysis simulates a large number of different lengths of the first break, so as to avoid the analysis results to depend on the (arbitrary choice) of a specific first break length. A sensitivity analysis on the impact of break length is carried out in Chapter 3.

Figure 3: Daily driving schedule if the length of the first break is 0:45 hours



B=Break

Ferries are not considered as corridor segments. They are neither included in the route distance nor incorporated in the external cost analysis. Ferry time is, however, taken into account while computing the time schedule for the route. Ferry time is calculated as the time of the ferry crossing plus the expected waiting time.[12]

The speeds used for the various segments of each corridor depending on the time period are shown in the Annex.

[12] The expected waiting time in hours is calculated as 12/F, where F is the number of services per day. The services are assumed to be uniformly distributed over the day.

2.4 External cost estimation

Based on the characteristics of each corridor section (road classification, time period, country) the marginal external costs of air pollution, noise and congestion were calculated. External costs are based on a 40 tonne truck equipped with a EURO IV compliant engine. A sensitivity analysis on the EURO emission standard is carried out in Chapter 4.

Air pollution: Monetary costs of air pollution are calculated according to the instructions in Annex IIIA of the Commission proposal. For mountain area segments, a correction factor of 1.5 is used. The value of 1.5 was selected as an indicative value within the range of possible values suggested in the Commission proposal. A sensitivity analysis on the level of the correction factor is carried out in Chapter 4.

Noise: Monetary costs of noise pollution are based on calculations in the context of an ongoing project focusing on the update of Marco Polo external cost coefficients for 2009. For mountain area segments, a correction factor of 2.5 is used. The value of 2.5 was selected as an indicative value within the range of possible values suggested in the Commission proposal. A sensitivity analysis on the level of the correction factor is carried out in Chapter 4.

Congestion costs: Congestion charges are based on the value of time lost due to congestion for each segment and time period. The levels of congestion charges are the ones used in the impact assessment of the original amendment proposal [EC 2008b, Annex 3] and depend on the level of congestion for a specific link and the value of time in the country the link belongs to. The actual level of congestion that the truck is expected to encounter at a specific point at the specific time period is estimated using TRANSTOOLS results based on GPS traces describing the actual real time traffic flow speeds. Congestion levels are estimated using the ratio between the modelled average speed and the theoretical free flow speed on each link of the interurban road network. A road section is considered congested if the modelled average speed is less than 60% of the theoretical free flow speed.. A change in the level of traffic flow results in a change of this ratio that is proportional to the new level of congestion. The congestion indicator across the EU is an average for the whole network weighted according to the length and traffic flow of the individual road links. The principle assumed is that congestion charges depend on the location, time and congestion level.

An alternative scenario was tested where the congestion charges (in most cases for suburban areas) were the maximum permissible external cost ('caps') charges in Table 3 of Annex IIIa of the Commission proposal, even if not objectively justified by the congestion level. This can be considered as the "worst case scenario" for operators, and would correspond to the case that local authorities charge according to whether the time period is considered a peak period and not according to whether the actual congestion levels justify the charges.[13]

2.5 Maximum charges ('Caps')

In a second step, the estimated external costs are compared for each external cost category to the maximum permissible external cost charges ('caps') laid out in Annex IIIa of the Commission proposal underlying this analysis (EC 2008) (see Table 1). If the estimated costs are higher than the caps, the latter are adopted. Otherwise the estimated costs are maintained. In Chapter 4 a sensitivity analysis is carried out on the impact of removing the caps or applying an alternative set of caps.

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[13] Note that such charges would normally not be permissible under the Commission proposal as Member States would always have to justify the charge levels.

Table 1: Overview of maximum permissible external cost charges ('caps') for EURO IV standard trucks by externality type and time period (€/vkm)

Externality type		**Suburban roads**	**Other interurban roads**
Air pollution		4.00	4.00
Noise pollution	Day	1.10	0.13
	Night	2.00	0.23
Congestion	off peak/night	0.00	0.00
	medium peak	20.00	2.00
	high peak	65.00	7.00

Chapter 3. Calculation of external costs and sensitivity analysis on trip optimisation

This chapter concentrates on the analysis of the average and total external costs for each of the six corridors, based on the method and assumptions described in Chapter 2. The underlying assumptions are the following:

- Vehicle standard: Euro IV
- Congestion patterns: based on actual traffic speed from GPS traces
- Congestion charges: based on congestion patterns and the value of time in each country (table 2)
- Caps according to original proposal (tables 3 and 4)
- Low correction for mountain areas (1.5 for air pollution and 2.5 for noise)

This set of assumptions corresponds to the base scenario. In Chapter 4, where additional scenarios are examined, the results from the base scenario are used as a reference.

Table 2: Congestion charges for road segments analysed, per country and peak period, Base scenario, €-cents per km

	Medium peak	High peak
Austria	20	50
Denmark	20	50
France	10	20
Germany	20	40
Hungary	5	10
Italy	15	40
Netherlands	20	50
Portugal	5	10
Slovenia	5	10
Slovakia	5	10
Spain	5	10
Sweden	5	10
Switzerland	15	30
UK	20	65

Table 3: Maximum charges (caps) for air pollution, Base case, €-cents per km

	Suburban	Interurban
Austria	5.68	5.26
Denmark	3.05	1.86
France	4.97	5.20
Germany	6.74	6.75
Hungary	3.51	2.45
Italy	3.91	3.53
Netherlands	4.27	4.71
Portugal	1.34	0.71
Slovenia	4.23	3.09
Slovakia	3.44	2.42
Spain	1.97	1.09
Sweden	1.88	0.87
Switzerland	5.52	5.40
UK	2.60	2.11

Table 4: Maximum charges (caps) for noise, Base case, EU-wide , €-cents per km

Suburban		Interurban	
Day	Night	Day	Night
1.10	2.00	0.13	0.23

3.1 Monte Carlo analysis of external costs

Rather than using arbitrary assumptions on departure time and break length, the analysis adopts a Monte Carlo approach in which the external costs for a large number of different departure times and break lengths are simulated. In addition to producing more robust results, this approach allows the sensitivity analysis of the impact of the choice of departure time and the length of the break on the external costs.

Changes in the departure time affect the time schedule, i.e., the time (period) at which certain corridor segments are traversed. Driving time and cost savings could for example be attained by avoiding (sub)urban corridor segments during peak hours. The optimal departure time thus depends on the precise location of (sub)urban segments within a corridor. Hence, the optimal departure time is corridor-specific. The Monte Carlo analysis calculates the external costs and driving time for 1000 randomly[14] chosen departure times between 0:00 and 23:59[15]. As with departure time, changing the break length affects the time schedule throughout the corridor, which may lead to time and cost savings if (sub)urban corridor segments are avoided during peak hours. The optimal break length is also corridor-specific. It is assumed that the driver can only vary the length of the break period that is taken between the two driving periods of 4:30 hours each. The length of the two driving periods, and thus the total driving time, remain unchanged. The minimum break time is 0:45 hours and the maximum is 14:15 hours (to allow for a break of at least 0:45 hours between the second driving period and the first driving period of the subsequent 24-hour period). The simulation calculates the external costs and driving time for 1000 randomly[16] chosen break length between 0:45 and 14:15.

Figures 4, 6, 8, 10, 12 and 14 show the optimal path identified by TRANSTOOLS for each corridor, the congestion levels expected by the model (for the morning peak), urban areas in the vicinity of the highways. Figures 5, 7, 9, 11, 13, 15 and 16 show for each corridor the range of external costs charges per vehicle kilometre (on the x-axis) and the cumulative probability for each particular charge (on the y-axis). For each value on the x-axis The cumulative probability graph shows the probability that of the external costs being equal or lower than a specific value, if departure time and break time are chosen randomly. As an example, Figure 5 shows that the probability that the external costs for the Paris - Sines corridor are lower than 0.030 is about 72 per cent if departure time and break time are chosen randomly. The probability that the external costs are within a certain range of values can be calculated by subtracting the cumulative probability of the lower bound of the range from the upper bound. E.g., the probability that the external costs for the Paris - Sines corridor lies between 0.030 and 0.029 is 72 per cent minus 39

[14] Based on the assumption of a uniform distribution
[15] Note that the Monte Carlo analysis is simultaneously based on variation in the departure time and on variation in the break length. Due to the large number of replications we are able to isolate the two individual effects from the analysis results.
[16] Based on the assumption of a uniform distribution

per cent. The difference in the range of charges is the result of different combinations of departure time and rest periods. Depending on these, the vehicle will be able to drive at a certain speed at each segment (in turn depending on the time of day), encounter different congestion levels and will face different levels of charges. Note that the shape of the distribution graph differs among corridors, mainly due to difference in the distribution of (sub)urban sections throughout the corridors.

The overall range of average charges is wide, between 2.6 and 5.3 €cents/km. If the whole range of possible values is taken into account, the range becomes wider, between 2 and 8.5 €cents/km, depending mainly on the congestion encountered.

