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EXPEDITE

EXpert-system based PrEdictions of Demand for Internal Transport in Europe

Contract No: 2000-AM-10816

Prepared for the European Commission
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PREFACE

The EXPEDITE project was carried out for the European Commission, Directorate-General for Energy and Transport (DGTREN) by a consortium of consultants and institutes, coordinated by RAND Europe, as part of the 5th Framework.

The objectives of EXPEDITE were:

- to generate forecasts for both passenger and freight transport for Europe for 2005, 2010, 2015 and 2020;
- to show which policies can be effective to achieve substitution from car, lorry and air to other modes, such as train, bus, inland waterways transport and non-motorised modes;
- to identify market segments that are sensitive (and those that are insensitive), in terms of modifications of modal usage, to policy measures.

This Final Publishable Report contains the main outcomes of the deliverables that were written in the course of the EXPEDITE project. In the various deliverables in this project, we have:

- described the planned interaction with THINK-UP, the thematic network that was set up to describe the state-of-the-art methodologies in transport forecasting and to improve the mutual understanding of the results obtained (deliverable 1 or D1, joint deliverable with THINK-UP);
- reviewed existing national and international transport models (D2);
- presented the base-year (1995) data (D4);
- defined a Reference Scenario for 2020 and the intermediate years and defined policies to be simulated (D3);
- carried out runs with existing models: the SCENES European model and a number of national models for passenger and freight transport (D5, D6 and D7);
- created, on the basis of this information, two new models, the EXPEDITE meta-model for passenger transport and the EXPEDITE meta-model for freight transport (D8);
- carried out runs with the meta-models and the SCENES models for the Reference Scenario, policy runs and the evaluation of these policies in EXPEDITE. On the basis of these policy runs we reached conclusions on the effectiveness of policy measures and on (in)sensitive market segments (D9).

In this Final Report, which builds on all the above-mentioned deliverables, there is a focus on deliverable 9, because the answers to the research questions (the EXPEDITE objectives) were given in this deliverable. This Final Report was written for researchers and policy-advisors who want to learn about passenger and freight transport forecasts for the European Union (current member states and accession countries) and about the possibilities for policies that try to change the modal split: which policies are most effective and in which segments of the market?

For more information on the EXPEDITE project, please contact the project leader Gerard de Jong (jong@rand.org).

The author of this report is the EXPEDITE consortium, co-ordinated by RAND Europe. RAND Europe is an independent not-for-profit policy research organization that serves the public interest by informing policymaking and public debate. Clients are European governments, institutions, and firms with a need for rigorous, impartial, multi-disciplinary analysis of the problems they face. This report has been peer-reviewed in accordance with RAND's quality assurance standards (http://www.rand.org/about/standards/).

EXECUTIVE SUMMARY

The EXPEDITE project was carried out for the European Commission, Directorate-General for Energy and Transport (DGTREN) by a consortium of consultants and institutes, coordinated by RAND Europe, as part of the 5th Framework.

The objectives of EXPEDITE were to generate forecasts for both passenger and freight transport for Europe for 2005, 2010, 2015 and 2020, to show which policies can be effective to reach substitution from car and lorry and air transport to other modes and to identify market segments that are sensitive (and those that are insensitive) to policy measures.

In previous deliverables in this project, we have reviewed existing national and international transport models, presented the base-year (1995) data, defined a Reference Scenario for 2020 and the intermediate years, defined policies to be simulated, and carried out runs with existing models (the SCENES European model and a number of national models for passenger and freight transport). On the basis of this information we created two new models, the EXPEDITE meta-model for passenger transport and the EXPEDITE meta-model for freight transport.

In this EXPEDITE Final Report, we present the main outcomes of the entire project. In particular we give the results of runs with the meta-models and the SCENES models for the Reference Scenario. Furthermore, we report on the policy runs carried out with those models and the evaluation of these policies in EXPEDITE. On the basis of these policy runs we have also reached conclusions on the effectiveness of policy measures and on (in)sensitive market segments.

Conclusions on freight transport:

- In the period 1995-2020, under the assumptions of the Reference Scenario, the number of tonnes lifted in the study area will increase by 44% (lorry +39%) and tonne-kilometrage will grow by 79% (lorry +89%). A higher growth is predicted for the Central and Eastern European Countries (CEEC), for long distance transport and for general cargo.
- If lorry costs increase, there will only be significant shifts at trip distances above 100 kilometres. Below 100 kilometres, road transport is the dominant mode (except for some small niche segments, e.g. shipments between firms with rail sidings or inland waterways or sea terminals at both origin and destination). Policy measures are unable to change this situation below 100 kilometres; it is an insensitive market segment. This is not generally true for shipments with trip distances above 100 kilometres. Here, an increase in lorry cost can lead to substitution, mainly to inland waterways transport (where available) and train.
- If the lorry transport time goes up, there will also be only significant mode shifts for consignments above 100 kilometres. For this change in transport conditions, most of the substitution is towards combined road-rail transport, but also to conventional rail transport.
- If the rail/combined transport cost or time decreases, then for fuels and ores, metal products, basic and other chemicals, large machinery (but only above 100 kilometres) there will be a significant decline in lorry tonne-kilometrage, but a shift will also take place from inland waterways transport (where this mode exists).

- If the cost or time of inland waterways transport decrease, then there will only be a significant reduction of lorry transport for specific countries (where inland waterways transport is a viable option, such as The Netherlands, Belgium, Germany and France).
- If the sea shipping cost or time goes down, there will only be small shifts towards sea transport and no significant reduction for lorry.
- In passenger transport an increase in transport time by x% has a bigger impact than an increase in transport cost by x%. This is not generally true in freight transport; in many situations an x% change in cost has a bigger impact than an x% change in time.
- Elasticities keep increasing with distance after 100 kilometres (especially time elasticities).
- Changes in tonne-kilometres are bigger than changes in tonnes for lorry, while the changes are close to being equal in tonnes and tonne-kilometres for rail and inland waterways. This shows that goods would mostly be transferred between modes in consignments where trip lengths are longer than average lorry trips.
- The most effective policy measures to achieve substitution from road to other modes are (without implying that these are the best policies for society; that depends on the outcomes of the overall evaluation; see the last three bullet points for freight):
    - Increases in lorry cost for all or the higher distances (congestion and road pricing, infrastructure tariff, cost internalisation, kilometre charging, fuel price increase);
    - Increase in lorry time (maximum speed limits, harmonisation of rules on speeding);
    - Decrease in non-road handling and storage cost (intermodality and interconnectivity).
- Policies that make the non-road modes cheaper or reduce the travel times on the non-road networks are less effective for reducing lorry tonne-kilometrage; often they also lead to substitution between the non-road modes.
- Effective policy bundles should contain elements of the three most effective policies (increased cost and time for road, lower non-road handling and storage cost). Decreasing the non-road travel times and cost can only have a substantial effect on substitution away from the road mode if the bundle includes measures that make all non-road modes more attractive. Otherwise, there will be a large amount of substitution between the non-road modes.
- To make polices effective the target segment should be shipments above 100 kilometres. Also policies targetted at bulky products are more effective for substitution from road to the other modes than policies focussing on other commodities.
- Increasing the lorry cost (one of the three effective types of policy mentioned above) leads to increases in the cost for the users of transport, which according to the evaluation carried out, are not compensated by the reduction in external cost for society as a whole (emissions, noise, accidents). On the other hand this type of policy increases government revenues.
- Policies that increase the lorry transport time (another of the three effective types of policies) increase the time cost of transport users, but decrease the driving cost of the user and the external cost (because of substitution from road to modes that are cheaper and have lower external cost). The total internal and external costs remain more or less the same, according to our evaluation.
- Intermodality and interconnectivity, simulated as a decrease in handling and storage cost (the third of the above effective policies) reduce both internal user cost and external cost

of transport. These policies however require substantial investments in infrastructure and do not generate government revenues.

The above conclusions on the policy measures for freight transport are summarised in the table below.

Summary table for the assessment of policies for freight transport

	Effectiveness (modal shift from road to other modes)	**Change in internal and external transport cost**	**Required investment and operation and maintenance cost**
Intermodality	High	Small user cost reduction	Medium
Interconnectivity	High	Small user cost reduction	Medium
Congestion and road pricing	High	Big user cost increase	Low and government revenues
Parking policies	Low	Big user cost increase	Low and government revenues
Infrastructure tariff	High	Big user cost increase	Low and government revenues
Rail and fluvial interoperability	Medium	Small user cost reduction	Medium
Market liberalization (rail)	Medium	Small user cost reduction	Low
Cost internalisation	High	Big user cost increase	Low and government revenues
Maximum speed limits	High	No change in user cost	Low
Vignette, Eco-points, km charge	High	Small user cost increase	Low
Sea motorways	Low	Small user cost reduction	Low
Harmonisation of inspections and controls	High	Small user cost increase	Low
Harmonisation of rules on speeding	High	No change in user cost	Low
Deregulation for sea and IWW	Low	Small user cost reduction	Low
Fuel price increase	High	Big user cost increase	Low and government revenues

Conclusions on passenger transport:

- For the period 1995-2020 the meta-model predicts for the bulk of usual daily travel (trip distances up to 160 kilometres) that the number of tours (these are round-trips that start and end at home) will grow by 5% (car driver +22%) and passenger kilometrage will increase by 10% (car driver +24%). There will be a much higher growth in the CEEC.
- Long distance travel (above 160 kilometres) increases much faster (car, train and especially air) than shorter distance transport.
- Policies that increase car cost (fuel price increase, congestion and road pricing, parking policies, infrastructure tariff, cost internalisation), will only have limited mode shift effects, especially for business travel. There will be non-marginal reductions of car use, but most of the impact on car kilometrage is due to destination switching. The biggest reduction in car kilometrage is found for ‘other’ purposes (social and recreational traffic).
- Policies that lead to an increase in car time (speed limits, speed controls) are a relatively effective means of reducing car use (again mainly through destination switching, not mode shift). This does not automatically imply that these are the most desirable policies

for passenger transport; this also depends on the other impacts (see the evaluation outcomes below) of the measures than just the impacts on the transport volumes.

- Air transport (especially the leisure segment) is very sensitive to the level of the air fares.
- Increasing travel time by x% has a larger impact than increasing travel cost by x%. This goes for changes in cost and time for all modes.
- Policies that decrease the public transport cost or time (intermodality, interconnectivity, public transport pricing, rail and fluvial interoperability, rail market liberalisation), will have a large impact on kilometrage for the mode itself (or these modes themselves), but a very limited impact on car use.
- Elasticities (in absolute values) increase with distance.
- None of the policies simulated was really effective in shifting passengers from car driver to the non-car modes. Policies that increase the car cost or time are most effective in reducing car kilometres (mainly through destination switching, not much modal shift), but considerable increases in car cost or time are needed for this. To be effective in reducing car use, a policy bundle should include elements of a car cost and/or car time increase. At the same time, such a policy could be complemented by policies that make public transport more attractive (also for equity purposes and to provide accessibility to lower income groups).
- Segments of the passenger transport market that might be targeted because of their higher than average sensitivity to policy measures are long distance travel and social/recreational travel (and by definition for policies that make car less attractive: travellers from car owning-households). We did not find clear differences between the responsiveness of different income groups, area types and countries.
- Policies that make public transport cheaper or faster, such as public transport pricing, intermodality, interconnectivity, new urban public transport, interoperability and rail market liberalisation lead to a reduction in the total internal and external cost of transport. Such policies increase the user benefits from transport, because the public transport users have lower fares or lower time costs, and at the same time (slightly) decrease the external effects. Not taken into account here is that the revenues of the public transport operator might decrease when the fares are reduced. Most policies that make public transport more attractive require substantial investment and/or operation costs.
- Promoting housing densification or employment densification leads to a decrease in the external costs, but the increase in internal cost for the travellers dominates the picture.
- Cost internalisation, congestion pricing, road pricing, parking policies, harmonisation of rules on speeding, maximum speed limits and fuel price increases all make car more expensive or slower. This leads to a substantial increase in the user cost (the travellers have to pay more or incur higher time costs), which is not outweighted by the reduction in the external cost for society as a whole. Therefore all these policies lead to an increase in the total internal and external cost of transport. Not taken into account here is that the policy measures that increase the cost for transport users also increase government revenues (there is a shift of taxes or charges from the transport users to the government). Moreover, policies that make car less attractive usually have lower investment cost than policies that make public transport more attractive.

The above conclusions on the policy measures for passenger transport are summarised in the table below.

Summary table for the assessment of policies for passenger transport

	Effectiveness (modal shift from road to other modes)	**Change in internal and external transport cost**	**Required investment and operation and maintenance cost**
Intermodality	Low	Big reduction	Medium
Interconnectivity	Low	Big reduction	Medium
Congestion and road pricing	High	Medium increase	Low and government revenues
Parking policies	High	Medium increase	Low and government revenues
Rail and fluvial interoperability	Low	Small reduction	Medium
Market liberalization (rail)	Low	Small reduction	Medium
Cost internalisation	High	Big increase	Low and government revenues
Maximum speed limits	High	Big increase	Low
Harmonisation of rules on speeding	High	Big increase	Low
Public transport pricing	Low	Big reduction	Medium
New urban public transport	Low	Medium reduction	Medium
Fuel price increase	High	Big increase	Low and government revenues
Housing and employment densification	Low	Big increase	Medium

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1 INTRODUCTION: OBJECTIVES OF THE PROJECT

EXPEDITE is an EU-5th Framework project that started in May 2000 and was completed in October 2002.

EXPEDITE had the following aims:

- producing multi-modal demand forecasts up to 2020 for passengers and freight transport for Europe (using the NUTS2 zoning system for Europe, with about 250 zones in the study area, comprising the current member states and accession countries),
- identifying market segments which react most to control measures, and
- formulating efficient policy bundles to achieve mode-switching in line with Common Transport Policy (CTP) objectives (this means substitution away from car and air transport for passengers and away from road transport in freight).

This project was closely linked to the THINK-UP thematic network, which is set up to describe the state-of-the-art methodologies in forecasting and to improve the mutual understanding of the results obtained.

This is the Final Report in the EXPEDITE project. It contains an overview of the main outcomes from all work packages.

The focus in this report is given by the aims of EXPEDITE: we report the forecasts for the horizon years up to 2020, and outcomes on different policies as well as on sensitive and insensitive market segments. A *sensitive market segment*, is a segment (e.g. a population group, a travel purpose, a distance band, an area type or combinations of these) of the market for transport services where the mode share would change substantially if transport policy measures in line with the CTP would be implemented. An *insensitive market* segment is a segment where the mode shares react hardly or not to policy measures. The people or shipments transported in such segments are practically ‘captive’ to the mode used.

In chapter 2 of this report, a general overview of the EXPEDITE methodology is given. The method is based on the use of existing transport models, integrating outcomes from new runs with available models (reported in deliverables 5-7). The models that were used in EXPEDITE, as well as the larger set of models that was reviewed in EXPEDITE deliverable 2 are listed in chapter 2. Chapter 2 also includes descriptions of the meta-models for passenger and freight transport that were developed in EXPEDITE. In chapter 3 an overview is given of the assumptions used in the Reference Scenario for 2020 and of the policies simulated as variants of the Reference Scenario. This chapter also contains a description of how the Reference Scenario for EXPEDITE and the policies to be simulated were selected. In EXPEDITE we not only studied the effects of the policies on the transport volumes by mode, but we also carried out an approximate evaluation of the impacts of the policy on society (internal and external costs and benefits). The evaluation methodology is discussed in chapter 4 (freight) and 5 (passengers). Forecasting results for freight and passenger transport are given in chapter 6. Chapter 7 contains the baseline forecasts of the EXPEDITE meta-model for freight transport and chapter 8 those from the EXPEDITE meta-model for passenger transport. The latter results are only for trip distances up to 160 km. To produce forecasts for passenger transport for all distance bands, the meta-model needs to be combined with the SCENES model. Outputs for this combination are presented in chapter 9. All the results in the chapters 6-9 are for baseline situations, focussing on the impact of autonomous (non-policy) factors on transport. In chapter 10 are the outcomes of a large number of model runs for the impact of different policy instruments on freight transport and the evaluation outcomes for freight. This chapter also contains findings on sensitive and insensitive market segments and on policy bundles. Chapter 11 contains similar results for passenger transport. A summary and the conclusions from this study are given in chapter 12.

2 OVERVIEW OF THE EXPEDITE APPROACH

2.1 The general approach

The methodology which has been developed to deliver forecasts in EXPEDITE for transport demand, in Europe at the zonal level, is as follows. The EXPEDITE forecasts exploit existing international and national transport models. For predictions focussing on long-distance, inter-zonal transport EXPEDITE uses outcomes of runs with one or more European transport models, in particular new runs with the SCENES European model (see SCENES consortium, 2001).

The EXPEDITE meta-model for freight is based on runs with four national freight transport models available within EXPEDITE, runs with the SCENES model, and runs with the NEAC model (see Chen and Tardieu, 2000).

For forecasts focussing on passenger transport with trip distances up to 160 km, EXPEDITE has developed the EXPEDITE meta-model for passenger transport, based on the outcomes of runs with five national passenger transport models, taken to represent behaviour of travellers. In EXPEDITE the results of these runs of the underlying models are transferred to other zones in Europe, corrected for specific factors such as may arise from specific geographical differences. Results of the meta-model for a specific zone are obtained by scaling results for a prototypical area to match known totals (e.g. from transport statistics, sector statistics, etc). For a large number of segments within a zone, the meta-model produces a levels matrix (distribution of tours and passenger-kilometres by mode and distance class) and switching matrices for different policy measures. For each zone, expansion factors were calculated depending on the importance of the segments in the zone (many of these weights could be zero for a specific zone). Within any of the five existing national passenger transport models, simulations were carried out concerning the impact on transport demand of differences in the distribution of the population, employment, incomes, densities, both by looking at the existing inputs for the country and by making the inputs represent other areas. The outcomes of these simulations are used in the meta-model.

The meta-models for freight and passengers have been used, together with the SCENES model,

- to simulate the Reference Scenario;
- to simulate the impact of a large number of policy measures;
- to identify policy-sensitive and non-sensitive market segments;
- to reach statements about feasible and efficient bundles of policy measures.

Policy evaluation modules, which use the policy impacts on travel demand from the meta-models as inputs, have been developed to give other impacts of the policy measures on society such as emissions, noise and accidents. The outcomes of these transport model runs and evaluation runs are also reported in this Final Report.

2.2 Models reviewed in EXPEDITE

EXPEDITE started with a review of transport models that exist in Europe. Part of the material for this review was obtained through THINK-UP workshops and seminars.

The review of transport forecasting systems in deliverable 2 contains the following models:

Passenger transport:

- European models:
  - TINA/VACLAV;
  - STREAMS/SCENES;

- International corridor models:
  - the Storebælt model;
  - the Fehmarnbelt traffic demand model;

- National models:
  - the Dutch national model system;
  - the Norwegian national model system;
  - the Italian decision support system;
  - the Danish national model;
  - the Swedish national model;
  - the Swiss national model;
  - the Austrian national model;
  - the German national model (for the Federal Transport Infrastructure Plan, BWVP);
  - the French MATISSE model.

Freight transport:

- European models:
  - STREAMS/SCENES;
  - NEAC;

- International corridor models:
  - the Storebælt model;
  - the Fehmarnbelt traffic demand model;

- National models:
  - the Norwegian national model system;
  - the Italian decision support system;
  - the Swedish national model;
  - the Belgian (Walloon Region) model;
  - the Dutch TEM model;
  - the Dutch SMILE model;
  - the Dutch MOBILEC model.

2.3 The EXPEDITE national models

Since the mid-1980's, a number of model systems have been developed in Europe, predicting future passenger transport at the national scale, using disaggregate, behavioural (based on the micro-economic concept of utility maximisation) model structures. Within the EXPEDITE consortium, five of these models are available. These are all the existing national models based on this methodology, as far as we are aware[1]. The five models are (in the order in which they were originally developed):

- the Dutch National Model System (NMS or LMS);
- the Norwegian National Model (NTM-4);
- the Italian National Model (SISD);
- the Danish National Model;
- the Swedish National Model (SAMPERS).

Within the EXPEDITE Consortium, there are four national models for freight transport:

- the Swedish model (SAMGODS);
- the Norwegian model (NEMO);
- the Belgian model (WFTM);
- the Italian model (SISD).

The first three freight transport models are all built up around a so-called network model (this is a model that searches for the modes and routes that minimize transport cost on the network) while the latter is based on discrete choice theory (explaining choices between alternatives such as modes on the basis of utility maximization), as the national models for passenger transport. The Italian model contains components for both passenger and freight transport.

2.4 The STREAMS/SCENES model and the NEAC model

2.4.1 The STREAMS/SCENES model

The STREAMS project, funded by European Commission (former DGVII) under the 4th Framework programme, provided a strategic level analysis of how European transport systems will cope with possible future levels of demand. It is a multi-modal, network-based transport model of the European Union, and can produce reference forecasts of transport in the EU in 2020.

The STREAMS model combines freight and passenger demand elements with a network representation and traffic assignment of all modes across the EU15. The following networks are represented:

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[1] National models based on different methodologies exist in for instance France, Germany, Hungary and Switzerland. Disaggregate, behavioural models have been developed for large regions within a country (e.g. Paris, Portland, Sydney) and have also been used for international corridors (e.g. Great Belt, Fehmarn Belt).

- for goods transport: road, rail, inland waterway, shipping, pipelines (for petroleum products) and inter-modal networks (ports, terminals, etc.);
- for passenger transport: road, rail and air.

In the SCENES project (5th Framework), carried out by the SCENES consortium headed by ME&P, the STREAMS Strategic Transport Model of the EU has been extended to Eastern Europe and enhanced. The passenger model of SCENES now not only has the NUTS2 zones of the EU15, but also zones in 8 CEEC as internal zones (Poland, Czech Republic, Slovak Republic, Hungary, Slovenia, Estonia, Latvia and Lithuania, CEEC8). In the freight model within SCENES, only EU15 zones are handled as internal zones; Eastern Europe forms a number of external zones (traffic between these external zones and internal zones is modelled, but not traffic within the external zones). SCENES has been re-calibrated to observed data on passenger and freight transport. The model has been linked to an appended module on freight to demonstrate how the SCENES model can take into account more detailed information from other models, for areas of specific policy interest (especially location of distribution centres and distribution patterns using such centres). The SCENES model is owned by the European Commission and has been run within the EXPEDITE project by the EXPEDITE consortium.

2.4.2 The NEAC model

In building the freight meta-model in EXPEDITE, outcomes from runs with the NEAC model have been used for 1995 and the 2020 reference for transports originating in Switzerland, Norway and the CEEC8. These countries are not included as internal zones in the SCENES freight model. The runs with the NEAC model were done by NEA on request of EXPEDITE, as part of the THINK-UP project.

2.5 The EXPEDITE meta-model for passenger transport

2.5.1 Introduction

A methodology has been developed for the EXPEDITE meta-models for passenger transport and freight transport and implemented as a PC-based software tool. These two EXPEDITE meta-models cover transport generated in the following countries (at the NUTS2 level):

- the EU15;
- Norway;
- Switzerland;
- Estonia;
- Latvia;
- Lithuania;
- Poland;
- Hungary;
- The Czech Republic;
- Slovakia;
- Slovenia.

The modes considered for passenger transport are:

- car driver;
- car passenger;
- train;
- bus/tram/metro;
- non-motorised modes.

Furthermore, several segments are distinguished (e.g. household car ownership, age, income class, travel purpose and area type).

The passenger meta-model can be used to predict the travel demand in terms of tours (tours are defined here as round trips that start and end at home) and passenger-kilometres by mode and distance band and segment generated in each of the NUTS2 zones of the countries mentioned above, for the base year 1995, the future reference year 2020 and several intermediate years. Moreover this model can be used to give the impact of many changes in policy variables, such as the travel time and cost of the different modes. The meta-model for passenger transport is based on a large number of runs carried out within the EXPEDITE project with the national models of Norway, Sweden, Denmark, The Netherlands and Italy. This model also includes area-wide speed-flow curves to take account of the feedback effect of changes in congestion due to policies that change the amount of car use.

2.5.2 Explanation of how the meta-model for passenger transport works for a hypothetical zone

The EXPEDITE meta-model has been developed because there is a need to explore a large number of policy options and the impacts on many segments of the transport markets in the European context. Running the SCENES model is cumbersome and time-consuming. Moreover, the SCENES model cannot provide all the segmentations and sensitivities that the EXPEDITE national models can provide, especially for short distance transport (more than 90% of all passenger transport is in trips below 30 km). On the other hand, the EXPEDITE national models also have long run times and do not cover all of the (future) European Union. The requirements for the EXPEDITE meta-model therefore were that it would run quickly and extend the available national models to cover the whole (future) EU. In this extension it is not of vital importance that models for all countries in the EU are included, but that the most relevant segments of the local travelling population in the EU are included in the models used and expanded properly, and that the outcomes are calibrated to observed base-year distributions for transport in the respective zones.

Initial calculation for 1995

Let us assume that one of the zones in the EXPEDITE study area is called ‘Brussels’. This is a hypothetical zone that does not correspond to any zone that may exist in reality. In 1995 it had a population of 2 mln, of which 80% in car-owning households and 20% in non-car-owning households. To simplify this presentation, we only use a two-category segmentation by household car ownership. The full meta-model for passenger transport uses a segmentation by:

- travel purpose:
  - commuting;
  - business travel;
  - education;
  - shopping;
  - other purposes,

- age:
  - under 18;
  - 18-65;
  - 65 and older,

- gender:
  - male;
  - female,

- occupation:
  - employed;
  - not employed,

- household size:
  - one-person household;
  - two-persons household;
  - three-persons household;
  - four-or-more-persons household,

- household income class:
  - net annual income below 11300 Euros;
  - net annual income 11300-18200 Euros;
  - net annual income 18200-29500 Euros;
  - net annual income 29500-38600 Euros;
  - net annual income above 38600 Euros,

- and car ownership (four categories):
  - person in a household without a car;
  - person without a driving licence in a household with a car;
  - person with a driving licence in a household that has more driving licences than cars (car competition in household);
  - persons with a driving licence in a household that has at least as many cars as licences (car freely available).

Furthermore, the full meta-model for passenger transport distinguishes between area types and road and rail network types by applying multiplicative factors for this (see section 2.5.3).

From the runs with the five national models, we have a levels matrix for each of the segments distinguished. This levels matrix T_{mdp} gives the number of tours (round trips) by mode m and distance class d, for a segment or 'primitive' p, for all m, d and p; m=1, … M; d=1, … D and P=1, … P. The results of the five national models were averaged (unweighted average) to obtain the levels matrices.

For persons in car-owning households, $T_{md,p=carown}$ from the national models might be as follows (this is a hypothetical example):

Table 1. Number of tours per person per year from national model runs, car-owning households

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	10	30	50	60	50	30	20	250
car-passenger	0	15	25	35	25	20	5	125
train	0	0	2	3	5	5	5	20
BTM	4	5	5	5	5	4	2	30
non-motorised	60	120	70	50	0	0	0	300
Total	74	170	152	153	85	59	32	725

BTM in this table stands for bus/tram/metro. The distance classes refer to one-way (trip) distance. Long distance interzonal trips will come from the SCENES model.

For persons in non-car-owning-households, the national models might have resulted in $T_{md,p=nocar}$ (hypothetical example):

Table 2. Number of tours per person per year from national model runs, non-car-owning households

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0	0	0	0	0	0	0	0
car-passenger	2	3	5	8	7	3	2	30
train	0	0	5	10	12	8	5	40
BTM	5	8	8	10	8	6	5	50
non-motorised	90	150	95	60	5	0	0	400
Total	97	161	113	88	32	17	12	520

The number of tours that the meta-model initially predicts for 'Brussels' in 1995 is given by:

$$T^{0,95}_{md,i=brussels} = \Sigma_p \, w^{95}_{p,i=brussels} \, T_{mdp} \, POP^{95}_{i=brussels95}$$

In which:
w^{95}_{pi}: fraction of zone i belonging to primitive p in 1995
POP^{95}_{i}: population of zone i in 1995.

For Brussels this means taking 80% of the cell values from Table 1 and adding this to 20% of the corresponding cell values from Table 2. After this, all cell values are multiplied by 2 mln. For Brussels this gives the following table.

Table 3. Number of tours (x 1000) in 1995 for 'Brussels', initial forecast of meta-model

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
Car-driver	16000	48000	80000	96000	80000	48000	32000	400000
Car-passenger	800	25200	42000	59200	42800	33200	8800	212000
Train	0	0	5200	8800	12800	11200	10000	48000
BTM	8400	11200	11200	12000	11200	8800	5200	68000
non-motorised	132000	252000	150000	104000	2000	0	0	640000
Total	157200	336400	288400	280000	148800	101200	56000	1368000

The meta-model calculates the tours for the other NUTS2 zones similarly. Differences between zones are represented by differences in the population and in the relative importance of the segments.

The total number of passenger-kilometres in 1995 in ‘Brussels’ can be calculated along similar lines: the national models give a table of kilometres per person per year, by mode and distance class, for each segment (in this simplified example for car-owning and non-car-owning households). By multiplying by the population and applying the weights of the segments for a specific zone, an initial forecast for the zone is terms of passenger kilometres K in 1995 is derived:

$$K^{0,95}_{md,i=brussels} = \Sigma_p\, w^{95}_{p,i=brussels}\, T_{mdp}\, POP^{95}_{i=brussels}$$

The resulting initial forecast for the number of kilometres in ’Brussels’ is given in Table 4.

Table 4. Number of passenger-kilometres (x 1000) in 1995 for ‘Brussels’, initial forecast of meta-model

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	35200	248160	976800	2523840	4919200	6330720	8448000	23481920
car-passenger	1760	130284	512820	1556368	2631772	4378748	2323200	11534952
Train	0	0	63492	231352	787072	1477168	2640000	5199084
BTM	18480	57904	136752	315480	688688	1160632	1372800	3750736
Non-motorised	290400	1302840	1831500	2734160	122980	0	0	6281880
Total	345840	1739188	3521364	7361200	9149712	13347268	14784000	50248572

After the expansion of the tour and passenger kilometrage rates to the zone(s) under investigation, using the information on size and composition of the zonal population, has been carried out, the EXPEDITE meta-model performs a number of corrections for the area type composition of the zone(s), and the road and rail network type of the zone(s). This is worked out in section 2.5.3 and done before the scaling described below.

Scaling and final calculation for 1995

Suppose now that we also have available information from the national travel survey of ‘Eurostan’, the hypothetical country to which ‘Brussels’ belongs, for passenger-kilometres by mode and distance class in ‘Brussels’ in 1995. We can now compare the initial meta-model prediction, as in Table 4 with the observed data, in terms of modal split and distance band distribution. We can also derive scaling factors to scale the initial forecasts as follows.

Minimise the ‘distance’ between the observed levels matrix for zone i in 1995 $K^{obs,95}_{i}$ and the synthetic initial levels matrix from the meta-model:

$$\text{Min} \;||\; K^{obs,95}_{i} - F_{mi}\, K^{0,95}_{mdi}\, F_{di} \;||$$

In which:

F_{mi}: an MxM diagonal matrix with (initially unknown) mode-specific scaling factors for zone i

F_{di}: an DxD diagonal matrix with (initially unknown) distance band scaling factors for zone i.

This means that every cell in the synthetic levels matrix gets two scaling factors, one for the mode to which it belongs and one for the distance band it is part of.

For many countries, the determination of these scaling factors can probably not be done for each zone (NUTS-2 zones in EXPEDITE) in the country, but the initial forecasts for the zones will first have to be added to produce an initial total forecast for the country, which can be compared to the observed base-year data. The scaling factors will then be country-specific, but apply to each zone.

To continue the worked-out hypothetical example, suppose that we only have the observed 1995 mode split for 'Brussels'. The scaling factors are in Table 5. Application of these scaling factors to the 1995 initial kilometres forecast of Table 4 gives the meta-model forecast $K^{1,95}_{md,i=brussels}$ (no longer initial) for 'Brussels' for 1995.

$$K^{1,95}_{md,i=brussels} = F_{m,i=brussels} K^{0,95}_{md,i=brussels}$$

The outcomes of this are in Table 6.

Table 5. Comparison of initial meta-model forecast and observed data for 1995 for 'Brussels' (passenger-kilometres, x 1000)

Mode	Meta-model	Observed	Scaling factor
car-driver	23481920	22000000	0.937
car-passenger	11534952	12100000	1.049
Train	5199084	4400000	0.846
BTM	3750736	4800000	1.280
Non-motorised	6281880	5500000	0.876
Total	50248572	48800000	0.971

Table 6. Number of passenger-kilometres (x 1000) in 1995 for 'Brussels', forecast of meta-model

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	32979	232499	915155	2364563	4608754	5931195	7914855	22000000
car-passenger	1846	136666	537941	1632608	2760691	4593244	2437004	12100000
Train	0	0	53733	195794	666101	1250132	2234240	4400000
BTM	23650	74103	175008	403735	881348	1485317	1756839	4800000
non-motorised	254255	1140681	1603541	2393850	107673	0	0	5500000
Total	335870	1689050	3419850	7148990	8885943	12962491	14357805	48800000

Calculation for 2020 (reference scenario)

According to the reference scenario data, in 2020, 'Brussels' will have 2.1 mln inhabitants, of which 90% in car-owning and 10% in non-car-owning households. Application of this new population, these new shares for the two segments and the scaling factors derived for 1995 gives the following meta-model prediction for kilometres in 2020 for the reference scenario for 'Brussels, $K^{1,20}_{md,i=brussels}$. The same 1995 scaling factors are used in forecasting for future years.

$K^{1,20}_{md,i=brussels} = F_{m,i=brussels} \Sigma_p w^{20}_{p,i=brussels} K_{mdp} POP^{20}_{i=brussels}$

Table 7. Number of passenger-kilometres (x 1000) in 2020 under the reference scenario for 'Brussels', forecast of meta-model

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	38956	274639	1081027	2793140	5444091	7006224	9349423	25987500
car-passenger	969	157166	618632	1870605	3142544	5316818	2733321	13840055
Train	0	0	49910	172877	622909	1242318	2345952	4433966
BTM	24241	73639	173914	388595	875839	1488693	1631833	4656756
non-motorised	254833	1169198	1627594	2465205	56528	0	0	5573358
Total	342344	1782993	3687959	7854953	9994894	14740351	16152531	54556025

Calculating the impact of an increase of the car running cost by 25%

The impact of a policy measure will be given by the meta-model in the following way. For many changes in policy variables, we have done runs with the national models to obtain switching matrices (also called change matrices). For instance the switching matrices D^1_{mdp} (by segment) for a 25% increase in the running cost of the car in number of tours are as follows:

Table 8. Change in number of tours per person per year from national model runs, car-owning households, car running cost +25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	-1	-2	-5	-7	-7	-5	-3	-30
car-passenger	0	1	2	3	2	1	1	10
Train	0	0	1	1	2	1	0	5
BTM	1	1	1	1	1	0	0	5
non-motorised	2	3	3	2	0	0	0	10
Total	2	3	2	0	-2	-3	-2	0

Table 9. Change in number of tours per person per year from national model runs, non-car-owning households, car running cost +25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0	0	0	0	0	0	0	0
car-passenger	0	0	0	0	0	0	0	0
Train	0	0	0	0	0	0	0	0
BTM	0	0	0	0	0	0	0	0
non-motorised	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0

For kilometres, we have similar change matrices C^1_{mdp}, derived directly from the national models. The superscript 1 indicates policy measure 1 (the 25% increase in car running cost). By applying the population of Brussels in 1995 and the 1995 weights of the segments we get the following changes for 1995 in terms of kilometres.

Table 10. Change in number of kilometres in 1995 for 'Brussels' from meta-model, car running cost +25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	-2200	-10340	-61050	-184030	-430430	-659450	-792000	-2139500
car-passenger	0	5170	24420	78870	122980	131890	264000	627330
Train	0	0	12210	26290	122980	131890	0	293370
BTM	2200	5170	12210	26290	61490	0	0	107360
non-motorised	4400	15510	36630	52580	0	0	0	109120
Total	4400	15510	24420	0	-122980	-395670	-528000	-1002320

The total number of kilometres in 1995 in 'Brussels' after a 25% in the running cost (policy measure 1, indicated with a 1 in the third superscript of K) is calculated as:

$$K^{1,95,1}{}_{md,i=brussels} = F_{m,i=brussels}\ \Sigma_p\ w^{95}{}_{p,i=brussels}\,(K_{mdp} + C^{1}{}_{mdp})\ \ POP^{95}{}_{i=brussels}$$

Table 11. Number of passenger-kilometres (x 1000) in 1995 for 'Brussels', forecast of meta-model, car running cost +25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	30917	222811	857958	2192147	4205488	5313362	7172838	19995522
car-passenger	1846	142089	563557	1715341	2889696	4731595	2713936	12758060
Train	0	0	64067	218043	770180	1361750	2234240	4648280
BTM	26465	80719	190634	437380	960039	1485317	1756839	4937394
non-motorised	258107	1154260	1635611	2439886	107673	0	0	5595538
Total	340143	1704113	3443566	7148990	8766508	12578228	13845026	47826575

Similarly, the number of kilometres in 2020 for 'Brussels' for the reference scenario with the additional policy measure 1 is:

$$K^{1,20,1}{}_{md,i=brussels} = F_{m,i=brussels}\ \Sigma_p\ w^{20}{}_{p,i=brussels}\,(K_{mdp} + C^{1}{}_{mdp})\ POP^{20}{}_{i=brussels}$$

This can be found in Table 12.

Table 12. Number of passenger-kilometres (x 1000) in 2020 for 'Brussels', forecast of meta-model, reference scenario and car running cost +25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	36895	264952	1023830	2620724	5040825	6388391	8607405	23983022
car-passenger	969	162589	644248	1953338	3271548	5455169	3010253	14498115
Train	0	0	60243	195126	726987	1353937	2345952	4682246
BTM	27056	80256	189540	422240	954531	1488693	1631833	4794150
non-motorised	258685	1182777	1659665	2511241	56528	0	0	5668897
Total	346617	1798055	3711675	7854953	9875460	14356087	15639752	53582600

Calculating the impact of other policy measures

For some other percentage changes in the car running cost (+10%, +40%, -10%, -30%), national model runs have also been carried out in EXPEDITE and switching matrices have been derived for these changes. For instance for a 10% increase in the car running cost, the effects on the car-owning households might be as follows (again the non-car-owning households are not affected).

Table 13. Change in number of tours per person per year from national model runs, car-owning households, car running cost +10%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0	-1	-2	-3	-4	-3	-1	-14
car-passenger	0	1	1	1	1	0	0	4
Train	0	0	0	1	1	1	0	3
BTM	0	1	1	1	0	0	0	3
non-motorised	0	1	2	1	0	0	0	4
Total	0	2	2	1	-2	-2	-1	0

This switching matrix can be applied in the same way as described above for a 25% increase in the car running cost.

For a change in the car running cost for which the national models have not been run (e.g. +20%), we could have derived the switching matrices by linear interpolation between the matrices of a 10% change and a 25% change. This would amount to assuming a piece-wise linear response to cost changes. However, in the meta-model we try to account for the non-linearities in the response to policy changes by going back to the original logit formulation, as used in the national models. This method is described below in the sub-section on the calculation of the impact of policy bundles, but we also use it for changes in individual policy measures by some % that is not covered by the national model runs (within a pre-specified interval of possible policy changes to a variable).

Calculating the impact of policy bundles

A policy bundle is a combination of individual policy measures (e.g. increase in car cost and decrease in public transport cost). A limited number of policy bundles have been tested in the national models, and change matrices for these bundles are directly available for use in the meta-model. For all other policy bundles, the meta-model calculates the effects of the combination of policy measures from the results of individual policy measures, taking account of non-linear effects in the following way.

- sub-additivity: the combined effect is less than the sum of the separate effects
- super-additivity: the combined effect is more than the sum of the separate effects.

The method used can lead to both types of effects, depending on the location on the logit curve. As an example we study the combined effect of an increase in the car running cost of 25% and a decrease in the train and bus/tram/metro cost by 25%.

The change matrix for the first policy measure has been given above. For the latter policy measure, we assume that the national model runs have produced the following two change matrices.

Table 14. Change in number of tours per person per year from national model runs, car-owning households, train and bus/tram/metro fares -25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	-1	-1	-2	-2	-2	-1	-1	-10
car-passenger	0	-1	-1	-1	-1	0	0	-4
Train	0	0	2	3	3	2	2	12
BTM	2	3	3	1	2	1	0	12
non-motorised	-3	-2	-3	-2	0	0	0	-10
Total	-2	-1	-1	-1	2	2	1	0

Table 15. Change in number of tours per person per year from national model runs, non-car-owning households, train and bus/tram/metro fares -25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0	0	0	0	0	0	0	0
car-passenger	0	-1	-1	-1	-1	0	0	-4
Train	0	0	2	3	2	1	1	9
BTM	2	3	3	1	1	1	0	11
non-motorised	-4	-3	-5	-4	0	0	0	-16
Total	-2	-1	-1	-1	2	2	1	0

We now calculate probability matrices P_{mdp} (by dividing all numbers in the levels matrix of a segment by the total in the bottom-right cell) for:

- the levels matrices T_{mdp};
- the levels matrices with policy 1: $T_{mdp} + D^1_{mdp}$;
- the levels matrices with policy 2: $T_{mdp} + D^2_{mdp}$.

We further assume that:

- the non-linearities in the responses of the meta-model to policy measures are due to the logit nature of the underlying utility-based models;
- the average utility of the shortest distance band for the non-motorised modes will remain unchanged in any forecast scenario (for standardisation).

Now the average utilities (standardised by the utility of the shortest distance band for the non-motorised modes) can be calculated from the probability matrices as follows.

The general formula for the multinomial logit model is:

$$P_{mdp} = \frac{e^{U_{mdp}}}{\sum e^{U_{mdp}}}$$

Therefore:

$$\ln(P_{mdp}) = U_{mdp} - \ln(\sum e^{U_{mdp}})$$

and:

$$U_{mdp} = \ln(P) + \ln(\sum e^{U_{mdp}})$$

The same can be done for the average utility of the shortest distance band for the non-motorised mode. The standardised utility for mode m, distance class d and primitive p then becomes:

Standardised $U_{mdp} = \ln(P_{mdp}) - \ln(P_{m=non\text{-}motorised,d=shortest,p})$

We calculate these average utility matrices for each of the three situations (base, base with policy 1, base with policy 2). Then to obtain the utility matrix of the policy bundle 1&2, we add the utility of the base, the utility change of policy 1 and the utility change of policy 2. After that we standardise the outcome by using the utility of the shortest distance band for non-motorised as the base. The results is transformed to probabilities (by exponentiation). The resulting probability matrices for the base with the policy bundle 1&2 are below.

Table 16. Probability matrix for tours per person per year from national model runs, car-owning households, car cost +25% and train and bus/tram/metro fares -25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0.011172	0.037333	0.059586	0.070666	0.056938	0.033333	0.022276	0.29131
car-passenger	0.0001	0.020598	0.035752	0.050916	0.035752	0.028966	0.008276	0.180248
Train	0.0001	0.0001	0.008276	0.011034	0.015448	0.011586	0.009655	0.055172
BTM	0.010345	0.013241	0.013241	0.009931	0.011586	0.006897	0.002759	0.067586
non-motorised	0.081241	0.166828	0.096374	0.068855	0.0001	0.0001	0.0001	0.413333
Total	0.101994	0.237217	0.211016	0.209655	0.117176	0.07986	0.042672	1

Table 17. Probability matrix for tours per person per year from national model runs, non-car-owning households, car cost +25% and train and bus/tram/metro fares -25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
car-passenger	0.003846	0.003846	0.007692	0.013462	0.011538	0.005769	0.003846	0.05
Train	0.0001	0.0001	0.013462	0.025	0.026923	0.017308	0.011538	0.094231
BTM	0.013462	0.021154	0.021154	0.021154	0.017308	0.013462	0.009615	0.117308
non-motorised	0.165385	0.282692	0.173077	0.107692	0.009615	0.0001	0.0001	0.738462
Total	0.182692	0.307692	0.215385	0.167308	0.065385	0.036538	0.025	1

Using the original (hypothetical) number of tours per person per year from the national model runs (725 for the car-owning segment and 520 for the non-car owning segment, see Table 1 and 2), these probabilities can be converted to numbers of tours per person per year. After subtracting the original levels matrices, we obtain the change matrices for policy 1&2:

Table 18. Change in number of tours per person per year from national model runs, car-owning households, car cost +25% and train and bus/tram/metro fares -25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	-2	-3	-7	-9	-9	-6	-4	-39
car-passenger	0	0	1	2	1	1	1	6
Train	0	0	4	5	6	3	2	20
BTM	4	5	5	2	3	1	0	19
non-motorised	-1	1	0	0	0	0	0	0
Total	0	2	1	-1	0	-1	-1	0

Table 19. Change in number of tours per person per year from meta-model, non-car-owning households, car cost +25% and train and bus/tram/metro fares -25%

Mode\distance	0-1.5	1.6-3.1	3.2-7.9	8.0-15.9	16-39.9	40-79.9	80+	Total
car-driver	0	0	0	0	0	0	0	0
car-passenger	0	-1	-1	-1	-1	0	0	-4
Train	0	0	2	3	2	1	1	9
BTM	2	3	3	1	1	1	0	11
non-motorised	-4	-3	-5	-4	0	0	0	-16
Total	-2	-1	-1	-1	2	2	1	0

The change matrix we get for the non-car-owning households is the same as we had for policy measure 2 only, because policy measure 1 did not affect the non-car-owning households.

These change matrices for a policy bundle can then further be processed in the meta-model, just as the individual policy measures.

All kinds of policy actions can be translated in terms of policy measures or bundles which can be simulated in the meta-model. Since the meta-model is a fast-running model (which is due for a large part to the fact that it is not a network model), many policy actions can be tested.

This procedure of expansion of tour and kilometrage rates, using the (expected) population distribution for each NUTS2 zone, takes account of many socio-demographic and economic impacts, but the effect of area type, road and rail network type on transport are not taken into account in this procedure. Furthermore there are all kinds of 'residual' factors (including climate, hilliness and country-specific historic developments) that could influence the use of the various modes. The next section describes how these influences were taken into account in the meta-model, and also presents the treatment of congestion in the meta-model.

Output on consumer surplus: the logsum

The meta-model for passenger transport not only produces forecasts in terms of tours and kilometres by segment, but also a measure of consumer surplus, called the **logsum**. The logsum gives the expected utility to a traveller from a choice of mode and destination/distance band for a particular tour.

$$\text{Logsum} = \ln(\sum e^{U_{mdp}})$$

By summing over tours, the impact on consumer surplus of a segment of the population or the total population can be found. Policy measures can be evaluated by comparing the change in the logsum (the change in consumer surplus) relative to the reference case. This is not a complete evaluation of the impacts on society, but only the impacts on the travellers (including impact on travel time, cost and other attributes in the utility functions of the travellers). Not included in the logsum are impacts on producers, government and external effects. In the evaluations carried out in EXPEDITE, these changes are taken into account together with the logsum change.

2.5.3 Handling of area types, network types, residual factors and congestion in the EXPEDITE meta-model for passenger transport

The EXPEDITE area typology

Settlement patterns can cause great differences in travel behaviour. In the EXPEDITE area type classification we use information on population and population density, but also on distance to the big metropolitan centres. There are several theoretical fundamental principles of regional structure systems (e.g. of Lösch and Christaller). The theory of the central locations of Christaller is related to the three principles the supply/market principle, the traffic principle and the separation principle. Christaller classified a central city as a focus point of a region. The next classification step he defined, were surrounding towns on a circle around a central city. We used the same basic ideas, but there are a few differences between Christaller and our classification system. Christaller´s theory is made for towns not for regions. He analysed the south of Germany and not the whole of Europe (Christaller, 1969). The data he used for his theory is not available for all of Europe.

We used the following idea for our classification. First we searched for a classification of the metropolitan areas (Paris, London, Rome...) or huge agglomerations (Greater Manchester, Ruhrgebiet) based on population density and the total number of inhabitants. After this we made a classification for big towns (Marseilles, Frankfurt, Zurich) or smaller agglomerations (Rhône-area with Lyon) based on density, total inhabitants and distance to the next metropolitan area. Then we tried to identify suburban areas around these two classifications (Agglomeration Haarlem, Oberhausen, Halle-Vilvoorde) based on density, total inhabitants and distance to the next agglomeration. The remaining NUTS3 zones we classified into three segmentation areas (medium population density area, low population density area and very low population density area), based on population density.

On the next page the classification system is described. The Figures 1 and 2 show the classification for NUTS3 zones of Europe. (There are no possibilities of gaps in the classification because Area Type 1 has stricter requirements than Area Type 2, ...).

This classification of area types, using NUTS3 population density, but also population size and proximity to large centres, was chosen for the EXPEDITE meta-model for passenger transport. The meta-model itself operates at the NUTS2 level. For application in the meta-model, the percentage of the population of the NUTS2 zone in each of the seven area types at the NUTS3 level was calculated.

EXPEDITE area type classification-system: Inhabitants [1.000 persons]; Density [persons/square kilometre]

- Area Type 1 (red): Very densely populated area

  (INHABITANTS >= 350 and DENSITY >= 2.000 and next to another area type 1)

  or (INHABITANTS >= 750 and DENSITY >= 2.000)

  or (INHABITANTS >= 1.000 and DENSITY >= 1.000)

  or (INHABITANTS >= 3.000 and DENSITY >= 600)

- Area Type 2 (blue): densely populated area

  (Distance to area of type 1 >= 50 km) and

  ((INHABITANTS >= 100 and DENSITY >= 1.500) or

  (INHABITANTS >= 250 and DENSITY >= 1.000) or

  (INHABITANTS >= 500 and DENSITY >= 800) or

  (INHABITANTS >= 750 and DENSITY >= 600) or

  (INHABITANTS >= 1.000 and DENSITY >= 250))

- Area Type 3 (orange): densely populated area next to very densely populated area

  (Distance to area of type 1 < 40 km) and

  ((INHABITANTS >= 1 and DENSITY >= 500) or

  (INHABITANTS >= 250 and DENSITY >= 400) or

  (INHABITANTS >= 500 and DENSITY >= 300) or

  (INHABITANTS >= 750 and DENSITY >= 200) or

  (INHABITANTS >= 1.000 and DENSITY >= 200))

- Area Type 4 (light blue): Very densely populated area next to densely populated area

  DENSITY >= 200 and distance to area of type 1 < 20 km

- Area Type 5 (violet): medium population density area

  DENSITY >= 150

- Area Type 6 (green): low population density area

  DENSITY >= 50

- Area Type 7 (yellow): Very low population density area

  DENSITY > 0.

Correction factors based on area type

In the meta-model, travel behaviour in passenger transport differs between the seven area types in the following way. The differences between socio-economic and demographic population groups follow from the runs with the five EXPEDITE national passenger transport models, as implemented in the meta-model, using expansion factors for each NUTS2 zone. Furthermore, these tour and kilometrage rates (per person per year) are post-processed using multiplicative factors to account for differences in travel behaviour between area types.