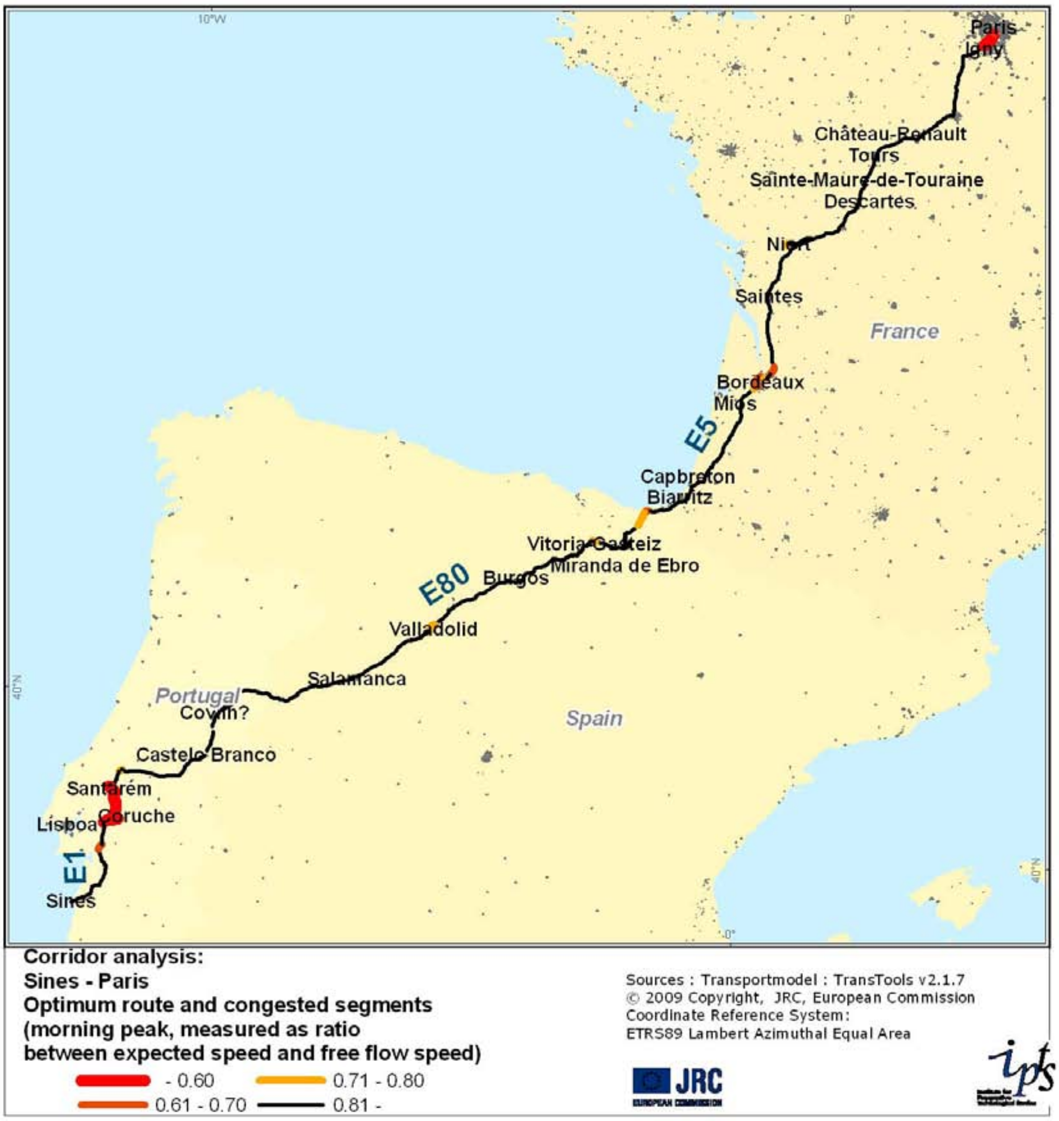

Figure 4: Optimal route for Sines – Paris corridor and congestion levels

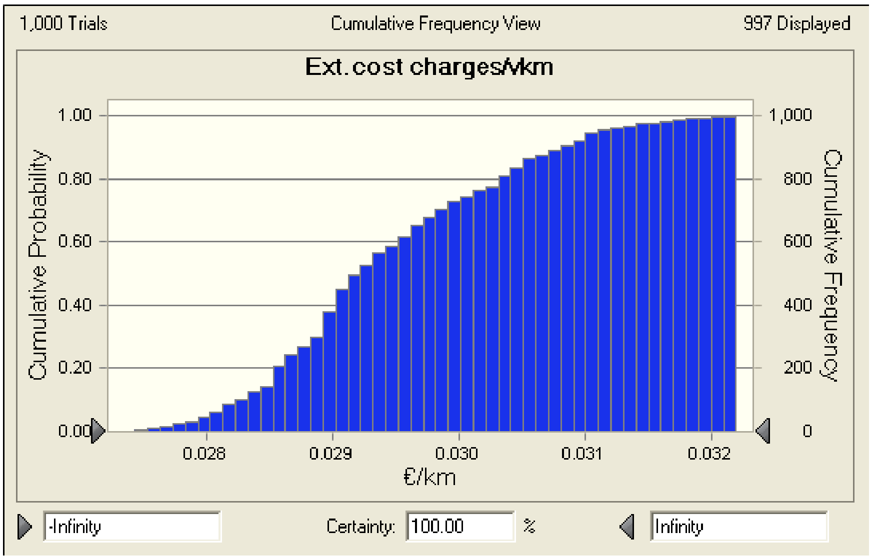

Figure 5: External cost charges for corridor Sines- Paris

Figure 6: Optimal route for Lyon - Bratislava corridor and congestion levels

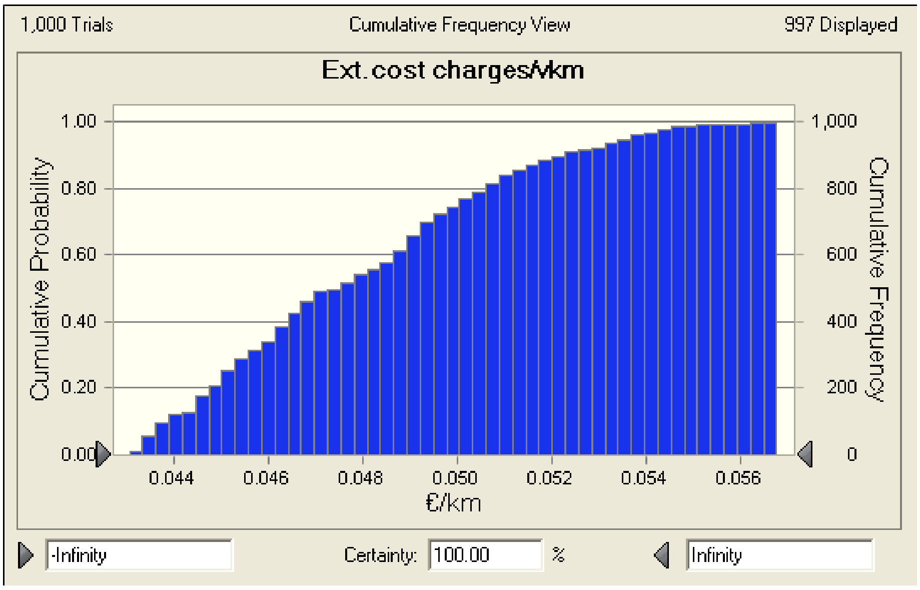

Figure 7: External cost charges for corridor Lyon - Bratislava

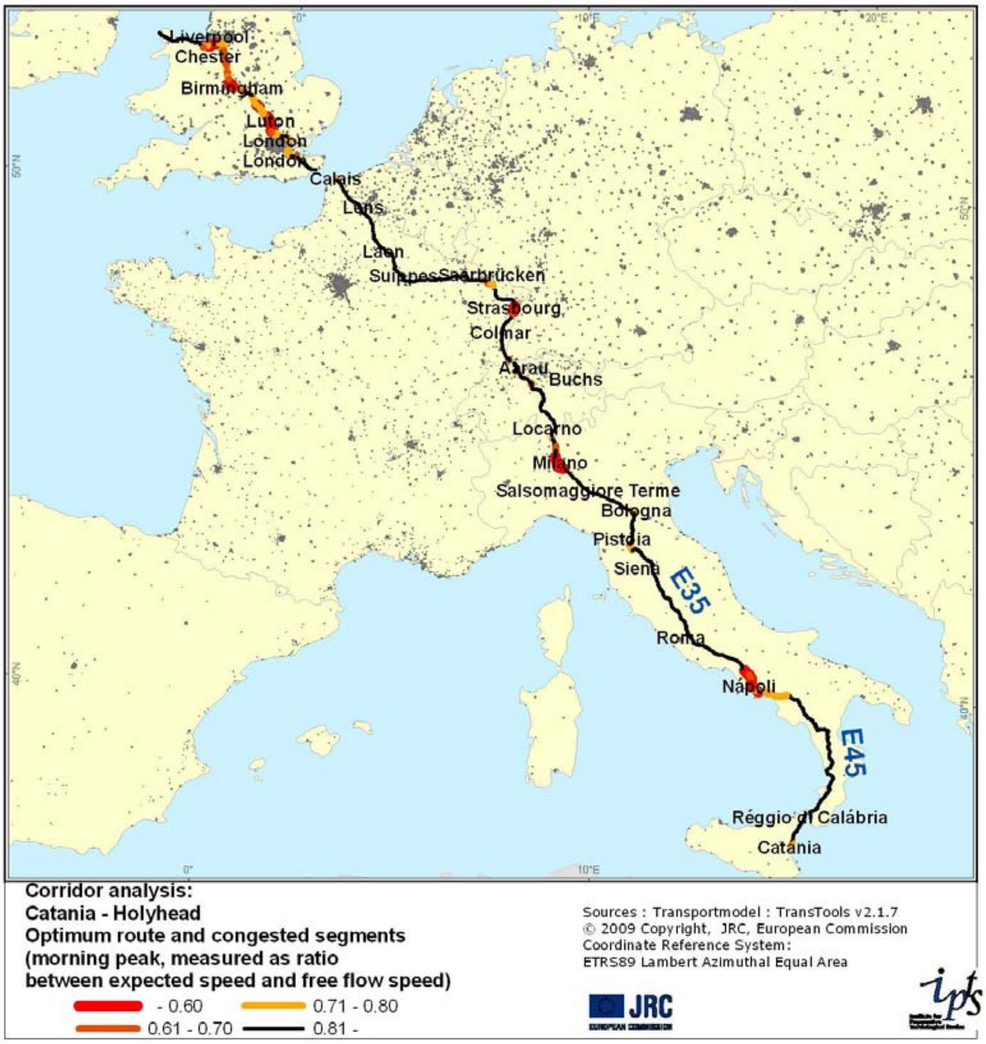

Figure 8: Optimal route for Catania - Holyhead corridor and congestion levels

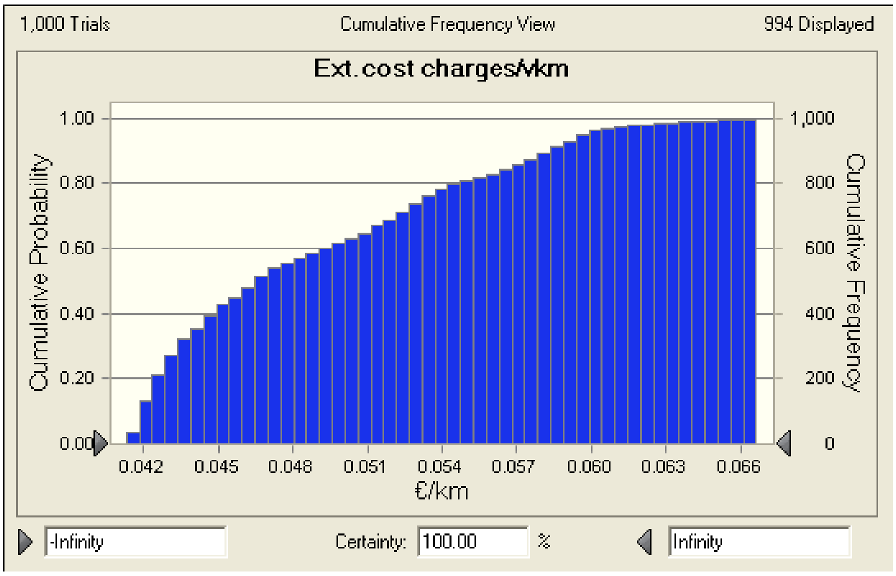

Figure 9: External cost charges for corridor Catania - Holyhead

Figure 10: Optimal route for Milano - Lübeck corridor and congestion levels

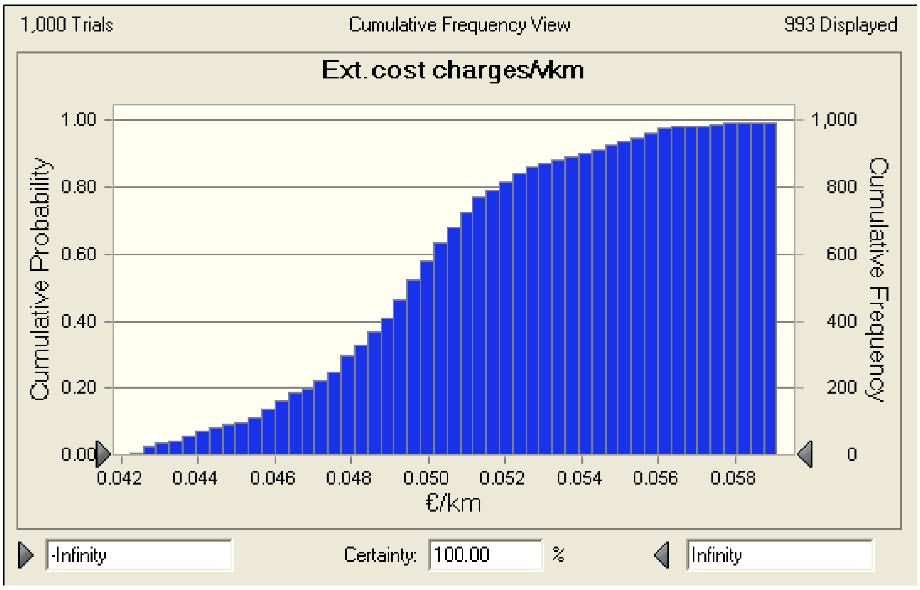

Figure 11: External cost charges for corridor Milano - Lübeck

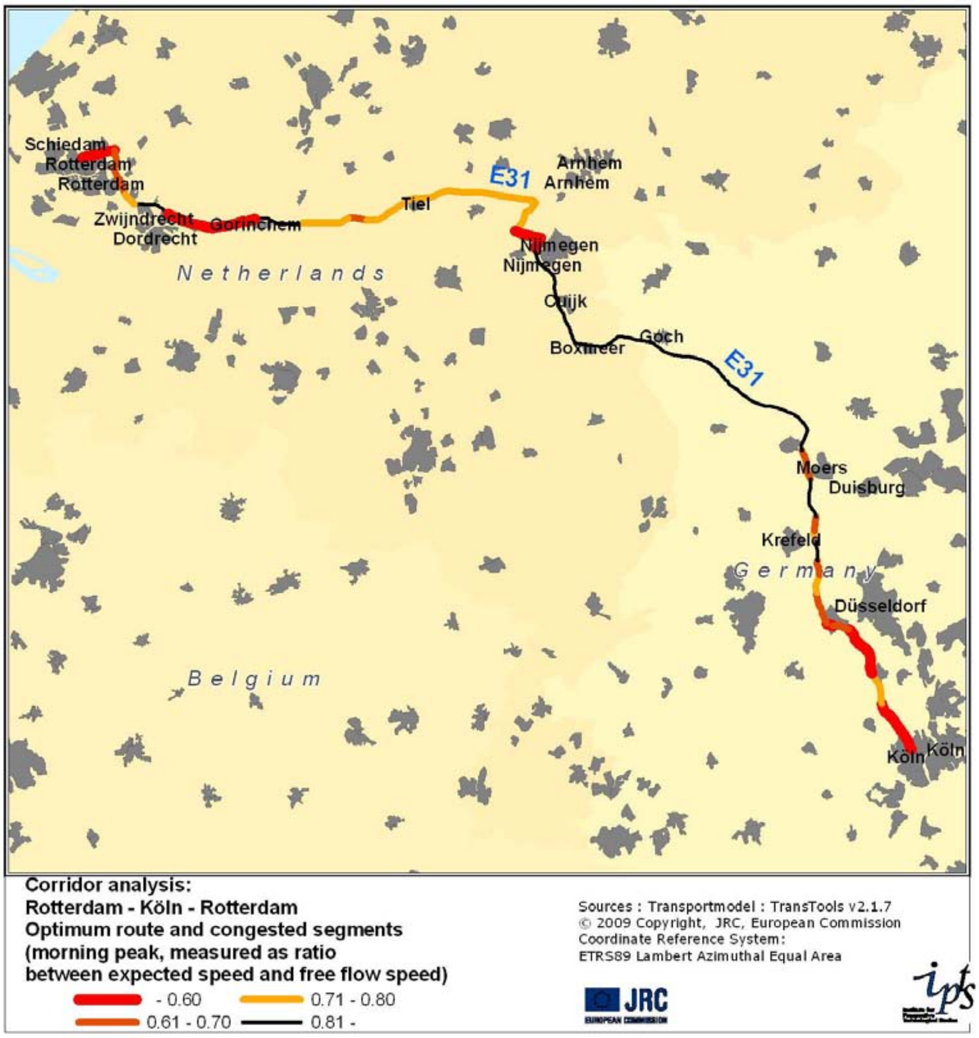

Figure 12: Optimal route for Rotterdam – Köln - Rotterdam corridor and congestion levels

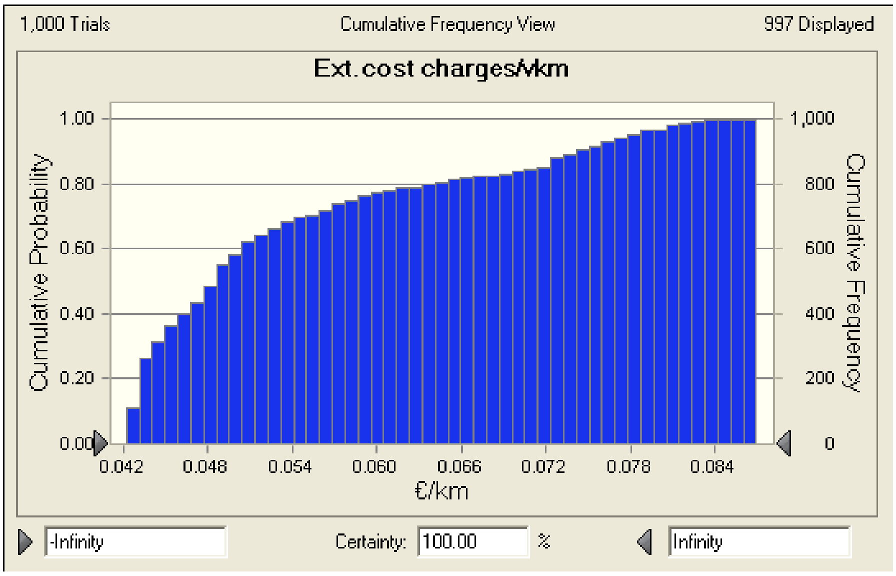

Figure 13: External cost charges for corridor Rotterdam- Köln - Rotterdam

Figure 14: Optimal route for Stockholm - Odense corridor and congestion levels

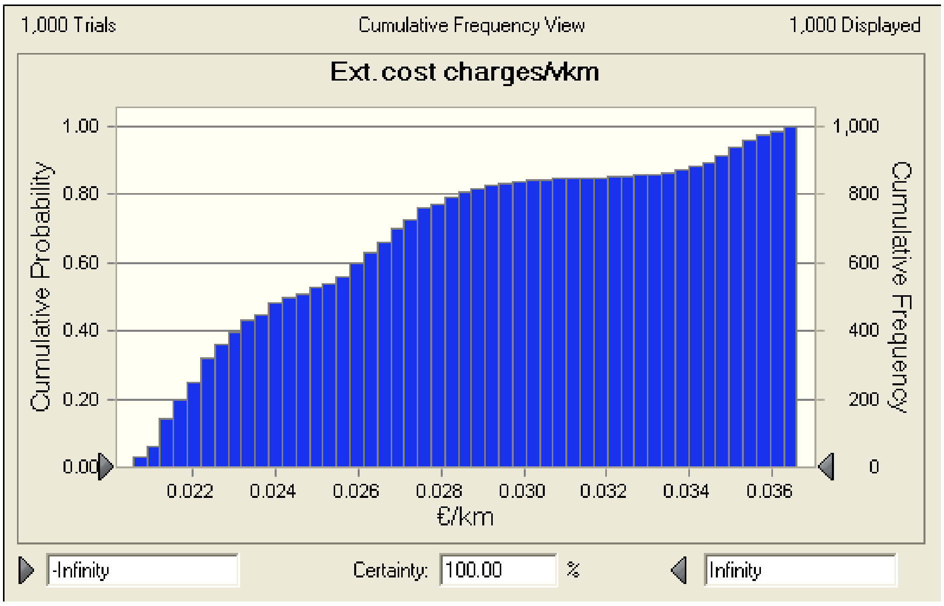

Figure 15: External cost charges for corridor Stockholm – Odense (bridge)

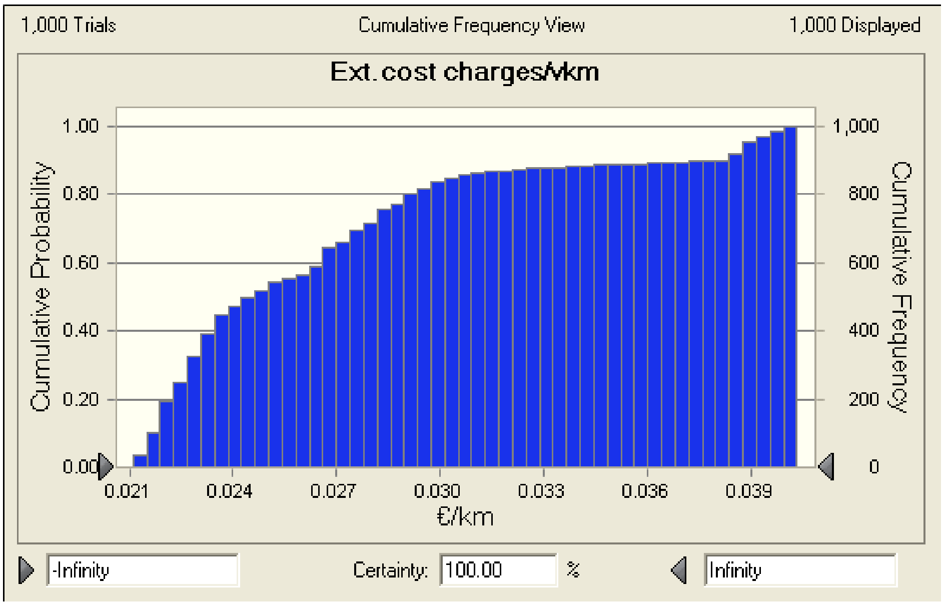

Figure 16: External cost charges for corridor Stockholm – Odense (ferry)

Table 5 summarises the resulting external cost charges per trip for each corridor. For all corridors there is a considerable difference between the minimum and maximum value, with total charges varying between €11 and €45. These considerable differences indicate that substantial cost savings could be achieved if departure time and break length are chosen as to optimize the total cost of the trip.

The share of each of the three externalities covered by the charges varies depending on the length and location of the corridor as well as the level of congestion encountered in a specific time schedule. On average, noise charges represent 5-10% of total charges, air pollution 73%-87% and congestion 6-18%. The Sines – Paris corridor has the lowest average share of congestion charges, while Rotterdam – Köln and Stockholm – Odense have the highest.
The reason that congestion charges are lower than air pollution charges is that the former may be very high, but only so for (sub)urban sections and during peak hours, while air pollution costs are incurred on all corridor sections and time periods. Rather than concluding that congestion costs deserves less attention than air pollution costs, one should note that congestion charges which reflect the temporal and spatial pattern in congestion costs can effectively influence hauliers' behaviour in terms of their route choice and timing of freight trips.

Table 5: Monte Carlo analysis results (6 different corridors, €)

Corridor	**Total external cost charges** Mean costs (min, max)	**Charges by externality type** Average share of total charges (min, max)		
		Noise	Air	Congestion
1. Sines – Paris	54.38 (50.74-62.06)	7% (5%-11%)	87% (76%-93%)	6% (0%- 19%)
2. Lyon – Bratislava	67.24 (60.49-82.48)	5% (4%-7%)	85% (69%-94%)	10% (0%- 26%)
3. Catania – Holyhead	145.96 (123.25-209.96)	5% (3%-8%)	83% (64%-95%)	13% (0%- 33%)
4. Milano – Lübeck	64.37 (55.04-79.08)	5% (3%-7%)	81% (66%-95%)	14% (0%- 30%)
5. Rotterdam – Köln – Rotterdam	25.72 (20.37-42.58)	5% (3%-9%)	78% (45%-95%)	17% (0%- 52%)
6a. Stockholm – Odense (bridge)	20.73 (16.48-29.28)	10% (6%-15%)	73% (50%-89%)	17% (0%- 43%)
6b. Stockholm – Odense (ferry)	20.53 (15.98-30.61)	9% (5%-14%)	73% (47%-90%)	18% (0%- 47%)

3.2 Departure time

Figure 17 displays the total external costs (vertical axis) as a function of departure time (horizontal axis) for the corridor Rotterdam – Köln – Rotterdam. (similar figures for the other corridors are available in Annex 1). Apart from the large range in external costs, which indicate that considerable cost and time savings can be made by choosing the optimal departure time, the graph shows that there is a clear pattern in the relationship between departure time and external costs. The costs are low for departure times between 0:00 and 2:00, rise sharply until about 4:20, where it peaks. Then it drops sharply until 8:00, remains low until about 14:00, rises sharply again until about 16:00, where a second peak is formed. Then it drops sharply until 20:00 and remains low until 24:00. The pattern could be explained from the fact that a departure from Rotterdam about two hours before peak hours implies that the truck passes through the Ruhrgebiet during peak hours. As the Ruhrgebiet consists of many (sub)urban segments, this increases the external costs of the corridor.

The Rotterdam – Köln – Rotterdam corridor is the shortest of the ones analysed and at the same time the one having the highest congestion levels. Since congestion charges have a significant impact on total external cost charges it can be expected that the charges can stimulate a change in trip scheduling, especially for operators who make frequent deliveries using this corridor. If one takes into account the value of time for the truck's load, the driver and the vehicle itself, it is to be expected that the tendency to ship the goods the earliest possible would be accentuated. The extent to this can be done of course also depends on the availability of the shipment and truck, as well as on the additional costs that an earlier departure would mean for the operator. For the specific corridor it would mean that night driving would increase, since departures between 20:00 and 02:00 would be charged less.

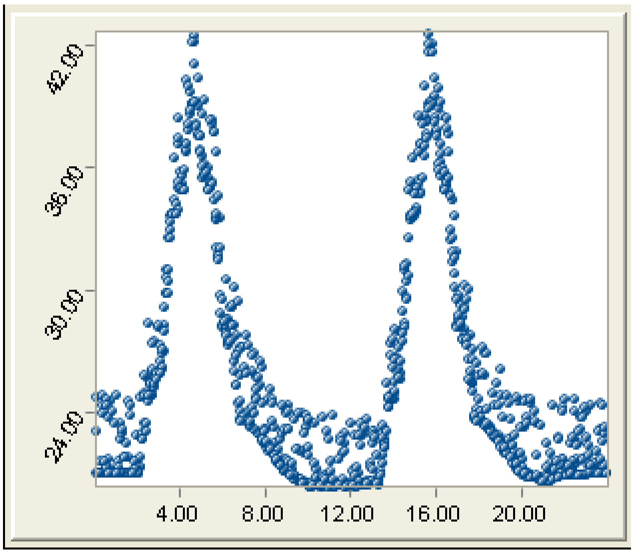

Figure 17: Total external cost charges for the Rotterdam – Köln – Rotterdam corridor as a function of departure time (€ per round-trip)

The range of the charges for a given departure time is the result of different resting periods. It is evident that they can also play a role in the optimisation of the trip, although in the case of the specific corridor they are limited.

In order to illustrate the impact of departure time optimization in more detail, Table 6 shows the detailed segment-by-segment overview of the results for the Rotterdam-Köln-Rotterdam corridor, based on a departure time at 6:00 and a break of 0:45 hour taken after 4:30 hours driving (similar tables for the other corridors are available in Annex 2). The Rotterdam-Köln-Rotterdam corridor consists of three parts. The first 190 kilometres consist of interurban sections. Next follows a segment of about 100 kilometres in which urban and suburban sections alternate more or less equally. The final 190 kilometres back to Rotterdam are again interurban sections. The table shows that three out of five suburban sections were traversed during (medium) peak hours. The per kilometre costs are very high for these sections.

Table 7 shows the segment-by-segment overview of the Rotterdam-Köln-Rotterdam corridor, based on a more favourable departure time at 10:00. The assumptions on timing of the break remain the same. As the off-peak period starts at 10:00 and 17:00, a 10:00 departure implies that the morning peak is avoided. As the Rotterdam-Köln-Rotterdam corridor is relatively short, the whole trip is made before the evening peak starts at 17:00. The external costs are considerably lower for the 10:00 departure. Comparing the results from both tables shows that by optimizing the departure time the total costs decrease from €28.36 to €20.37; a decrease of about 8 euro, or 28.2 per cent. The total travel time decreases by 52 minutes.

3.3 In-trip optimisation of breaks

Figure 18 displays the total external costs and driving time as a function of departure time for the corridor Rotterdam – Köln – Rotterdam. The estimated total external costs vary between 11 and 45 Euro. However, there is no clear pattern visible between the length of the break and the total external costs. This is due to the fact that, as seen above, the deciding factor for the level of charges in this corridor is departure time. A pattern is observed for the other corridors (Annex 1), since the longer length dilutes the impact of different strategy in resting periods.

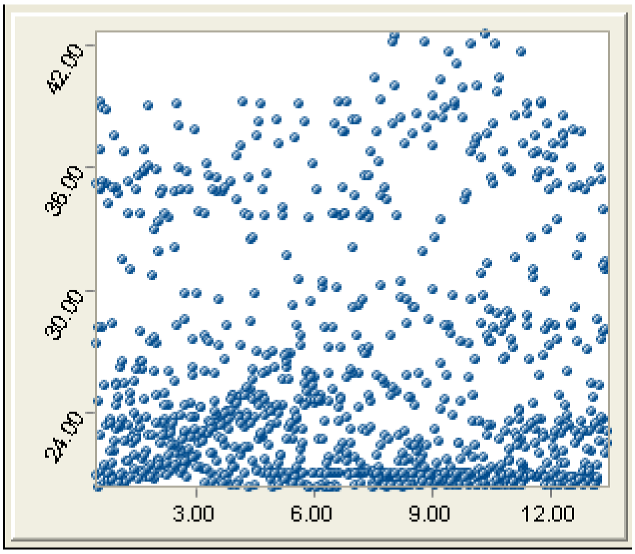

Figure 18: Total external costs for the Rotterdam – Köln – Rotterdam corridor as a function of break length time.

The Monte Carlo analysis focuses on a single aspect of break optimization, i.e. the length of the break. In this section, we aim to analyze the impact of break optimization in more detail, by focusing on the Rotterdam-Köln-Rotterdam corridor and planning the optimal breaks 'manually', making use of all possibilities to induce changes in the timing of breaks as laid out in Driving Time Regulation (EC) No 561/2006.