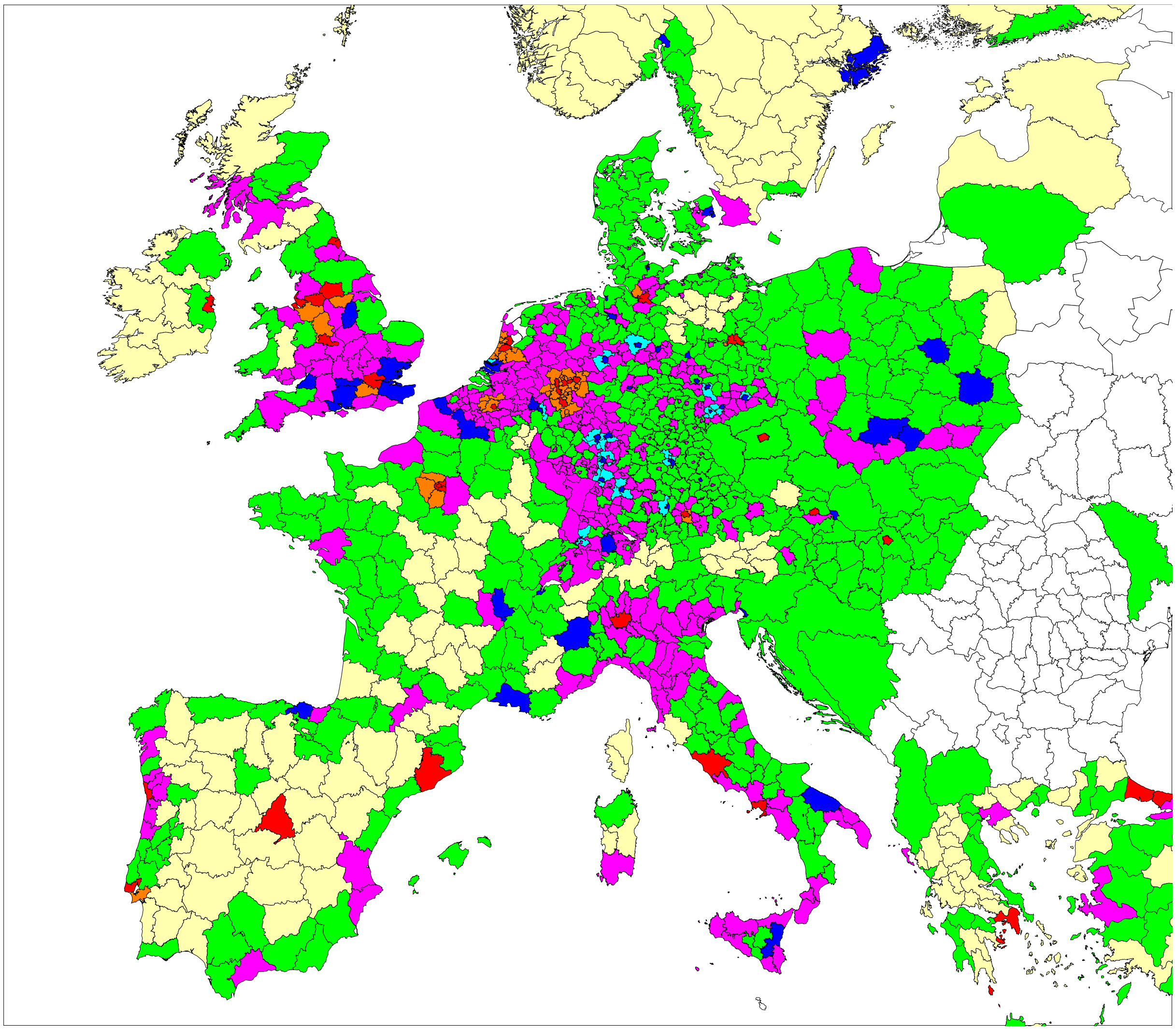


Figure 1. Europe (colours explained on page 19)

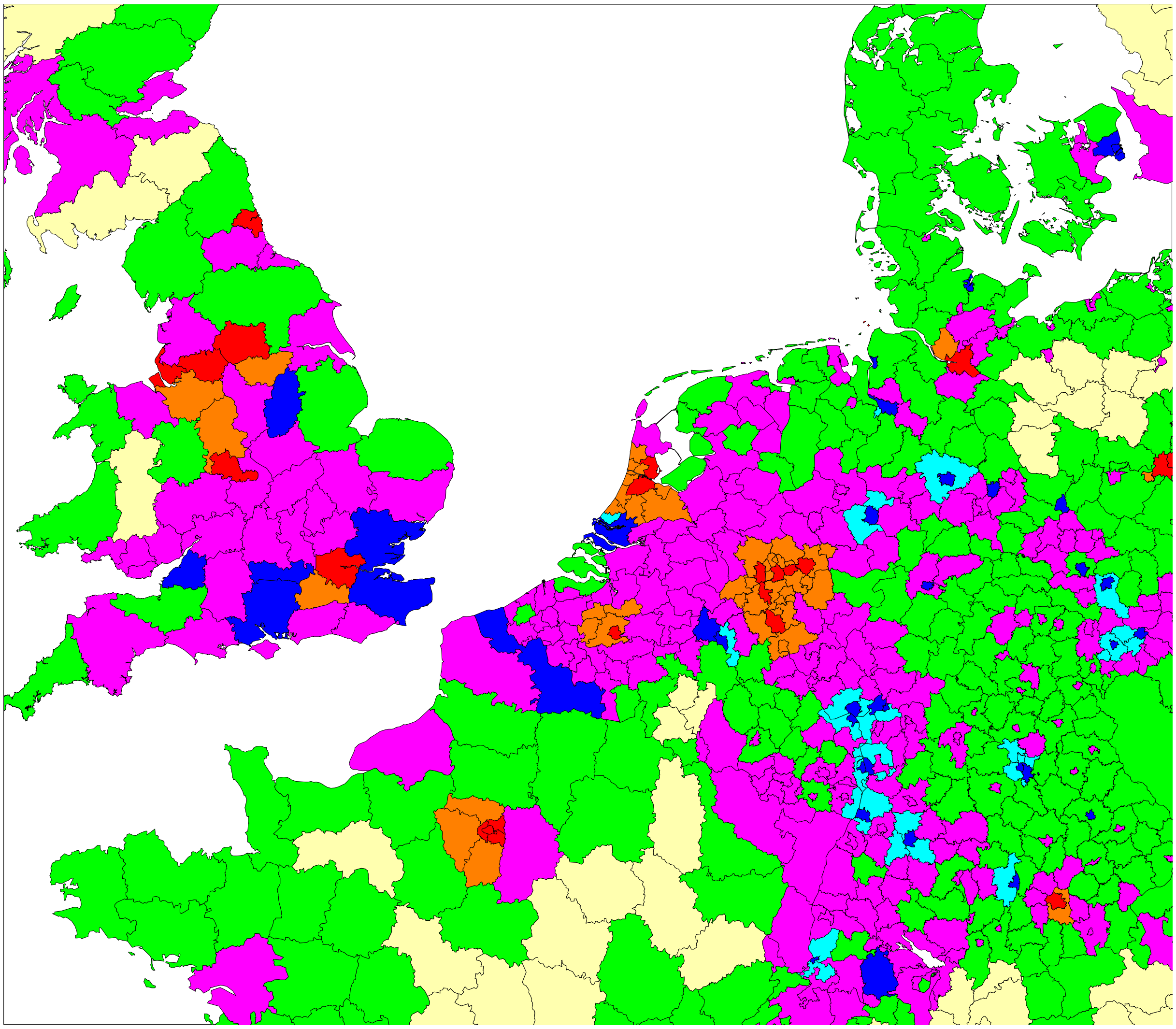


Figure 2. Central Europe (colours explained on page 19)

For area type we use the following multiplicative factors:

Table 20. Area type factors for tours per person per year in the meta-model

Area type	Car (driver and passenger)	Bus/tram/ metro	Non-motorised	Train
1 (metropolitan)	0.75	1.17	1.72	1.61
2 (urban)	0.89	1.25	1.07	1.01
3 (around 1)	0.97	0.97	1.02	1.22
4 (around 2)	0.99	1.00	1.00	1.01
5 (medium density)	1.06	0.94	0.97	0.90
6 (low density)	1.10	0.90	0.95	0.85
7 (very low density)	1.15	0.85	0.90	0.80

Table 21. Area type factors for kilometres per person per year in the meta-model

Area type	Car (driver and passenger)	Bus/tram/ metro	Non-motorised	Train
1 (metropolitan)	0.75	1.17	1.72	1.61
2 (urban)	0.78	1.07	0.99	0.88
3 (around 1)	0.96	0.93	0.91	0.99
4 (around 2)	1.00	0.96	1.02	0.96
5 (medium density)	1.00	0.96	1.02	0.96
6 (low density)	1.12	0.93	0.95	0.90
7 (very low density)	1.18	0.90	0.93	0.85

The factors for the area types 2, 3, 4 and 5 are based on runs done with the Dutch National Model System. The rates for area type 1 are based on runs with the ANTONIN model for the Paris region. For the area types 6 and 7 the rates were derived from extrapolation from the other rates and by the condition that the total mobility after taking into account the area types should be the same as before applying these factors. The differences between the modes were broadly confirmed by a specific analysis within EXPEDITE on the mobility behaviour within rural regions in Europe.

Area types 1-4, and especially the metropolitan areas, have fewer than average car tours per person. The more metropolitan areas have more than average non-motorised, bus/tram/metro and train tours. The areas with lower density have proportionally more car tours and fewer tours with the other modes. In the effects on kilometrage, some differences between area types are mitigated (or strengthened) because of the larger average tour distances in the non-urban areas.

Correction factors based on road network density

For road network density categories we use in the meta-model a classification based on the weighted road lengths divided by area size from the SCENES network data. This classification was done for the NUTS2 zones, and in the expansion is applied directly at the NUTS2 level. The road network density classification is depicted in Figure 3.

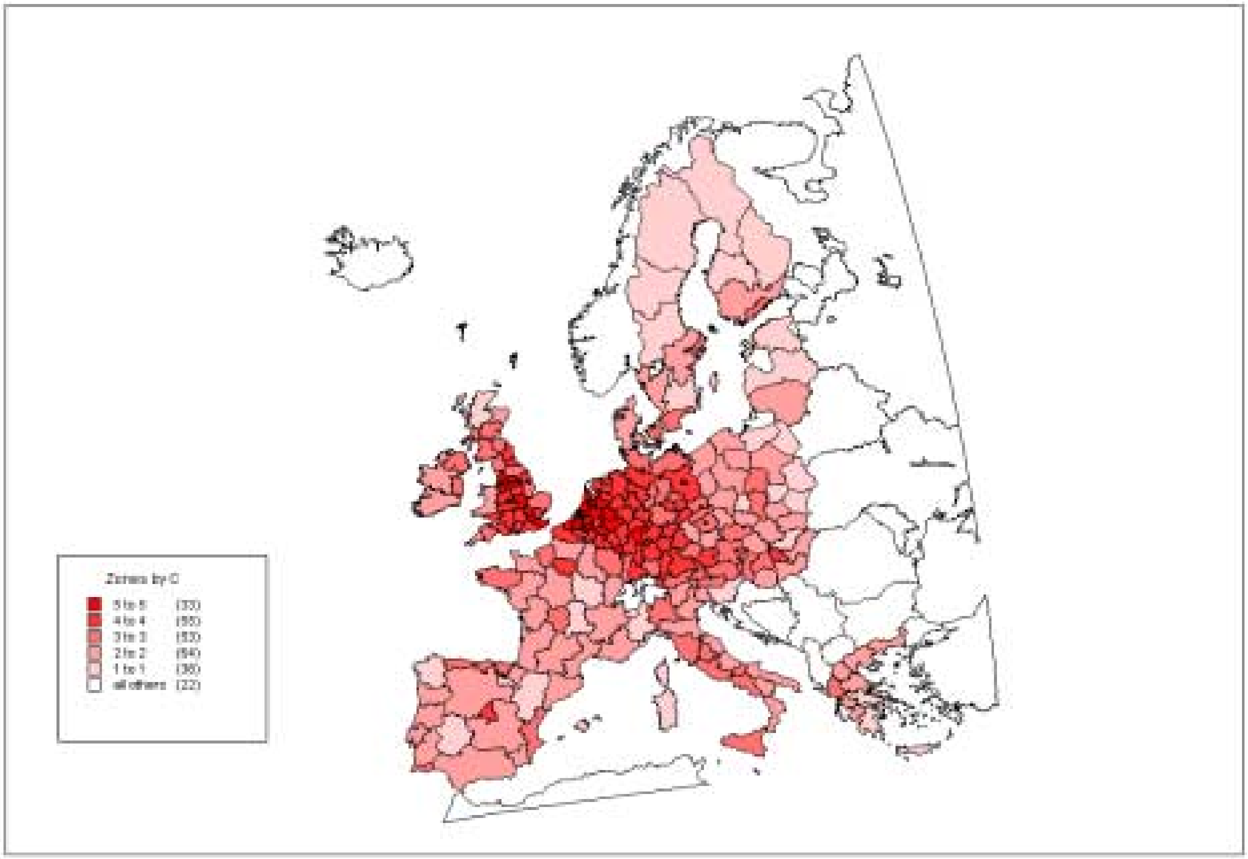
The formula used here is:

Weighted road network density = 3*Motorway length in km/area in km^2
+ 2*dual carriageway length in km/ area in km^2
+ length of other roads in km/area in km^2.

In Figure 3 we use the following classification for road network density.

Category	value
1	< 0.05
2	0.05 – 0.1
3	0.1 – 0.2
4	0.2 – 0.5
5	> 0.5

Figure 3. Road network density categorisation used in the meta-model



The differences in mobility behaviour between the network density categories are based on an analysis of the SCENES outcomes for 1995 by network density category for the EU15 and CEEC8. An analysis on the five countries with EXPEDITE national models was not chosen here, because there is only limited variation in road network density categories within each of those countries. The multiplicative factors used in the meta-model are in Table 22.

Table 22. Road network density factors in the meta-model

Network density category	Factor for car driver and passenger	
	Tours	Kilometres
1 (lowest density)	0.68	0.55
2	0.83	0.69
3	1.02	1.01
4	1.08	1.16
5 (highest density)	1.05	1.09

The higher the road density, the higher the number of car tours and kilometres per person.

Correction factors based on rail network density

For rail too, the classification used in the meta-model is based on the SCENES networks. Rail length is divided by area size at the NUTS2 level. The expansion in the meta-model is done at this level. In Figure 4 is the rail network density classification by NUTS2 zone.

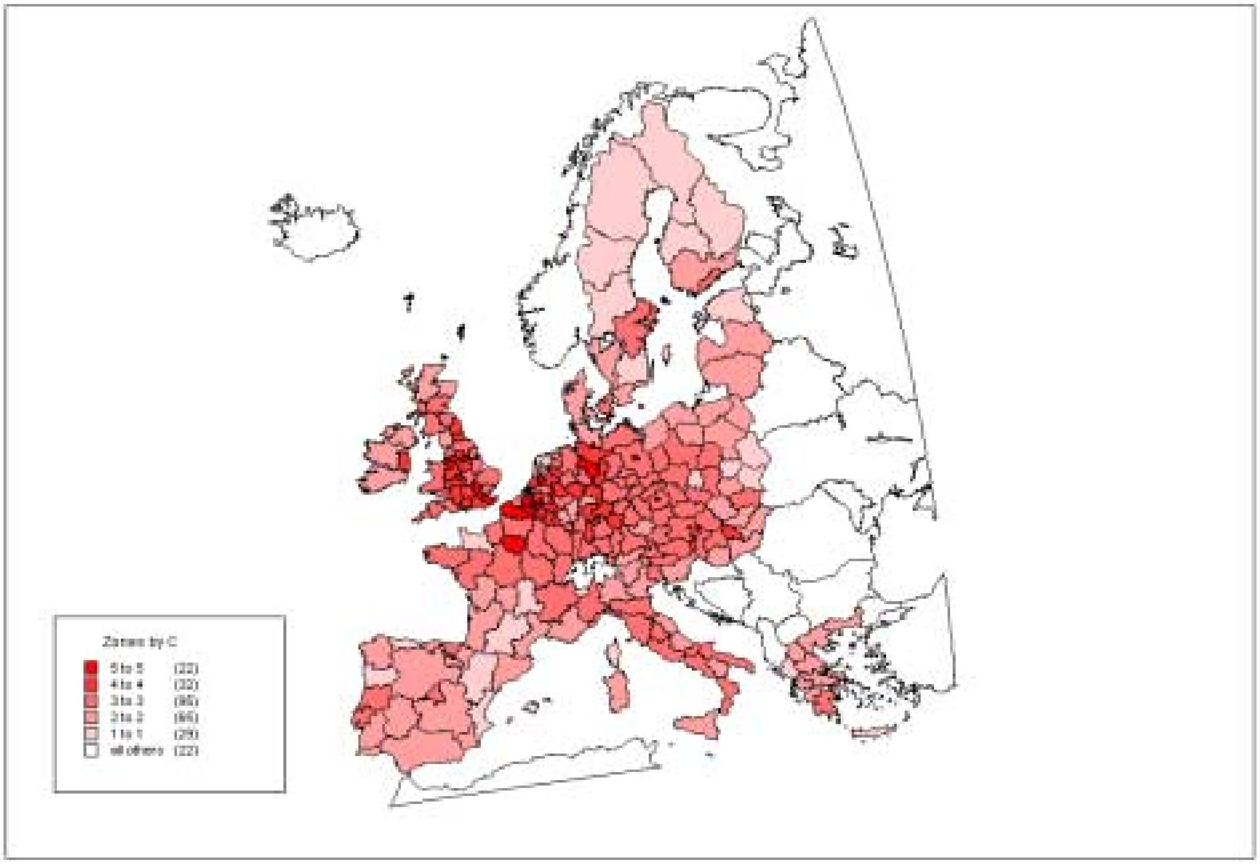
The formula used for rail network density is:

Weighted rail network density = 2*length of high-speed rail network in km/area in km^2 + length of conventional rail network in km/area in km^2.

The categories in Figure 4 are defined on this measure:

Category	value
1	< 0.025
2	0.025 – 0.05
3	0.05 – 0.1
4	0.1 – 0.15
5	> 0.15

Figure 4. Rail network density categorisation used in the meta-model.



The factors used for the differences in mobility between the rail network categories are based on an analysis of the SCENES model results for 1995. These multiplicative factors are given in Table 23.

Table 23. Rail network density factors in the meta-model

Network density category	Factor for train passenger	
	Tours	Kilometres
1 (lowest density)	0.32	0.41
2	0.62	0.67
3	1.08	1.12
4	1.42	1.11
5 (highest density)	1.58	1.60

The use of rail sharply rises with increasing rail network density.

For other public transport (e.g. buses) no quality classification could be made, because consistent data on this was lacking.

Treatment of residual factors

After these multiplicative factors for area type and those for network density had been applied, the validation against base-year data on the mode and distance distribution per country took place (see section 2.5.2 under 'scaling and final calculation for 1995'). On the basis of this, mode and distance-specific correction factors were derived, which are kept in forecasting. These factors account for factors not explicitly included in the meta-model, such as climate, hilliness and country-specific historical developments.

Treatment of congestion in the meta-model for passenger transport

If a policy leads to a decrease in road traffic, then this might reduce congestion and in this way leads to shorter travel times. This in turn, might attract (back) car users with high values of time, thereby decreasing the initial reduction in car kilometrage. Alternatively, a policy that increases the use of the roads, might lead to more congestion and longer travel times, which in turn might decrease the initial growth of car kilometrage. In the EXPEDITE meta-model, this 'congestion feedback' phenomenon is handled by using area-wide speed-flow curves.

Assignment runs with different volumes were done with the Dutch national model to get inputs for these area-wide speed-flow curves. For these curves we also used some Belgian inputs (link speed-flow curves aggregated over all motorways) and we have area-wide speed-flow values from the UK national models (UK Department of Transport, 1997, 2000).

For the congestion feedback in the EXPEDITE meta-model, the following equations are used:

Cost impact: $$\frac{dV}{dc} = \frac{\frac{\partial D}{\partial c}}{1 - \frac{\partial D}{\partial t}\frac{\partial S}{\partial V}}$$

Time impact: $\frac{dV}{dx} = \frac{\frac{\partial D}{\partial t}\frac{\partial S}{\partial x}}{1-\frac{\partial D}{\partial t}\frac{\partial S}{\partial V}}$

With: V= D(t, c, z) and t = S(V,x),

in which:
V is transport volume (flow);
D is the transport demand function;
S is the supply function;
x is time at free-flow speed;
t is actual transport time;
c is transport cost;
and z includes the other factors affecting transport demand.

The numerator gives the initial impact of cost on demand. For ∂D/∂t in the denominator (impact of time change, due to change in flow, on demand) we use elasticities from the TRACE project of the 4^{th} framework (∂D/∂t in the numerator of dV/dt comes from the EXPEDITE model runs, as does ∂D/∂c in the numerator of dV/dc). For ∂S/∂V (impact of flow on time) we use elasticities from the Dutch and Belgian assignment runs (24 hours basis; checked against the published UK values) and for ∂S/∂x (impact of initial time on congested time) we can use the value of 1, since t = x + f(V).

The values used in the meta-model, based on the TRACE project for the Commission (4^{th} Framework) and the EXPEDITE assignment runs, are as follows:

The values from TRACE for ∂D/∂t in the denominator (impact of time change, due to change in flow, on demand) are the following long-term elasticities E_t^D:

Tours (TRACE D5, Table 12 on Page 14, TRACE, 1990):	
commuting:	-0.45
business:	-0.16
education, shopping and other:	-0.37
total:	-0.31

Kilometres (TRACE D5, Table 16 on page 16):	
commuting:	-1.04
business:	-0.15
education:	-0.84
shopping and other:	-0.86
total:	-0.80.

For ∂S/∂V, the impact of area-wide flow volume on travel time, we use the following elasticities E_s^v from the assignment runs with the Dutch national model system, the published tables for area-wide speed-flow curves from the UK national model system as used in 2000 for the 10-Year Plan, and the Belgian analysis for motorways:

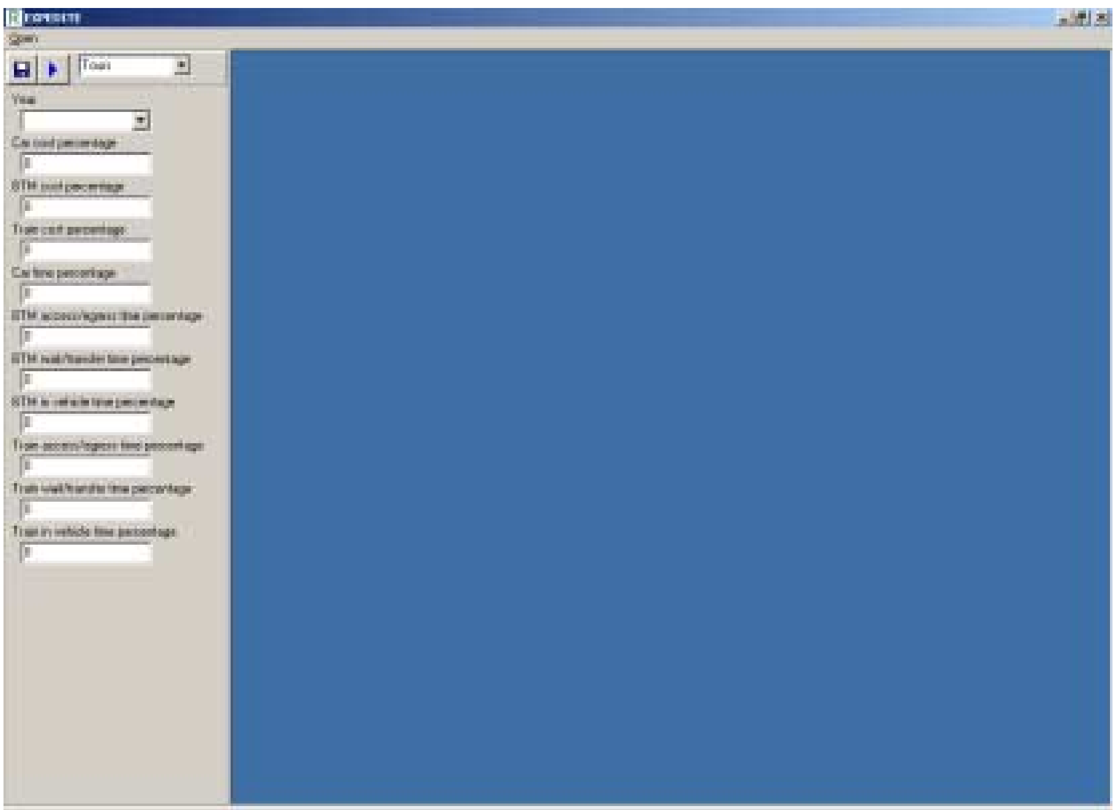
Metropolitan and high density urban area, good car network:	0.60
High density dispersed area, good car network:	0.30
Metropolitan and high density urban area, poor car network:	0.60
High density dispersed area, poor car network:	0.40.

To give an example, if the transport flows in a high density dispersed area with a poor car network increase by 10%, travel time will increase by 4%.

2.5.4 How to operate the meta-model?

Running the EXPEDITE meta-model for 1995 or for a future year or a simulating a policy change is fairly simple. It can be run on a modern PC with 1 Gigabyte free disk space available.

The EXPEDITE meta-model can be started by double-clicking the .exe file (the file with the R-icon). The user now sees the following opening screen that contains a number of items from which a selection needs to be made.



First the user has to choose whether the run will produce outputs in terms of tours or kilometres and the year for which the meta-model will be run. In the top left are options called 'Tours' and 'Km' (and for population, which can be used as the denominator for mobility rates per person), and a box for the choice of year. The options for the year can be made visible by scrolling.