In the present analysis we assume that the departure time remains fixed at 6:00 in the morning (Table 6), but that the driver tries to avoid suburban periods during the peak period in order to reduce congestion charges (as well as other external costs). For the Rotterdam-Köln-Rotterdam corridor this could be achieved as follows. The driver departs at 6:00 and, without taking breaks, arrives at the first suburban area at 9:12. At 9:12, it is still (medium) peak hour so instead of continuing to drive until 10:30 hour, at which time he would be obliged to take a 0:45 hour break, he takes the 0:45 hour break at 9:12. At 9:57, he needs to start driving again, but by then the (medium) peak is over, and the rest of the route, including all the suburban areas, is traversed during off peak hours. Comparing tables 7 and 8 shows that avoiding the suburbs during peak results in external cost reduction of €4.78, or 17 per cent. There is a slight decrease in total travel time of three minutes, due to an increase in the average speed.

Comparing these results with those in table 8, we see that the optimization of the timing of breaks resulted in lower external cost reductions than the optimization of departure time. Taking into account the value of time, operators would probably simply limit resting periods to the minimum required by law at any given moment and maximize driving time before a break is made. The prevailing parameter for the decision would be total roundtrip time rather than external costs, and in the majority of cases operators would prefer the rest strategy that would minimize the total roundtrip time. In most cases, the value of time lost due to the longer roundtrip duration would be higher than the possible savings from the difference in external cost charges.

Table 6: Overview of external costs per segment for the corridor Rotterdam-Köln-Rotterdam for a departure time at 6:00 (length of break 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
	Description	Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	Rotterdam-Border NL-D	Netherlands	interurban	MP	57	57	6:00 - 7:00	1:00	1:00	4,00	0,13	1,00	5,13	229	7	57	294
2	Rotterdam-Border NL-D	Netherlands	interurban	HP	48	74	7:00 - 8:31	1:31	2:31	4,00	0,13	3,00	7,13	295	10	221	526
3	Border NL-D - Duisburg/Krefeld	Germany	interurban	HP	85	40	8:31 - 9:00	0:28	3:00	4,00	0,13	0,00	4,13	160	5	0	165
4	Border NL-D - Duisburg/Krefeld	Germany	interurban	MP	94	19	9:00 - 9:12	0:12	3:12	4,00	0,13	0,00	4,13	76	2	0	79
5	Duisburg/Krefeld	Germany	suburban	MP	72	9	9:12 - 9:19	0:07	3:19	4,00	1,10	20,00	25,10	36	10	180	226
6	Duisburg/Krefeld-Düsseldorf/Neuss	Germany	interurban	MP	82	9	9:19 - 9:26	0:06	3:26	4,00	0,13	0,00	4,13	36	1	0	37
7	Düsseldorf/Neuss	Germany	suburban	MP	66	11	9:26 - 9:36	0:10	3:36	4,00	1,10	20,00	25,10	44	12	220	276
8	Düsseldorf/Neuss-Köln	Germany	interurban	MP	76	20	9:36 - 9:52	0:15	3:52	4,00	0,13	0,00	4,13	80	3	0	83
9	Köln	Germany	suburban	MP	30	4	9:52 - 10:00	0:07	4:00	4,00	1,10	20,00	25,10	16	4	78	98
10	Köln	Germany	suburban	OP	53	2	10:00 - 10:02	0:02	4:02	4,00	1,10	0,00	5,10	8	2	0	11
11	Köln-Düsseldorf/Neuss	Germany	interurban	OP	79	20	10:02 - 10:17	0:15	4:17	4,00	0,13	0,00	4,13	80	3	0	83
12	Düsseldorf/Neuss	Germany	suburban	OP	69	11	10:17 - 10:27	0:09	4:27	4,00	1,10	0,00	5,10	44	12	0	56
13	Düsseldorf/Neuss-Duisburg/Krefeld	Germany	interurban	OP	80	4	10:27 - 10:30	0:02	4:30	4,00	0,13	0,00	4,13	16	1	0	16
14	Düsseldorf/Neuss-Duisburg/Krefeld	Germany	interurban	OP	80	5	11:15 - 11:18	0:03	5:18	4,00	0,13	0,00	4,13	20	1	0	21
15	Duisburg/Krefeld	Germany	suburban	OP	81	9	11:18 - 11:25	0:06	5:25	4,00	1,10	0,00	5,10	36	10	0	46
16	Duisburg/Krefeld-Border D-NL	Germany	interurban	OP	94	59	11:25 - 12:03	0:37	6:03	4,00	0,13	0,00	4,13	236	8	0	244
17	Border D-NL-Rotterdam	Netherlands	interurban	OP	78	130	12:03 - 13:43	1:40	7:43	4,00	0,13	0,00	4,13	518	17	0	535
Total corridor														1930	107	756	2794

Table 7: Overview of external costs per segment for the corridor Rotterdam-Köln-Rotterdam for a departure time at 10:00 (length of break 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
	Description	Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	Rotterdam-Border NL-D	Netherlands	interurban	OP	78	131	10:00 - 11:41	1:41	1:41	4,00	0,13	0,00	4,13	524	17	0	541
2	Border NL-D - Duisburg/Krefeld	Germany	interurban	OP	94	59	11:41 - 12:18	0:37	2:18	4,00	0,13	0,00	4,13	236	8	0	244
3	Duisburg/Krefeld	Germany	suburban	OP	81	9	12:18 - 12:25	0:06	2:25	4,00	1,10	0,00	5,10	36	10	0	46
4	Duisburg/Krefeld-Düsseldorf/Neuss	Germany	interurban	OP	80	9	12:25 - 12:32	0:06	2:32	4,00	0,13	0,00	4,13	36	1	0	37
5	Düsseldorf/Neuss	Germany	suburban	OP	69	11	12:32 - 12:41	0:09	2:41	4,00	1,10	0,00	5,10	44	12	0	56
6	Düsseldorf/Neuss-Köln	Germany	interurban	OP	79	20	12:41 - 12:57	0:15	2:57	4,00	0,13	0,00	4,13	80	3	0	83
7	Köln	Germany	suburban	OP	53	6	12:57 - 13:03	0:06	3:03	4,00	1,10	0,00	5,10	24	7	0	31
8	Köln-Düsseldorf/Neuss	Germany	interurban	OP	79	20	13:03 - 13:18	0:15	3:18	4,00	0,13	0,00	4,13	80	3	0	83
9	Düsseldorf/Neuss	Germany	suburban	OP	69	11	13:18 - 13:28	0:09	3:28	4,00	1,10	0,00	5,10	44	12	0	56
10	Düsseldorf/Neuss-Duisburg/Krefeld	Germany	interurban	OP	80	9	13:28 - 13:35	0:06	3:35	4,00	0,13	0,00	4,13	36	1	0	37
11	Duisburg/Krefeld	Germany	suburban	OP	81	9	13:35 - 13:42	0:06	3:42	4,00	1,10	0,00	5,10	36	10	0	46
12	Duisburg/Krefeld-Border D-NL	Germany	interurban	OP	94	59	13:42 - 14:19	0:37	4:19	4,00	0,13	0,00	4,13	236	8	0	244
13	Border D-NL-Rotterdam	Netherlands	interurban	OP	78	14	14:19 - 14:30	0:10	4:30	4,00	0,13	0,00	4,13	54	2	0	56
14	Border D-NL-Rotterdam	Netherlands	interurban	OP	78	116	15:15 - 16:44	1:29	6:44	4,00	0,13	0,00	4,13	464	15	0	479
Total corridor														1930	107	0	2037

Table 8: Overview of external costs per segment for the corridor Rotterdam-Köln-Rotterdam for a departure time at 6:00, the timing of the break is chosen optimally

Segment		**Classification**			**Speed, distance, time**					**External costs per vkm (€-cent)**				**External costs per segment (€-cent)**			
Description		Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	Rotterdam-Border NL-D	Netherlands	interurban	MP	57	57	6:00 - 7:00	1:00	1:00	4,00	0,13	1,00	5,13	229	7	57	294
2	Rotterdam-Border NL-D	Netherlands	interurban	HP	48	74	7:00 - 8:31	1:31	2:31	4,00	0,13	3,00	7,13	295	10	221	526
3	Border NL-D - Duisburg/Krefeld	Germany	interurban	HP	85	40	8:31 - 9:00	0:28	3:00	4,00	0,13	0,00	4,13	160	5	0	165
4	Border NL-D - Duisburg/Krefeld	Germany	interurban	MP	94	19	9:00 - 9:12	0:12	3:12	4,00	0,13	0,00	4,13	76	2	0	79
5	**Duisburg/Krefeld**	**Germany**	**suburban**	**OP**	**81**	**9**	**10:00 - 10:06**	**0:06**	**4:06**	**4,00**	**1,10**	**0,00**	**5,10**	**36**	**10**	**0**	**46**
6	Duisburg/Krefeld-Düsseldorf/Neuss	Germany	interurban	OP	80	9	10:06 - 10:13	0:06	4:13	4,00	0,13	0,00	4,13	36	1	0	37
7	**Düsseldorf/Neuss**	**Germany**	**suburban**	**OP**	**69**	**11**	**10:13 - 10:23**	**0:09**	**4:23**	**4,00**	**1,10**	**0,00**	**5,10**	**44**	**12**	**0**	**56**
8	Düsseldorf/Neuss-Köln	Germany	interurban	OP	79	9	10:23 - 10:30	0:06	4:30	4,00	0,13	0,00	4,13	37	1	0	38
9	Düsseldorf/Neuss-Köln	Germany	interurban	OP	79	11	10:30 - 10:38	0:08	4:38	4,00	0,13	0,00	4,13	43	1	0	44
10	**Köln**	**Germany**	**suburban**	**OP**	**53**	**6**	**10:38 - 10:44**	**0:06**	**4:44**	**4,00**	**1,10**	**0,00**	**5,10**	**24**	**7**	**0**	**31**
11	Köln-Düsseldorf/Neuss	Germany	interurban	OP	79	20	10:44 - 11:00	0:15	5:00	4,00	0,13	0,00	4,13	80	3	0	83
12	**Düsseldorf/Neuss**	**Germany**	**suburban**	**OP**	**69**	**11**	**11:00 - 11:09**	**0:09**	**5:09**	**4,00**	**1,10**	**0,00**	**5,10**	**44**	**12**	**0**	**56**
13	Düsseldorf/Neuss-Duisburg/Krefeld	Germany	interurban	OP	80	9	11:09 - 11:16	0:06	5:16	4,00	0,13	0,00	4,13	36	1	0	37
14	**Duisburg/Krefeld**	**Germany**	**suburban**	**OP**	**81**	**9**	**11:16 - 11:23**	**0:06**	**5:23**	**4,00**	**1,10**	**0,00**	**5,10**	**36**	**10**	**0**	**46**
15	Duisburg/Krefeld-Border D-NL	Germany	interurban	OP	94	59	11:23 - 12:00	0:37	6:00	4,00	0,13	0,00	4,13	236	8	0	244
16	Border D-NL-Rotterdam	Netherlands	interurban	OP	78	130	12:00 - 13:40	1:40	7:40	4,00	0,13	0,00	4,13	518	17	0	535
Total corridor														1930	107	278	2316

Chapter 4 Overview of scenarios with respect to different assumptions on the calculation and implementation of external cost charges

This chapter and the next one focus on the analysis of the impact of various assumptions with respect to the methods used for the calculation and implementation of external cost charges on the total external costs and driving time of the six corridors. The aim is to investigate the impact of the level of mountain correction factors, the height of congestion charges, the use of caps, the use of an alternative set of caps, and the European emission standard that is applied. In order to analyse this six different scenarios have been distinguished (see Table 9 for an overview). Scenario I, the base scenario, corresponds to the assumptions as described in Chapter 1. Each of the five alternative scenarios differs in only one respect from scenario I.

Table 9: Overview of different scenarios analysed

Scenario	Mountain correction factor	Road charges	Caps	Euro emission standard
I. Base scenario	low	low	set 1	Euro IV
II. Higher mountain area charges	**high**	low	set 1	Euro IV
III. Higher congestion charges	low	**high**	set 1	Euro IV
IV. Alternative set of caps	low	low	**set 2**	Euro IV
V. No caps	low	low	**off**	Euro IV
VI. Euro V standard	low	low	set 1	**Euro V**

4.1 Mountain correction factors

In the base scenario, for mountain area segments correction factors of 2.5 and 1.5 have been implemented for noise pollution and air pollution, respectively. In scenario II, we analyse the impact on external cost charges of implementing the maximum correction factors specified in the Commission Proposal of 5 and 2, respectively.

4.2 Congestion charges

Congestion charges are based on the value of time lost due to congestion for each segment and time period, using TRANSTOOLS results. Segments are classified as 'congested' when the calculated congestion costs for the day as a whole are non-zero. Scenario I assumes that on congested segments, the level of congestion charges applied by the member states depends on the period of the day. In scenario III it is assumed that member states always apply the maximum possible congestion charge during peak time periods on all congested corridor segments, even if not justified by the actual congestion levels.

4.3 Caps

In the base scenario, in order to determine the actual external cost charges, the caps from Annex IIIa of the Commission proposal underlying this analysis (EC 2008) are used. With scenario IV we analyse the impact of the application of an alternative set of caps as laid out in the 2009 European Parliament legislative resolution on the proposal (EC 2009). The application of these caps reduces the maximum chargeable air pollution for each EURO class. For vehicles less polluting than EURO VI the maximum charge is even zero. For vehicles conforming to the Euro IV standard only the maximum permissible charge for air pollution on interurban roads changes (from 4 to 3 euro per vehicle*km). Furthermore, by including scenario V, which assumes that no caps are applied, we investigate the impact of implementing caps in the first place

4.4 European emission standard

In the base scenario we assume that the truck complies with the Euro IV emission standard. With scenario VI we investigate the impact of changing the emission standard to Euro V. The change in Euro standard affects both the calculation of the external costs of air pollution and the value of the caps that should be applied. For the Euro V emission standard the caps for suburban and interurban roads are 3 and 2 euro per vkm, respectively, whereas for the Euro IV standard, they are both 4 euro per vkm.

4.5 Analysis Results

For each of the scenarios a Monte Carlo analysis is carried out. The sensitivity analysis in this chapter consists of a comparison of the analysis results for the different scenarios. The analysis results for each of the six corridors are shown in Table 10 to Table 16.

Table 10: Monte Carlo analysis results for the corridor Sines – Paris (6 different scenarios, €)

Scenario	**Total external cost charges** Mean (min, max)	**Charges by externality type** Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	54.38 (50.74-62.06)	7% (5%-11%)	87% (76%-93%)	6% (0%- 19%)
II. Higher mountain area charges	as in Sc I	as in Sc I	as in Sc I	as in Sc I
III. Higher congestion charges	61.42 (50.40-90.74)	7% (4%-10%)	78% (52%-93%)	16% (0%-44%)
IV. Alternative set of caps	47.21 (43.33-55.85)	8% (6%-12%)	85% (72%-92%)	7% (0%-21%)
V. No caps	104.51 (101.01-112.57)	20% (18%-21%)	77 (71%-79%)	3% (0%-10%)
VI. Euro V standard	33.49 (29.82-40.64)	12% (8%-17%)	79% (65%-88%)	10% (0%- 27%)

Table 11: Monte Carlo analysis results for the corridor Lyon - Bratislava (6 different scenarios, €)

Scenario	**Total external cost charges** Mean (min, max)	**Charges by externality type** Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	67.24 (60.49-82.48)	5% (4%-7%)	85% (69%-94%)	10% (0%- 26%)
II. Higher mountain area charges	68.46 (61.71-83.68)	6% (4%-8%)	84% (68%-94%)	10% (0%- 26%)
III. Higher congestion charges	72.87 (60.07-95.81)	5% (3%-7%)	79% (59%-95%)	16% (0%-37%)
IV. Alternative set of caps	54.81 (47.92-68.30)	7% (5%-9%)	82% (65%-93%)	12% (0%-29%)
V. No caps	104.92 (98.05-120.34)	16% (14%-18%)	77% (67%-83%)	6% (0%-18%)
VI. Euro V standard	40.59 (33.50-53.46)	9% (6%-13%)	75% (57%-90%)	16% (0%- 37%)

Table 12: Monte Carlo analysis results for the corridor Catania – Holyhead (6 different scenarios, €)

Scenario	**Total external cost charges** Mean (min, max)	**Charges by externality type** Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	145.96 (123.25-209.96)	5% (3%-8%)	83% (64%-95%)	13% (0%- 33%)
II. Higher mountain area charges	147.43 (125.08-208.53)	5% (3%-8%)	83% (64%-95%)	12% (0%- 32%)
III. Higher congestion charges	149.33 (122.96-222.73)	5% (3%-7%)	81% (59%-95%)	15% (0%-38%)
IV. Alternative set of caps	121.50 (99.10-181.36)	6% (4%-9%)	79% (57%-94%)	15% (0%-39%)
V. No caps	253.21 (227.89-323.26)	16% (14%-18%)	75% (64%-82%)	9% (0%-22%)
VI. Euro V standard	89.63 (67.42-142.59)	8% (4%-13%)	72% (47%-91%)	20% (0%- 48%)

Table 13: Monte Carlo analysis results for the corridor Milano - Lübeck (6 different scenarios, €)

Scenario	**Total external cost charges** Mean (min, max))	**Charges by externality type** Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	64.37 (55.04-79.08)	5% (3%-7%)	81% (66%-95%)	14% (0%- 30%)
II. Higher mountain area charges	65.00 (55.48-81.21)	5% (3%-7%)	81% (65%-95%)	14% (0%-31%)
III. Higher congestion charges	68.15 (54.82-96.67)	5% (3%-7%)	77% (54%-95%)	18% (0%-43%)
IV. Alternative set of caps	52.88 (43.10-69.87)	6% (4%-9%)	77% (60%-94%)	17% (0%-37%)
V. No caps	160.01 (150.59-182.38)	11% (10%-12%)	84% (75%-89%)	6% (0%-15%)
VI. Euro V standard	39.48 (29.69-58.78)	8% (4%-13%)	69% (46%-91%)	22% (0%- 49%)

Table 14: Monte Carlo analysis results for the corridor Rotterdam- München- Rotterdam (6 different scenarios, €)

Scenario	**Total external cost charges** Mean (min, max))	**Charges by externality type** Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	25.72 (20.37-42.58)	5% (3%-9%)	78% (45%-95%)	16% (0%- 52%)
II. Higher mountain area charges	as in Sc I	as in Sc I	as in Sc I	as in Sc I
III. Higher congestion charges	28.96 (20.37-59.09	5% (2%-8%)	72% (33%-95%)	23% (0%-65%)
IV. Alternative set of caps	21.38 (16.01-38.54)	6% (3%-11%)	74% (39%-93%)	19% (0%-58%)
V. No caps	55.23 (50.00-71.99)	12% (9%-13%)	80% (61%-87%)	8% (0%-31%)
VI. Euro V standard	16.52 (11.18-33.58)	9% (3%-15%)	67% (30%-90%)	24% (0%- 67%)

Table 15: Monte Carlo analysis results for the corridor Stockholm – Odense (bridge) (6 different scenarios, €)

Scenario	Total external cost charges Mean (min, max))	Charges by externality type Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	20.73 (16.48-29.28)	10% (6%-15%)	73% (50%-89%)	17% (0%- 43%)
II. Higher mountain area charges	as in Sc I	as in Sc I	as in Sc I	as in Sc I
III. Higher congestion charges	25.76 (16.48-51.25)	9% (3%-14%)	62% (29%-89%)	29% (0%-67%)
IV. Alternative set of caps	20.36 (16.48-29.27)	11% (6%-15%)	74% (50%-89%)	15% (0%-43%)
V. No caps	29.71 (25.72-38.33)	37% (28%-43%)	51% (39%-58%)	12% (0%-33%)
VI. Euro V standard	15.32 (11.08-23.87)	15% (7%-22%)	64% (39%-84%)	21% (0%- 53%)

Table 16: Monte Carlo analysis results for the corridor Stockholm – Odense (ferry) (6 different scenarios, €)

Scenario	Total external cost charges Mean (min, max))	Charges by externality type Average share of total charges (min, max)		
		Noise	Air	Congestion
I. Base scenario	20.53 (15.98-30.61)	9% (5%-14%)	73% (47%-90%)	18% (0%- 47%)
II. Higher mountain area charges	as in Sc I	as in Sc I	as in Sc I	as in Sc I
III. Higher congestion charges	23.88 (15.98-41.66)	8% (4%-14%)	64% (35%-90%)	27% (0%-61%)
IV. Alternative set of caps	20.69 (15.98-31.08)	9% (5%-14%)	73% (46%-90%)	18% (0%-49%)
V. No caps	29.51 (24.95-39.36)	36% (26%-42%)	51% (37%-59%)	13% (0%-36%)
VI. Euro V standard	15.09 (10.74-25.36)	13% (6%-20%)	65% (36%-86%)	22% (0%- 57%)

Chapter 5 Comparison of scenario results

A first comparison between the scenarios shows that the degree of internalisation of the charges is greatly influenced by the level of caps selected. Scenario V (No caps) corresponds to the charges if the full external costs were internalised, while scenarios I and IV correspond to the original and the alternative caps proposal respectively.