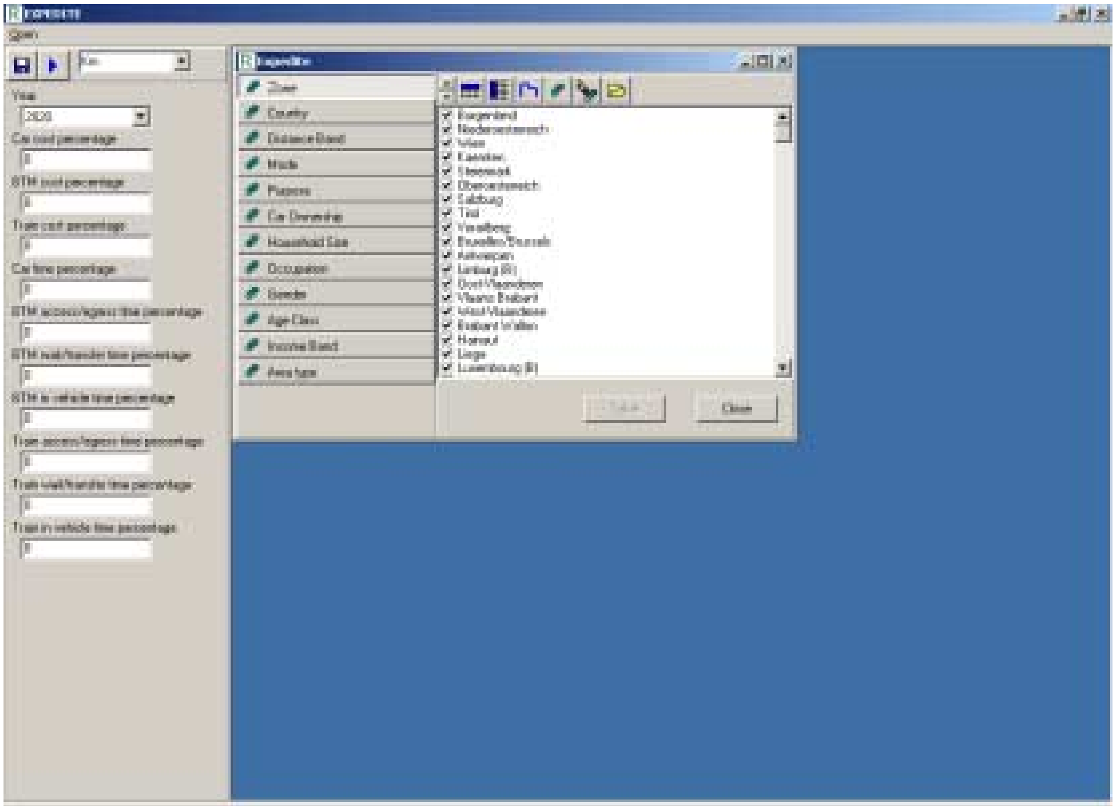
Below this box are the policy variables that can be chosen in the EXPEDITE meta-model for passenger transport. This is not the same list as the list of policy variables to be simulated in

EXPEDITE (see section 3.3). The latter list contains general policy descriptions (e.g. ‘intermodality’), whereas the list in the meta-model tool refers to the model variables: the variables to which the model is sensitive. In EXPEDITE a translation has been made from general policy variables to model variables (see section 3.3). The list of policy variables does not contain all simulations that can be done with the tool. Some other simulations (changing the population distribution, changing car ownership) can also be done, but this requires access to the program code. For the policy variables that are included the user can specify a percentage change, within certain bounds. The bounds are necessary, because the model cannot predict reactions outside the range that was investigated using the underlying national models. The user can specify changes for one variable only (relative to the reference situation for some year), but also for any combination of policy variables. If the user does not select a policy change, the outcomes of the run will be for the reference for the selected year.

If a user wants to test a policy measure that is only implemented in a specific country, group of countries, area type, travel purpose or population segment, then the user can do this by selecting this target group in the table selection window and run the model for this group. The results for other groups will be the same as in the Reference Scenario. Results for all groups together can be obtained by combining the outcomes of the targeted policy measure on the target group and outcomes for the reference situation for the non-target group in Excel. Policy measures that target on specific distance bands (e.g. a car cost increase for all car travel at trip distances over 40 km) are not possible in the meta-model.

After the user has selected the year and the policy, the data preparation will start following the clicking of the ► button at the top (it is also possible to open a specific file if the user already knows the file name). The program will ask for a filename for the outputfile. This will be a very large file (close to 100 megabyte, compressed), so one needs to guarantee that it is written to a directory that has enough space available. Also the program will ask for the scenario label (if the user does not want such labels, he/she can click ‘OK’ and the program will continue) After having given the name, the tool multiplies the tour rates and kilometre rates with the expansion factors. This will take between a few seconds to a few minutes, depending on the PC.

After this, the user will see a new window in which he or she can select the table that he or she wants to look at. This includes the selection of NUTS2 zones that the user wants to study as origins for internal and external traffic. If the user wants to select all zones (of the EU15, Norway, Switzerland and CEEC8), the fourth button on the top bar of the window can be clicked. This can be undone by clicking the fifth (one but last) button. Zones selected are marked by a √.



Furthermore in this window, the user can select the format of the table to be made. The possible dimensions of the table are listed on the left of the window. These are the segmentation variables of the meta-model. First one has to click one of these segmentation variables, and then one of the buttons of the top-bar to have this variable:

- in the columns of the table (first button of the top bar of the table selection window);
- in the rows of the table (second button of the top bar of the table selection window);
- in different spreadsheets (tab pages; third button).

It is also possible to make a table with more than three (row, column, tabs) dimensions, by selecting more variables on the rows and/or columns. In the window for the selection of variables for the table, the row or column dimension that will appear first in the new table (utmost left or on top) will be listed first. If the user wants to change the order of say the row variables, he/she has to click on the variable name and then use the arrows at the top bar of the window to move the variable up or down. This will immediately change the order of the listing of the variables in the table selection window.

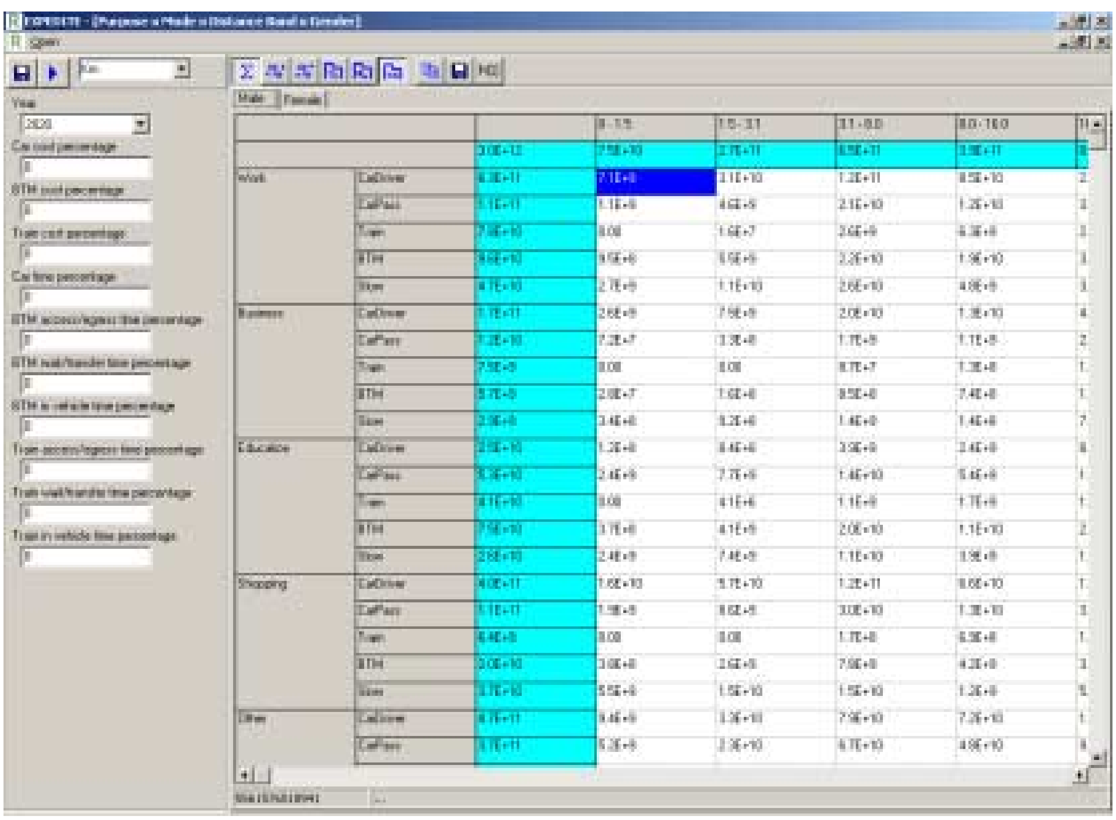
Important. If the user wants to calculate logsums (as measure of the consumer surplus), the dimensions mode and distance need to be selected as row or column dimension. This is because the logsums are calculated for some segment over all modes and distance bands, and these variables need to be available for the calculation. Moreover, the modes and distance bands need to be selected as the variables directly bordering the cells with the values. So if a user would wish to use mode, distance, purpose, gender and age, then purpose could be on the tabs, gender and age could be the first row and column dimensions (or any other arrangement of these three variables over these positions), and mode and distance should be the second row and column dimensions.

The final button in the top bar is for opening the files of previous runs (e.g. for a base scenario), which can then be selected on the tab page dimension. This makes it possible to have a base (e.g. reference 2020) on one tab page and a policy situation (e.g. reference 2020 with 10% increase in car cost) on another tab page. Using the buttons for the indices (see below), the values on the former tab page can be fixed at 100 and on the policy tab page as index numbers relative to this base.

After selecting the table options, the user can choose ‘Table’ in this window to run the meta-model to produce the table. Again this will take a few seconds to a few minutes depending on the PC. When the program is ready, the table appears on the screen. Buttons are included to:

- add row and column totals (first button in the window);
- to calculate row, column and tab page percentages (second, third and fourth button);
- set all values on a tab page at 100 and calculate index number for the other tab pages on this basis (fifth and sixth button);
- copy to clipboard (seventh button);
- save the output table (as an Ascii file, which can also be read in in Excel, eight button);
- calculate the logsum values (ninth button). See above for how to select the variables for this. The logsum value is the same for all mode-distance combinations in a segment, which is indicated by presenting the same value in every mode-distance cell (so these values should not be added over these cells, it is a single value). The logsum table can be saved as well.

The table can be moved to a text or spreadsheet by cut and paste, but can also be saved to a file (eighth button). Tables with more than three dimensions are also possible, by having more than one row and/or column variable.



2.6 The EXPEDITE meta-model for freight transport

The EXPEDITE freight meta-model has the same 'look and feel' as the passenger meta-model, but is conceptually simpler. The EXPEDITE meta-model can only give the impact in terms of tonnes and tonne-kilometres of changes in policy variables such as the transport time ands cost by mode, on top of the levels given by SCENES and NEAC.

The modes used in the meta-model for freight transport are:
- lorry;
- conventional train;
- combined road-rail transport;
- inland waterways transport;
- maritime transport.

Furthermore the model distinguishes between NUTS2 zones (which can be aggregated, e.g. to countries), distance class and commodity class (bulk, petroleum and petroleum products, general cargo).

The EXPEDITE meta-model for freight differs in a number of ways from the meta-model for passenger transport.

In the freight meta-model both the 1995 and the 2020 reference situation are not produced by the meta-model itself (as the meta-model for passenger transport does, by expansion factors applied to tour and kilometre rates). The pattern of freight flows originating in some zone comes directly from the SCENES model (for transports originating in the EU15, both domestic and international) or directly from the NEAC model (for transports originating in the CEEC8 and Switzerland, both domestic and international, and Norway for international only). The reason for this is that the EXPEDITE national models applied within EXPEDITE focus on mode choice. With the exception of the Italian model, these models are made to distribute a given matrix (e.g. from an exogenous input-output model) over modes and routes. Therefore, by themselves these models are not capable of producing the trends in future freight transport demand, they can only give the response in terms of modal shift to policy measures. We decided to use the SCENES model outputs for 1995 and the 2020 reference. The SCENES freight model does not have the CEEC8, Norway and Switzerland as internal zones. Because of this, EXPEDITE asked NEA to run the NEAC model for 1995 and 2020 reference for these countries. NEA carried out these runs within the THINK-UP project.

The runs with the four national models in EXPEDITE and policy runs with the SCENES model were used to calculate elasticities for each of the policy variables. The meta-model applies these elasticities on top of the base levels provided by SCENES and NEAC, to give percentage and absolute deviations from the base levels.

The user operation of the EXPEDITE meta-model for freight is identical to that of the passenger model.

3 THE REFERENCE SCENARIO FOR 2020 AND THE POLICIES

3.1 Approach

An overview of scenarios used in European transport research projects can be found in deliverable 3. In EXPEDITE a single Reference Scenario has been selected/developed. This contains information for each NUTS2 zone on population, age structure, household types, sectoral employment, car ownership, wealth and travel time and cost by mode for 2005, 2010, 2015 and 2020. This Reference Scenario does not contain any new policy measures (that is, only included are measures to which there is already a commitment). The new policy measures were added later, on top of the reference scenario (see section 3.3).

3.2 The Reference Scenario

3.2.1 Overview of existing Reference Scenarios

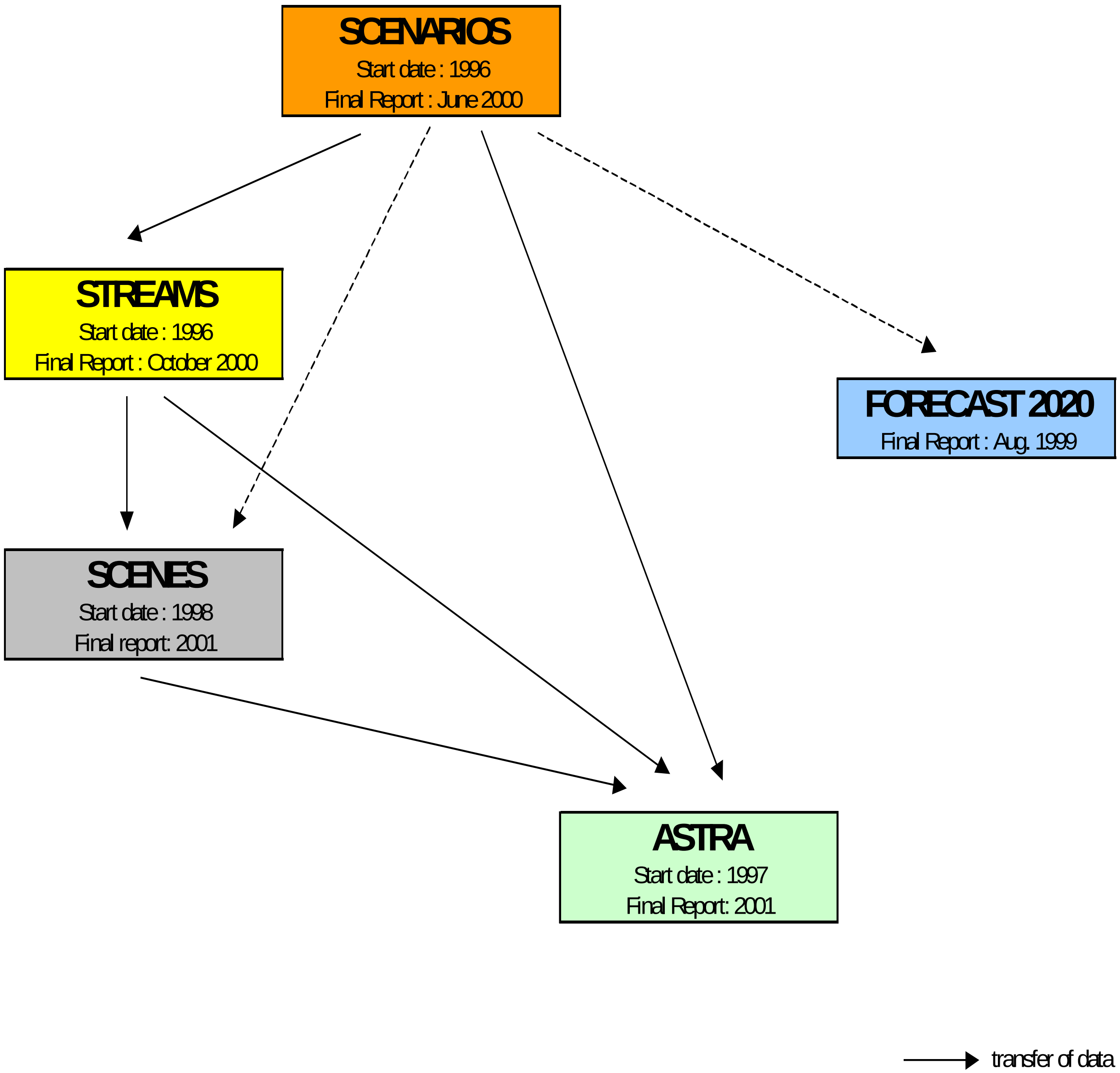
For 2020 several reference scenarios have been developed recently in a number of EU projects. These are reviewed in some detail in EXPEDITE Deliverable 3. These projects include STREAMS, SCENARIOS, SCENES, FORECAST 2020 and ASTRA.

Figure 5 summarises the main interrelationships that exist between the European studies regarding the definition of the Reference Scenario[2]. Each arrow represents a transfer of data or assumptions between studies. Some data from SCENARIOS have been used in the Reference Scenario of STREAMS, ASTRA and SCENES (though, for the latter, data at the level of functional regions have been converted to data at NUTS2 level). Similarly, some data from STREAMS have been used in ASTRA and SCENES.

The sources of data in FORECAST 2020 rely only to a small extent on the other EU projects reviewed in Deliverable 3. Limited data from the SCENARIOS database have been used in FORECAST 2020 for a small number of countries (for GDP and population growth assumptions), when it was thought that the other data sources were not available, or biased.

[2] We do not consider here the interrelationships that may exist regarding the model structure.

Figure 5. Main interrelationships between the European studies, regarding the definition of the Reference Scenario



The sources used (by variable) for the reference scenarios in the various European projects are summarised in the following Table (see the following three pages).

This table should be read as follows: each project has been assigned a unique colour. For several variables, the colour of a specific project appears in the column of another project: this indicates that there has been a transfer of data, and that the second project has 'borrowed' the value of the variable (or the underlying assumption) from the first one. Hence, the interrelationships between the projects can be visualised at a glance[3].

This summary table on the reference scenarios is not exhaustive: it summarises what information was available in the most recent deliverables from the reviewed European projects. The purpose is to help find appropriate information on each variable, for the needs of EXPEDITE.

In this summary table, the following symbols are used to indicate Reference Scenario variables:

C: private consumption
I: investment
G: public consumption
X: exports
M: imports.

Furthermore, SDM in the summary table refers to 'system dynamics model' (as developed in the SCENES project).

[3] Although SCENES extends the work of STREAMS, the available deliverables from SCENES do not specify which data have been transferred from STREAMS to SCENES; this is the reason why no explicit link is shown here between these two studies.

STREAMS	SCENARIOS	SCENES	ASTRA	FORECAST 2020
Spatial coverage				
EU15 (NUTS2)	EU15, functional regions	EU15 (NUTS2) + CEEC (30 zones for 8 countries)	EU15 (NUTS2), functional regions	EU15 (NUTS2) + CEEC (NUTS0)
Macroeconomic assumptions				
Population growth forecasts (EUROSTAT), segmented by age class and activity level	Population growth forecasts based on the SCENARIOS SDM	Population growth forecasts based on the SCENES SDM	Population growth forecasts, base on EUROSTAT	Population growth forecasts based on EUROSTAT (+ PROGNOS, Pan European study)
Average GDP growth = 2,55 % / year (trend extrapolation approach)	Average GDP growth = 2,55 % / year (trend extrapolation approach)	GDP growth forecasts based on the SCENES SDM	Average GDP growth = 2,55 % / year (trend extrapolation approach)	GDP growth forecasts based on EUFRANET (+ SCENARIOS for some countries)
	Employment growth (trend extrapolation approach) : a slow decrease is expected in the number of employees	Employment growth forecasts based on the SCENES SDM	Employment growth forecasts based on EUROSTAT	Employment growth forecasts, based on EUFRANET (+ SCENARIOS for some countries)
C, I, G growth based on EUROSTAT		C, I, G growth based on the SCENES SDM		
X, M growth (trend extrapolation approach)	X, M growth (trend extrapolation approach)			
	Fuel price variations (3 scenarios)		Diesel and gasoline price increase	

STREAMS	SCENARIOS	SCENES	ASTRA	FORECAST 2020
Variation in transport costs - passenger transport				
Increase of car operating costs (2 % / year)	Increase of car operating costs (2 % / year)	(*)	Increase of car operating costs, based on SCENES (adapted for ASTRA) : 2 - 2.5 % / year	Increase of car operating costs (0.25 % / year)
Increase of rail, bus and coach tariffs(2 % / year) ; decrease of air tariffs (0.5 % / year)		(*)	Increase of bus and train tarifs (0 - 1 % / year), and decrease of air tariffs (0.5 % / year), based on SCENES (adapted for ASTRA) :	Increase of rail tariffs (0.5 % / year, or 0.25 % / year for HST services) ; decrease of air tariffs (0.25 % / year)
Passenger VOT growth = GDP growth = 2,55 % / year	Passenger VOT growth = GDP growth = 2,55 % / year		Passenger VOT growth = GDP growth = 2,55 % / year	
Freight VOT remain unchanged			Freight VOT remain unchanged (bulk) VOT increase for semi bulk and unitised freight	
Variation in transport costs - freight transport				
Decrease of road, and rail/sea shipping (unitised goods) transport costs. No change for inland waterways		(*)	Increase of road and rail transport costs, and decrease of sea transport costs, based on SCENES (adapted for ASTRA)	Increase of road and rail transport costs, and decrease of costs for inland waterways transport

STREAMS	SCENARIOS	SCENES	ASTRA	FORECAST 2020
Transport demand determinants				
Car ownership, based on several national forecasts		Car ownership growth forecasts based on the SCENES SDM	Car ownership, based on several national forecasts	Car ownership, based on a logistical function
Slow but steady decrease in car occupancy rates, by purpose (AUTO-OIL)			Slow but steady decrease in car occupancy rates, by purpose (AUTO-OIL)	
Slight increase in trip rates (UK-DETR)			Slight increase in trip rates (UK-DETR)	

Note
(*) the variable exists and has been used in SCENES, however its value is not specified in current Deliverables.

3.2.2 Selection of Reference Scenario for EXPEDITE

EXPEDITE would like to use one of the existing European Reference Scenarios. The choice then should be one from the most recent Reference Scenarios: SCENES, FORECAST2020 or ASTRA. On the basis of the available information, all three studies appear to have developed internally consistent and plausible Reference Scenarios with great care. In this respect, all three would seem acceptable for EXPEDITE. ASTRA does not include Eastern Europe, which should be included in EXPEDITE. Furthermore, EXPEDITE will be using the SCENES models for forecasting and policy simulation, and it would be desirable to have comparable reference outcomes.

For these reasons EXPEDITE has chosen the SCENES Reference Scenario for 2020 as the basis for its own Reference Scenario. For the intermediate years for which EXPEDITE needs to produce forecasts (2005, 2010, 2015), the SCENES project can only provide some aggregate information. For these years, EXPEDITE has developed its own Reference Scenario, using information from SCENES and other European projects.

3.2.3 Description of the EXPEDITE Reference Scenario

In SCENES the scenarios for 2020 consist of two elements. The first is called the ‘External’ scenario, to emphasise that it includes autonomous changes, not policy changes. The second component is a transport scenario. The EXPEDITE Reference Scenario includes for 2020:

- Population will grow in most EU15 countries, but will decline in some (e.g. Italy, Germany); net migration is included in these forecasts. For the CEEC, population will decline somewhat, except in Poland and the Slovak Republic; by the year 2020 the total EU15 population will have grown by almost 4% compared to 1995.

- The proportion of persons of 65 year and older will increase.

- Total employment will increase in most EU15 countries, but will decline in some (e.g. Greece); the same applies to the CEEC.

- Car ownership rates per 1000 persons will increase in all countries, especially in Eastern Europe; for the EU15 by about 25% in total, for some CEEC countries the motorisation rate will almost double. For the EU15, EXPEDITE adopted the ASTRA forecasts on the future number of passenger cars per 1000 persons. The SCENES consortium adopted growth rates from the PRIMES project, which give a total growth in motorisation in the EU15 of 50% in the period 1995-2020. THINK-UP partners and national experts have argued that these growth rates are too high (notably for the EU15). The EXPEDITE team agrees with this and has therefore chosen the –lower- ASTRA forecasts for the EU15. For the CEEC, the predictions on motorisation from the SCENES Internet Database are used.

- For most EU15 countries the gross domestic product (GDP) will in the period 1995-2020 grow by between 2 and 3 % per year; in the CEEC the growth rates are 4-5.5%. We also tested a scenario with a lower income growth.

- The transport networks will be expanded according to planned national and international infrastructure developments (especially the European Commission’s ‘TEN Implementation Report’); the networks are the same in all scenarios tested using the SCENES model, unless otherwise specified. In the runs with the EXPEDITE meta-models (which are not network models), we use the assumption that in the Reference Scenario in the EU15 the travel times will stay the same. Where travel demands grow over time, at some links the new demand may exceed the old capacity. Here our assumption implies that capacity will be expanded to keep the network performance at the 1995 level. For the CEEC we assume that the network performance of the road and rail networks will become better between 1995 and 2020, moving towards West-European standards.

In SCENES there are four different transport scenarios, both for passenger and freight transport. The only differences are in the future levels of transport cost by mode, the networks and travel times are the same in all scenarios tested. Note that the values of time are expected to grow with income, but with an elasticity of around 0.5.

The SCENES Transport scenarios for passenger transport are:

- Constant cost: all modes have constant cost in real terms;
- Income tracking: costs for all modes increase with the same percentage as average EU income growth 1995-2020;
- Long term trend: car becomes cheaper and public transport more expensive in real terms;
- Radical: car becomes more expensive and public transport cheaper in real terms.

The SCENES Transport scenarios for freight transport are:

- Constant cost: all modes have constant cost in real terms;
- Basic: HGV and maritime transport cost decrease; costs for all other modes increase in real terms;
- Observed trend: maritime transport becomes cheaper, rail and inland waterway transport become more expensive and lorry transport costs remain constant, in real terms;
- Radical: lorry becomes more expensive and costs for other modes decrease or stay the same in real terms.

For the CEE countries (both for passenger and for freight transport) there is only one scenario in SCENES with decreasing car cost (following past Western European developments) and increasing public transport cost (less subsidies, privatisation).

In EXPEDITE we use the combination of the SCENES external scenario (but modified for motorisation in the EU15) with the SCENES constant cost scenarios for passengers and freight as the Reference Scenario for 2020. This implies that in the reference for 2020 the cost for all modes remain fixed in real terms at the 1995 levels, except for Eastern Europe, where car becomes cheaper and public transport more expensive. In the following, this scenario is called the ‘EXPEDITE Reference Scenario’.

For the purpose of checking the operation of the SCENES model, within EXPEDITE a run was carried out that used the same input assumptions for 2020 as the runs done in the SCENES project for the SCENES external scenario with the constant transport cost scenario. This scenario is called the ‘SCENES constant cost scenario’ in the results below.

To show the sensitivity of the predictions to external factors, notably car ownership and income, EXPEDITE also carried out a run with SCENES for 2020 for a scenario that is identical to the SCENES external scenario with the constant cost policy scenario, but that differs in two ways:

- The number of cars per 1,000 persons in 2020 will be 85% of the levels that are in the SCENES constant cost scenario. This implies that car ownership will still grow between 1995 and 2020, but the average growth in motorisation in the EU15 + CEEC8 will not be 61%, but 36%.
- The gross domestic product (GDP) and gross value added (GVA) per head in 2020 will be 85% of what is in the SCENES constant cost scenario. This is consistent with an average economic growth of just above 2% per year.

For both car ownership and income, the distribution by country will remain the same as in the SCENES constant cost scenario: only the average growth is different, not its distribution. This additional scenario is called : 'the 85% scenario'. The scenarios simulated for 2020 with the SCENES model can be summarised as follows (please note that the % changes refer to the entire study area, including the CEEC):

Scenario	income growth 1995-2020	growth in motorisation 1995-2020
EXPEDITE Reference	+2.7% p.a.	+34%
SCENES constant cost	+2.7% p.a.	+61%
EXPEDITE 85%	+2.0% p.a.	+36%

3.3 The policy measures simulated

In deliverable 3, many possible policy measures were discussed. These were mainly taken from documents of the European Commission on the Common Transport Policy (CTP). Section 3.3.1 describes the policy measures that can be found in older documents on the CTP, section 3.3.2 adds policy measures from the recent 'Time to Decide' White Paper.

3.3.1 Policies from older (before the 'Time to Decide' White Paper) CTP documents

In Table 24a below, policy measures, as extracted from documents on the CTP published before the recent White Paper, are listed. Most of the policies can be classified into one of the following four main categories:

- *development of transport infrastructure:* upgrading existing highways or freight corridors, building missing links, improving the efficiency of existing infrastructures using new communication technologies, creating multimodal nodes for freight and passenger transport, ...;
- *administrative or regulative policies*: harmonisation of technical standards or national regulations, reduction of administrative procedures for international freight transport, ...;
- *pricing policies:* road pricing, tax schemes, subsidies to operators, ...;
- *land-use policies:* linking land-use strategies with transport planning.

This classification has been used for the presentation of policy elements below. Furthermore, we also mention which distance classes are likely to be affected by the proposed measures (SD = short distance, MD = medium distance, LD = long distance). In the table, we also mention previous model simulations: (1) tested as a component of the TEN-T policy in the STREAMS study; (2) tested as a policy element in the SPARTACUS study; (3) tested as a component of a policy package in ASTRA; 4) tested as part of the EST-80 scenario of the EST/OECD project. If strong assumptions and further investigations are required to determine which model variable(s) need to be changed and to what extent, the policy is marked by an asterisk (*).

Table 24a. Listing and classification of policy measures: based on documents published before the 'Time to Decide' White Paper

A. Transport infrastructure policies

Policy name	Description	Variable by which the policy could be modelled	Distance class	Type of transport
Trans-European networks	Completion of the Trans-European networks : road network ; rail network (HST). Expected impacts : higher travel speed ; lower transport costs.	New links in the transport model, leading to transport cost and time reductions.	MD, LD	Passenger and freight
Intermodality (1)	Building and promoting multi-modal transport networks and terminals, for freight as well as for passenger transport. Expected impacts : reduction in the transport costs for operators ; tariff and time savings for users.	Lower transfer penalty values in the transport model (or lower transport cost and time).	all	Passenger and freight
Interconnectivity (1)	Improving connections between international, national, regional and local networks, both within and between modes : improving the accessibility of ports and airports (easy access to local, regional and international road and freight networks) ; removing some existing bottlenecks around several North-Sea ports. Expected impacts : reduction in the transport costs for operators ; tariff and time savings for users.	Lower transfer penalty values in the transport model (or lower transport cost and time) ; New links, leading to transport cost and time reductions.	all	Passenger and freight

Rail network electrification	Extension of the rail electrified network Expected impacts reduction in the operating costs ; reduction in the emissions of harmful gases ; speed increase.	Lower costs for operators, modification of the characteristics of some railway links in the transport model, leading to transport cost and time reductions.	all	Passenger and freight
Advanced information and communication technologies	Increase in the efficiency of the transport networks Expected impacts : (marginal) increase in road capacity ; new dynamic routing technologies ; better fleet management (for PT or freight operators).	(*)	all	Passenger and freight
Urban public transport development	Building of new public transport infrastructures : metro, light rail, segregated lanes,... Expected impacts : higher operating speed ; lower costs for operators ? increase in the public transport patronage.	(*)	SD	Passenger
HST development	Expected impacts : higher market share for rail operators ; higher competition between modes (rail, car, air).	New links in the rail transport network, leading to transport cost and time reductions.	MD, LD	Passenger
Rail freeways	Completion of the planned rail freeways for freight transport Expected impacts : lowering of travel time ; lowering of operating costs for operators ; lowering of tariffs for shippers.	increase in travel speed, lowering of costs.	MD, LD	Freight

B. Transport administration / regulation policies

Policy name	**Description**	**Variable by which the policy could be modelled**	**Distance class**	**Type of transport**
Rail interoperability (1)	Harmonisation of technical standards throughout Europe : gauge, clearance, telecommunication,... Expected impacts : reduction in the transport costs for operators ; tariff and time savings for users.	increase in travel speed, lower costs for operators, lower tariffs for users (*)	MD, LD	Passenger and freight
Cost and tax harmonisation	Expected impacts : improved competition ; lower costs ;	Variation of cost (*)	MD, LD	Passenger and freight
Market liberalisation	To go further in the liberalisation of the transport sector, both within the EU countries and with EU candidates. Expected impacts : improved competition ; lower transport costs ; possible relocalisation effects.	Variation of cost (*)	LD	Passenger and freight
Promotion of teleworking / teleservice (2)	Diminution of the travel demand for home - work trips (e.g. 10 % of employment teleworking)	Diminution of the travel demand.	SD	Passenger
Promotion of car-pooling (2)	Diminution of the travel demand for home - work trips	Diminution of the travel demand.	SD	Passenger
Maximum speed limits (2) (3) (4)	Increase or reduction of the maximum allowed speed on urban or interurban highways or motorways	Transport network adaptations, leading to travel time modifications	all	Passenger

Border effect within the EU	Removing the remaining barriers to trade within the 15 EU countries : technical, fiscal, cultural barriers...	Lowering of costs (*)	LD	Freight
Border effect with non-EU countries	Reducing or removing the barriers to trade between the EU countries and other Eastern-European countries : border controls, administrative procedures, custom duties,... Expected impact : lowering of costs ; lowering of travel time ; better accessibility to Eastern-European markets ; increase in competition ; modification in the travel demand pattern.	Variation of costs (*) Modification in the travel demand matrix	LD	Freight
Harmonisation of social regulations in the transport sector within the EU	Harmonisation of driving durations, safety regulations,... throughout the EU. Expected impact : better competition between operators of different countries.	Variation in costs (*)	MD, LD	Freight
"eco-points"	Bilateral agreement between the EU and some non-EU countries based on tariff and quotas (e.g. "eco-points" must be paid when crossing a country, in proportion to the degree of pollution produced by each truck). E.g. Austria prior to its integration into the EU	Variation in costs, variation in routes (*)	LD	Freight

C. Transport pricing policies

Policy name	**Description**	**Variable by which the policy could be modelled**	**Distance class**	**Type of transport**
Cost internalisation	Optimal pricing of transport for every mode, taking external cost into account : congestion costs ; environmental costs (emissions, noise) ; safety costs. Expected impacts : diminution of the market share of less efficient transport modes.	increase in transport costs (*)	all	Passenger and freight
Increase in the price of fuel (through fuel tax) (3) (4)	% increase in the price of fuel. The price increase may be different for each mode and / or for each purpose (e.g. introduction of a "professional gasoline", suppression or reduction of the price differential between gasoline and diesel, or suppression of the tax-free fuel for airlines). Expected impacts : higher market share for transport modes that are more environment friendly	increase in transport costs	all	Passenger and freight
Congestion pricing	Time-related and / or distance-related tariff on congested links Expected impacts : lower congestion ; lower market share of congested modes.	increase in transport costs	all	Passenger and freight

Road pricing in urban (or suburban) areas (4)	Expected impacts : reduction of the market share of car in urban areas ; positive environmental effects (either globally or at the local scale).	Increase of the transport costs for the private car.	SD	Passenger and freight
Parking regulations (4)	Restrictive parking policy in order to discourage long-duration parking in centre-business districts. Expected impacts : diminution of the market share of car for home - work trips in urban areas.	Increase of the transport costs for the private car.	SD	Passenger
Public transport pricing	Lower fares for the public transport modes.	Decrease of the transport costs for public transport modes.	all	Passenger
Public transport fare integration	Unified fare system for every kind of urban public transport (buses, light rail, metro, suburban trains,...). Expected impacts : increase in the public transport patronage.	(*)	SD	Passenger
"vignette"	Tax affecting road freight carriers in Germany and in the Benelux countries, or in Switzerland (fro freight and passenger transport). Could be extended to other countries	increase in costs.	SD, MD, LD	Freight
Infrastructure tariff (3)	Tax for lorries for the use of infrastructure	increase in costs	SD, MD, LD	Freight

D. Land-use policies

Policy name	Description	Variable by which the policy could be modelled	Distance class	Type of transport
Housing estate location (4)	Constraints to the settlement of new housing areas in suburban areas, or measures to promote the residential function in city-centres. Expected impact : modification in the local travel demand pattern.	Modification of the travel demand matrix (at a local scale)	SD	Passenger
Commerce and employment location (4)	Regulations regarding the location of commercial and employment zones, in the city-centre or in suburban areas. Expected impact : modification in the local travel demand pattern.	Modification of the travel demand matrix (at a local scale)	SD	Passenger
New trends in logistic	Building and operation of new international intermodal freight platforms. Concentration of production units in the heavy industry, in order to benefit from positive returns to scale. Delocalisation of production units to countries in which the manpower is less expensive. Expected impacts : modification in the travel demand matrix structure ; modification in the transport costs ; modification in the modal repartition of freight carriers.	Variation in transport costs (*) Variation in the transport demand (*)	MD, LD	Freight

Some of these policy elements in Table 24a can easily be simulated within the framework of EXPEDITE:

- those resulting in travel time changes (e.g. major network modifications);
- those resulting in a direct modification in the transport cost structure (e.g. pricing policies);
- those resulting in a modification of the transport demand pattern: volume or distribution of the demand (e.g. teleworking policies).

However, other policy elements induce an indirect impact on the attributes that are contained in the model, and merit further investigation before the beginning of policy tests: either to determine which attribute is likely to be the most affected by the policy measure or the extent of its variation. For instance, the harmonisation of legislation between European countries or an increase in competition due to further market liberalisation are likely to induce a variation in the transport cost structure, but the quantification of this variation requires a further study. Such policies are marked with an asterisk in the table below. An option would be to translate such policies into changes in the intrinsic modal constant of the modes concerned. For some supply quality variables (e.g. reliability of travel time, personal safety), trade-offs with travel cost or time have been established in stated preference studies, which might be used for simulation with the EXPEDITE meta-model.

3.3.2. Additional policies from the ‘Time to Decide’ White Paper

The European Commission’s recent White Paper was reviewed and the 60 policy measures that are advocated were compared to the policies listed above to identify any additional policies that could be tested in the meta-model and in the SCENES model. Below in Table 24b is a list of the most relevant measures for EXPEDITE (in terms of objectives) that have not already been described in Table 24a above. These measures were classified in the same way as the policy measures in the previous section. Some of the measures are closely related to policies already mentioned in section 3.3.1. In these cases, the last column of the table indicates the related policy’s name.

Table 24b. Listing and classification of policies: additional policies from the 'Time to Decide' White Paper

1. Transport infrastructure policies

Transport mode	Policy Description	Type of transport	Distance class	Variable by which the policy could be modelled	Relation with a policy measure mentioned in section 3.3.1
Maritime	Development of "sea motorways" (sea links around bottlenecks such as the Alps or the Pyrenees), integration of these motorways in the TEN	Freight	LD	New links in the transport model	Not mentioned in 3.3.1. This policy would be difficult to simulate. Required are assumptions on the time gains that could be corridor-specific
Rail	Opening up the national freight markets to cabotage (to avoid trains running empty)	Freight	MD	Variation of cost	Associated with market liberalisation
Air/rail	Integration of air transport into an efficient system with the other modes of transport (e.g. intermodality between air transport and railways/ high speed trains)	Passengers	LD, MD	Time reduction	Associated with intermodality.

2. Transport administration/ regulation policies

Transport mode	Policy Description	Type of transport	Distance class	Variable by which the policy could be modelled	Relation with a policy measure mentioned in section 3.3.1
Road	Harmonisation of inspections procedures/ tightening up controls and penalties to put an end to practices preventing fair competition	Freight	All	Cost variation	Not mentioned in 3.3.1. Highly promoted by the Commission.
Road	Harmonise the rules governing checks and penalties for international commercial transport with regard to speeding and drink-driving	Freight	LD	Time increase	Not mentioned in section 3.3.1. Recommended by the Commission.
Road	Harmonisation of social regulations	Freight	All	Cost and time variation	Mentioned in section 3.3.1

Maritime and inland waterways	Simplification of the regulatory framework for maritime and inland waterway transport by encouraging in particular the creation of one-stop offices for administrative and customs formalities and by linking up all the players in the logistics chain.	Freight	LD	Time reduction	Not mentioned in section 3.3.1. May lead to a significant reduction in time of transport by waterways.
Air	Creation of the single sky: Community regulator (harmonised procedures, common rules on use of airspace)	Freight/ passenger	LD	Time reduction (less delays), cost reduction (less fuel waste)	Not mentioned in section 3.3.1
Air	Revision of the slot allocation system	Freight/ passenger	LD	Time reduction (less delays), cost reduction (less fuel waste)	Not mentioned in 3.3.1.
Combined transport (all modes)	Encouraging the emergence of freight integrators	Freight	All	Cost and time reductions	Associated with intermodality in section 3.3.1.
Combined transport (all modes)	Harmonisation of loading units: standardising containers and swap bodies	Freight	LD, MD	Cost and time reduction	Associated with intermodality in section 3..3.1
Inland waterways	Current standardisation of technical requirements for the entire Community waterway network by 2002	Freight	LD, MD	Cost and time reduction	Not mentioned in section 3.3.1. Will be considered as fluvial interoperability
Maritime	Tighten the maritime safety rules by incorporating the minimum social rules to be observed in ship inspections and by developing a genuine European maritime traffic management system	Freight	LD, MD	Time reduction	Not mentioned in section 3.3.1.

3. Transport pricing policies

Transport mode	**Policy Description**	**Type of transport**	**Distance class**	**Variable by which the policy could be modelled**	**Relation with a policy measure mentioned in section 3.3.1**
Air	Introduction of a kerosene tax by 2004	Freight / passenger	LD	Cost increase	Associated with fuel price increase in Section 3.3.1.
Air	Differential *en route* air navigation charges according to environmental impact of aircrafts	Freight / passenger	LD	Cost variation	Associated with cost internalisation in Deliverable 3.
Road	Proposal of uniform taxation for commercial fuel by 2003	Freight / passenger	All	Cost variation	Associated with cost and tax harmonisation in Section 3.3.1
Road	Interoperability of means of payment on the road TEN	Freight / passenger	LD, MD	Time reduction	Not mentioned in Section 3.3.1. Will be considered as road interoperability
Maritime	Encourage the reflagging of ships to the Union through measures on tonnage-based taxation system	Freight	LD	Cost variation	Not mentioned in Section 3.3.1.

Transport mode	Policy Description	Type of transport	Distance class	Variable by which the policy could be modelled	Relation with a policy measure mentioned in section 3.3.1
All	Development of an infrastructure-charging system that takes into account external costs: proposition of a European framework directive to define an infrastructure-charging system and a common methodology for setting charging levels, offset by the removal of existing taxes, and allowing cross-financing[4]	Freight/ passengers	All	Cost variation	Associated with infrastructure tariffs in Section 3.3.1 and cost internalisation in Section 3.3.1

[3] The White Paper remarks on Eurovignette replacement by distance related pricing : "The current Community rules, for instance Directive 62/99 on the 'Eurovignette', therefore need to be replaced by a modern framework for infrastructure-use charging systems so as to encourage advances….. while ensuring fair competition between modes of transport and more effective charging, and ensuring that service quality is maintained". "Whether for airports, ports, roads, railways or waterways, the pricing of using infrastructure should vary in the same manner according to category of infrastructure used, time of day, distance, size and weight of vehicle, and any other factor that affects congestion and damages the infrastructure or the environment".

Additional remarks on these policies from the White Paper are:

- In Switzerland, there has been a change from flat HVF (heavy vehicle fee) to distance-related pricing for heavy good vehicles (>3,5 t). Tariffs are calculated per kilometre and per ton and are emission dependent. Distance-related pricing is now being introduced in Germany and Austria, and is planned for the UK.

- Other important measures and issues discussed in the White Paper, but which do not meet the Expedite selection criteria or which cannot be modelled, include the new MARCO POLO program to promote alternative solutions to road transport, the revitalisation of the railways, the promotion of alternative modes (e.g. inland waterways), the promotion of clean fuels, the reinforcement of air passengers' rights and railway users' rights, increased road safety and safety in all other modes of transport, the GALILEO satellite navigation system, community licenses and harmonised pilot certificates (air and inland waterway transport) and reinforcement of the European Union's presence in international transport organisations. A measure is also proposed for the harmonisation of certain clauses in contracts in order to protect carriers from consignors and enable them to revise their tariffs in the event of a sharp rise in fuel price.

- The White Paper indicates that a two-stage revision of the Trans-European network will be undertaken (2001-2004). A description of the timeline is provided on page 63. In addition, annex III of the White Paper provides a list of projects submitted by the Member States and the European Parliament and under review by the Commission to be added to the list of 'specific' projects adopted by the Essen European Council.

Subsequent to the White Paper, we are aware of new initiatives, to completely redraw the 'Essen' list of transport infrastructure network projects, but no further information is available at this time.

3.3.3 Selection for simulation in EXPEDITE

The selection of policy measures to be simulated in EXPEDITE was also discussed with experts at a number of THINK-UP workshops and seminars. The policies listed were classified in Table 24c, taking into account the comments made by the experts, using a two-way classification of policy measures:

- whether strong assumptions are needed to simulate the policy in EXPEDITE (roughly the policies marked with an asterisk in the Table 24a);
- the potential for a mode shift away from passenger car, lorry and airplane, towards public transport, freight by train, inland waterways and sea transport.

The second dimension was chosen because this really is the policy background of the EXPEDITE project: for which market segments can policy measures influence the modal split and which measures are most effective in doing this?

EXPEDITE was tasked with the following policy simulations:

- policy measures in D will be simulated first ;
- policy measures from C will be simulated in a second round ;
- selected policy measures from B will be simulated in a third round, if time and budget allows ;
- policy measures in A will not be simulated.

Table 24c. Classification of policy measures for passenger transport (p) and freight (f) (policy measures in italics were added in accordance with the 'Time to Decide' White Paper, see section 3.3.2)

Strong assumptions needed to get model input Potential for mode shift*	Yes	No
Low	***A*** Advanced ICT (unless in relation with intermodality or rail interoperability) *(p-f)* Cost and tax harmonisation *(p-f)* Border effect within EU *(f)* Border effect with non-EU countries *(f)* Harmonisation of social regulations *(f)* Eco-points *(f)* Public transport fare integration *(p)* New trends in logistics *(f)* *Single sky (p-f)* *Revision of slot allocation (p-f)* *Tighter maritime safety rules (f)* *Road interoperability (p-f)* *Reflagging of ships to Union (f)*	***B*** TEN-roads *(p-f)* Rail network electrification *(p-f)* Promotion of teleworking & teleservice *(p)* Promotion of carpooling *(p)*
High	***C*** New urban public transport *(p)* Rail and fluvial interoperability *(p-f)* Market liberalization *(p-f)* Cost internalisation *(p-f)* Maximum speed limits *(p)* Vignette *(f)* Promoting housing densification *(p)* Promoting employment location in corridors along public transport routes or around stations *(p)* *Sea motorways (f)* *Harmonisation of inspections and controls (f)* *Harmonise rules/penalties on speeding (f)* *Deregulation for sea and inland waterways transport (f)*	***D*** TEN-public transport (e.g. HST) *(p)* Intermodality *(p-f)* Interconnectivity *(p-f)* Rail freeways *(f)* Fuel price increase *(p-f)* Congestion pricing *(p-f)* Urban/suburban road pricing *(p-f)* Parking policies *(p)* Public transport pricing *(p)* Infrastructure tariff *(f)*

* Shift away from car, lorry and airplane, towards public transport, freight by train, inland waterways and sea transport.

Some a priori (before presenting the policy simulations in EXPEDITE) comments on some measures (most of them classified in C and D) are as follows:

- *TEN-public transport (e.g. HST)*: it is expected that the completion of the rail HST network will induce a significant modal shift. On the contrary, it seems that the completion of new road links of the TERN will only have minor impact on the modal shares ;
- *congestion pricing*: it is expected that this will lead to both a change in the departure time for car users and a modal shift ;
- *market liberalisation*: according to several experts, the market liberalisation in the rail sector in Europe could be one of the factors having the highest impacts on the modal shares for freight transport in the next years. The effect of the current monopolistic situation of national railways companies is that the rail supply is sometimes not adequate compared with the demand: there are some demand segments which do not seem to be profitable on short term, and currently, the railway companies do not care about supplying high quality services to them. In case of competition, the quality level of the supply would probably be significantly improved and this would have a significant impact on the modal share of rail ;
- *maximum speed limits*: this measure could induce significant modal shift provided that the changes in speed limits are major changes ;
- *promoting housing densification and promoting employment location in corridors along public transport routes or around stations*: these are “land use measures” rather than “transport measures”, but they could nevertheless have a significant influence on transport. Experts and decision-makers are more and more convinced that one has to build comprehensive and integrated land-use/transport policies, because they are more efficient in terms of reducing car use. These measures could lead to an increase of the modal share of public transport ;
- *carpooling*: it is worth noting that the promotion of carpooling is likely to have no or a minor impact on the modal shares (in terms of car versus public transport), but could have a significant impact on the number of vehicle-km by road;
- *ICT, intermodality, rail interoperability*: ICT could increase the rail share if it is part of intermodal strategies (real time information on public transport, real time information on location of the goods, load management); also, rail interoperability can only be achieved with ICT (for following and guiding trains through the networks).

3.3.4 Translation of policy measures to mode input variables

In chapter 10 and 11 of this report are the outcomes from the first and second round (categories D and C) of policy simulations. Time and budget did not permit to simulate selected measures from category B in the current project (but doing this is possible with the combination of SCENES and the meta-models). The policy measures from D and C were translated into changes in the input variables of the passenger and freight meta-model and the SCENES model. Table 25 lists how this was done. For most policy measures, several changes in the model input variables have been simulated, because there is a great deal of uncertainty about the impacts on travel time and cost by mode of the policy measures. Carrying out simulations for several changes in the inputs can be regarded as a kind of sensitivity testing for different assumptions on how the policies might effect the cost and time by mode.

Table 25. Translation of policy measures for simulation in EXPEDITE?

Policy in D	Model F=freight P=passengers	Simulation (for 2020)
TEN-T public transport (HST)	Scenes P+F	This requires changing rail networks manually (new links, reclassified links), see Essen and Christophersen list and White Paper. Scenes could give approximate effects, but more detailed corridor study recommended; not simulated here.
Intermodality	Meta-model F	Rail/combined/sea handling and storage cost –5%, -10%, or Travel time rail/combined/iww/sea –3%, -5%
	Meta-model P	Rail and BTM access/egress time –5%, -10% and Rail and BTM wait and transfer time –5%, -10%
Interconnectivity	Meta-model F	Rail/combined/sea handling and storage cost –5%, -10%, or Travel time rail/combined/iww/sea –3%, -5%
	Meta-model P	Rail and BTM access/egress time –5%, -10% and Rail and BTM wait and transfer time –5%, -10%
Rail freeways	Scenes F	This requires changing rail networks manually (new links, reclassified links). Scenes could give approximate effects, but more detailed corridor study recommended; not simulated here.
Fuel price increase	Scenes P	Variable car cost +10%, +25%, +40% and Air fares +10%, +25%, +40%
	Meta-model P	Variable car cost +10%, +25%, +40%
	Meta-model F	Lorry cost +10%, +25%
Congestion and road pricing	Meta-model P	Variable car cost +25%, +40% in area types 1, 2, 3 and 4
	Meta-model F	Variable lorry cost +25%, +40% in area types 1, 2, 3 and 4
Parking policies	Meta-model F	Lorry cost +25% for trips <100 km in/from area type 1, 2, 3 and 4
	Meta-model P	Car cost +25% in/from area type 1, 2, 3 and 4
Public transport pricing	Scenes P	Rail and coach cost –10%, -30%
	Meta-model P	Rail and BTM cost –10%, -30%
Infrastructure tariff	Meta-model F	Lorry cost +10%, +25% and rail cost +10%, +25%

Table 25 (continued). Translation of policy measures for simulation in EXPEDITE?