For noise, both proposals use the same caps which are significantly lower than the actual external cost estimated by the Eurovignette methodology (Table 17). The level of internalisation is very similar for all six corridors and is close to 20%. Given this low level of internalisation, the share of noise charges compared to total external cost charges is therefore low, in the range of 5%-10% on average, while it could correspond to over 30% of real external costs in some cases (Table 10 to Table 16).

Table 17: Noise charges, € per trip

Corridor	I. Base scenario	Level of internali-zation (I/V)	IV. Alternative set of caps	Level of internali-zation (IV/V)	V. No caps
1. Sines – Paris	3.96	19%	3.96	19%	20.93
2. Lyon – Bratislava	3.55	21%	3.54	21%	17.01
3. Catania – Holyhead	6.70	17%	6.80	17%	40.42
4. Milano – Lübeck	3.14	18%	3.18	18%	17.19
5. Rotterdam – Köln – Rotterdam	1.28	20%	1.28	20%	6.48
6a. Stockholm – Odense (bridge)	2.11	19%	2.11	19%	10.92
6b. Stockholm – Odense (ferry)	1.88	18%	1.87	18%	10.36

For air quality, the level of internalisation is much higher, although varies significantly among the corridors (Table 18). For most corridors it is between 40% and 70% according to the original proposal and drops to 30% to 55% according to the alternative caps proposal. For the Stockholm-Odense corridor the caps in both proposals are very close to the external cost estimated by the Eurovignette methodology and therefore is on average 98% for both scenarios and both alternatives routes.

Table 18: Air charges, € per trip

Corridor	I. Base scenario	Level of internali-zation (I/V)	IV. Alternative set of caps	Level of internali-zation (IV/V)	V. No caps
1. Sines – Paris	47.11	59%	40.04	50%	80.30
2. Lyon – Bratislava	56.84	70%	44.54	55%	81.10
3. Catania – Holyhead	117.37	63%	93.17	50%	187.74
4. Milano – Lübeck	52.18	39%	40.44	30%	133.62
5. Rotterdam – Köln – Rotterdam	19.30	44%	14.93	34%	43.62
6a. Stockholm – Odense (bridge)	14.74	98%	14.74	98%	14.97
6b. Stockholm – Odense (ferry)	14.43	98%	14.43	98%	14.73

The fact that the level of internalisation is below 100%, in this case because of the political decision to define maximum charges, is not against the principles of internalization of external costs. Since the importance lies in giving a price signal that will stimulate a change in the users' behaviour, the level of internalisation chosen depends on the desired degree of effectiveness of the measure (the goal in reduction of external costs at a given cost) as well as the options given to the users to adapt their behaviour. The decision for a low internalisation rate for noise and a high for air can be justified by the fact that the users have more options to reduce the pollutants they emit (by e.g. shifting from EURO IV to EURO V) than to reduce noise (which is largely independent of the engine standard).

Table 19 gives an interview of the average cost charges per vehicle*km for each scenario and corridor. It is evident that the caps applied, the vehicle technology used and the congestion encountered affect the most the external costs and charges.

On average though, external cost would be 11.4 €cents/vehicle*km and charges would range from 4.4 to 6.0 €cents/vehicle*km. The shift to EURO V would reduce both costs and charges significantly though, since air pollution would decrease. The highest external cost would be generated in the Rotterdam- Köln- Rotterdam corridor for a EURO IV vehicle during congestion, 14.9 €cents/vehicle*km (maximum value for scenario V). Depending on the caps used in that case, charges would range between 8 €cents/vehicle*km (maximum for scenario IV) and 12.2 €cents/vehicle*km (maximum for scenario III), while for the base scenario the charge would be 8.8 €cents/vehicle*km.
A similar picture can be seen for all corridors, although the ranges of the charges are more limited. Longer corridors with less congestion tend to have an average charge of between 2.5 and 5.2 €cents/vehicle*km for EURO IV (for scenarios I to V). The use of EURO V would reduce average charges from between 2.6 and 5.3 €cents/vehicle*km (scenario I) to between 1.8 and 3.4 €cents/vehicle*km (scenario VI).

Table 19: Average total charges per vehicle kilometre (€cents), mean value (min, max)

Corridor	I. Base scenario	II. Higher mountain area charges	III. Higher congestion charges	IV. Alternative set of caps	V. No caps	VI. Euro V standard
1. Sines – Paris	2.9 (2.8–3.4)	2.9 (2.8–3.4)	3.3 (2.7-4.9)	2.6 (2.3-3.0)	5.7 (5.5-6.1)	1.8 (1.6-2.2)
2. Lyon – Bratislava	4.8 (4.3-5.9)	4.9 (4.3-5.9)	5.2 (4.3-6.8)	3.9 (3.4-4.9)	7.5 (7.0-8.6)	2.9 (2.4-3.8)
3. Catania – Holyhead	4.9 (4.1-7.0)	4.9 (4.2-6.9)	5.0 (4.1-7.4)	4.0 (3.3-6.0)	8.4 (7.6-10.8)	3.0 (2.2-4.7)
4. Milano – Lübeck	4.9 (4.2-6.1)	5.0 (4.3-6.2)	5.2 (4.2-7.4)	4.1 (3.3-5.4)	12.3 (11.5-14.0)	3.0 (2.3-4.5)
5. Rotterdam – Köln – Rotterdam	5.3 (4.2-8.8)	5.3 (4.2-8.8)	6.0 (4.2-12.2)	4.4 (3.3-8.0)	11.4 (10.4-14.9)	3.4 (2.3-7.0)
6a. Stockholm – Odense (bridge)	2.6 (2.1-3.7)	2.6 (2.1-3.7)	3.2 (2.1-6.4)	2.5 (2.1-3.7)	3.7 (3.2-4.8)	1.9 (1.4-3.0)
6b. Stockholm – Odense (ferry)	2.7 (2.1-4.0)	2.7 (2.1-4.0)	3.2 (2.1-5.5)	2.7 (2.1-4.1)	3.9 (3.3-5.2)	2.0 (1.4-3.3)

Chapter 6. Mountain areas and steep segments

The amendment proposal foresees that higher external cost charges may be charged for high altitude or steep road segments. Traffic under such conditions can generate higher levels of pollution and noise, while the valuation of such externalities can also be higher for sensitive areas. The amendment proposal foresees that local authorities may apply an increased charge for noise and air in such areas as long as this is justified by higher external impacts and cost.

However, there is no official definition of what can be considered as a mountainous or steep segment. In order to simulate the possibility of the application of additional charges by local authorities, the analysis explored different options of identifying segments in the corridors analysed that could be possible considered as such.

Two criteria were set to distinguish mountainous and steep zones:

The elevation criterion takes only altitude into account and considers as mountainous any segment of the corridor over a specific altitude. Several combinations were tested by changing the altitude limit (Figure 19). For the purposes of the analysis the altitude of 1000 m was used as the limit, a limit that in practice would include main links in the Alps and the Pyrenees and predominantly links of the secondary road network for the rest of the EU.

The steepness criterion used data on the gradient (slope) of the road segments included in the TeleAtlas database. The threshold for the consideration of a segment as mountainous was assumed to be a gradient of 5% or higher, which according to research results is the level over which the impact on vehicle emissions of heavy duty vehicles becomes noticeable [ARTEMIS 2007]. This definition would include about 3% of the interurban road network in the EU, but did not result in any links of the six corridors being considered as steep. This is mainly due to the fact that steep links are mainly on the secondary road network. National and European highway standards normally limit the maximum allowable slope and the largest part of the trips analysed uses such networks. Nevertheless, the impacts of including a higher share of steep segments can be derived the same way as for increases in the share of high altitude links.

Figure 20 shows the parts of the corridors used in the analysis that would be considered as mountainous. Since the criterion was altitude over 1000m, all of them lie in the Alps area and affect only three of the corridors analysed. Table 20 summarizes the information concerning the length of each corridor that could be considered as mountainous and for which the analysis assumes that additional charges are applied if the threshold for the definition of high altitude segments is 1000m. Obviously, changing the threshold would have an impact on the total length of a corridor for which the charges should be applied (Table 20 gives an example for a threshold of 800m).

A simple rule of thumb can be applied to estimate the impact that changing the share of the route considered as mountainous would have on average on the external cost charges:

*Increase in charges = share of mountainous kilometres for corridor * (share of air charges for the corridor * 1.5+ share of noise charges for the corridor * 2.5)*

If, for example 5% of the Catania-Holyhead were to be considered as mountainous or steep, the total charges would increase from €146.00 to €149.80, an increase of 2.6%.

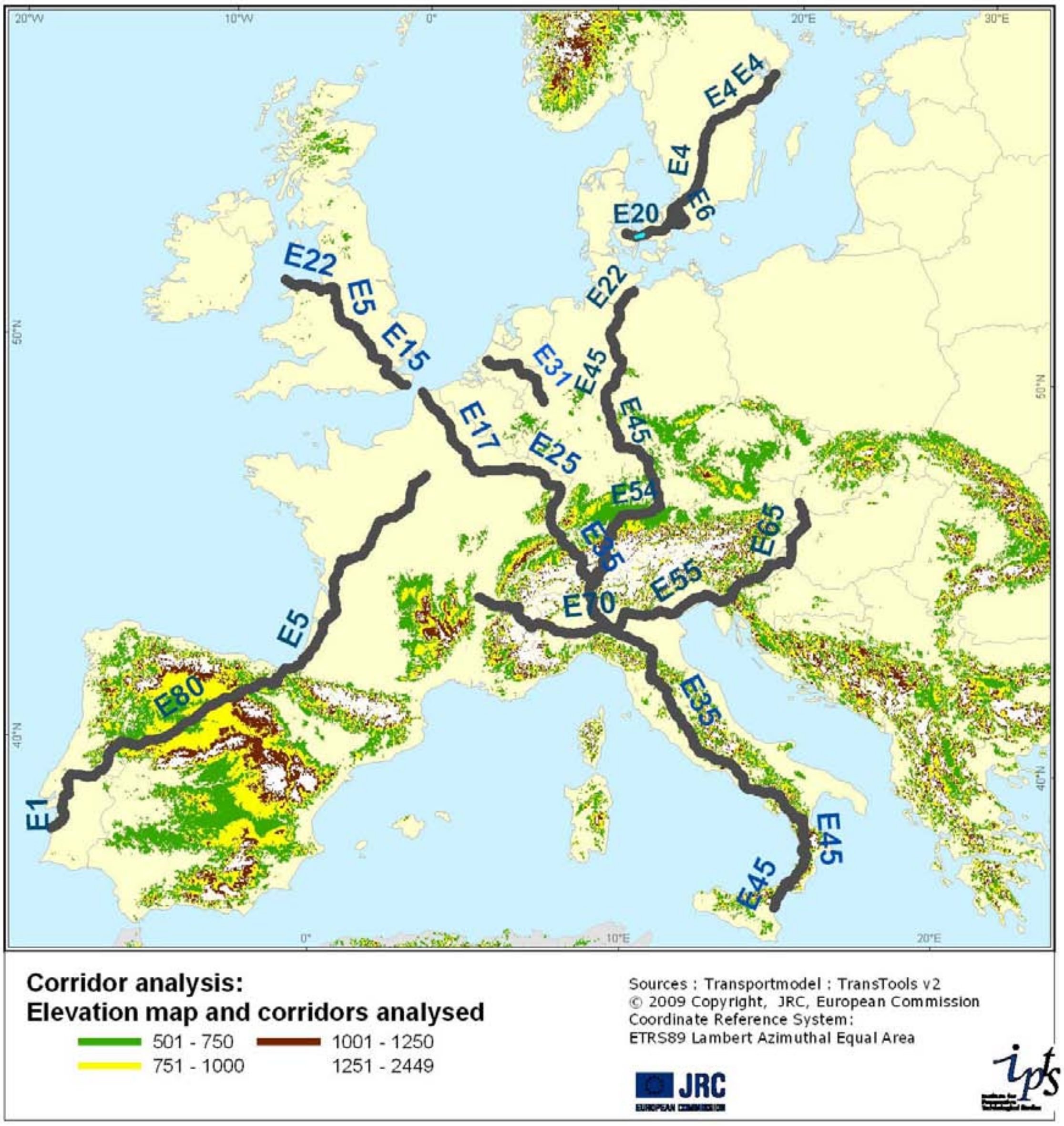

Figure 19: Corridors analysed in relation to elevation ranges above 500m

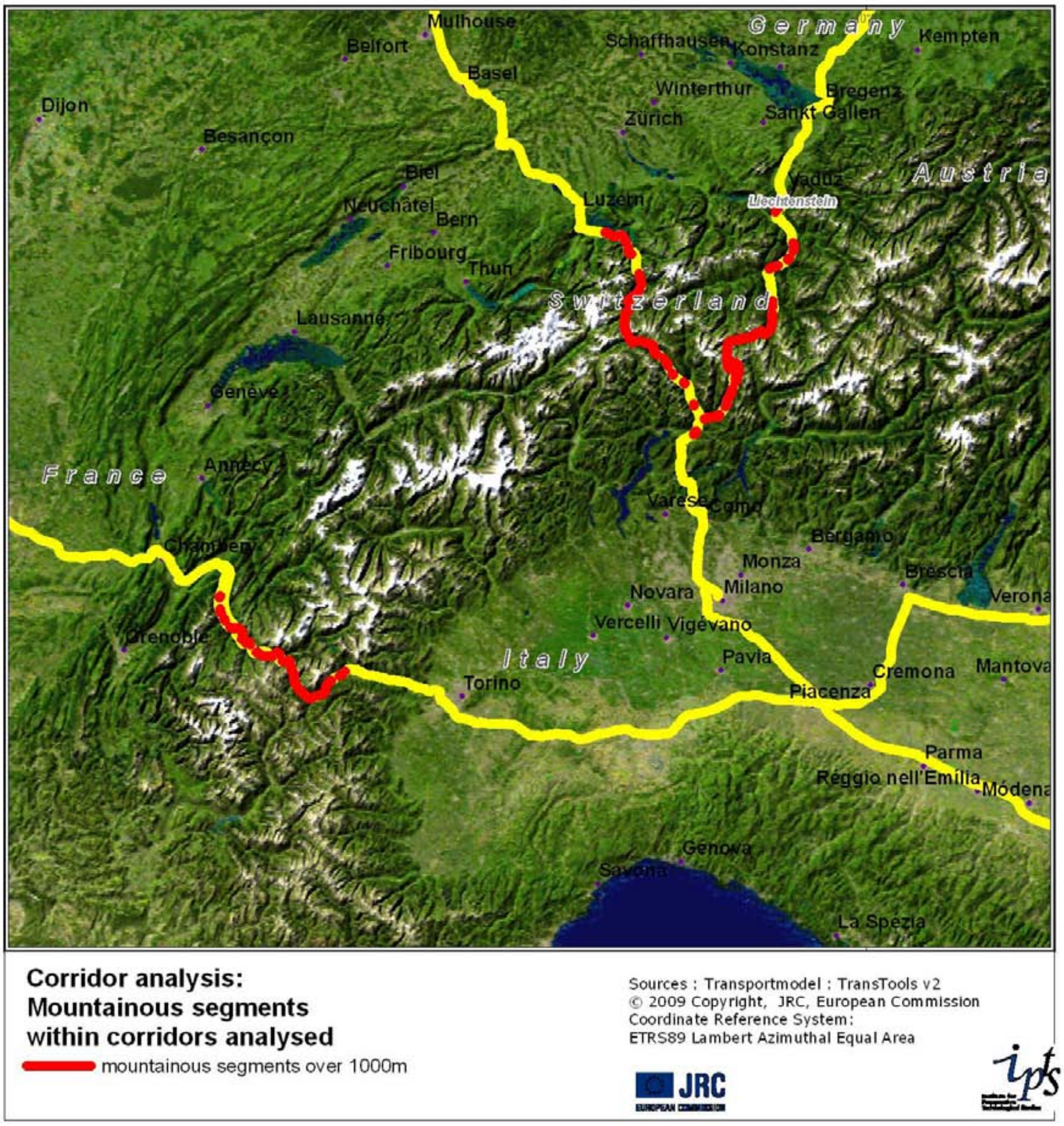

Figure 20: Mountainous segments of corridors analysed

Table 20: Length and share of mountain sections for different mountain section classification criteria

Corridor	Total length	Length/share of mountain sections	
		altitude: >1000m	Altitude: >800m
1. Sines – Paris	1844	-	220 / 11.9%
2. Lyon – Bratislava	1401	32 / 2.3%	161 / 11.5%
3. Catania – Holyhead	3007	44 / 1.5%	192 / 6.4%
4. Milano – Lübeck	1305	46 / 3.5%	167 / 12.8%
5. Rotterdam – Köln – Rotterdam	483	-	-
6a. Stockholm-Odense (bridge)	801	-	-
6b. Stockholm-Odense (ferry)	757	-	-

Chapter 7. Impact on transport costs and modal competiveness

In this chapter the external costs, as calculated according to scenario I, are compared with the tolls currently charged on each corridor. Furthermore, the impacts of external cost charges on the total transport costs and the competitiveness of road transport are analysed.

For each corridor, the breakdown of operating costs for the haulier was estimated based on data on fuel consumption and fuel prices, driver costs, tolls and other costs that depend on distance driven and trip length. The results were combined with data from ECOTRA and the TRANSTOOLS model. Table 21 summarizes the estimated average operational costs for the road hauliers for each corridor. These figures will evidently vary significantly between operators, truck size used, product type, season, volume, speed requirements, frequency, etc., but can be used as a reference case for comparison purposes.

Table 21: Average operational costs for freight transport in selected corridors, €/trip

Corridor	Fuel and maintenance	Driver costs	Tolls[1]	Ferry costs[2]	Vehicle depreci-ation	Fixed costs	Total operation al costs
1. Sines – Paris	836	671	139		76	317	**2038**
2. Lyon – Bratislava	680	428	190		50	232	**1580**
3. Catania – Holyhead	1460	1031	184	123	118	522	**3438**
4. Milano – Lübeck	634	915	124		98	329	**2100**
5. Rotterdam – Köln – Rotterdam	235	140	28		16	78	**497**
6a. Stockholm – Odense (bridge)	415	332	156		37	157	**1097**
6b. Stockholm – Odense (ferry)	392	331	75	139	37	152	**1126**

Source: own calculations based on TRANSTOOLS, ECOTRA

[1]Source: TransTools 2005

[2] Based on the one-way tariff for the ferry service for an 18.75 m freight vehicle (sources: www.scandlines.com, www.carontetourist.it/v2.0_us/strettoc.mvd)

Table 22 compares the total external cost charges to the estimated fuel costs, existing tolls and total operating costs in each corridor. The results of the base scenario are used (Scenario I) and the comparison is made using the average and maximum external cost charges estimated for each corridor.

The lowest increase in average transport costs is expected in the Stockholm – Odense corridor (less than 2%) and the highest in Rotterdam – Köln – Rotterdam (5.2%). If the highest charges for scenario I are taken into account (corresponding to trips encountering the highest levels of congestion), the range of cost increases becomes 2.7% to 8.6%.

Compared to fuel costs, external cost charges would represent an increase of between 5 and 11%. For comparison purposes, such an increase would be the equivalent –in terms of the impacts on the road transport sector- of an increase in oil prices from $70 to between $78 and $85.