Policy in C	**Model**	**Simulation (for 2020)**
New urban public transport	Meta-model P	BTM travel times in area types 1, 2, 3 and 4 –10%, -25%
Rail and fluvial interoperability	Scenes P	Rail times -5% and rail cost -5%
	Meta-model F	Rail/combined times -5% and cost -5%, and IWW times -5% and cost –5%
	Meta-model P	Rail times -5% and cost -5%
Market liberalization (rail)	Scenes P	Rail cost –5%, -10%
	Meta P+F	Rail cost –5%, -10%
Cost internalisation	Scenes P	Car cost +25 +40%, and Bus cost +10%, +25%, and Air fares +25%, +40%
	Meta F	Lorry cost +25%, +40%
	Meta-model P	Car cost +25%, +40%, and Bus cost +10%, +25%
Maximum speed limits	Scenes P	Car time +10%, +20%
	Meta P	Car time +10%, +20%
	Meta F	Lorry time +10%, +20%
Vignette, Eco-points, km charge	Meta F	Lorry cost +3%, +5%, +10% for trips above 200 km
Promoting housing densification	Meta P	Shift of population from area types 5-7 to 1-4
Promoting employment densification	Meta-model	Shift of employed population from area types 5-7 to 1-4
Sea motorways	Meta F	Sea time –10%, -20%
Harmonisation of inspections and controls	Meta-model F	Lorry cost +3%, +5% and lorry time +3%, +5%
Harmonisation of rules on speeding	Scenes P	Car time +5%, +10%
	Meta F	Lorry time +5%, +10%
	Meta P	Car time +5%, +10%
Deregulation for sea and IWW	Meta F	Sea and IWW cost –5%, -10%

The EXPEDITE meta-models for passengers and freight can also be used for simulations of car ownership changes and simulations for qualitative ('soft') factors (e.g. reliability). In the latter case the change in the soft factor needs to be translated into a change in model inputs, such as time and cost by mode, but results from stated preference valuation studies for a number of qualitative factors are available to do this.

4 SCORING FREIGHT POLICIES: EVALUATION OF ASPECTS NOT MODELLED IN THE EXPEDITE META-MODEL

Policy simulation with the EXPEDITE meta-model gives the impact of various policies on traffic volumes. This is however not a complete assessment of those policies. A complete cost and benefit assessment should also include other impacts of those policies, as well as implementation costs. In this chapter, we will detail the methodology used to assess those costs and benefits for freight policies. Passenger policies are covered in chapter five. The methodology for passenger traffic has been developed in parallel with this one. Freight and passenger assessment are thus consistent.

4.1 Introduction

To evaluate policies, we have tried to use an approach as close to cost benefit analysis as it was possible in the EXPEDITE framework. Impacts have thus been as much as possible evaluated in monetary terms.

The costs we included in this analysis are the following:

- The direct cost of transport, i.e. the cost of running the vehicles;
- The cost of time spent travelling;
- External costs:
    - Emissions (pollutants and greenhouse gases);
    - Noise;
    - Accidents, safety;
    - Road damage cost;
- Investment, maintenance and operating costs: in this case, monetary valuation was not possible in the context of EXPEDITE, because the policies simulated (e.g. ‘intermodality’ or ‘road pricing’) are not specific localised projects, but are measures of a more general nature. We have therefore provided a qualitative judgment on the magnitude of these costs.

Valuation of external costs

The valuation of external costs is in many cases a function of revenue per capita. Richer people have a higher willingness to pay to avoid pollution and nuisances, or for hospital costs. Production losses are also higher in richer countries. External costs are thus often proportional to revenue per capita (adjusted for purchasing power parities).

However, this method of valuation has some drawbacks. For example, it gives a higher weight to richer countries, and exchange rates adjustments are not always meaningful when large variations occur. In the context of this project, with the aim of developing a simple methodology, we used a single set of external costs for all countries, an EU average.

Load factors
In some cases, we had to convert tonne-kilometre into vehicle-kilometre. For such purposes, we have used the average load factors used by the European Commission in the White paper '"Time to decide", as shown in Table 26. We have assumed that the 1998 values can be used for 1995.

In the white paper, all trucks are aggregated, with a load factor of 4 tonnes per vehicle in 1995 and 4.4 in 2020. For HGVs, the average Belgian load factor was 10.02 tonnes per vehicle in 1995. We used this value. Assuming that the load factors will grow as expected in the white paper for all trucks (LCVs and HGVs), we obtain a load of 11.03 tonnes per HGV in 2020. For LCVs, we have used a load of 250 kg per vehicle in 275 in 2020.

Table 26. Average load factors (in tonnes per vehicle)

	1998	2020
Rail	185.4	195.9
Inland Waterways	403.3	417.5
Short Sea Shipping	3886.7	4087.5

Source: European Commission (2001)

4.2 Investment and operation & maintenance

Estimating the actual investment and operation/maintenance (O&M) costs of scenarios would be a large and complex task. In the scope of this study, we only propose a qualitative assessment of these costs for each scenario considered (see the table on the next page).

4.3 Driving costs

To compute these costs, we have simply multiplied the volume of traffic forecast by EXPEDITE by an estimate of the cost per km for each mode.

Table 27. Direct cost of transport per tonne-kilometre (ECU95)

Transposed	road	IWW	rail	combined	sea
Base	0.270	0.182	0.150	0.146	0.066

Source: STRATEC, based on information from several freight models used in EXPEDITE

Low investment and O&M cost
3 Congestion and road pricing (truck cost increase for shortest distances)
4 Parking policies (truck cost increase for shortest distances)
5 Infrastructure tariff (higher costs for trucks and rail)
7 Rail Market liberalisation (lower cost)
8 Cost internalisation for road (higher truck costs)
9 Maximum speed limits (higher travel time for trucks)
10 Eco-vignette, km charge for trucks (higher costs for trucks) (this policy increase the cost for transporters, but this is balanced by an increase in government revenues; for society, the cost is thus low, while from the point of view of transport users, it might be high)
11 Sea motorways (faster sea transport)
12 Harmonisation of inspections and controls for trucks (cost and travel time increase for trucks)
13 Harmonisation of rules on speeding (road travel time increase)
14 Deregulation for sea and IWW (lower costs)
15 Truck fuel price increase (this policy increase the cost for transporters, but this is balanced by an increase in government revenues; for society, the cost is thus low, while from the point of view of transport users, it might be high)
Medium investment and O&M cost
1 Intermodality (decrease in handling and storage costs or in travel time)
2 Interconnectivity (decrease in handling and storage costs or in travel time)
6 Rail and fluvial interoperability (cost and travel time decrease for rail, waterways and combined transport)
High investment and O&M cost
None policies assessed with the EXPEDITE meta-model requires heavy infrastructure works, and none are thus qualified as "high costs". Two policies that require the SCENES model and/or specific corridor models for simulation, TEN-T and rail freeways do involve heavy investment in infrastructure.

4.4 Time cost

The time spent in transport is a cost, as valuable goods are immobilised during transport. We have used values proposed by Rand Europe in previous studies, as shown on Table 28. Time costs were then computed as total spent in transport multiplied by the value of time for each mode. We assumed that average speed was 60 km/h for road freight (ECMT 2002) and 18km/h for rail (EC DG TREN, 2001). We also assumed an average speed of 10 km/h for waterways, and 15 km/h for combined transport and short sea shipping. These average speeds are relatively low, as they take account of the actual travel time (including various stops at borders, in warehouses, for refuelling, etc.).

Table 28. Value of time for freight transport (ECU95 per hour)

	per vehicle	per tonne
LCV	39.823	144.811
HGV	42.810	3.884
Rail	148.225	0.757
IWW	74.818	0.179
Sea	732.495	0.179

Source: RAND Europe

The simplified approach taken here could cause some problems in case of mode substitution. When a user decides to transport a tonne by road or by (for example) rail, his value of time (VOT) is not a function of the mode chosen. While in our approach, a tonne shifted from road to rail would get different value of time.

The problem is however not as critical as described above, because of the approximation we are forced to use. While we apply a single value of time for all road transport, each transport has actually its own intrinsic value of time (function of the nature of the goods, the users' needs, geography, etc.). We are using here a single average value to represent what is actually a continuum of values.

In our model, the varying VOT is represented by a single, average value of time per mode. Road (fast) is used for high VOT goods/users, and non-road (slow) is used for low VOT goods/users.

When speed of non-road (slow) modes increase, non-road captures some of the goods normally transported by road (those with the lowest VOT among these). This means that those goods that are transferred from road to non-road are already relatively low VOT goods and the error is thus relatively small.

4.5 Emissions

Environmental performances of road vehicles have dramatically improved in the last decade, thanks to the enforcement of stricter emission standards for new vehicles. Factors such as

- the introduction of catalyst exhausts;
- the ban on leaded gasoline;
- the lowering of sulphur content in gasoline and diesel;
- the introduction of European emission standards Euro I (1992) to Euro IV (2005) and Euro V (2008, for trucks only),

all played an important role in this progress. For most pollutants, emissions per vehicle were ten times lower in 2000 than in 1980. Further progress will occur in 2005, with the introduction of Euro IV for cars and trucks, and in 2008 with Euro V for trucks.

The fall in unit emissions have been much larger than the regular increase of traffic in the past. As a result, total emissions from road traffic have significantly decreased.

This will continue in the future. As the new emission standards only apply to new vehicles, the progressive replacement of old vehicles by new ones will continue to improve the average emission performance of the fleet.

The only exception to this trend is CO_2, not a pollutant *stricto sensu* (it is not toxic) but a greenhouse gas. Because emission of CO_2 are directly proportional to fuel consumption, and fuel consumption only improves slowly, CO_2 emissions have increased steadily, and are at best expected to stabilise in the future, if the voluntary agreements between the EU and with the producers (ACEA, JAMA and KAMA) produce the expected results (an average of 140 grams of CO_2 per kilometre for new cars in 2008, and 120 g/km in 2012).

The average life expectancy of cars is now about 13 years and about the same for trucks. Thus in 2020, there will still be a significant proportion of vehicles that do not comply with the Euro IV and Euro V emission standards. We have to take account of this fact in the emission estimations.

The 2020 average emission factors of cars and trucks depend on a number of factors, such as:

- the age structure is a first factor, as old vehicles have higher emissions that more recent ones;
- the split between diesel and gasoline vehicles, as emissions of these two types of engines are quite different. The share of LPG and alternative fuels vehicles is also relevant;
- the structure in terms of engine size.

In the Auto-Oil II programme, emission factors for cars and trucks have been developed for vehicle fleet in 9 European countries, using the COPERT III methodology (developed for the European Environment Agency) and taking account of the detailed fleet composition in each country. We propose to use the values for these countries (France, Germany, Greece, Finland, Ireland, Italy, Netherlands, Spain, United Kingdom). We matched the other countries with one of these nine, using expert judgment to choose the best model, considering climate and GDP per capita (as listed in Table 29).

Table 29. Country correspondence for emission factors estimates

	Country	GDP/cap 1995 (€)	Model country
LU	Luxembourg	32 386	Germany
DK	Denmark	27 474	Germany
CH	Switzerland	27 263	Germany
NW	Norway	24 895	Finland
DE	Germany	22 526	Germany
SE	Sweden	22 398	Finland
AT	Austria	21 847	Germany
FR	France	21 586	France
NL	Netherlands	20 893	Netherlands
BE	Belgium	20 752	Netherlands
FI	Finland	17 207	Finland
IT	Italy	16 655	Italy
IE	Ireland	15 576	Ireland
UK	United-Kingdom	15 499	United-Kingdom
ES	Spain	11 561	Spain
GR	Greece	9 278	Greece
PT	Portugal	8 190	Spain
SI	Slovenia	7 479	Greece
CZ	Czech Republic	4 310	Greece
HU	Hungary	3 173	Greece
SK	Slovak Republic	2 865	Greece
PL	Poland	2 383	Greece
EE	Estonia	2 347	Greece
LT	Lithuania	1 698	Greece
LV	Latvia	1 625	Greece

Source: EXPEDITE, OECD (PPP data)

The tables with emission factors are given below (Table 30) for trucks.

Table 30. Emission factors for trucks (in g/vkm)

CO2 emissions by HGV g/km	1995	2000	2020
Finland	707.6	707.4	614.7
France	821.6	820.0	705.7
Germany	736.8	748.2	638.1
Greece	658.3	661.3	575.7
Ireland	579.6	646.4	562.9
Italy	698.5	700.1	613.2
Netherlands	682.6	693.1	591.2
Spain	660.9	632.7	581.5
UK	610.2	628.7	577.9
Average	705.0	705.9	618.7

CO2 emissions by LCV g/km	1995	2000	2020
Finland	232.7	251.2	208.2
France	253.5	269.3	216.9
Germany	258.9	272.8	209.4
Greece	277.3	275.1	212.2
Ireland	237.9	249.3	195.9
Italy	255.2	265.2	208.5
Netherlands	238.8	251.5	193.1
Spain	261.2	276.4	228.0
UK	255.9	271.3	217.7
Average	255.3	269.0	213.7

Source: Auto-Oil II basecase

CO emissions by HGV	1995	2000	2020
Finland	2.982	2.500	0.894
France	1.831	1.547	0.723
Germany	1.946	1.618	0.700
Greece	2.216	1.782	0.811
Ireland	1.835	1.747	0.783
Italy	2.307	1.875	0.775
Netherlands	3.411	3.036	2.707
Spain	4.299	3.668	2.192
UK	2.050	1.680	0.741
Average	2.486	2.104	1.121

CO emissions by LCV	1995	2000	2020
Finland	3.924	2.427	0.362
France	6.905	3.180	0.307
Germany	4.079	1.895	0.239
Greece	22.212	11.620	0.675
Ireland	2.334	1.480	0.257
Italy	6.270	3.570	0.373
Netherlands	5.633	2.589	0.371
Spain	11.092	5.832	0.322
UK	12.138	5.153	0.300
Average	7.929	3.803	0.328

Source: Auto-Oil II basecase

NOx emissions by HGV	1995	2000	2020
Finland	7.850	5.808	1.478
France	8.837	6.900	1.678
Germany	7.017	5.723	1.458
Greece	6.832	5.194	1.323
Ireland	5.644	5.049	1.347
Italy	7.284	5.604	1.367
Netherlands	7.117	5.827	2.057
Spain	7.092	5.551	1.509
UK	6.341	5.007	1.286
Average	7.250	5.730	1.481

NOx emissions by LCV	1995	2000	2020
Finland	1.223	0.847	0.161
France	1.312	0.833	0.148
Germany	1.254	0.701	0.133
Greece	1.796	1.053	0.090
Ireland	1.168	0.719	0.128
Italy	1.311	0.884	0.131
Netherlands	1.312	0.743	0.179
Spain	1.425	0.923	0.139
UK	1.478	0.876	0.148
Average	1.353	0.835	0.142

Source: Auto-Oil II basecase

PM emissions by HGV	1995	2000	2020
Finland	0.560	0.369	0.041
France	0.515	0.352	0.029
Germany	0.424	0.304	0.029
Greece	0.468	0.310	0.029
Ireland	0.391	0.303	0.034
Italy	0.491	0.335	0.031
Netherlands	0.450	0.319	0.033
Spain	0.466	0.326	0.033
UK	0.448	0.304	0.028
Average	0.463	0.322	0.030

PM emissions by LCV	1995	2000	2020
Finland	0.343	0.163	0.041
France	0.311	0.207	0.056
Germany	0.333	0.175	0.042
Greece	0.005	0.003	0.000
Ireland	0.360	0.195	0.040
Italy	0.254	0.159	0.024
Netherlands	0.287	0.164	0.056
Spain	0.198	0.142	0.032
UK	0.199	0.155	0.049
Average	0.268	0.171	0.044

Source: Auto-Oil II basecase

VOC emissions by HGV	1995	2000	2020
Finland	1.206	1.251	0.557
France	0.978	0.888	0.425
Germany	0.996	0.916	0.419
Greece	1.199	1.081	0.540
Ireland	1.001	1.059	0.514
Italy	1.220	1.107	0.506
Netherlands	1.131	1.045	0.739
Spain	1.306	1.225	0.647
UK	1.149	1.042	0.483
Average	1.118	1.032	0.511

VOC emissions by LCV	1995	2000	2020
Finland	0.717	0.458	0.114
France	1.159	0.595	0.143
Germany	0.675	0.366	0.105
Greece	3.591	1.789	0.070
Ireland	0.487	0.323	0.103
Italy	1.045	0.582	0.077
Netherlands	0.934	0.458	0.146
Spain	1.871	0.994	0.099
UK	2.018	0.888	0.124
Average	1.322	0.666	0.118

Source: Auto-Oil II basecase

Other freight transport modes (rail, short sea shipping and waterways) must be taken into account, especially if we want to assess substitution between these modes.

For inland waterways and short sea shipping, the EC White Paper "Time to decide", in Annex II, Table 3, gives total CO_2 emissions and traffic (in tonne-kilometre and vehicle-kilometre) for all non-road modes. CO_2 emissions allow computing the corresponding fuel consumption, if we very reasonably assume that the whole carbon content of the fuel is transformed into CO_2.

Emission factors are usually given in gram per unit of fuel. This is for example the case at the EEA EMEP/CORINAIR emission inventory guidebook, or in the reports from the European research project MEET (Methodologies for Estimating air pollutant emissions from Transport).

EMEP/CORINAIR actually gives current emission factors for barges and diesel trains, as well as emission factors for "future barges". We have used these ones. MEET data have been used for electric trains and short sea shipping (we took the data for a medium speed diesel engine using marine diesel oil, the most usual combination).

Using these figures, we estimated emission factors per tonne-kilometre for inland waterways, short sea shipping and trains. Results are presented in Table 31.

Table 31. Emission factors for non-road modes

	CO2	VOC	CO	Nox	PM10	SOx
1998 (g/1000 tkm)						
Rail	7 884	51.300	31.111	115.975	10.703	76.325
Inland waterways	29 752	69.249	138.499	387.796	6.015	55.369
Short sea shipping	19 983	14.987	46.210	355.944	7.494	124.893
2020 (g/1000 tkm)						
Rail	7 207	25.650	4.725	33.826	4.128	22.338
Inland waterways	27 545	0.436	6.411	7.693	5.568	20.505
Short sea shipping	18 165	13.624	42.007	64.713	6.812	22.706
Changes						
Rail	-8.6%	-50.0%	-84.8%	-70.8%	-61.4%	-70.7%
Inland waterways	-7.4%	-99.4%	-95.4%	-98.0%	-7.4%	-63.0%
Short sea shipping	-9.1%	-9.1%	-9.1%	-81.8%	-9.1%	-81.8%

Source: STRATEC, based on European Commission (for CO_2), EEA and MEET data

To evaluate the cost to society of these emissions, we use the values proposed by the ExternE for transport projects. ExternE is a research programme from the JOULE III programme of the European Commission. It estimated cost of externalities for energy. For the transport sector, ExternE gives external values per pollutant emitted by road transport (Bickel et al., 1997).

ExternE proposes a value for urban areas, where pollutants have a higher impact because they affect more people, more buildings, causing more damages, and a value for rural areas.

For road modes, we have used an average between the urban and non-urban values. For non-road modes, as most emissions occur in non-urban areas, we propose to use the ExternE valuation for rural areas.

Table 32. External costs of pollutants (in 1995 ECU/kg)

1995	PM	NOx	SO2	CO	VOC	CO2
Urban	340.2	6.86	10.78	0.002941	0.7647	0.02471
Interregional	166.7	8.82	8.82	0.001961	0.7647	0.02471
2020	**PM**	**NOx**	**SO2**	**CO**	**VOC**	**CO2**
Urban	558.1	11.26	17.69	0.004825	1.2546	0.04053
Interregional	273.4	14.48	14.48	0.003217	1.2546	0.04053

Source: 1995: ExternE for Transport; 2020: STRATEC estimates

4.6 Noise

Noise is another external cost we have to take into account. In Maibach (2000), we have noise costs per vehicle type and mode per country as a Western Europe average for 1995. We used the European average for all countries in EXPEDITE. To evaluate the 2020 values, we have assumed a growth proportional to that of GDP/capita.

Table 33. External costs of noise for freight, Western Europe average

ECU/ 1000 tkm	1995
LDV	35.7
HDV	5.1
Rail	3.5
Aviation	19.3
Waterborne	0

Source: Maibach (2000)

4.7 Accidents

Several sources give statistics on accidents per country. IRTAD (for International Road Traffic and Accident Data), an OECD database, provides accident rates and number of fatalities per country, for reported accidents with injuries.

Accident data suffer from several limitations. The biggest limitation is that they only cover accidents reported to the police, and with injuries or deaths. Data on accidents with material damage only are very difficult to find. In many countries, they just do not exist.

In addition, we had to assume that the accident and fatality rates would remain constant. Although it is likely that accident rates will decrease in the future as they did in the past, we cannot forecast this decline in any meaningful way.

We must take account of the difference of accident rate across countries. This is important, as it varies from 0.14 accidents per million vehicle-kilometre in Finland to 0.65 in the Czech republic or 0.61 in Germany. Fatality rates also vary widely across countries. These rates are given in Table 34.

Accident rates should be differentiated per vehicle type, or at least between passenger and freight traffic. The available international statistics does not, however, provide this level of detail. As a significant share of accidents involve vehicles of both categories, it might in any case be difficult to establish.

We will assume that there are no accidents for non-road modes. Although this is not totally correct, the number of accidents for rail, water and sea transport is several orders of magnitude lower than for roads. This assumption is thus entirely justified.

Accidents have a cost to society (health costs, lost production, risk, pain, grief and suffering). Estimates of the cost per accidents vary with the methodology used to estimate them. We have used a value, proposed by RAND Europe in previous studies, of 1 million euros per fatality and 35,000 euros per casualty. The cost of accidents and fatalities can easily be computed from the data in Table 34 and these two values.

Table 34. Accident (with casualties) and fatality rates

Country	Accident rate (accidents / million Mvkm)	Fatality rate (Killed/billion vkm)
Austria	0.57	13.2
Belgium	0.54	16.3
Switzerland	0.43	10.6
Czech Republic	0.65	37.8
Germany	0.61	12.0
Denmark	0.16	10.6
Estonia	0.65	37.8
Spain	0.23	15.1
Finland	0.14	8.5
France	0.23	15.1
Greece	0.30	26.7
Hungary	0.65	37.8
Ireland	0.25	13.1
Italy	0.23	15.1
Lithuania	0.65	37.8
Luxembourg	0.54	16.3
Latvia	0.65	37.8
Netherlands	0.34	8.9
Norway	0.26	9.6
Poland	0.65	37.8
Portugal	0.30	26.7
Sweden	0.23	8.3
Slovenia	0.65	37.8
Slovak Republic	0.65	37.8
United-Kingdom	0.52	7.5

Source: IRTAD, STRATEC estimates for some countries

4.8 Road damage

Damage to road is proportional to the weight of the vehicle, actually, to the fourth power of the weight per axle. In practice, cars and light trucks do not cause any damage to road surface. Only trucks above 3.5 tonnes have to be taken into account. De Borger & Proost (2001) suggest a value of 1.411 ECU (in 1995) per 1000 vehicle-kilometres.

For 2020, we will use the same value (in constant 1995 ECU), as road construction and maintenance costs do not increase proportionally to revenues, as do health costs.

For the other modes, we shall assume that the damage to the infrastructure is negligible.

5 SCORING PASSENGER TRANSPORT POLICIES: EVALUATION OF ASPECTS NOT MODELLED IN THE EXPEDITE META-MODEL

Policy simulation with the EXPEDITE meta-model for passenger transport gives the impact of various policies on passenger traffic volumes by mode. This is however not a complete assessment of those policies. A complete cost and benefit assessment should also include other impacts of those policies, as well as implementation costs. In this chapter, we will detail the methodology used to assess those costs and benefits for passenger policies. Freight policies were covered in chapter 4. The methodology for freight traffic has been developed in parallel with the one for passengers. Freight and passenger assessment are thus consistent. This chapter is in many ways similar to the chapter on freight, the differences can mainly be found in the treatment of internal effects and in the fact that some of the values on emissions and noise are stated for cars rather than freight vehicles.

5.1 Introduction

To evaluate policies, we have tried to use an approach as close to cost benefit analysis as it was possible in the EXPEDITE framework. Impacts have thus been as much as possible evaluated in monetary terms.

The costs we included in this analysis are the following:

- The direct cost of transport, i.e. the cost of running the vehicles;
- The cost of time spent travelling;
- External costs:
    - Emissions (pollutants and greenhouse gases);
    - Noise;
    - Accidents, safety;
- Investment, maintenance and operating costs: in this case, monetary valuation was not possible in the context of EXPEDITE. We have therefore provided a qualitative judgment on the magnitude of these costs.

Valuation of internal costs

Changes in time or cost consumption for the different modes will have an impact through the logsums from the EXPEDITE meta-model for passengers (see section 2.5.2). The logsum is a measure of the expected utility that the traveller will get from the mode and destination alternatives in the choice set. As such it is a measure of consumer surplus. Thus, the effect of a policy regarding direct cost of transport and cost of time spent travelling can be measured in terms of logsum differences (change in consumer surplus).

Valuation of external costs

For the valuation of external costs in passenger transport, we used a single set of external costs for all countries, an EU average, as for freight transport.

5.2 Logsum valuation

The EXPEDITE passenger transport model outputs logsums (see section 2.5.2). These logsums have been compared between a base case and the investigated policy to get a logsum difference. The logsum difference needs to be attributed a monetary value. Theoretically this could be done by comparing a base case with a case where all travellers are forced to pay a constant amount of money in some form (for example a constant increase in travel costs for all modes). This has not entirely been possible, partly because there are no costs connected to the 'slow' modes (walking and bicycling). An approximation has been applied where a car cost increase by 10 % for the year 1995 has been used to establish conversion cost factors for the logsums, with a distinction by purpose of the trip. The monetary values used for the conversion of the logsum to internal transport costs are (in Euros per logsum unit):

Commuting	-12.73
Business	-66.99
Education	-29.75
Shopping	-5.09
Other purposes	-11.18
All purposes	-13.53.

5.3 Investment and operation & maintenance

Estimating the actual investment and operation/maintenance (O&M) costs of scenarios would be a large and complex task. In the scope of this study, we only propose a qualitative assessment of these costs for each scenario considered. This is presented in the table below.

5.4 Emissions

For a discussion on the treatment of emissions, we refer to section 4.5. The tables with emission factors are given below (Tables 35-37) for cars. We use the same values as for freight (Table 32) for conversion to money units.