Table 22: Impact of external cost charges on operating costs

Corridor	**Total external cost charges** Average (min, max) €/trip	**Average external cost charges / Average fuel cost**	**Average external cost charges / tolls or vignettes** (on sections with an existing user charge)	**Average increase % (av. external cost charges / av. operating costs)**	**Maximum increase % (max external cost charges / av. operating costs)**
1. Sines – Paris	54.38 (50.74-62.06)	6.5%	16.2%	**2.7 %**	**3.0 %**
2. Lyon – Bratislava	67.24 (60.49-82.48)	9.9%	23.7%	**4.3 %**	**5.2%**
3. Catania – Holyhead	145.96 (123.25-209.96)	10.0%	47.9%	**4.2 %**	**4.5%**
4. Milano – Lübeck	64.37 (55.04-79.08)	10.2%	47.6%	**3.1 %**	**3.8 %**
5. Rotterdam – Köln – Rotterdam	25.72 (20.37-42.58)	10.9%	40.3%	**5.2 %**	**8.6%**
6a. Stockholm – Odense (bridge)	20.73 (16.48-29.28)	5.0%	0.7%	**1.9 %**	**2.7 %**
6b. Stockholm – Odense (ferry)	20.53 (15.98-30.61)	5.2%	1.5%	**1.8 %**	**2.7%**

Before passing the price increases onto the shipper, in the form of increased transport prices, and indirectly the final consumer, the operator can still reduce the impact on operating costs through trip planning and organisational changes. In the short term, avoiding periods or routes with high congestion can significantly limit the cost increases. An increase in load factors can also lead into both reduced external cost charges and lower operating costs. In the longer term, the substitution of the trucks used with more efficient ones, e.g. EURO V, can also lead to cost savings. All three strategies are desirable results from the policy point of view and among the main drivers behind internalization measures. Since the whole road transport sector would face the same increase in charges, competition within the mode would not be directly influenced. Indirectly though, operators who chose to adapt their behaviour to improve their efficiency would gain a competitive advantage.

Especially concerning the improvements in the engine technology used, the analysis of the charges per truck on an annual basis can give a picture of the extent it is stimulated by external cost charges. The total external cost charges per truck on an annual basis are calculated in Table 23, assuming that the truck performs the same route the whole year and using the average charges estimated in Scenario I. The number of trips per year is estimated under the assumption that the truck operates 250 days a year on the same route and that there is a 20% turnaround time in-between trips. Rotterdam- Köln is already calculated as a roundtrip, for the other corridors it is assumed that the return trip will have the same characteristics as the original trip.

The potential benefits from the substitution of a EURO IV truck with a EURO V truck are shown in Table 24. Although they are probably low compared to the total capital and operating costs, they can be in some cases a factor to take into account in fleet renewal decisions.

Table 23: External cost charges per truck on an annual basis for each corridor

Corridor	Average distance (km)	Average travel time (hours)	Trips per year	Distance driven (km)	Total charges, €/year (Sc I- Base)
1. Sines – Paris	1844	64.4	78	143168	4222
2. Lyon – Bratislava	1401	41.1	122	170272	8172
3. Catania – Holyhead	3007	99.0	51	151884	7372
4. Milano – Lübeck	1305	87.8	57	74283	3665
5. Rotterdam – Köln – Rotterdam	483	13.4	372	179688	9578
6a. Stockholm – Odense (bridge)	801	31.9	157	125549	3249
6b. Stockholm – Odense (ferry)	757	31.8	157	118950	3224

Table 24: Potential savings from improvement of engine technology

Corridor	Savings from shift from EURO IV to EURO V (€/year)
1. Sines – Paris	1622
2. Lyon – Bratislava	3239
3. Catania – Holyhead	2845
4. Milano – Lübeck	1417
5. Rotterdam – Köln – Rotterdam	3427
6a. Stockholm – Odense (bridge)	848
6b. Stockholm – Odense (ferry)	854

Chapter 8. Impact on final product prices and regional competitiveness

In order to estimate the impact of external cost charges on final product prices the increases in transport costs estimated in Chapter 7 are applied on the costs and prices of a number of typical products. The results of a previous study for the JRC, ECOTRA (2005) are used as input for the cost structure of each product and the share of transport costs in its final price. ECOTRA provides data on transport costs per tonne kilometre for eleven different product types (biscuit, tuna, tomato, blouse, jeans, suit, coffee pack, coffee pods, passenger car, mobile phone, pharmaceuticals).

The available data refer to the EU level and as such not corridor-specific. In order to calculate corridor-specific transport costs the OD-freight data from Trans-Tools is used to calculate the corresponding transport costs for each corridor relative to the weighted average for all OD-pairs. Given the share of transport costs in the final product price for each combination, the transport cost increases estimated in Chapter 7 are used in order to estimate the impact on the final product price. Although aggregating at such a level requires many assumptions that may rest precision to the analysis, the results are indicative enough to allow general conclusions to be drawn.

In principle, the impact on final product prices is negligible and only in some extreme situations of low weight-to-volume and low price-to-weight products charges in high congestion periods could have a visible, though still marginal, impact on final prices.

If any, the main impacts would be concentrated in areas producing or consuming agricultural products or raw materials that are transported in bulk. Fresh products may be less susceptible to changing their shipment strategy because of delivery speed requirements, but other non-perishable goods of low value or high volume would probably turn to more efficient shipments or other transport modes.

Table 25: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Sines-Paris corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	6.67	7.3%	**0,19%**	**0,14%**
Tuna	5.66	9.6%	**0,26%**	**0,18%**
Tomato	2.73	5.8%	**0,15%**	**0,11%**
Blouse	11.93	1.2%	**0,03%**	**0,02%**
Jeans	10.21	0.9%	**0,02%**	**0,02%**
Suit	34.57	2.8%	**0,08%**	**0,05%**
Coffee pack	2.93	4.0%	**0,11%**	**0,08%**
Coffee pods	4.65	1.5%	**0,04%**	**0,03%**
Passenger car	4.14	3.9%	**0,11%**	**0,07%**
Mobile phone	1.00	1.0%	**0,03%**	**0.02%**
Pharmaceuticals	0.06	0.8%	**0,02%**	**0.02%**

Table 26: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Lyon-Bratislava corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	6.00	6.5%	**0,28%**	**0,19%**
Tuna	5.09	8.6%	**0,37%**	**0,26%**
Tomato	2.45	5.2%	**0,22%**	**0,15%**
Blouse	10.73	1.1%	**0,05%**	**0,03%**
Jeans	9.18	0.8%	**0,03%**	**0,02%**
Suit	31.09	2.6%	**0,11%**	**0,08%**
Coffee pack	2.64	3.6%	**0,15%**	**0,11%**
Coffee pods	4.18	1.4%	**0,06%**	**0,04%**
Passenger car	3.73	3.6%	**0,15%**	**0,11%**
Mobile phone	1.00	1.0%	**0.04%**	**0.03%**
Pharmaceuticals	0.06	0.8%	**0.03%**	**0.02%**

Table 27: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Catania-Holyhead corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	5.73	6.3%	**0,27%**	**0,19%**
Tuna	4.86	8.3%	**0,35%**	**0,25%**
Tomato	2.34	5.0%	**0,21%**	**0,15%**
Blouse	10.24	1.0%	**0,04%**	**0,03%**
Jeans	8.77	0.8%	**0,03%**	**0,02%**
Suit	29.69	2.4%	**0,10%**	**0,07%**
Coffee pack	2.52	3.5%	**0,15%**	**0,10%**
Coffee pods	3.99	1.3%	**0,06%**	**0,04%**
Passenger car	3.56	3.4%	**0,14%**	**0,10%**
Mobile phone	1.00	1.0%	**0.04%**	**0.03%**
Pharmaceuticals	0.06	0.8%	**0.03%**	**0.02%**

Table 28: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Milano-Lübeck corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	5.71	6.2%	**0,19%**	**0,13%**
Tuna	4.84	8.2%	**0,25%**	**0,18%**
Tomato	2.34	4.9%	**0,15%**	**0,11%**
Blouse	10.21	1.0%	**0,03%**	**0,02%**
Jeans	8.74	0.8%	**0,02%**	**0,02%**
Suit	29.58	2.4%	**0,07%**	**0,05%**
Coffee pack	2.51	3.5%	**0,11%**	**0,07%**
Coffee pods	3.98	1.3%	**0,04%**	**0,03%**
Passenger car	3.55	3.4%	**0,10%**	**0,07%**
Mobile phone	1.00	1.0%	**0.03%**	**0.02%**
Pharmaceuticals	0.06	0.8%	**0.02%**	**0.02%**

Table 29: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Rotterdam-Köln-Rotterdam corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	6.58	7.2%	**0,37%**	**0,26%**
Tuna	5.58	9.5%	**0,49%**	**0,34%**
Tomato	2.69	5.7%	**0,29%**	**0,21%**
Blouse	11.76	1.2%	**0,06%**	**0,04%**
Jeans	10.07	0.9%	**0,05%**	**0,03%**
Suit	34.09	2.8%	**0,14%**	**0,10%**
Coffee pack	2.89	4.0%	**0,21%**	**0,14%**
Coffee pods	4.59	1.5%	**0,08%**	**0,05%**
Passenger car	4.09	3.9%	**0,20%**	**0,14%**
Mobile phone	1.00	1.0%	**0.05%**	**0.04%**
Pharmaceuticals	0.06	0.8%	**0.04%**	**0.03%**

Table 30: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Stockholm-Odense (bridge) corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	7.50	8.2%	**0,15%**	**0,11%**
Tuna	6.36	10.8%	**0,20%**	**0,14%**
Tomato	3.07	6.5%	**0,12%**	**0,09%**
Blouse	13.40	1.4%	**0,03%**	**0,02%**
Jeans	11.47	1.0%	**0,02%**	**0,01%**
Suit	38.84	3.2%	**0,06%**	**0,04%**
Coffee pack	3.29	4.5%	**0,09%**	**0,06%**
Coffee pods	5.22	1.7%	**0,03%**	**0,02%**
Passenger car	4.66	4.4%	**0,08%**	**0,06%**
Mobile phone	1.00	1.0%	**0.02%**	**0.01%**
Pharmaceuticals	0.06	0.8%	**0.02%**	**0.01%**

Table 31: Actual average transport costs, share of transport costs in final product price and impact of external cost charges on final product price, various products (Stockholm-Odense (ferry) corridor)

Product	Transport costs (€/tonne*km)	Share of transport costs in final product price	Average increase of product price (100% of cost increase is passed on)	Average increase of product price (70% of cost increase is passed on)
Biscuit	7.93	8.7%	**0,16%**	**0,11%**
Tuna	6.73	11.4%	**0,21%**	**0,15%**
Tomato	3.24	6.9%	**0,12%**	**0,09%**
Blouse	14.18	1.4%	**0,03%**	**0,02%**
Jeans	12.14	1.1%	**0,02%**	**0,01%**
Suit	41.10	3.4%	**0,06%**	**0,04%**
Coffee pack	3.49	4.8%	**0,09%**	**0,06%**
Coffee pods	5.53	1.8%	**0,03%**	**0,02%**
Passenger car	4.93	4.7%	**0,09%**	**0,06%**
Mobile phone	1.00	1.0%	**0.02%**	**0.01%**
Pharmaceuticals	0.06	0.8%	**0.01%**	**0.01%**

The results at corridor level are not sufficient to quantify the impacts on regional development and competitiveness, but do allow a qualitative assessment of expected trends if they are combined with the findings of the impact assessment of the amendment proposal [EC 2008b]. The various policy options examined in the impact assessment included different combinations of types of externalities, internalisation instruments and geographic coverage[17].

The analysis of impacts at regional level consisted of estimating the changes in consumer surplus and total welfare for each NUTS2 zone (corresponding to the level of region in most Member States) due to the introduction of internalization charges:

- Consumer surplus measures the change in transport costs. Applying a charge would normally increase costs, but the resulting reduced levels of traffic would decrease travel times and have a positive repercussion for transport users.
- Total welfare measures the net balance of increased costs and savings from the reduction of externalities. For most internalization measures a decrease in externalities is expected as a result of the decrease in traffic and congestion, modal shift and technological improvement. Increases can be expected in areas where traffic is shifted to from other areas, where the external costs were higher.

At an aggregate EU level the benefits in terms of increased net welfare are clearly positive, in the order of magnitude of twice the amount of increased transport costs (negative consumer surplus). At regional level though, these benefits and costs are not distributed equally and a clear pattern can be distinguished:

- Regions with a high proportion of through-traffic would benefit from the reduction of externalities and increased toll income caused by trade between other regions that crosses them.
- Peripheral regions would face a marginal increase in the costs for their imports and exports that in the short run may not be compensated by the increase in welfare from the reduction of externalities in the region. In the longer term the shift of international traffic and economic activities from congested areas to low congested areas may create new business opportunities for some peripheral regions and constitute an important positive spillover effect for regional development (see TEN-STAC study, 2004) that in the case of some peripheral regions may more than compensate for the increases in the costs of trade.

[17] Policy option 2C was the closest to the measures analysed in this study, since it assumed the internalisation of air quality, noise and congestion impacts, although it used higher charge levels than the ones currently analysed (roughly two times as high) mainly as the result of the higher proportion of urban areas.

Table 32: Summary of expected impacts on regional competitiveness based on region profile

/Production profile **Region location /**	Agricultural/ raw materials	Manufacturing	Technology-services
Central regions – high output	=	+	++
Central regions – low output	+	+	+
Peripheral regions, near agglomerations	=	+	+
Peripheral regions, away from agglomerations	-	=	=

Note: = no significant impact, + marginally positive impact, ++ positive impact, - marginally negative impact

Chapter 9. Benefits for transport users and society at large

External cost charges will obviously increase transport costs since a part of the environmental impact of transport that was before borne by the society as a whole would now be paid by the users of the transport system who generate these impacts. The internalisation of external costs is in principle a measure to improve the distribution of the costs (fairness), but would also lead to direct and indirect benefits for both transport users and society as a whole (efficiency).

The increase in transport costs due to external cost charges can stimulate reactions across the whole transport chain. The direct impacts are expected at operator or shipper level who can limit the increase in costs with one or more of the following strategies:

- **Route choice**: charging for environmental damages and congestion can motivate operators to avoid routes with high congestion levels or areas where environmental impacts are valued as high. Alternative routes may exist where total operating costs, including external cost charges, are lower than for the route originally chosen.
- **Trip scheduling**: even if the route cannot be changed, changing the timing of a trip can help to avoid periods when congestion or noise and their associated charges are high.
- **Efficiency of transport operations**: only about 70% of loading capacity is used on average for long distance freight operations by road in EU. The differentiated charges would provide further incentives for better planning and improved vehicle utilisation. Increasing the average load and minimizing empty trips through improved organisation and scheduling would limit the cost increases for the shippers and would increase the efficiency of the transport system as a whole.
- **Technological improvement:** the differentiated air pollution cost charges will accelerate the renewal of the vehicle fleet. Shifting to a less polluting technology, e.g. from EURO IV to EURO V has a significant impact on emissions and the resulting charges for pollution and can thus lead to cost savings for the operators in the long term.
- **Modal split**: if the cost increases are transferred to the price of transport services, the competitive position of road against the other modes will change and for some combinations of product type, geographic area and time period it may become more economical to use rail, short-sea shipping or maritime transport. Shippers would have alternatives to limit the increase in transport costs.

Apart from the above options that directly limit the increase in costs, additional savings can be expected from the indirect effects of charging for external costs:

- **Savings from fuel consumption**: changes in route choice, trip scheduling, load factors, technology and modal split would also indirectly lead to savings in fuel consumption since operators would be driven to minimize the cost per unit of product transported over a specific distance.
- **Time savings**: avoiding congestion in order to reduce the charges to be paid may also lead to reductions in the time spent on the road.
- **Decrease in other external costs**: although only pollution, noise and congestion costs are internalised, other externalities that are generated by transport activities would be also indirectly reduced. For example, greenhouse gas emissions would be reduced as a result of lower fuel consumption. Fewer accidents can be expected as a result of the reduction in vehicles needed to transport the same volume of goods, as a result of efficiency improvements.
- **Increase in reliability of delivery times:** in addition to time savings, reducing congestion peaks would also reduce the uncertainty in travel time. As less buffer time

needs to be incorporated this would lead to a reduction in delivery times for both short and long distance trips. For freight operators, this would mean advantages in the planning of complex logistic process, more efficient use of resources, and hence increased competitiveness. Furthermore, reliable delivery times provide advantages for customer and may in turn stimulate demand for goods and freight services.

From the policy point of view, internalisation of external costs can stimulate desirable changes in user behaviour in the long term. Improving the efficiency of freight transport and reducing its external cost –apart from leading to a more equitable distribution of costs- will also improve the quality of the transport system for all users:

- **Improvement of congestion for passengers**: charges for congestion will stimulate freight operators to avoid congested links or periods and would thus decrease levels of congestion in general and travel time for passenger transport. According to the congestion indicator calculated in EC2008b on the basis of interregional transport model, congestion would decrease from 28.62% to 27.37%; a reduction of 4.4% (if congestion charging applies to cars in addition to trucks a reduction from 28.62% to 27.37% can be expected; a decrease of 7.2%) (EC2008b, p.59). Empirical evidence and local studies based on disaggregated modelling reflecting both interregional and intraregional flows suggest a much higher potential to reduce local congestion; between 10-35% in congested areas.
- **Optimization of use of infrastructure**: congestion in interurban road networks is mainly a problem of demand management; in very few cases is it an issue of overall infrastructure capacity. Congestion charging tends to soften congestion peaks and redistribute traffic to a wider time period. As a result, road and other transport infrastructure can be used in a more efficient way, hence saving public spending by reducing the need for capacity expansion.
- **Reduction of fuel consumption, pollution and greenhouse gases**: Both as an impact of improvements in freight transport and as a secondary effect of savings in passenger transport due to less congestion, overall fuel consumption and the resulting emissions of pollutants and greenhouse gases would be reduced. Based on the results of the impact assessment (EC2008b) CO2 emissions from road freight transport and fuel consumption would be reduced by 8%. The total CO2 emissions of the whole road transport sector could also reduced by a similar extent if congestion charging applied to all road users and not only to trucks. Similar reductions would be achieved for the emissions of other pollutants as well. As 10-30% of fuel consumption and CO2 emissions are usually considered as caused by congestion, there would be additional important benefits in terms of climate change if congestion decreases are higher, as suggested by local studies.

Longer term policy objectives are also served by internalisation of external costs of freight transport:

- **Stimulation of new solutions for logistics and distribution**: new solutions based on different forms of organisation for logistics and distribution that may include more efficient vehicle combinations, packaging, distribution centres, co-operation between different transport modes
- **Stimulation of technological development for reduction of external impact of transport**: information and communication technologies to improve vehicle and fleet operation and management, improved engine technologies and fuels, vehicle design (materials, aerodynamics, etc.)
- **Relocation to less congested/less sensitive areas**: location decisions for production or distribution facilities would take into account, in the long term, the additional cost on their operations that external cost charges for transport would represent. This will

probably stimulate a shift to areas with infrastructure that is not saturated and away from zones with a high valuation of external costs of transport.

- **Provision of correct signals for capacity expansion**: charging for the external costs of transport gives a more correct price signal to users and infrastructure providers. If decisions on additional investment in capacity take them into account, infrastructure development as a whole can become more efficient.
- **Environmental sustainability for transport in general**: charging the right price for external costs of transport can improve the sustainability of transport in the long term. User choices and investment decisions would be made taking into account environmental impact as a real cost.
- **Revenues**: The results of the impact assessment (EC2008b) suggest that the revenues from external charges can be used to create better connections of peripheral regions to the core trans-European transport network, develop carbon-free road vehicles and generate additional indirect benefits.

At the level of the whole economy, external cost charges are expected to stimulate an improvement as regards the environmental impacts of economic activity, while having a negligible impact on the final price of products. They are thus not expected to change consumption levels as a whole or have a major effect on demand and supply for specific products.

Assuming that the corridors analyzed in this study are characteristic of the range of transport services across the EU, the impact of the application of external cost charges on the EU interregional traffic flows can be extrapolated by using the estimated transport cost increases in the TRANSTOOLS model. If an average increase in transport costs of 3% is assumed, a decrease of 13.5 billion tonne*kms in road transport volumes would be expected (representing a decrease of 0.7% of the year 2007 total road freight volume). More than 95% of the volume lost by road would be shifted to other modes and in particular rail transport.

Table 33: Summary of expected impacts on transport volumes per mode

Input: **Increase in transport costs due to road charges**	**3%**
Expected impacts	**Transport volume (% of 2007 value)**
Decrease in road transport volume	13.5 billion ton*kms (0.7%)
Increase in rail transport volume	8.2 billion ton*kms (1.8%)
Increase in maritime transport	3.8 billion ton*kms (0.2%)
Increase in inland waterways	0.8 billion ton*kms (0.6%)

EC 2008 b provides some indication of the order of magnitude of the quantifiable benefits of road pricing based on external cost charges applied to all traffic and not only trucks on the main corridors. The impacts on transport volumes and modal shift would be more important (-4% for road freight, +1.7% for rail and +1.8% for short-sea shipping) and would have a clear impact on the external costs that the transport sector as a whole generates. In most cases the alternative transport modes to road produce lower levels of externalities and modal shift would decrease their cost. Applying aggregate marginal external cost coefficients at EU level [EC JRC 2008] on the expected changes in transport volumes allows the estimation of savings in external costs, for several types of externalities. It is worth noting that significant savings are also expected for externalities not directly included in the charges used in this analysis, most notably climate change costs and accidents. It is also interesting to compare the savings in terms of congestion with those for pollutants: the decrease in congestion costs is higher than that in pollutants, to a large extent because of the fact that the alternative modes would still generate pollution, while their congestion levels and costs are significantly lower than those of road transport.

Table 34: Expected benefits and annual savings in external costs, EU-27

Cost element	**Total savings/benefits**
Accidents	100
Noise	50
Pollutants	200
Climate Change Costs	300
Infrastructure tear and wear	50
Congestion	1100
Technology renewal	200
Efficiency gains	300
Indirect benefits[18]	200
Total benefits	**€ 2300 M**

Table 34 summarizes the savings of external costs and benefits of the main impacts that can be identified and quantified. Impacts on employment, regional competitiveness, longer tern trends or strategic objectives cannot be quantified with the data available, but would not probably change the overall picture significantly. The difference in external cost charges between EURO IV standards to EURO V or newer is expected, based on simulations of comparable measures for fleet renewal, to accelerate the renewal by the equivalent of one year for 3-5% of the fleet. At aggregate level, this would correspond to savings in terms of air pollution equal to around € 200 million a year. The efficiency gains from increased load factors and the introduction of new logistics and distribution technologies as a result of the charges are expected to bring a decrease in vehicle traffic in the range of 0.3% to 0.5% for the same volume of transported goods. In terms of external costs, such an improvement would lead to annual savings of € 300 million.

The estimation of the benefits is based on scenario PO2Call of the impact assessment on the internalisation of external costs accompanying the proposal for a directive (COM) and a communication on the internalisation of external costs (COM) (see EC 2008b). According to the results from the impact assessment such a scenario would result in a total net welfare gain of €2.3 Billion per year for the road transport network simulated in TRANSTOOLS (EC2008b, p.182).

To conclude, the overall benefits of charging for external costs outweigh the limited negative price impacts on individual transport operators. There is though a possible future improvement that could increase the benefits for society as a whole even more: applying external cost charges for passenger transport and for other transport modes following the same principles of internalisation would provide a level playing field and stimulate sustainable solutions for the whole transport system.

[18] Second-order effects from the more efficient use of the road network as a result of the direct benefits

Chapter 10. Main conclusions

The analysis explored the impacts that the application of the external cost charges foreseen in the proposal for amending Directive 1999/62/EC on road infrastructure charging would have on six characteristic transport corridors. The goal was to estimate the repercussion of these charges on real cross-border transport operations. Various combinations of trip schedules and levels of charges were simulated in order to analyze the extent to which different operator strategies and different charges application scenarios would influence total costs per trip. Following the estimation of the impacts on transport costs for each corridor, the repercussion on the final product price for a number of typical goods was estimated. The last step discussed the overall benefits of external cost charging at EU level and the magnitude of the expected economic and environmental impacts.

The baseline scenario corresponds to the application of the original European Commission proposal, assuming that a EURO IV vehicle is driven by one driver. Various combinations of different departure times and resting periods were tested in order to account for possible differences in the levels of congestion encountered during the trip, as well as the difference in the valuation of the cost of noise. **The average charges for the six corridors in the baseline scenario range between 2.6 and 5.3 €cents per vehicle*km.** If periods of high external cost charges are avoid, external cost charges can be lowered to 2.1 €cents per km while –in the other extreme case- the highest charges may reach 8.8 €cents per km (for the corridor with the highest external costs under the worst congestion conditions).

Charges for air pollution represent the largest share of total charges, on average 73-87%. Although congestion charges are higher on a km basis, the fact that they are applied on a small share of the network only makes their share in the total rather limited, between 6% and 18% on average. The share of congestion charges can reach the range of 19% to 52% though, for the trips that encounter the highest congestion levels. The share of noise charges is limited to less than 10% in most cases, as a result of the caps foreseen by the proposal.

Applying high correction factors for mountainous areas (Scenario 2) would increase total charges marginally, and only for the three corridors that have high altitude segments. Scenario 3 examines the impact of the maximum allowable congestion charges during all high peak periods, regardless of the actual congestion levels. This would be the theoretically worst case scenario for congestion charges and would correspond to an increase of € 3 to € 7 per trip. The alternative set of caps proposed by the European Parliament (Scenario 4) foresees slightly lower maximum allowable charges and would reduce total charges by 15% to 20% compared to the baseline case. Compared to the real external costs though, both proposals allow charges that are significantly lower than in Scenario 5, which estimates the impacts of removing the caps.

The original proposal would lead to the internalization of 40% to 70% of air pollution costs, while the alternative set of caps would reduce the level of internalization to 30% to 55% (with the exception of the Stockholm- Odense corridor, where the caps coincide with the external costs). **Both proposals would lead to a low internalization level for noise costs, in the order of 20%**.

The use of EURO V vehicles instead of EURO IV (Scenario 6) would reduce air pollution charges drastically. **The shift from EURO IV to V could lead to savings of between € 800 and € 3400 per year and could partially stimulate the acceleration fleet renewal.**

External cost charges on these corridors would increase average operating costs by 1.8% to 5.2%. Even if the full increase in transport costs is passed onto the price of the final product, the impacts would be in most cases negligible. **Final product prices are expected to increase by a maximum of 0.5% on average**. Only the prices of low value and/or bulk goods would be affected in practice.

The increased charges would stimulate a change in transport activities though. Part of the increases would have to be absorbed by the operators who, in order to limit the increase in their prices would need to modify their trip schedules, vehicle technologies and organization. At a second level, if road freight prices are increased, a part of transport demand would shift to other modes.

If the charges proposed for the six corridors are applied at EU level, it is expected that road transport volumes will decrease by 0.7%, the equivalent of 13.5 billion ton*kms a year. Most of this volume would shift to rail transport, but maritime transport and inland waterways would also attract important traffic.

The increase in efficiency of road transport operations, technological improvement and modal shift all account for noticeable benefits in terms of external costs. Even though only air pollution, noise and congestion costs are internalized, a decrease in other externalities such as climate change impacts, accidents and infrastructure wear is also expected. **Results from a previously carried out impact assessment on the internalisation of external costs estimate that when external cost charging is applied more widely to all types of traffic and vehicles the total net welfare gain for the whole EU network is € 2.3 billion per year, without taking into account the even higher benefits expected from local congestion reduction for cars which could not be modelled.**

The application of external cost charges would lead to a redistribution of costs and benefits between users, regions and productive activities depending on the level of externalities their transport operations generate. It would stimulate a change in the behaviour of the users of the transport system without increasing transport and product costs significantly. In the long term, they can induce a reorganisation of transport activities and contribute to a change in business processes and industrial productions locations towards more sustainable patterns. Such policy can yield much higher benefits for society as a whole if applied more widely to all vehicles including passenger transport. Applying it to other transport modes following the same principles of internalisation would provide a level playing field and stimulate sustainable solutions for the whole transport system.

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Annex 1: Total external costs of each corridor as a function of departure time and break length time

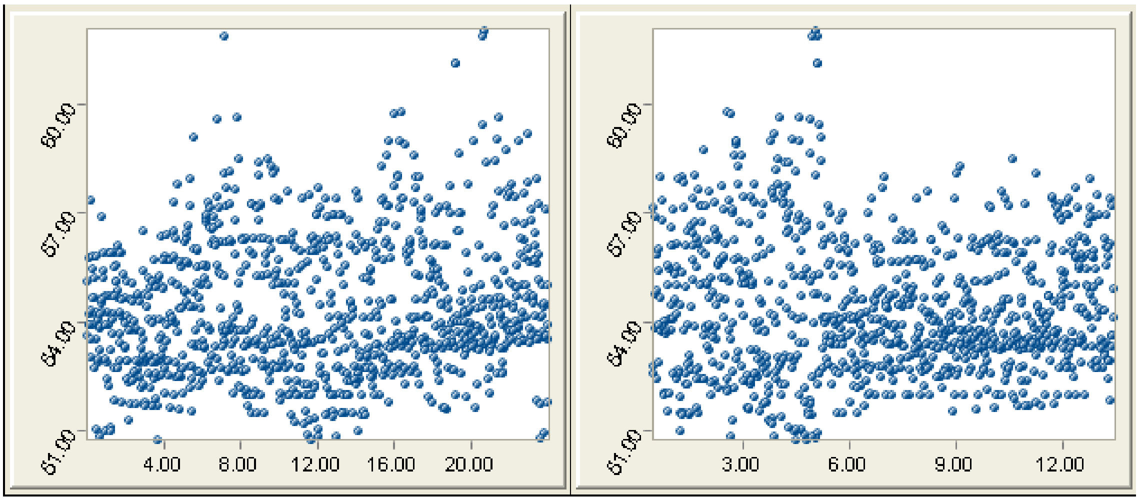

Figure A1.1: Total external costs for the Sines-Paris corridor as a function of departure time (left) and break length time (right)

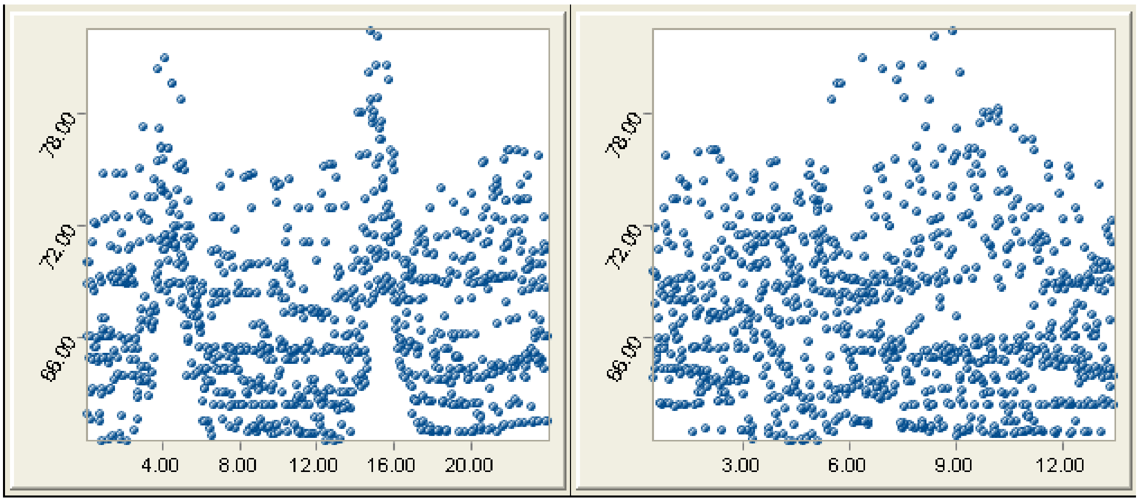

Figure A1.2: Total external costs for the Lyon-Bratislava corridor as a function of departure time (left) and break length time (right)

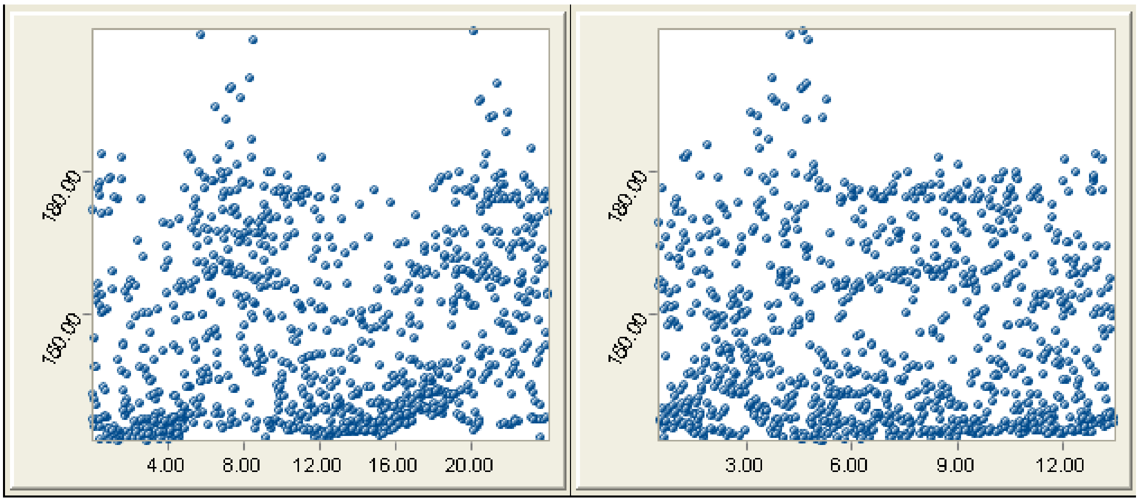

Figure A1.3: Total external costs for the Catania-Holyhead corridor as a function of departure time (left) and break length time (right)

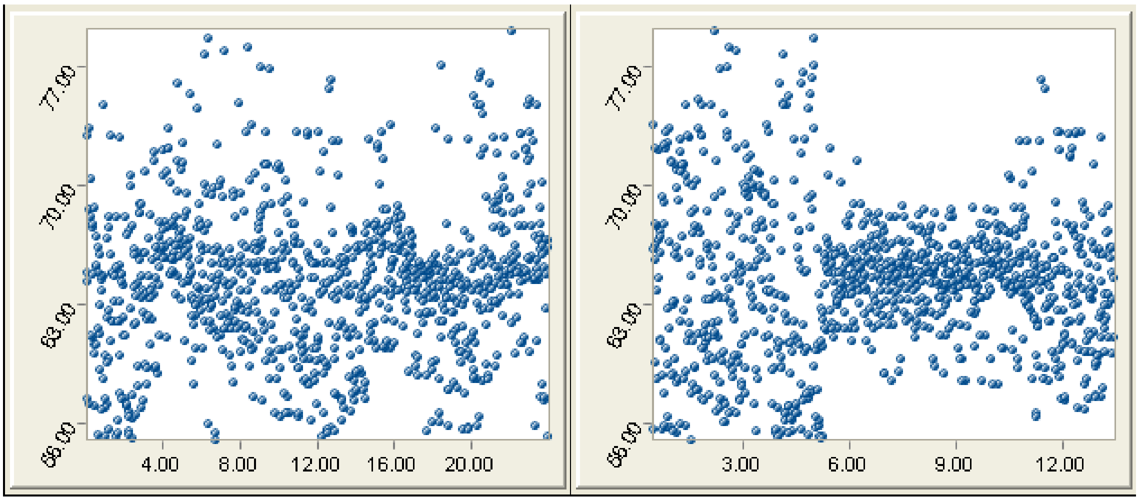

Figure A1.4: Total external costs for the Milano-Lübeck corridor as a function of departure time (left) and break length time (right)

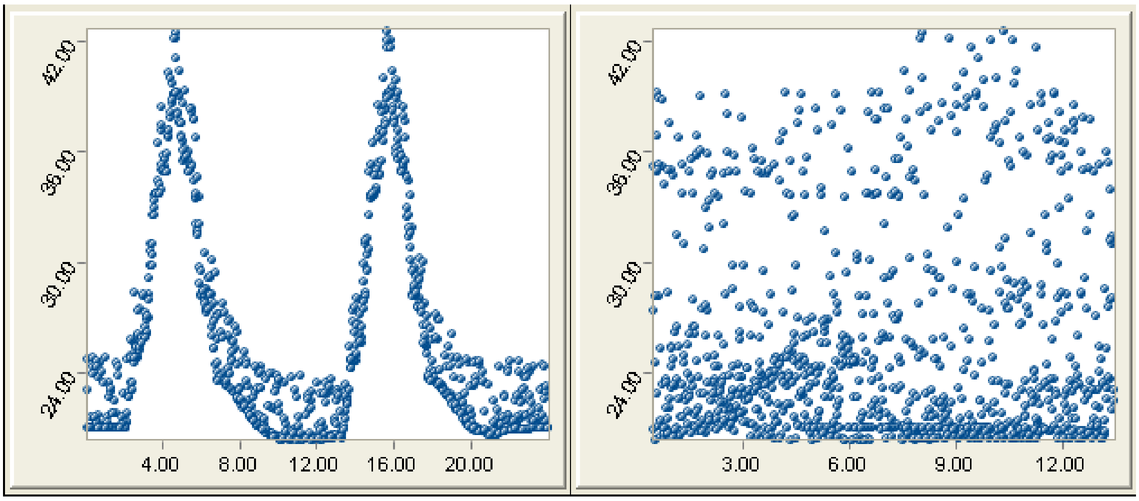

Figure A1.5: Total external costs for the Rotterdam – Köln – Rotterdam corridor as a function of departure time (left) and break length time (right)

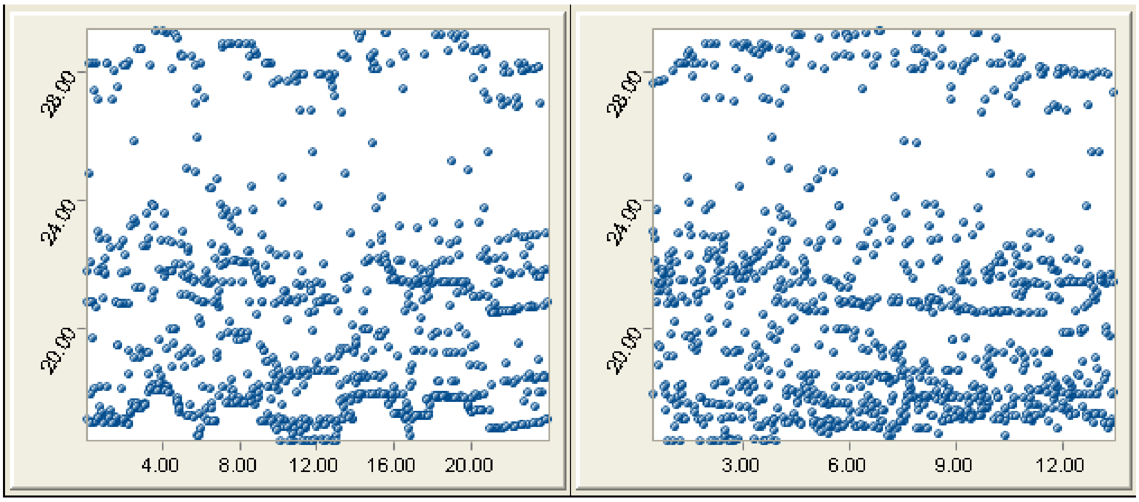

Figure A1.6: Total external costs for the Stockholm-Odense (bridge) corridor as a function of departure time (left) and break length time (right)

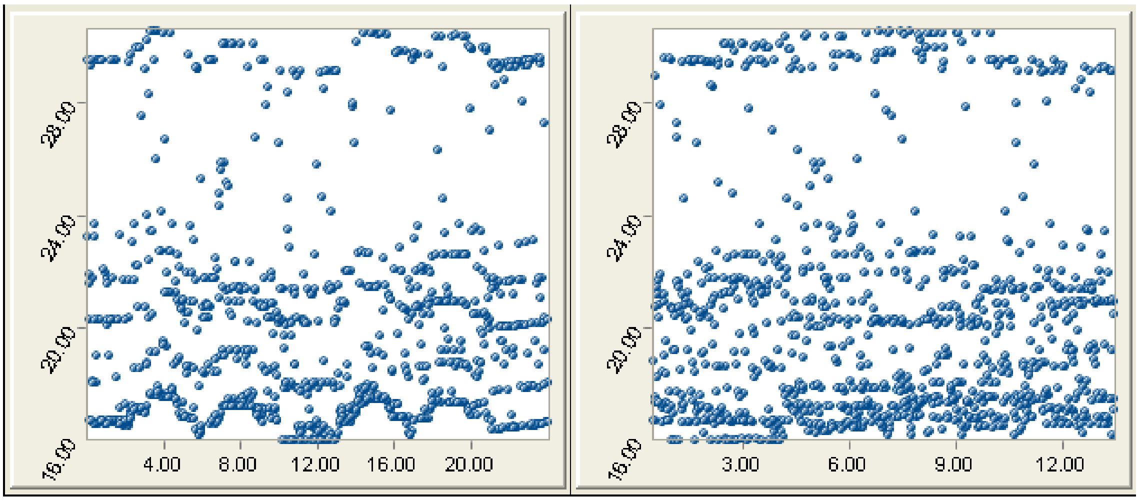

Figure A1.7: Total external costs for the Stockholm-Odense (ferry) corridor as a function of departure time (left) and break length time (right)