Low investment and O&M cost
8 Cost internalisation, Car cost +25% and Bus cost +10%
9 Fuel price increase, Car cost +10%
10 Fuel price increase, Car cost +25%
11 Fuel price increase, Car cost +40%
14 Cost internalisation, Car cost +40% and Bus cost +25%
19 Harmonisation of rules on speeding, Car time +5%
20 Harmonisation of rules on speeding, Car time +10%
21 Maximum speed limits, Car time +20%
22 Congestion and road pricing, Car cost +25% in area types 1, 2, 3 and 4
23 Congestion and road pricing, Car cost +40% in area types 1, 2, 3 and 4
Medium investment and O&M cost
5 Intermodality/ Interconnectivity, Rail and BTM access/egress time –5% and Rail and BTM wait and transfer time –5%
6 Intermodality/ Interconnectivity, Rail and BTM access/egress time –10% and Rail and BTM wait and transfer time –10%
7 Rail and fluvial interoperability, Rail times -5% and cost -5%
12 Public transport pricing, Rail and BTM cost –10%
13 Public transport pricing, Rail and BTM cost –30%
15 Market liberalization (rail), Rail cost –5%
16 Market liberalization (rail), Rail cost –10%
17 New urban public transport, BTM travel times in area types 1, 2, 3 and 4 –10%
18 New urban public transport, BTM travel times in area types 1, 2, 3 and 4 –25%
24 promoting housing densification, increasing housing in area types 1-4 and decreasing in 5-7 keeping the totals equal
25 promoting employment densification, increasing employment in area types 1-4 and decreasing in 5-7 keeping the totals equal
High investment and O&M cost
None of the policies assessed in the meta-model requires heavy infrastructure works, and none are thus qualified as "high costs". The TEN-T (public transport) policy however would fall in this category.

Table 35. CO and NO_x emission factors for cars (in g/vkm)

CO average emission factor for cars g/km			
	1995	**2000**	**2020**
Finland	11.35	6.80	1.32
France	9.69	6.27	0.94
Germany	9.48	6.38	1.03
Greece	10.19	6.40	1.31
Ireland	9.46	6.90	1.27
Italy	8.75	6.31	1.27
Netherlands	7.83	5.79	1.05
Spain	9.62	6.49	1.10
UK	12.39	8.12	1.21

Source: Auto-Oil II basecase

NOx average emission factor for cars g/km			
	1995	**2000**	**2020**
Finland	1.80	1.14	0.13
France	1.38	0.85	0.14
Germany	1.14	0.75	0.11
Greece	1.22	0.89	0.12
Ireland	1.52	0.96	0.13
Italy	1.51	1.05	0.12
Netherlands	1.22	0.80	0.10
Spain	1.55	1.00	0.12
UK	1.64	1.02	0.12

Table 36. PM10 and VOC emission factors for cars (in g/vkm)

PM10 average emission factor for cars g/km			
	1995	**2000**	**2020**
Finland	0.0230	0.0085	0.0011
France	0.0645	0.0431	0.0112
Germany	0.0284	0.0164	0.0032
Greece	0.0231	0.0055	0.0004
Ireland	0.0264	0.0158	0.0037
Italy	0.0413	0.0200	0.0019
Netherlands	0.0329	0.0168	0.0029
Spain	0.0250	0.0142	0.0030
UK	0.0141	0.0116	0.0038

source: Auto-Oil II basecase

VOC average emission factor for cars g/km			
	1995	**2000**	**2020**
Finland	1.909	1.043	0.048
France	1.668	0.852	0.052
Germany	1.098	0.575	0.043
Greece	1.617	0.912	0.042
Ireland	1.861	0.955	0.045
Italy	1.729	1.082	0.043
Netherlands	1.018	0.595	0.044
Spain	1.840	1.071	0.045
UK	2.192	1.190	0.052

Table 37. CO_2 and SO_2 emission factors for cars (in g/vkm)

CO2 emissions by cars g/km			
	1995	**2000**	**2020**
Finland	181	179	137
France	179	168	118
Germany	217	207	145
Greece	195	191	142
Ireland	174	164	116
Italy	187	184	138
Netherlands	178	168	119
Spain	175	169	129
UK	191	187	139

Source: Auto-Oil II basecase

SO2 emissions by cars g/km			
	1995	**2000**	**2020**
Finland	0.0357	0.0034	0.0026
France	0.0397	0.0207	0.0030
Germany	0.0433	0.0195	0.0036
Greece	0.0383	0.0165	0.0035
Ireland	0.0349	0.0160	0.0029
Italy	0.0360	0.0167	0.0032
Netherlands	0.0332	0.0150	0.0027
Spain	0.0353	0.0165	0.0032
UK	0.0376	0.0177	0.0035

5.5 Accidents

For accidents we refer to the discussion in section 4.7.

5.6 Noise

Maibach (2000) contains not only external noise costs for freight, but also for passenger transport. These are noise costs per vehicle type and mode per country as a Western Europe average for 1995. We used the European average for all countries in EXPEDITE. To evaluate the 2020 values, we have assumed a growth proportional to that of GDP/capita.

Table 38. External costs of noise for passenger transport, Western Europe average

ECU/1000 passenger-km 1995	
Car	5.7
Motos	17
Bus	1.3
Rail	3.9
Aviation	3.6

Source: Maibach (2000)

6 FORECASTING RESULTS WITH THE SCENES MODEL

6.1 Runs for 2020 with the SCENES freight model

Some of the results in this section were obtained within the SCENES project (co-ordinated by MEP in Cambridge), commissioned by DGTREN. These results were taken from SCENES Deliverable 7 'SCENES Transport Forecasting Model: Calibration and Forecast Scenario Results'. In the EXPEDITE project, runs were undertaken for the base year 1995 and for 2020 with the constant cost scenario to check whether we were able to reproduce the published results of SCENES. This is at the same time the run for the EXPEDITE Reference Scenario for 2020, since the only difference between the SCENES external scenario and the EXPEDITE Reference Scenario concerns car ownership, which is not relevant for the freight model. Furthermore, in EXPEDITE a new run for 2020 was done for a situation with lower income and production than assumed in the runs of the SCENES project (the '85% scenario'; see section 3).

In Table 39 are the main outcomes for the total amount of tonnes for 1995 and 2020.

Table 39. Total freight tonnages by movement in 1995 and 2020 (x 1 mln, per year)

	1995 TREX 'observed'	1995 Modelled	2020 Modelled SCENES	2020 Modelled EXPEDITE	2020 85% scenario EXPEDITE
Intra-EU15 total	11,418	11,424	14,605	14,633	12,390
EU15 national	10,653	10,639	13,116	13,134	11,135
Intra-EU15 international	765	786	1,488	1,499	1,255
CEEC – EU15	98	103	245	239	203
EU15 – CEEC	26	26	60	62	53
Rest Europe – EU15	191	191	453	416	353
EU15 – rest Europe	80	75	163	157	134
Rest World – EU15	544	543	1,172	1,175	997
EU15 – rest World	179	183	428	396	337
Index 1995 modelled =100					
Intra-EU15 total	100	100	128	128	108
EU15 national	100	100	123	123	105
Intra-EU15 international	97	100	189	191	160
CEEC – EU15	95	100	238	232	197
EU15 – CEEC	100	100	231	238	204
Rest Europe – EU15	100	100	237	218	185
EU15 – rest Europe	107	100	217	209	179
Rest World – EU15	100	100	216	216	184
EU15 – rest World	98	100	234	216	185

In Table 39, the second column gives the TREX data for 1995 of Eurostat (actually this is a modification of the original TREX data, carried out in the SCENES project to correct for known deficiencies in the TREX data). The SCENES model predictions for 1995 are very similar to TREX at this level. Likewise, the SCENES model run results for 2020 in EXPEDITE are very similar to the runs of the SCENES consortium (for the same reference scenario).

The first row gives the sum of the EU15 national and intra-EU15 international tonnages. These grow by 28% between 1995 and 2020 in the Reference Scenario and by 8% in the scenario in which the 2020 GDP and gross value added per head are only 85% of the reference for 2020. The freight transport volumes are very sensitive to assumptions on production growth.

The domestic freight transport within the countries of the EU15 has a much higher tonnage than the cross-border transport, but the latter is predicted to grow very much faster (just above 20% versus 100% and more relative to 1995). Transport to/from the EU15 (from/to the CEEC, the rest of Europe and the rest of the world) in turn is growing at a slightly faster rate than international transport within the EU15.

The SCENES model forecasts for modal split are in Table 40 (domestic transport) and 41 (international transport within the EU15). The modes here are the main mode: if SCENES predicts that several modes are used within the same consignment, the main modes is the one that is highest in the modal hierarchy: pipeline – air - shipping – inland waterway – rail – truck. An exception is intercontinental transport: for goods entering or leaving the European continent by sea, the main mode in SCENES is set to be main mode on the European continent.

Table 40. Modal share of EU national tonnes lifted in 2020, in %

Scenario	Truck	Rail	Shipping	Inland waterways	Other
1995 Base	92.4	4.3	1.1	1.8	0.3
Expedite 85% scenario	91.4	5.4	1.8	0.9	0.3
Expedite constant cost	91.4	5.4	2.0	0.9	0.3
Scenes constant cost	91.8	4.9	0.8	2.1	0.3

The modal shares for different scenarios for shipping and inland waterways are rather different. In all scenarios, truck has more than 90% of the national market (in tonnes).

Table 41. Modal share of intra-EU international tonnes lifted in 2020, in %

Scenario	Truck	Rail	Shipping	Inland waterways	Other
1995 Base	45.0	9.0	33.1	12.9	0.0
Expedite 85% scenario	46.9	12.1	29.5	11.5	0.0
Expedite constant cost	47.7	12.4	30.2	9.7	0.0
Scenes constant cost	48.3	11.6	30.3	9.8	0.0

In the international transport market, road does not have the dominant position that it has on the national markets. Especially maritime transport also has a large share of the total tonnage. The impact of the 85% scenario (compared to the constant cost scenario, which has the same cost assumptions) on the modal shares is rather limited, the main difference is on the total volume.

In Table 42 the mode shares for the EXPEDITE 2020 constant cost scenario are split by transport flow (‘commodity type’). These are the mode shares in the total of national and intra-EU15 international tonnages.

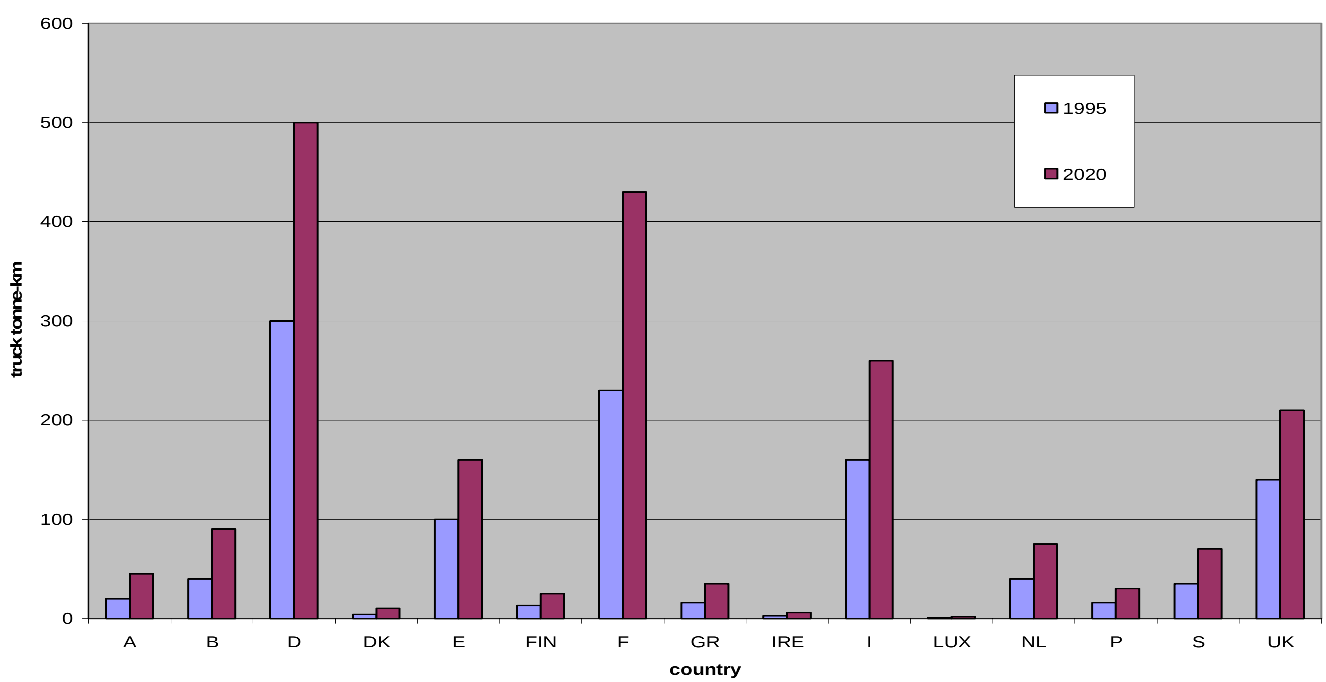
Table 42. Modal share of intra-EU international and national tonnages by transport flow in EXPEDITE 2020 constant cost scenario, in %

Flow	% of flow in total	Truck	Rail	Shipping	Inland waterways
1-Cereal&Agriculture	8.1	87.5	5.0	4.8	2.8
2-Consumer food	5.2	94.4	2.3	1.6	1.7
3-Conditioned food	4.4	96.9	0.6	1.4	1.1
4-Solid Fuel&Ores	4.3	49.5	38.6	5.9	6.0
5-Petroleum products	5.5	58.5	6.4	21.5	7.6
6-Metal products	4.3	66.8	24.1	6.7	2.4
7-Manufactured building materials	9.4	96.3	2.3	0.7	0.7
8-Crude building materials	34.4	94.0	1.8	0.7	3.5
9-Basic chemicals	2.2	78.2	6.4	10.3	5.1
10-Fertilisers&Plastics&Other chemicals	4.2	79.1	9.6	7.3	4.0
11-Large machinery	2.4	82.6	9.5	7.2	0.7
12-Small machinery	0.7	84.4	8.7	6.5	0.2
13-Miscellaneous articles	14.9	89.7	5.7	3.8	0.8

The mode share of truck will be below 75% for three transport flow types: solid fuel and ores, petroleum products and metal products. For the first and the third, rail is predicted to be quite important, for petroleum products, shipping also has a large market share. The flows with the highest tonnages however (crude building materials and miscellaneous articles) get truck shares of 94% and 84% respectively.

Figure 6 below gives the tonne-km by truck in 1995 and 2020 (constant cost scenario) for kilometres travelled within each country of the EU15.

Figure 6. Tonne-km travelled by truck within each EU15 country in 1995 and 2020 (constant cost scenario), in tonne-km (x 1,000 mln, per year)



The largest amounts of tonne-km by truck are driven in Germany, France, Italy and the UK. Truck tonne-km is predicted to grow by almost 3% per year for most countries. The highest growth rates are predicted for Denmark, Belgium, Greece and Portugal, the lowest for Italy and the United Kingdom.

6.2 Runs for 2020 with the SCENES passenger transport model

Some of the results in this section were obtained within the SCENES project (co-ordinated by MEP in Cambridge), commissioned by DGTREN. These results were taken from SCENES Deliverable 7 ‘SCENES Transport Forecasting Model: Calibration and Forecast Scenario Results’. In EXPEDITE runs were done for the base year 1995 and for 2020 with the constant cost scenario, to check whether we were able to reproduce the published results of SCENES. Moreover, in EXPEDITE new runs for 2020 were done for a situation with lower car ownership and incomes than assumed in the runs of the SCENES project (the ‘85% scenario’; see chapter 3) and for the EXPEDITE Reference Scenario (with lower car ownership than in SCENES, but with the same income change assumptions).

Table 43 presents the number of kilometres travelled by mode according to the various model runs. These results are for domestic travel inside each of the EU15 countries only.

Table 43. EU domestic passenger transport in 2020 (x 1,000 mln person-km per year)

Scenario	Car	Bus-Coach	Train	Slow	Air	Total	Total mechanised *
1995 base	3,669	406	273	210	37	**4,594**	**4,348**
Expedite 85% scenario	4,784	491	467	195	88	**6,025**	**5,742**
Expedite constant cost	5,224	486	508	184	106	**6,507**	**6,217**
Scenes constant cost	5,175	482	497	184	105	**6,443**	**6,153**
Expedite Reference	4,902	503	500	192	96	**6,193**	**5,902**
Index 1995=100:							
1995 base	100	100	100	100	100	**100**	**100**
Expedite 85% scenario	130	121	171	93	238	**131**	**132**
Expedite constant cost	142	120	186	88	286	**142**	**143**
Scenes constant cost	141	119	182	88	284	**140**	**141**
Expedite Reference	134	124	183	91	259	**135**	**136**

* Comprises Car, Bus/Coach, Train

The growth in the total number of domestic person-kilometres in the EU15 in 2020 varies between 30% and 42% of the 1995 base levels. The use of non-motorised transport (cycling, walking) decreases under all scenarios for 2020. For bus/coach a relatively modest increase is predicted and for train the growth percentages from the SCENES model are quite high (when assuming constant real cost for all modes).

The outcomes of the SCENES consortium run for the constant cost scenario for 2020 and the EXPEDITE run for the same scenario are very similar, but not identical. In the 85% scenario, with car ownership and income in 2020 at 85% of what it would be under the constant cost scenario, the total mobility growth relative to 1995 is 11% lower than for the constant cost scenario. For kilometrage by car this difference is 12%. Train and air transport kilometrage are also considerably lower in the 85% scenario; these modes show a considerable income sensitivity. For bus/coach transport there is hardly an overall difference between both scenarios, and the use of slow modes is higher under the 85% scenario (substitution from other modes).

In Table 44, the international transport between the EU15 countries was added to the domestic transport.

Table 44. EU domestic plus intra-EU international passenger transport in 2020 (x 1,000 mln person-km per year)

Scenario	Car	Bus-Coach	Train	Slow	Air	Total	Total mechanised *
1995 Base	3,987	431	318	210	277	**5,221**	**4,735**
Expedite 85% scenario	5,329	525	588	195	941	**7,580**	**6,444**
Expedite constant cost	5,777	518	633	184	988	**8,100**	**6,928**
Scenes constant cost	5,713	512	620	184	992	**8,021**	**6,845**
Expedite Reference	5,432	537	622	192	937	**7,720**	**6,591**
Index 1995=100:							
1995 base	100	100	100	100	100	**100**	**100**
Expedite 85% scenario	134	122	185	93	340	**145**	**136**
Expedite constant cost	145	120	199	88	357	**155**	**146**
Scenes constant cost	143	119	195	88	358	**154**	**145**
Expedite Reference	136	125	196	91	338	**148**	**139**

* Comprises Car, Bus/Coach, Train

The picture is basically similar to Table 43. International transport is predicted to grow faster than domestic transport. Car and bus/coach transport are a bit higher than in Table 43, now that cross-border traffic has been added. The use of the slow modes is exactly the same as for domestic transport only. For train passenger kilometrage, international transport is more important than for the other surface transport modes. The biggest difference with Table 43 however is the use of air transport. For some scenarios, after adding international transport, this is ten times the domestic amount.

In Table 45 are the outcomes for domestic transport in the 8 CEEC that are internal to the SCENES passenger transport model (Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia and Slovakia).

Table 45. CEEC domestic passenger transport in 2020 (x1,000 mln person-km per year)

Scenario	Car	Bus-Coach	Train	Slow	Air	Total	Total mechanised *
1995 Base	318	93	47	33	0	**491**	**458**
Expedite 85% scenario	624	91	35	22	1	**773**	**751**
Expedite 2020 CEEC	712	105	58	20	1	**896**	**875**
Scenes 2020 CEEC	700	103	53	19	1	**876**	**856**
Expedite Reference	724	105	58	19	1	**907**	**887**
Index 1995=100							
1995 Base	100	100	100	100	-	**100**	**100**
Expedite 85% scenario	196	98	74	67	-	**157**	**164**
Expedite 2020 CEEC	223	113	123	61	-	**182**	**191**
Scenes 2020 CEEC	220	111	113	58	-	**178**	**187**
Expedite Reference	228	113	123	58	-	**185**	**194**

* Comprises Car, Bus/Coach, Train

The overall mobility grows faster in the CEEC8 than in the EU15 (57-85% versus 31-42%). Especially car use is predicted to grow very fast (to about twice the 1995 levels in 2020), due largely to high income and car ownership growth. Slow modes will be used less, and the use of public transport is quite sensitive to the assumptions on car ownership and income.

In Table 46 are the forecasts of the SCENES model for domestic and international (within the EU15) passenger kilometrage by mode and country, for the 85% scenario. In Table 47 are the same outcomes, but for the constant cost scenario (both are EXPEDITE runs). The total kilometrage (all modes) of the 85% scenario is 4-8% lower than in the constant cost scenario, but the kilometrage by car is 3-12% lower, depending on the country. Table 48 gives the same outcomes for the EXPEDITE Reference Scenario. For most combinations the outcome for the Reference Scenario is between those for the 85% and the constant cost scenario.

Table 46. EU domestic plus intra-EU international passenger transport in 2020, by country, for EXPEDITE 85% scenario (x 1 mln person-km per year)

	Car	Bus-Coach	Train	Slow	Air	Total
Austria	99,217	17,203	18,801	2,905	35,496	173,622
Belgium	157,780	16,826	20,948	3,618	32,407	231,579
Denmark	81,634	17,003	10,828	4,920	21,554	135,939
Finland	69,213	10,306	6,062	1,979	26,716	114,276
France	994,102	61,050	145,291	33,185	78,657	1,312,285
Germany	1,271,918	94,940	123,981	43,358	260,051	1,794,247
Greece	71,496	15,734	1,808	3,152	12,426	104,615
Ireland	44,414	8,522	2,887	1,722	7,440	64,984
Italy	821,992	116,322	111,735	35,114	57,271	1,142,433
Luxembourg	17,156	1,137	447	268	5,644	24,653
Netherlands	266,325	24,466	38,138	13,935	82,054	424,917
Portugal	100,360	18,907	7,846	3,374	4,544	135,031
Spain	438,099	51,861	32,532	9,975	42,845	575,312
Sweden	107,939	11,914	10,436	6,515	56,909	193,714
UK	787,841	58,676	56,547	31,236	217,641	1,151,941
Total EU15	5,329,486	524,866	588,287	195,256	941,655	7,579,549

Table 47. EU domestic plus intra-EU international passenger transport in 2020, by country, for EXPEDITE constant cost scenario (x 1 mln person-km per year)

	Car	Bus-Coach	Train	Slow	Air	Total
Austria	105,714	20,088	17,425	2,683	38,309	184,220
Belgium	172,988	23,057	16,723	3,353	35,589	251,709
Denmark	90,508	11,226	16,519	4,500	23,909	146,661
Finland	75,421	6,653	9,859	1,843	28,810	122,586
France	1,088,013	162,551	58,874	31,041	89,155	1,429,633
Germany	1,369,480	138,005	91,027	41,154	285,211	1,924,877
Greece	78,108	1,717	16,303	2,941	11,861	110,930
Ireland	50,241	3,430	8,730	1,562	3,531	67,495
Italy	862,546	117,663	121,228	34,462	58,184	1,194,082
Luxembourg	17,760	423	1,089	243	6,215	25,731
Netherlands	290,338	37,385	23,198	12,957	91,386	455,264
Portugal	111,804	8,465	18,638	3,124	2,413	144,444
Spain	493,283	32,513	50,901	9,067	45,914	631,679
Sweden	116,507	10,594	11,512	6,096	62,148	206,856
UK	854,687	58,747	55,879	29,133	205,501	1,203,946
Total EU15	5,777,397	632,518	517,906	184,158	988,135	8,100,113

Table 48. EU domestic plus intra-EU international passenger transport in 2020, by country, for EXPEDITE Reference Scenario (x 1 mln person-km per year)

	Car	Bus-Coach	Train	Slow	Air	Total
Austria	101,526	17,392	19,735	2,797	37,120	178,571
Belgium	157,853	17,698	21,993	3,627	32,823	233,994
Denmark	92,658	16,342	11,273	4,410	24,371	149,055
Finland	61,467	12,106	6,428	2,325	24,148	106,474
France	1,031,657	60,228	159,895	32,279	84,748	1,368,807
Germany	1,289,590	95,049	132,892	42,698	271,464	1,831,693
Greece	66,990	17,953	1,821	3,239	10,662	100,665
Ireland	45,229	9,089	3,285	1,708	3,365	62,676
Italy	826,528	120,075	115,794	35,115	54,774	1,152,285
Luxembourg	19,377	1,015	469	218	6,544	27,623
Netherlands	275,014	24,413	37,544	13,557	86,033	436,560
Portugal	102,858	19,711	8,339	3,321	2,358	136,586
Spain	425,516	55,203	32,287	10,113	41,146	564,264
Sweden	104,795	12,888	10,906	7,044	55,955	191,587
UK	830,615	57,718	58,884	29,897	202,025	1,179,139
Total EU15	5,431,673	536,881	621,545	192,346	937,535	7,719,980

7 FORECASTING RESULTS WITH THE FREIGHT META-MODEL

Both the predictions for 1995 and the EXPEDITE Reference Scenario for 2020 come from the SCENES model (transports originating in the EU15) and the NEAC model (transports originating in Norway, Switzerland and the CEEC8), which are combined in the EXPEDITE freight meta-model. Table 49 presents the tonnes generated in each country. These are both domestic and international transports (but for Norway only the latter). The forecasts for 2005, 2010 and 2015 were based on interpolation between 1995 and 2020 (using uniform annual growth rates). The growth in tonnage lifted for all these countries together over the 25-year period is 41%. Except for the last column, the numbers refer to all transport modes together. Tonnes by lorry (used here to indicate all goods transport by road) increase by almost the same percentage: 39% (last column). The variation between countries is considerable. There are seven countries with more than 100% growth (for all modes together), all in CEE.