Annex 2: Segment-by-segment overview of external costs for each corridor

Table A2.1: Overview of external costs per segment for the corridor Sines-Paris (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
	Description	Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	Sines (Industrial zone Ligeira) -- A23	Portugal	interurban	MP	68	68	6:00 - 7:00	1:00	1:00	1,13	0,13	0,00	1,26	77	9	0	86
2	Sines (Industrial zone Ligeira) -- A23	Portugal	interurban	HP	65	130	7:00 - 9:00	2:00	3:00	1,13	0,13	0,00	1,26	147	17	0	164
3	Sines (Industrial zone Ligeira) -- A23	Portugal	interurban	MP	68	68	9:00 - 10:00	1:00	4:00	1,13	0,13	0,00	1,26	77	9	0	86
4	Sines (Industrial zone Ligeira) -- A23	Portugal	interurban	OP	75	38	10:00 - 10:30	0:30	4:30	1,13	0,13	0,00	1,26	42	5	0	47
5	Sines (Industrial zone Ligeira) -- A23	Portugal	interurban	OP	75	170	11:15 - 13:30	2:15	7:30	1,13	0,13	0,00	1,26	192	22	0	214
6	ES border (Vilar Formoso) -- Salamanca	Spain	interurban	OP	90	119	13:30 - 14:49	1:19	8:49	1,75	0,13	0,00	1,88	208	15	0	224
7	**Salamanca**	**Spain**	**suburban**	**OP**	**80**	**8**	**14:49 - 14:55**	**0:06**	**8:55**	**3,16**	**1,10**	**0,00**	**4,26**	**25**	**9**	**0**	**34**
8	Salamanca -- Valladolid	Spain	interurban	OP	92	75	14:55 - 15:45	0:49	9:45	1,75	0,13	0,00	1,88	132	10	0	141
9	Salamanca -- Valladolid	Spain	interurban	MP	75	36	6:00 - 6:28	0:28	24:28	1,75	0,13	0,00	1,88	63	5	0	67
10	**Valladolid**	**Spain**	**suburban**	**MP**	**51**	**6**	**6:28 - 6:35**	**0:07**	**24:35**	**3,16**	**1,10**	**5,00**	**9,26**	**19**	**7**	**30**	**56**
11	Valladolid -- Burgos	Spain	interurban	MP	75	30	6:35 - 7:00	0:24	25:00	1,75	0,13	0,00	1,88	53	4	0	57
12	Valladolid -- Burgos	Spain	interurban	HP	67	75	7:00 - 8:06	1:06	26:06	1,75	0,13	0,00	1,88	130	10	0	140
13	**Burgos**	**Spain**	**suburban**	**HP**	**42**	**11**	**8:06 - 8:22**	**0:15**	**26:22**	**3,16**	**1,10**	**10,00**	**14,26**	**35**	**12**	**110**	**157**
14	Burgos -- ES Border (via E5/E80/P1)	Spain	interurban	HP	85	53	8:22 - 9:00	0:37	27:00	1,75	0,13	0,00	1,88	93	7	0	100
15	Burgos -- ES Border (via E5/E80/P1)	Spain	interurban	MP	90	90	9:00 - 10:00	1:00	28:00	1,75	0,13	0,00	1,88	157	12	0	169
16	Burgos -- ES Border (via E5/E80/P1)	Spain	interurban	OP	105	53	10:00 - 10:30	0:30	28:30	1,75	0,13	0,00	1,88	92	7	0	99
17	Burgos -- ES Border (via E5/E80/P1)	Spain	interurban	OP	105	41	11:15 - 11:38	0:23	29:38	1,75	0,13	0,00	1,88	72	5	0	78
18	FR Border -- N10/E05/E70	France	interurban	OP	98	206	11:38 - 13:44	2:06	31:44	4,00	0,13	0,00	4,13	824	27	0	851
19	**Bordeaux**	**France**	**suburban**	**OP**	**94**	**20**	**13:44 - 13:57**	**0:12**	**31:57**	**4,00**	**1,10**	**0,00**	**5,10**	**80**	**22**	**0**	**102**
20	Bordeaux -- Angouleme	France	interurban	OP	98	108	13:57 - 15:03	1:06	33:03	4,00	0,13	0,00	4,13	432	14	0	446
21	**Angouleme**	**France**	**suburban**	**OP**	**70**	**8**	**15:03 - 15:10**	**0:06**	**33:10**	**4,00**	**1,10**	**0,00**	**5,10**	**32**	**9**	**0**	**41**
22	Angouleme -- Poitiers	France	interurban	OP	98	56	15:10 - 15:45	0:34	33:45	4,00	0,13	0,00	4,13	225	7	0	233
23	Angouleme -- Poitiers	France	interurban	MP	85	39	6:00 - 6:27	0:27	48:27	4,00	0,13	0,00	4,13	155	5	0	160
24	**Poitiers**	**France**	**suburban**	**MP**	**50**	**19**	**6:27 - 6:50**	**0:22**	**48:50**	**4,00**	**1,10**	**10,00**	**15,10**	**76**	**21**	**190**	**287**
25	Poitiers -- Tours	France	interurban	MP	85	14	6:50 - 7:00	0:09	49:00	4,00	0,13	0,00	4,13	56	2	0	58
26	Poitiers -- Tours	France	interurban	HP	70	88	7:00 - 8:15	1:15	50:15	4,00	0,13	0,00	4,13	352	11	0	363
27	**Tours**	**France**	**suburban**	**HP**	**40**	**9**	**8:15 - 8:28**	**0:13**	**50:28**	**4,00**	**1,10**	**20,00**	**25,10**	**36**	**10**	**180**	**226**
28	Tours -- E50/L'Aquitaine	France	interurban	HP	70	36	8:28 - 9:00	0:31	51:00	4,00	0,13	0,00	4,13	145	5	0	150
29	Tours -- E50/L'Aquitaine	France	interurban	MP	85	85	9:00 - 10:00	1:00	52:00	4,00	0,13	0,00	4,13	340	11	0	351
30	Tours -- E50/L'Aquitaine	France	interurban	OP	98	49	10:00 - 10:30	0:30	52:30	4,00	0,13	0,00	4,13	196	6	0	202
31	Tours -- E50/L'Aquitaine	France	interurban	OP	98	26	11:15 - 11:30	0:15	53:30	4,00	0,13	0,00	4,13	103	3	0	106
32	**E50/L'Aquitaine -- Boulevard Peripherique de**	**France**	**suburban**	**OP**	**70**	**11**	**11:30 - 11:40**	**0:09**	**53:40**	**4,00**	**1,10**	**0,00**	**5,10**	**44**	**12**	**0**	**56**
Total corridor														4711	329	510	5550

Table A2.2: Overview of external costs per segment for the corridor Lyon-Bratislava (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
	Description	Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/ km	Air	Noise	Conges-tion	Total
1	Lyon -- Modane	France	interurban	MP	85	85	6:00 - 7:00	1:00	1:00	4,00	0,13	0,00	4,13	340	11	0	351
2	Lyon -- Modane	France	interurban	HP	70	97	7:00 - 8:23	1:23	2:23	4,00	0,13	0,00	4,13	388	13	0	401
3	**Modane -- A32/E70 Tunnel du Frejus**	**France**	**interurban**	**HP**	**40**	**16**	**8:23 - 8:47**	**0:24**	**2:47**	**6,00**	**0,33**	**0,00**	**6,33**	**96**	**5**	**0**	**101**
4	**A32/E70 Tunnel du Frejus -- Salbertrand**	**Italy**	**interurban**	**HP**	**40**	**9**	**8:47 - 9:00**	**0:12**	**3:00**	**6,00**	**0,33**	**0,00**	**6,33**	**51**	**3**	**0**	**54**
5	**A32/E70 Tunnel du Frejus -- Salbertrand**	**Italy**	**interurban**	**MP**	**50**	**23**	**9:00 - 9:28**	**0:28**	**3:28**	**6,00**	**0,33**	**0,00**	**6,33**	**141**	**8**	**0**	**148**
6	Salbertrand -- Turin	Italy	interurban	MP	85	45	9:28 - 10:00	0:31	4:00	4,00	0,13	0,00	4,13	181	6	0	187
7	Salbertrand -- Turin	Italy	interurban	OP	98	2	10:00 - 10:01	0:01	4:01	4,00	0,13	0,00	4,13	7	0	0	8
8	**Turin**	**Italy**	**suburban**	**OP**	**80**	**19**	**10:01 - 10:15**	**0:14**	**4:15**	**4,00**	**1,10**	**0,00**	**5,10**	**76**	**21**	**0**	**97**
9	Turin -- Milan	Italy	interurban	OP	98	24	10:15 - 10:30	0:14	4:30	4,00	0,13	0,00	4,13	96	3	0	99
10	Turin -- Milan	Italy	interurban	OP	98	100	11:15 - 12:16	1:01	6:16	4,00	0,13	0,00	4,13	400	13	0	413
11	**Milan**	**Italy**	**suburban**	**OP**	**80**	**20**	**12:16 - 12:31**	**0:15**	**6:31**	**4,00**	**1,10**	**0,00**	**5,10**	**80**	**22**	**0**	**102**
12	Milan -- Peschiera del Garda	Italy	interurban	OP	98	181	12:31 - 14:22	1:50	8:22	4,00	0,13	0,00	4,13	724	24	0	748
13	**Vicenza**	**Italy**	**suburban**	**OP**	**80**	**9**	**14:22 - 14:28**	**0:06**	**8:28**	**4,00**	**1,10**	**0,00**	**5,10**	**36**	**10**	**0**	**46**
14	Vicenza -- Padova	Italy	interurban	OP	98	32	14:28 - 14:48	0:19	8:48	4,00	0,13	0,00	4,13	128	4	0	132
15	**Padova**	**Italy**	**suburban**	**OP**	**80**	**7**	**14:48 - 14:53**	**0:05**	**8:53**	**4,00**	**1,10**	**0,00**	**5,10**	**28**	**8**	**0**	**36**
16	Padova -- Mestre	Italy	interurban	OP	98	33	14:53 - 15:13	0:20	9:13	4,00	0,13	0,00	4,13	132	4	0	136
17	**Mestre**	**Italy**	**suburban**	**OP**	**80**	**20**	**15:13 - 15:28**	**0:15**	**9:28**	**4,00**	**1,10**	**0,00**	**5,10**	**80**	**22**	**0**	**102**
18	Mestre -- Trieste	Italy	interurban	OP	98	26	15:28 - 15:45	0:16	9:45	4,00	0,13	0,00	4,13	105	3	0	109
19	Mestre -- Trieste	Italy	interurban	MP	85	85	6:00 - 7:00	1:00	25:00	4,00	0,13	0,00	4,13	340	11	0	351
20	Mestre -- Trieste	Italy	interurban	HP	70	12	7:00 - 7:10	0:10	25:10	4,00	0,13	0,00	4,13	47	2	0	48
21	**Trieste -- SL Border**	**Italy**	**suburban**	**HP**	**50**	**10**	**7:10 - 7:22**	**0:12**	**25:22**	**4,00**	**1,10**	**40,00**	**45,10**	**40**	**11**	**400**	**451**
22	SL Border -- Postojna	Slovenia	interurban	HP	65	96	7:22 - 8:50	1:28	26:50	4,00	0,13	0,00	4,13	384	12	0	396
23	**Ljubljana**	**Slovenia**	**suburban**	**HP**	**50**	**8**	**8:50 - 9:00**	**0:09**	**27:00**	**4,00**	**1,10**	**10,00**	**15,10**	**31**	**9**	**78**	**118**
24	**Ljubljana**	**Slovenia**	**suburban**	**MP**	**60**	**3**	**9:00 - 9:03**	**0:03**	**27:03**	**4,00**	**1,10**	**5,00**	**10,10**	**13**	**4**	**16**	**32**
25	Ljubljana -- Maribor	Slovenia	interurban	MP	50	47	9:03 - 10:00	0:56	28:00	4,00	0,13	0,00	4,13	189	6	0	195
26	Ljubljana -- Maribor	Slovenia	interurban	OP	70	35	10:00 - 10:30	0:30	28:30	4,00	0,13	0,00	4,13	140	5	0	145
27	Ljubljana -- Maribor	Slovenia	interurban	OP	70	45	11:15 - 11:53	0:38	29:53	4,00	0,13	0,00	4,13	179	6	0	184
28	**Maribor**	**Slovenia**	**suburban**	**OP**	**80**	**5**	**11:53 - 11:57**	**0:03**	**29:57**	**4,00**	**1,10**	**0,00**	**5,10**	**20**	**6**	**0**	**26**
29	Maribor -- HU Border	Slovenia	interurban	OP	95	95	11:57 - 12:57	1:00	30:57	4,00	0,13	0,00	4,13	380	12	0	392
30	HU Border -- Szombathely	Hungary	interurban	OP	95	80	12:57 - 13:47	0:50	31:47	3,93	0,13	0,00	4,06	314	10	0	324
31	**Szombathely**	**Hungary**	**suburban**	**OP**	**80**	**6**	**13:47 - 13:52**	**0:04**	**31:52**	**4,00**	**1,10**	**0,00**	**5,10**	**24**	**7**	**0**	**31**
32	Szombathely -- Route 86	Hungary	interurban	OP	95	113	13:52 - 15:03	1:11	33:03	3,93	0,13	0,00	4,06	444	15	0	458
33	SK Border -- Bratislava	Slowakia	interurban	OP	95	13	15:03 - 15:11	0:08	33:11	3,87	0,13	0,00	4,00	50	2	0	52
Total corridor														5684	295	494	6473

Table A2.3: Overview of external costs per segment for the corridor Catania-Holyhead (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
	Description	Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	**Catania**	**Italy**	**suburban**	**MP**	**50**	**6**	**6:00 - 6:07**	**0:07**	**0:07**	**4,00**	**1,10**	**15,00**	**20,10**	**24**	**7**	**90**	**121**
2	Catania -- Messina	Italy	interurban	MP	80	70	6:07 - 7:00	0:52	1:00	4,00	0,13	0,00	4,13	282	9	0	291
3	Catania -- Messina	Italy	interurban	HP	75	22	7:00 - 7:17	0:17	1:17	4,00	0,13	0,00	4,13	86	3	0	89
4	**Messina**	**Italy**	**suburban**	**HP**	**40**	**3**	**7:17 - 7:21**	**0:04**	**1:21**	**4,00**	**1,10**	**40,00**	**45,10**	**12**	**3**	**120**	**135**
5	Messina -- Villa San Giovanni	Italy	ferry	HP	-	-	7:21 - 8:06	0:45	2:06								
6	**Villa San Giovanni**	**Italy**	**suburban**	**HP**	**40**	**2**	**8:06 - 8:09**	**0:03**	**2:09**	**4,00**	**1,10**	**40,00**	**45,10**	**8**	**2**	**80**	**90**
7	Villa San Giovanni -- A3/E45 (KM 364)	Italy	interurban	HP	75	63	8:09 - 9:00	0:50	3:00	4,00	0,13	0,00	4,13	251	8	0	259
8	Villa San Giovanni -- A3/E45 (KM 364)	Italy	interurban	MP	80	80	9:00 - 10:00	1:00	4:00	4,00	0,13	0,00	4,13	320	10	0	330
9	Villa San Giovanni -- A3/E45 (KM 364)	Italy	interurban	OP	90	45	10:00 - 10:30	0:30	4:30	4,00	0,13	0,00	4,13	180	6	0	186
10	Villa San Giovanni -- A3/E45 (KM 364)	Italy	interurban	OP	90	242	11:15 - 13:56	2:41	7:56	4,00	0,13	0,00	4,13	969	31	0	1000
11	**A3/E45 (KM 430) -- RA2/E841**	**Italy**	**suburban**	**OP**	**85**	**9**	**13:56 - 14:02**	**0:06**	**8:02**	**4,00**	**1,10**	**0,00**	**5,10**	**36**	**10**	**0**	**46**
12	RA2/E841 -- A1 motorway (KM 1)	Italy	interurban	OP	90	153	14:02 - 15:45	1:42	9:45	4,00	0,13	0,00	4,13	613	20	0	633
13	RA2/E841 -- A1 motorway (KM 1)	Italy	interurban	MP	80	80	6:00 - 7:00	1:00	25:00	4,00	0,13	0,00	4,13	320	10	0	330
14	RA2/E841 -- A1 motorway (KM 1)	Italy	interurban	HP	75	150	7:00 - 9:00	2:00	27:00	4,00	0,13	0,00	4,13	600	20	0	620
15	RA2/E841 -- A1 motorway (KM 1)	Italy	interurban	MP	80	80	9:00 - 10:00	1:00	28:00	4,00	0,13	0,00	4,13	320	10	0	330
16	RA2/E841 -- A1 motorway (KM 1)	Italy	interurban	OP	90	45	10:00 - 10:30	0:30	28:30	4,00	0,13	0,00	4,13	180	6	0	186
17	RA2/E841 -- A1 motorway (KM 1)	Italy	interurban	OP	90	47	11:15 - 11:46	0:31	29:46	4,00	0,13	0,00	4,13	187	6	0	193
18	**Florence**	**Italy**	**suburban**	**OP**	**85**	**15**	**11:46 - 11:56**	**0:10**	**29:56**	**4,00**	**1,10**	**0,00**	**5,10**	**60**	**17**	**0**	**77**
19	Florence -- E35/West ring road	Italy	interurban	OP	90	222	11:56 - 14:24	2:28	32:24	4,00	0,13	0,00	4,13	888	29	0	917
20	**E35/West ring road -- A50/E35**	**Italy**	**suburban**	**OP**	**85**	**1**	**14:24 - 14:25**	**0:00**	**32:25**	**4,00**	**1,10**	**0,00**	**5,10**	**4**	**1**	**0**	**5**
21	A50/E35 -- Chiasso - CH Border	Italy	interurban	OP	90	67	14:25 - 15:10	0:44	33:10	4,00	0,13	0,00	4,13	268	9	0	277
22	Chiasso - CH Border -- Palmengo	Switzerland	interurban	OP	90	52	15:10 - 15:45	0:34	33:45	4,00	0,13	0,00	4,13	209	7	0	216
23	Chiasso - CH Border -- Palmengo	Switzerland	interurban	MP	80	42	6:00 - 6:31	0:31	48:31	4,00	0,13	0,00	4,13	167	5	0	172
24	**Palmengo -- Wiler**	**Switzerland**	**interurban**	**MP**	**50**	**24**	**6:31 - 7:00**	**0:28**	**49:00**	**6,00**	**0,33**	**0,00**	**6,33**	**144**	**8**	**0**	**151**
25	**Palmengo -- Wiler**	**Switzerland**	**interurban**	**HP**	**40**	**17**	**7:00 - 7:25**	**0:25**	**49:25**	**6,00**	**0,33**	**0,00**	**6,33**	**102**	**6**	**0**	**108**
26	Wiler -- Basel	Switzerland	interurban	HP	75	118	7:25 - 9:00	1:34	51:00	4,00	0,13	0,00	4,13	472	15	0	487
27	Wiler -- Basel	Switzerland	interurban	MP	80	31	9:00 - 9:23	0:23	51:23	4,00	0,13	0,00	4,13	124	4	0	128
28	**Basel**	**Switzerland**	**suburban**	**MP**	**50**	**3**	**9:23 - 9:26**	**0:03**	**51:26**	**4,00**	**1,10**	**15,00**	**20,10**	**12**	**3**	**45**	**60**
29	Basel -- FR Border	Switzerland	interurban	MP	80	3	9:26 - 9:29	0:02	51:29	4,00	0,13	0,00	4,13	12	0	0	12
30	FR Border -- Strasbourg	France	interurban	MP	80	41	9:29 - 10:00	0:30	52:00	4,00	0,13	0,00	4,13	165	5	0	170
31	FR Border -- Strasbourg	France	interurban	OP	90	45	10:00 - 10:30	0:30	52:30	4,00	0,13	0,00	4,13	180	6	0	186
32	FR Border -- Strasbourg	France	interurban	OP	90	32	11:15 - 11:36	0:21	53:36	4,00	0,13	0,00	4,13	127	4	0	131
33	**Strasbourg**	**France**	**suburban**	**OP**	**85**	**16**	**11:36 - 11:47**	**0:11**	**53:47**	**4,00**	**1,10**	**0,00**	**5,10**	**64**	**18**	**0**	**82**
34	Strasbourg -- Reims	France	interurban	OP	90	346	11:47 - 15:38	3:50	57:38	4,00	0,13	0,00	4,13	1384	45	0	1429
35	**Reims**	**France**	**suburban**	**OP**	**85**	**3**	**15:38 - 15:40**	**0:02**	**57:40**	**4,00**	**1,10**	**0,00**	**5,10**	**12**	**3**	**0**	**15**
36	Reims -- Calais	France	interurban	OP	90	7	15:40 - 15:45	0:04	57:45	4,00	0,13	0,00	4,13	28	1	0	29
37	Reims -- Calais	France	interurban	MP	80	80	6:00 - 7:00	1:00	73:00	4,00	0,13	0,00	4,13	320	10	0	330
38	Reims -- Calais	France	interurban	HP	75	135	7:00 - 8:47	1:47	74:47	4,00	0,13	0,00	4,13	540	18	0	557
39	Calais -- UK Border	France	Eurotunnel	HP	40	8	8:47 - 9:00	0:12	75:00	4,00	0,13	0,00	4,13	32	1	0	33
40	Calais -- UK Border	France	Eurotunnel	MP	50	17	9:00 - 9:20	0:20	75:20	4,00	0,13	0,00	4,13	68	2	0	70
41	UK Border -- Folkestone	UK	Eurotunnel	MP	50	25	9:20 - 9:50	0:30	75:50	3,38	0,13	0,00	3,51	85	3	0	88
42	**Folkestone**	**UK**	**suburban**	**MP**	**50**	**3**	**9:50 - 9:53**	**0:03**	**75:53**	**4,00**	**1,10**	**20,00**	**25,10**	**12**	**3**	**60**	**75**
43	Folkestone -- Walderslade	UK	interurban	MP	80	8	9:53 - 10:00	0:06	76:00	3,38	0,13	0,00	3,51	27	1	0	28
44	Folkestone -- Walderslade	UK	interurban	OP	90	45	10:00 - 10:30	0:30	76:30	3,38	0,13	0,00	3,51	152	6	0	158
45	Folkestone -- Walderslade	UK	interurban	OP	90	19	11:15 - 11:27	0:12	77:27	3,38	0,13	0,00	3,51	64	2	0	66
46	**London**	**UK**	**suburban**	**OP**	**85**	**74**	**11:27 - 12:19**	**0:52**	**78:19**	**4,00**	**1,10**	**0,00**	**5,10**	**296**	**81**	**0**	**377**
47	London -- Birmingham	UK	interurban	OP	90	138	12:19 - 13:51	1:32	79:51	3,38	0,13	0,00	3,51	467	18	0	484
48	**Birmingham**	**UK**	**suburban**	**OP**	**85**	**38**	**13:51 - 14:18**	**0:26**	**80:18**	**4,00**	**1,10**	**0,00**	**5,10**	**152**	**42**	**0**	**194**
49	Birmingham -- Holyhead	UK	interurban	OP	90	129	14:18 - 15:45	1:26	81:45	3,38	0,13	0,00	3,51	438	17	0	455
50	Birmingham -- Holyhead	UK	interurban	MP	80	80	6:00 - 7:00	1:00	97:00	3,38	0,13	0,00	3,51	270	10	0	281
51	Birmingham -- Holyhead	UK	interurban	HP	75	26	7:00 - 7:20	0:20	97:20	3,38	0,13	0,00	3,51	86	3	0	90
Total corridor														11819	567	395	12781

Table A2.4: Overview of external costs per segment for the corridor Milan-Lübeck (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
Description		Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/ km	Air	Noise	Conges-tion	Total
1	Milan-Border I-CH	Italy	interurban	MP	70	42	6:00 - 6:36	0:36	0:36	4,00	0,13	0,00	4,13	169	5	0	174
2	Border I-CH-Border CH-AU	Switzerland	interurban	MP	86	34	6:36 - 7:00	0:23	1:00	4,00	0,13	0,00	4,13	136	4	0	141
3	Border I-CH-Border CH-AU	Switzerland	interurban	HP	84	169	7:00 - 9:00	2:00	3:00	4,00	0,13	0,00	4,13	675	22	0	697
4	Border I-CH-Border CH-AU	Switzerland	interurban	MP	86	37	9:00 - 9:25	0:25	3:25	4,00	0,13	0,00	4,13	146	5	0	151
5	**Border-Bregenz**	**Austria**	**interurban**	**MP**	**99**	**11**	**9:25 - 9:32**	**0:06**	**3:32**	**6,00**	**0,33**	**0,00**	**6,33**	**68**	**4**	**0**	**72**
6	**Bregenz**	**Austria**	**suburban**	**MP**	**36**	**8**	**9:32 - 9:45**	**0:13**	**3:45**	**4,00**	**1,10**	**20,00**	**25,10**	**32**	**9**	**160**	**201**
7	Bregenz-Border D	Austria	interurban	MP	65	4	9:45 - 9:49	0:03	3:49	4,00	0,13	0,00	4,13	16	1	0	17
8	Border D-München	Germany	interurban	MP	88	15	9:49 - 10:00	0:10	4:00	4,00	0,13	0,00	4,13	62	2	0	64
9	Border D-München	Germany	interurban	OP	93	46	10:00 - 10:30	0:30	4:30	4,00	0,13	0,00	4,13	185	6	0	191
10	Border D-München	Germany	interurban	OP	93	102	11:15 - 12:21	1:06	6:21	4,00	0,13	0,00	4,13	410	13	0	423
11	**München**	**Germany**	**suburban**	**OP**	**92**	**24**	**12:21 - 12:37**	**0:15**	**6:37**	**4,00**	**1,10**	**0,00**	**5,10**	**96**	**26**	**0**	**122**
12	München-Nürnberg	Germany	interurban	OP	99	152	12:37 - 14:09	1:31	8:09	4,00	0,13	0,00	4,13	608	20	0	628
13	**Nürnburg**	**Germany**	**suburban**	**OP**	**101**	**9**	**14:09 - 14:14**	**0:05**	**8:14**	**4,00**	**1,10**	**0,00**	**5,10**	**36**	**10**	**0**	**46**
14	Nürnberg-Kassel	Germany	interurban	OP	96	145	14:14 - 15:45	1:30	9:45	4,00	0,13	0,00	4,13	579	19	0	598
15	Nürnberg-Kassel	Germany	interurban	MP	93	93	6:00 - 7:00	1:00	25:00	4,00	0,13	0,00	4,13	373	12	0	385
16	Nürnberg-Kassel	Germany	interurban	HP	92	56	7:00 - 7:36	0:36	25:36	4,00	0,13	0,00	4,13	224	7	0	231
17	**Kassel**	**Germany**	**suburban**	**HP**	**93**	**9**	**7:36 - 7:42**	**0:05**	**25:42**	**4,00**	**1,10**	**40,00**	**45,10**	**36**	**10**	**360**	**406**
18	Kassel-Gottingen	Germany	interurban	HP	93	34	7:42 - 8:04	0:21	26:04	4,00	0,13	0,00	4,13	136	4	0	140
19	**Gottingen**	**Germany**	**suburban**	**HP**	**91**	**9**	**8:04 - 8:10**	**0:05**	**26:10**	**4,00**	**1,10**	**40,00**	**45,10**	**36**	**10**	**360**	**406**
20	Gottingen-Hildesheim	Germany	interurban	HP	90	75	8:10 - 9:00	0:49	27:00	4,00	0,13	0,00	4,13	299	10	0	309
21	Gottingen-Hildesheim	Germany	interurban	MP	91	3	9:00 - 9:02	0:02	27:02	4,00	0,13	0,00	4,13	13	0	0	14
22	**Hildesheim**	**Germany**	**suburban**	**MP**	**94**	**7**	**9:02 - 9:06**	**0:04**	**27:06**	**4,00**	**1,10**	**20,00**	**25,10**	**28**	**8**	**140**	**176**
23	Hildesheim-Hannover	Germany	interurban	MP	77	17	9:06 - 9:19	0:13	27:19	4,00	0,13	0,00	4,13	68	2	0	70
24	**Hannover**	**Germany**	**suburban**	**MP**	**95**	**10**	**9:19 - 9:26**	**0:06**	**27:26**	**4,00**	**1,10**	**20,00**	**25,10**	**40**	**11**	**200**	**251**
25	Hannover-Hamburg	Germany	interurban	MP	95	53	9:26 - 10:00	0:33	28:00	4,00	0,13	0,00	4,13	213	7	0	220
26	Hannover-Hamburg	Germany	interurban	OP	97	48	10:00 - 10:30	0:30	28:30	4,00	0,13	0,00	4,13	193	6	0	199
27	Hannover-Hamburg	Germany	interurban	OP	97	27	11:15 - 11:31	0:16	29:31	4,00	0,13	0,00	4,13	108	4	0	111
28	**Hamburg**	**Germany**	**suburban**	**OP**	**98**	**20**	**11:31 - 11:44**	**0:12**	**29:44**	**4,00**	**1,10**	**0,00**	**5,10**	**82**	**23**	**0**	**105**
29	Hamburg-Lübeck	Germany	interurban	OP	48	44	11:44 - 12:39	0:54	30:39	4,00	0,13	0,00	4,13	174	6	0	180
Total corridor														5241	265	1220	6727

Table A2.5: Overview of external costs per segment for the corridor Rotterdam-Köln-Rotterdam (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
Description		Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	Rotterdam-Border NL-D	Netherlands	interurban	MP	57	57	6:00 - 7:00	1:00	1:00	4,00	0,13	1,00	5,13	229	7	57	294
2	Rotterdam-Border NL-D	Netherlands	interurban	HP	48	74	7:00 - 8:31	1:31	2:31	4,00	0,13	3,00	7,13	295	10	221	526
3	Border NL-D - Duisburg/Krefeld	Germany	interurban	HP	85	40	8:31 - 9:00	0:28	3:00	4,00	0,13	0,00	4,13	160	5	0	165
4	Border NL-D - Duisburg/Krefeld	Germany	interurban	MP	94	19	9:00 - 9:12	0:12	3:12	4,00	0,13	0,00	4,13	76	2	0	79
5	**Duisburg/Krefeld**	**Germany**	**suburban**	**MP**	**72**	**9**	**9:12 - 9:19**	**0:07**	**3:19**	**4,00**	**1,10**	**20,00**	**25,10**	**36**	**10**	**180**	**226**
6	Duisburg/Krefeld-Düsseldorf/Neuss	Germany	interurban	MP	82	9	9:19 - 9:26	0:06	3:26	4,00	0,13	0,00	4,13	36	1	0	37
7	**Düsseldorf/Neuss**	**Germany**	**suburban**	**MP**	**66**	**11**	**9:26 - 9:36**	**0:10**	**3:36**	**4,00**	**1,10**	**20,00**	**25,10**	**44**	**12**	**220**	**276**
8	Düsseldorf/Neuss-Köln	Germany	interurban	MP	76	20	9:36 - 9:52	0:15	3:52	4,00	0,13	0,00	4,13	80	3	0	83
9	**Köln**	**Germany**	**suburban**	**MP**	**30**	**4**	**9:52 - 10:00**	**0:07**	**4:00**	**4,00**	**1,10**	**20,00**	**25,10**	**16**	**4**	**78**	**98**
10	**Köln**	**Germany**	**suburban**	**OP**	**53**	**2**	**10:00 - 10:02**	**0:02**	**4:02**	**4,00**	**1,10**	**0,00**	**5,10**	**8**	**2**	**0**	**11**
11	Köln-Düsseldorf/Neuss	Germany	interurban	OP	79	20	10:02 - 10:17	0:15	4:17	4,00	0,13	0,00	4,13	80	3	0	83
12	**Düsseldorf/Neuss**	**Germany**	**suburban**	**OP**	**69**	**11**	**10:17 - 10:27**	**0:09**	**4:27**	**4,00**	**1,10**	**0,00**	**5,10**	**44**	**12**	**0**	**56**
13	Düsseldorf/Neuss-Duisburg/Krefeld	Germany	interurban	OP	80	4	10:27 - 10:30	0:02	4:30	4,00	0,13	0,00	4,13	16	1	0	16
14	Düsseldorf/Neuss-Duisburg/Krefeld	Germany	interurban	OP	80	5	11:15 - 11:18	0:03	5:18	4,00	0,13	0,00	4,13	20	1	0	21
15	**Duisburg/Krefeld**	**Germany**	**suburban**	**OP**	**81**	**9**	**11:18 - 11:25**	**0:06**	**5:25**	**4,00**	**1,10**	**0,00**	**5,10**	**36**	**10**	**0**	**46**
16	Duisburg/Krefeld-Border D-NL	Germany	interurban	OP	94	59	11:25 - 12:03	0:37	6:03	4,00	0,13	0,00	4,13	236	8	0	244
17	Border D-NL-Rotterdam	Netherlands	interurban	OP	78	130	12:03 - 13:43	1:40	7:43	4,00	0,13	0,00	4,13	518	17	0	535
Total corridor														1930	107	756	2794

Table A2.6: Overview of external costs per segment for the corridor Stockholm-Odense (bridge) (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
Description		Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/km	Air	Noise	Conges-tion	Total
1	**Stockholm**	**Sweden**	**suburban**	**MP**	**51**	**12**	**6:00 - 6:14**	**0:14**	**0:14**	**3,02**	**1,10**	**5,00**	**9,12**	**36**	**13**	**60**	**109**
2	Stockholm-Jörkoping	Sweden	interurban	MP	75	57	6:14 - 7:00	0:45	1:00	1,39	0,13	0,00	1,52	80	7	0	87
3	Stockholm-Jörkoping	Sweden	interurban	HP	70	140	7:00 - 9:00	2:00	3:00	1,39	0,13	0,00	1,52	194	18	0	212
4	Stockholm-Jörkoping	Sweden	interurban	MP	75	75	9:00 - 10:00	1:00	4:00	1,39	0,13	0,00	1,52	104	10	0	114
5	Stockholm-Jörkoping	Sweden	interurban	OP	80	22	10:00 - 10:16	0:16	4:16	1,39	0,13	0,00	1,52	31	3	0	34
6	**Jörkoping**	**Sweden**	**suburban**	**OP**	**80**	**13**	**10:16 - 10:26**	**0:09**	**4:26**	**3,02**	**1,10**	**0,00**	**4,12**	**39**	**14**	**0**	**54**
7	Jörkoping-Malmö	Sweden	interurban	OP	80	5	10:26 - 10:30	0:03	4:30	1,39	0,13	0,00	1,52	7	1	0	7
8	Jörkoping-Malmö	Sweden	interurban	OP	80	275	11:15 - 14:41	3:26	8:41	1,39	0,13	0,00	1,52	382	36	0	418
9	**Malmö**	**Sweden**	**suburban**	**OP**	**80**	**22**	**14:41 - 14:57**	**0:16**	**8:57**	**3,02**	**1,10**	**0,00**	**4,12**	**66**	**24**	**0**	**91**
10	Malmö-Copenhagen	Sweden	interurban	OP	80	15	14:57 - 15:09	0:11	9:09	1,39	0,13	0,00	1,52	21	2	0	23
11	**Copenhagen**	**Denmark**	**suburban**	**OP**	**80**	**18**	**15:09 - 15:22**	**0:13**	**9:22**	**4,00**	**1,10**	**0,00**	**5,10**	**72**	**20**	**0**	**92**
12	Copenhagen-Odense	Denmark	interurban	OP	80	29	15:22 - 15:45	0:22	9:45	2,97	0,13	0,00	3,10	87	4	0	91
13	Copenhagen-Odense	Denmark	interurban	MP	75	75	6:00 - 7:00	1:00	25:00	2,97	0,13	0,00	3,10	223	10	0	232
14	Copenhagen-Odense	Denmark	interurban	HP	70	34	7:00 - 7:29	0:29	25:29	2,97	0,13	0,00	3,10	101	4	0	106
15	**Odense**	**Denmark**	**suburban**	**HP**	**42**	**7**	**7:29 - 7:39**	**0:10**	**25:39**	**4,00**	**1,10**	**50,00**	**55,10**	**30**	**8**	**375**	**413**
Total corridor														1474	174	435	2083

Table A2.7: Overview of external costs per segment for the corridor Stockholm-Odense (ferry) (departure time at 6:00, break length of 0:45)

Segment		Classification			Speed, distance, time					External costs per vkm (€-cent)				External costs per segment (€-cent)			
Description		Country	Road	Time period	Speed (km/h)	Km	Clock time	Duration	Cumulative trip duration	Air	Noise	Conges-tion	Total/ km	Air	Noise	Conges-tion	Total
1	**Stockholm**	**Sweden**	**suburban**	**MP**	**51**	**12**	**6:00 - 6:14**	**0:14**	**0:14**	**3,02**	**1,10**	**5,00**	**9,12**	**36**	**13**	**60**	**109**
2	Stockholm-Jörkoping	Sweden	interurban	MP	75	57	6:14 - 7:00	0:45	1:00	1,39	0,13	0,00	1,52	80	7	0	87
3	Stockholm-Jörkoping	Sweden	interurban	HP	70	140	7:00 - 9:00	2:00	3:00	1,39	0,13	0,00	1,52	194	18	0	212
4	Stockholm-Jörkoping	Sweden	interurban	MP	75	75	9:00 - 10:00	1:00	4:00	1,39	0,13	0,00	1,52	104	10	0	114
5	Stockholm-Jörkoping	Sweden	interurban	OP	80	22	10:00 - 10:16	0:16	4:16	1,39	0,13	0,00	1,52	31	3	0	34
6	**Jörkoping**	**Sweden**	**suburban**	**OP**	**80**	**13**	**10:16 - 10:26**	**0:09**	**4:26**	**3,02**	**1,10**	**0,00**	**4,12**	**39**	**14**	**0**	**54**
7	Jörkoping-Helsingborg	Sweden	interurban	OP	80	5	10:26 - 10:30	0:03	4:30	1,39	0,13	0,00	1,52	7	1	0	7
8	Jörkoping-Helsingborg	Sweden	interurban	OP	80	233	11:15 - 14:09	2:54	8:09	1,39	0,13	0,00	1,52	323	30	0	353
9	Helsingborg-Helsingør	Sweden	ferry	OP	-	-	14:09 - 14:39	0:30	8:39								
10	Helsingør-Copenhagen	Denmark	interurban	OP	80	28	14:39 - 15:00	0:21	9:00	2,97	0,13	0,00	3,10	84	4	0	88
11	**Copenhagen**	**Denmark**	**suburban**	**OP**	**80**	**26**	**15:00 - 15:20**	**0:19**	**9:20**	**4,00**	**1,10**	**0,00**	**5,10**	**104**	**29**	**0**	**133**
12	Copenhagen-Odense	Denmark	interurban	OP	80	33	15:20 - 15:45	0:24	9:45	2,97	0,13	0,00	3,10	98	4	0	102
13	Copenhagen-Odense	Denmark	interurban	MP	75	75	6:00 - 7:00	1:00	25:00	2,97	0,13	0,00	3,10	223	10	0	232
14	Copenhagen-Odense	Denmark	interurban	HP	70	31	7:00 - 7:26	0:26	25:26	2,97	0,13	0,00	3,10	91	4	0	95
15	**Odense**	**Denmark**	**suburban**	**HP**	**42**	**7**	**7:26 - 7:36**	**0:10**	**25:36**	**4,00**	**1,10**	**50,00**	**55,10**	**30**	**8**	**375**	**413**
Total corridor														1443	155	435	2033

European Commission

JRC 54766 – Joint Research Centre – Institute for Prospective Technological Studies
Title: Impacts of the proposal for amending Directive 1999/62/EC on road infrastructure charging: An analysis on selected corridors and main impacts
Author(s): Panayotis Christidis, Martijn Brons
Luxembourg: Office for Official Publications of the European Communities
2009
Technical Note

Abstract

The internalization of external costs is main priority of transport policy at EU level. Charging heavy duty vehicles according to the "polluter pays" principle is one of the main policy options in an effort to reduce the negative impacts of transport on the environment. In this context, the European Commission is proposing the amendment of Directive 1999/62/EC on road infrastructure charging. The proposal foresees the application of charges on heavy duty vehicles that are proportional to the damage the produce in terms of pollution, noise and congestion. The Commission's proposal establishes the methodology to be followed for the estimation of external cost charges as well as the areas of their application.

The proposed amendment is currently being discussed between the European Commission, the European Parliament and the Council in order to ensure that the proposed measure meets the policy objective of reducing the external cost of freight transport while minimizing the negative impacts for the freight transport sector and economy as a whole. As part of the process, the Council of Ministers requested additional information on the possible impacts through case studies. The European Commission, DG TREN, presented preliminary calculations to the Land Transport Working Party of the Council on 12th March 2009 and an analysis of three case studies was discussed with experts from the Member States on 26th June 2009. As a result, it was requested that additional corridors and indicators were analysed. The European Commission's Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS) took the responsibility for the additional analysis that combined data from actual operations with models that simulate the level of charges under different assumptions.