Table 49. Tonnes (x1000) in 1995, 2005, 2010, 2015 and in 2020 Reference Scenario (domestic and international transport, by country of generation; Norway: only international transport)

	1995	2005	2010	2015	2020	% growth 95-2020	%growth lorry 95-2020
Austria	264072	295088	311937	329747	348372	132	128
Belgium	447738	504844	536073	569234	606268	135	135
Czech	570072	684530	750108	821969	899192	158	165
Denmark	203700	229681	243888	258975	275019	135	128
Estonia	26146	35710	41733	48772	56871	218	325
Finland	395345	463715	502213	543908	590409	149	137
France	1528622	1718470	1822061	1931897	2044722	134	122
Germany	3569364	3877510	4041419	4212258	4405169	123	122
Greece	192616	224096	241715	260720	281152	146	143
Hungary	290261	389805	451727	523487	607788	209	216
Ireland	78245	88225	93682	99477	105708	135	133
Italy	1305595	1427488	1492638	1560761	1634081	125	125
Latvia	33825	48799	58614	70403	84404	250	225
Lithuania	53978	73315	85444	99579	116249	215	236
Luxembourg	37551	43083	46148	49431	53105	141	143
Netherlands	578273	678278	734589	795576	861136	149	150
Norway	21713	25604	27804	30193	32777	151	259
Poland	842185	1124487	1299355	1501417	1731260	206	231
Portugal	284667	320975	340830	361913	382918	135	132
Slovakia	108135	153735	183306	218565	260418	241	245
Slovenia	57285	79375	93434	109984	129489	226	229
Spain	634061	699866	735287	772501	812191	128	132
Sweden	445746	514306	552445	593412	635517	143	135
Switzerland	50390	62887	70254	78484	87668	174	165
UK	1794832	2005642	2120158	2241212	2374309	132	129
Grand Total	13814413	15849665	16977115	18184766	19416194	141	139

In Table 50 are the outcomes in terms of tonne-kilometres, again by origin country of the respective transports. The total growth in tonne-kilometrage (79%) between 1995 and 2020 is almost twice as high as for tonnes (41%): the average transport distance is increasing quite a lot. The increase in GDP in the study area is of the same magnitude as the increase in tonne-kilometres. In terms of tonne-kilometres, lorry transport (+89%) grows more than average (+79%), whereas in terms of tonnage growth, lorry was just below the average growth percentage. Below, we shall come back to the reasons for this.

Table 50. Tonne-kilometres (x1mln) in 1995, 2005, 2010, 2015 in 2020 Reference Scenario (domestic and international transport, by country of generation; Norway: only international transport)

	1995	2005	2010	2015	2020	%growth 95-2020	%growth lorry 95-2020
Austria	37760	48915	55674	63366	71939	191	184
Belgium	101756	123414	135916	149683	164955	162	161
Czech	152840	186284	205657	227045	250120	164	177
Denmark	47176	59945	67572	76169	85869	182	193
Estonia	8849	11145	12507	14036	15779	178	339
Finland	101555	148371	179338	216769	262295	258	189
France	314000	410991	470201	537941	616416	196	185
Germany	465129	558517	612023	670655	736734	158	154
Greece	50133	66808	77122	89028	102906	205	290
Hungary	102945	142895	168353	198347	233209	227	236
Ireland	18018	22331	24860	27676	30751	171	204
Italy	319456	374702	405810	439501	475241	149	158
Latvia	3050	4656	5754	7109	8788	288	269
Lithuania	24239	32489	37614	43548	50363	208	291
Luxembourg	9829	11802	12933	14172	15578	158	178
Netherlands	149474	191176	216206	244514	276547	185	206
Norway	57076	71558	80124	89715	100229	176	249
Poland	315246	421733	487789	564191	651683	207	246
Portugal	32519	41771	47342	53655	60969	187	192
Slovakia	44870	65656	79421	96072	116036	259	266
Slovenia	12953	18537	22175	26528	31768	245	257
Spain	202457	227601	241321	255868	271974	134	173
Sweden	168830	218248	248143	282132	321232	190	213
Switzerland	11075	16453	20054	24442	29805	269	253
UK	381395	467109	516940	572086	631598	166	144
Grand Total	3132629	3954123	4442432	4991044	5612783	179	189

Figure 7 refers to the whole study area. If we look at the different modes, then we see that in the EXPEDITE Reference Scenario, in terms of tonnes, inland waterways transport, and rail transport grow slightly more than average, and sea transport considerably more. But for tonne-kilometres the picture is quite different: rail grows as fast as the total does, inland waterways and sea transport grow less fast and lorry grows fastest.

Figure 7. 2020 Reference Scenario forecasts by mode (1995=100; IWW=inland waterways transport)

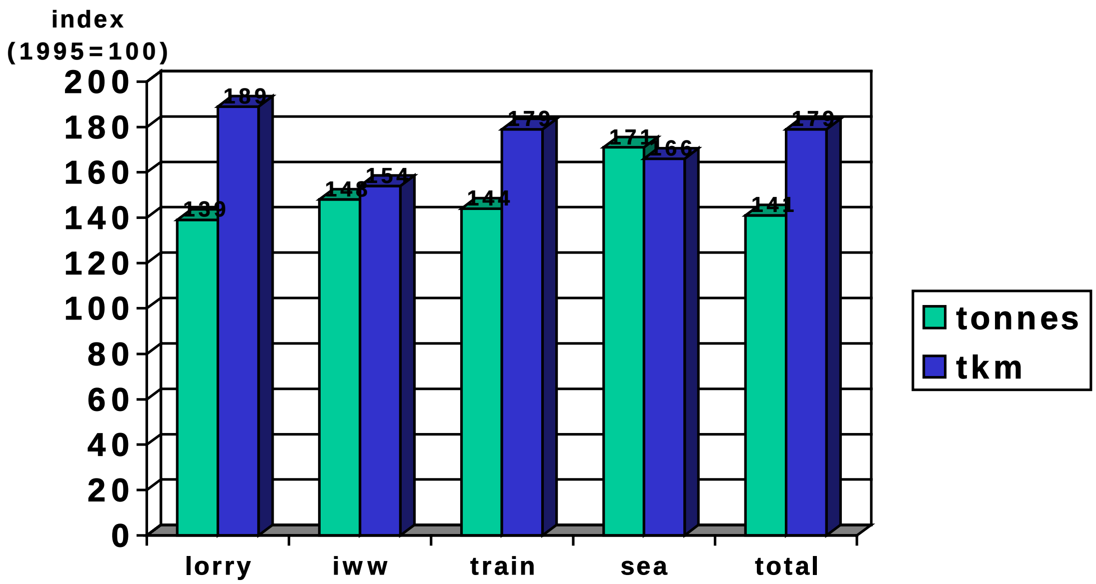


Figure 8. 2020 Reference Scenario forecasts by mode and commodity type (based on tonne-kilometres, 1995=100; IWW=inland waterways transport)

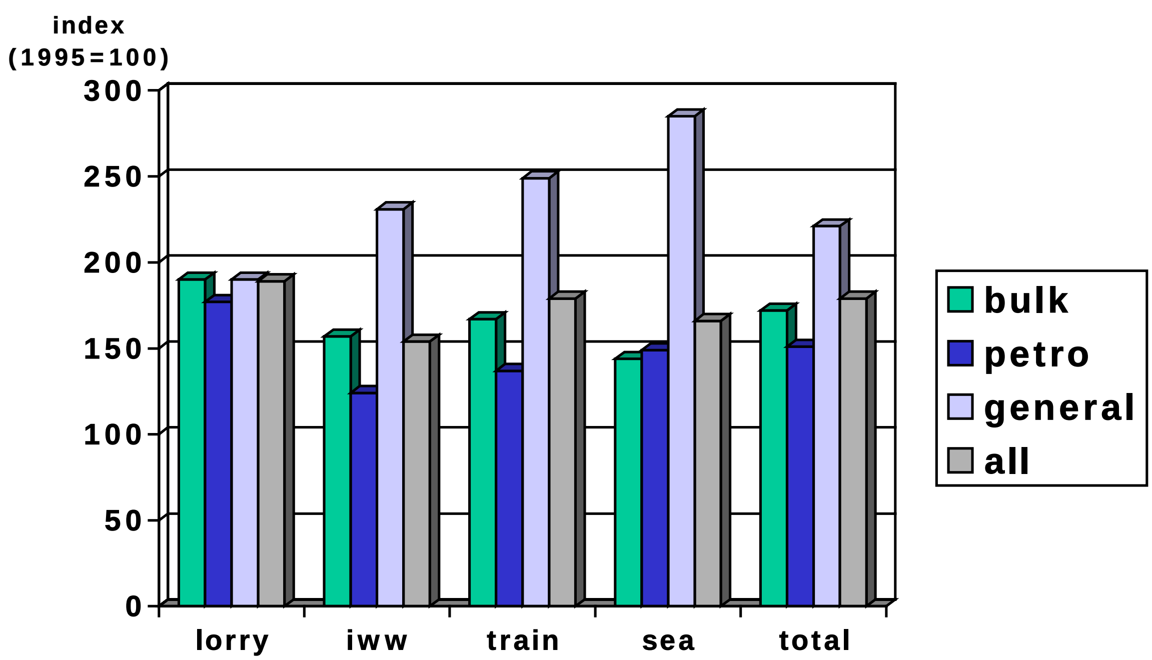
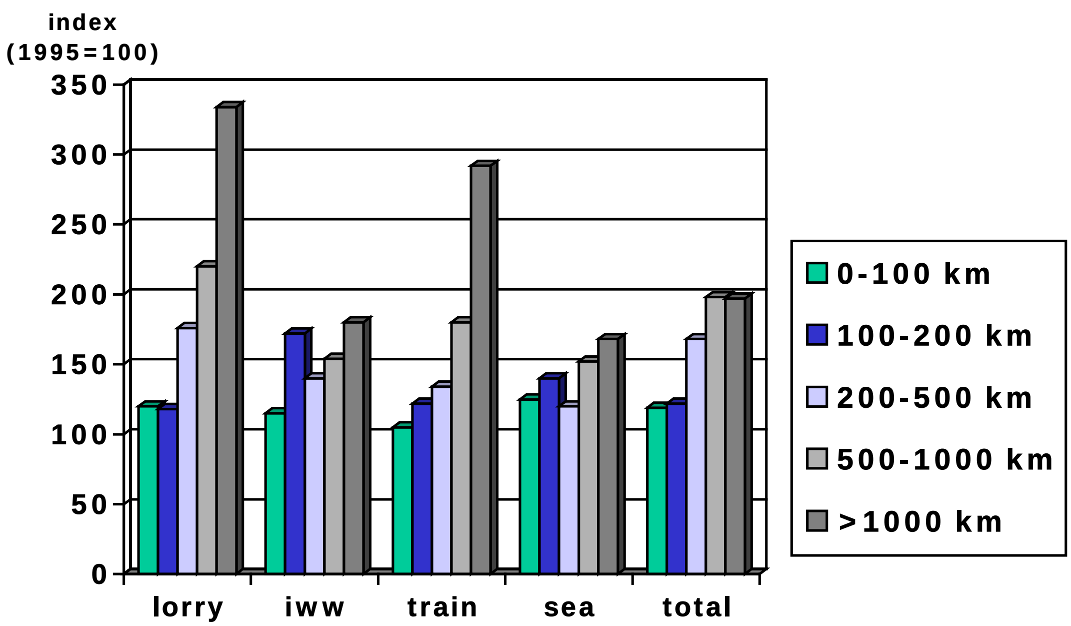


Figure 8 is similar to Figure 7, but adds the distinction by commodity type to the changes in tonne-kilometrage by mode. General cargo transport grows faster than for other commodities. This is a segment where road transport is in a relatively good position relative to the other modes.

In Figure 8 we can see a decrease in the degree of modal specialisation. Inland waterways, sea and rail transport grow faster than average in general cargo, taking away parts (usually small parts) from segments that used to be dominated by road transport. At the same time, road transport grows more than average in segments where other modes are relatively strong: bulk goods, petroleum and petroleum products.

Figure 9. 2020 Reference Scenario forecasts by mode and distance class (based on tonne-kilometres, 1995=100; IWW=inland waterways transport)



The growth in tonne-kilometrage by mode and distance class over the period 1995-2020 is given in Figure 9. Lorry grows fastest in the distance classes 500-1000 km and >1000 km. That explains why the overall tonne-kilometrage of lorry increases so much more that its tonnage. For train the distance class pattern is the same as for lorry, but less pronounced. Inland waterways and sea transport do not witness extra growth in tonne-kilometrage at the large distance end. Therefore their increase in overall tonne-kilometrage is not much bigger than the growth in tonnes.

8 FORECASTING RESULTS FOR SHORTER DISTANCE TRAVEL FROM THE META-MODEL FOR PASSENGERS

The results in this chapter are for passenger transport with trip (=one-way) distances up to 160 km. These results come from runs with the meta-model for passenger transport, developed within EXPEDITE. This model is based on the runs with the five national passenger transport models available in EXPEDITE.

In Table 51 are the annual number of tours (=round trips) for distances up to 160 km in the base-year 1995 according to the meta-model (after validation to available observed data for 1995). In Table 52 are the forecasts for 2020, for the EXPEDITE Reference Scenario. Table 53 gives the growth between 1995 and 2020 in terms of index numbers.

Table 51. Number of tours (x1000) in 1995 by country (with trip distances up to 160 km)

Country	Car driver	Car passenger	Train	Bus/tram/metro	Non-motorised	Total
Austria	1506064	408700	208429	443060	1230944	3797196
Belgium	1257517	546988	151702	84586	2435318	4476110
Germany	19647515	7666008	861833	1860426	15191183	45226966
Denmark	2097892	569998	87837	293298	1143443	4192468
Spain	10517353	5855994	326517	2630551	10632346	29962762
Finland	814147	366180	23114	217697	737614	2158751
France	11076060	5005514	566097	1373605	13901746	31923022
Greece	1686076	1240262	27070	1189827	3300764	7443999
Ireland	784430	475177	28154	291897	1093739	2673397
Italy	21296976	8569992	1037009	5678740	14536872	51119588
Luxembourg	69906	25974	1998	6843	86736	191456
Netherlands	2284177	1333084	148789	247183	4271587	8284821
Portugal	2019386	1170906	93424	817435	2738855	6840005
Sweden	1281917	556374	9908	259673	1033321	3141194
UK	10012286	5965167	258606	1814958	8297555	26348572
Czech Rep.	605086	397759	227805	2229117	2809654	6269421
Estonia	53813	125047	5683	272780	370486	827808
Hungary	415129	1045830	154557	2074152	2978004	6667672
Lithuania	133098	373141	15109	678190	980886	2180423
Latvia	58888	180240	21995	527997	641291	1430411
Poland	1158774	3552464	464185	1799819	10421382	17396624
Slovenia	128526	265225	12551	63469	469842	939612
Slovakia	202328	516115	77160	1142033	1410756	3348392
Norway	659903	394502	15756	95395	949193	2114748
Switzerland	2034203	958999	125870	465536	1543146	5127756
Grand Total	91801449	47565639	4951158	26558264	103206664	274083173

Table 52. Number of tours (x1000) in the 2020 Reference Scenario by country (with trip distances up to 160 km)

Country	Car driver	Car passenger	Train	Bus/tram/metro	Non-motorised	Total
Austria	1731689	414250	249786	498173	1245371	4139269
Belgium	1538415	561077	172922	92627	2434966	4800007
Germany	22715259	8175183	967468	2016490	15080720	48955119
Denmark	2591437	623732	105403	343040	1179371	4842983
Spain	13541092	5734988	336338	2404335	9934067	31950820
Finland	1040005	351764	24803	221417	730500	2368489
France	13658779	5155787	688691	1543502	14217466	35264225
Greece	2494098	1393815	26690	1027932	3253517	8196052
Ireland	1026404	535366	33794	315533	1082213	2993311
Italy	23161428	8181704	1042193	5288195	13104131	50777651
Luxembourg	96372	34045	2736	9866	102076	245097
Netherlands	3011963	1394243	177094	282479	4421921	9287701
Portugal	2593614	997895	94865	717352	2645849	7049576
Sweden	1542256	590815	11582	289363	1071418	3505433
UK	12433792	5807695	270606	1685076	8039585	28236754
Czech Rep.	897951	384281	229073	1525497	2210251	5247053
Estonia	88180	126074	6588	150382	240769	611992
Hungary	684568	1006986	150316	1341482	2240338	5423690
Lithuania	280242	437066	19132	453534	739681	1929656
Latvia	112876	214749	24150	313945	432954	1098674
Poland	2528237	4961402	500718	1221164	9163306	18374827
Slovenia	173513	219521	21568	52601	380881	848084
Slovakia	420743	672584	78783	816063	1187206	3175380
Norway	806759	391208	20056	115576	975808	2309406
Switzerland	2397972	962080	166179	572104	1532788	5631124
Grand Total	111567646	49328311	5421535	23297727	97647154	287262373

Table 53. Growth in the number of tours between 1995 and the 2020 Reference Scenario by country (with trip distances up to 160 km; index numbers 1995=100)

Country	Car driver	Car passenger	Train	Bus/tram/metro	Non-motorised	Total
Austria	115	101	120	112	101	109
Belgium	122	103	114	110	100	112
Germany	116	107	112	108	99	108
Denmark	124	109	120	117	103	116
Spain	129	98	103	91	93	107
Finland	128	96	107	102	99	110
France	123	103	122	112	102	110
Greece	148	112	99	86	99	110
Ireland	131	113	120	108	99	112
Italy	109	95	100	93	90	99
Luxembourg	138	131	137	144	118	128
Netherlands	132	105	119	114	104	112
Portugal	128	85	102	88	97	103
Sweden	120	106	117	111	104	112
UK	124	97	105	93	97	107
Czech Rep.	148	97	101	68	79	84
Estonia	164	101	116	55	65	74
Hungary	165	96	97	65	75	81
Lithuania	211	117	127	67	75	104
Latvia	192	119	110	59	68	77
Poland	218	140	108	68	88	106
Slovenia	135	83	172	83	81	90
Slovakia	208	130	102	71	84	95
Norway	122	99	127	121	103	109
Switzerland	118	100	132	123	99	110
Grand Total	122	104	110	88	95	105

The overall growth in the number of tours for the distances below 160 km in the period 1995-2020 is limited: +5% (see Table 53). Please note that travel for longer distances is predicted to grow much faster than this (see the next chapter). The mode that grows fastest is car driver (+22%). The variation between countries is considerable. The increase in the number of tours as car driver is lowest in countries which already have the highest car ownership levels, such as Italy and Germany. It is highest in the CEEC, where the number of car-driver tours sometimes goes up by more than 100%. For car passenger and train as main mode, there is also a growth in the number of short distance tours per year (+4% and +10% respectively). Bus/tram/metro tours and non-motorised (walking, cycling) tours will between 1995 and 2020 decrease by 12% and 5% respectively, according to the meta-model.

Table 54 presents the number of passenger kilometres for 1995 (again for trip distances up to 160 km), by mode and country. These are the meta-model forecasts after validation of the model against available national statistics. The forecasts for the EXPEDITE Reference Scenario for 2020 are in Table 55. Table 56 gives the growth in the 1995-2020 period in index numbers.

Table 54. Passenger kilometres (x1mln) in 1995 by country (in trips up to 160 km)

Country	Car driver	Car passenger	Train	Bus/tram/metro	Non-motorised	Total
Austria	44209	22583	8318	14043	2878	92030
Belgium	67388	28966	4239	2587	18234	121414
Germany	498716	243463	64219	86139	54641	947177
Denmark	34422	12979	4204	5154	3443	60201
Spain	180513	130804	17842	43789	79047	451996
Finland	37677	23133	3417	6028	4757	75013
France	360496	192940	47236	50288	20236	671196
Greece	28948	29911	1607	20889	24903	106257
Ireland	13192	10097	1311	5191	8158	37949
Italy	409040	203682	53600	91872	109090	867283
Luxembourg	3271	1426	300	399	668	6065
Netherlands	76155	32044	18401	7690	27850	162140
Portugal	35286	26871	4812	13606	21280	101855
Sweden	46300	21634	1552	9555	3883	82925
UK	305389	193806	30448	45061	19194	593899
Czech Rep.	8950	7939	8019	31111	22700	78720
Estonia	1329	2550	391	3096	2874	10238
Hungary	11757	24684	7565	23320	22459	89786
Lithuania	3434	7992	1849	8887	7647	29808
Latvia	1487	3924	1335	6274	5068	18088
Poland	34010	74102	26568	30333	80196	245209
Slovenia	7562	6275	648	2100	3491	20076
Slovakia	5214	11200	4249	12761	10708	44134
Norway	19931	13887	1301	2814	7215	45147
Switzerland	42555	22739	4603	3669	11682	85248
Grand Total	2277231	1349632	318033	526656	572300	5043852

Table 55. Passenger kilometres (x1mln) in the 2020 Reference Scenario by country (in trips up to 160 km)

Country	Car driver	Car passenger	Train	Bus/tram/metro	Non-motorised	Total
Austria	50604	23324	9889	16318	2923	103058
Belgium	81894	30211	4766	2933	18419	138223
Germany	567172	263941	70159	95599	54562	1051433
Denmark	41622	14682	4934	6138	3616	70991
Spain	247025	127103	18019	40763	72922	505832
Finland	48862	22639	3638	6292	4668	86098
France	440240	201666	56787	57843	20800	777336
Greece	45932	31923	1525	17974	23423	120778
Ireland	17544	11318	1528	5815	7957	44162
Italy	449816	192145	51817	86775	96434	876988
Luxembourg	4562	1977	401	590	835	8365
Netherlands	98996	33603	21362	9219	28973	192152
Portugal	48589	22460	4962	11946	19522	107479
Sweden	54717	23019	1754	10702	3989	94180
UK	385755	185909	30885	42040	17495	662085
Czech Rep.	14965	8076	5926	19854	16520	65340
Estonia	2244	2470	338	1571	1797	8420
Hungary	21150	23958	7082	14022	16116	82328
Lithuania	8512	10532	2059	5597	5605	32305
Latvia	2877	4405	1298	3539	3353	15471
Poland	84414	106576	22498	19529	68431	301449
Slovenia	11828	5651	1034	1747	2700	22960
Slovakia	12575	15686	3306	8515	8654	48737
Norway	23532	14163	1655	3418	7380	50148
Switzerland	49450	23738	6000	4603	11467	95259
Grand Total	2814877	1401175	333622	493342	518561	5561577

Table 56. Growth in the number of passenger kilometres between 1995 and the 2020 Reference Scenario by country (in trips up to 160 km; index numbers 1995=100)

Country	Car driver	Car passenger	Train	Bus/tram/metro	Non-motorised	Total
Austria	114	103	119	116	102	112
Belgium	122	104	112	113	101	114
Germany	114	108	109	111	100	111
Denmark	121	113	117	119	105	118
Spain	137	97	101	93	92	112
Finland	130	98	106	104	98	115
France	122	105	120	115	103	116
Greece	159	107	95	86	94	114
Ireland	133	112	117	112	98	116
Italy	110	94	97	94	88	101
Luxembourg	139	139	134	148	125	138
Netherlands	130	105	116	120	104	119
Portugal	138	84	103	88	92	106
Sweden	118	106	113	112	103	114
UK	126	96	101	93	91	111
Czech Rep.	167	102	74	64	73	83
Estonia	169	97	87	51	63	82
Hungary	180	97	94	60	72	92
Lithuania	248	132	111	63	73	108
Latvia	193	112	97	56	66	86
Poland	248	144	85	64	85	123
Slovenia	156	90	160	83	77	114
Slovakia	241	140	78	67	81	110
Norway	118	102	127	121	102	111
Switzerland	116	104	130	125	98	112
Grand Total	124	104	105	94	91	110

The total number of passenger kilometres (in trip distances up to 160 km) grows faster than the total number of tours: +10% versus +5% for the period 1995-2020 (see tables 56 and 53). There is thus not only an increase in the number of tours, but also in the average tour distance. As for tours, car driver is the mode with the highest growth (24% more passenger kilometres in the study area). The growth rates for vehicle kilometres (=car driver kilometres) in the EU15 countries are between 10 and 40%, but can go as high up as 150% in the CEEC. These high growth rates of car use are mainly caused by the predicted increases in car ownership and income in the CEEC (to a lesser extent also by the increased performance of the road networks). For some CEEC the total (all modes) number of tours and kilometres decreases, mainly as a result of a decline in population. Car passenger grows by 4% and train traveller kilometrage by 5%. The kilometrage travelled by bus/tram/metro and by the non-motorised modes will between 1995 and 2020 decline by 6% and 9% respectively.

The tables above all referred to the years 1995 or 2020. In Table 57 the number of tours (with trip distances up to 160 km) for the intermediate years is given, as generated directly by the passenger meta-model, using data on the model inputs (e.g. population and income) for the different years. The number of passenger kilometres for the intermediate years is in Table 58.

Table 57. Number of tours (x1000) in 1995, 2000, 2005, 2010, 2015 and 2020 Reference Scenario by country (with trip distances up to 160 km)

Country	1995	2000	2005	2010	2015	2020
Austria	3797196	3842590	3914357	4007413	4085834	4139269
Belgium	4476110	4532359	4600115	4667098	4745447	4800007
Germany	45226966	45912197	47180770	47934676	48555298	48955119
Denmark	4192468	4420769	4524853	4618908	4786753	4842983
Spain	29962762	29927037	30708244	31288996	31856976	31950820
Finland	2158751	2237627	2282582	2328126	2338884	2368489
France	31923022	32493529	33048847	33874548	34772676	35264225
Greece	7443999	7465603	7678851	7935711	8050449	8196052
Ireland	2673397	2723185	2789325	2847897	2924152	2993311
Italy	51119588	51296749	51289412	51472066	51222596	50777651
Luxembourg	191456	205968	217165	226351	234311	245097
Netherlands	8284821	8527136	8759828	8991698	9176654	9287701
Portugal	6840005	6762884	6899761	7017541	7111101	7049576
Sweden	3141194	3167444	3249250	3303505	3419442	3505433
UK	26348572	27094149	27459630	27666477	27927036	28236754
Czech Rep.	6269421	6066913	5793926	5573183	5422936	5247053
Estonia	827808	795855	731969	666433	654662	611992
Hungary	6667672	6365744	6080689	5799893	5670962	5423690
Lithuania	2180423	2130673	2045773	1972993	2028166	1929656
Latvia	1430411	1359550	1267218	1180384	1154637	1098674
Poland	17396624	17486404	17423430	17408214	18282337	18374827
Slovenia	939612	931613	893696	882575	887542	848084
Slovakia	3348392	3329040	3272741	3229948	3242658	3175380
Norway	2114748	2166358	2221839	2261368	2277771	2309406
Switzerland	5127756	5199253	4802215	5402160	5539602	5631124
Grand Total	274083173	276440627	279136485	282558164	286368883	287262373

Table 58. Number of passenger kilometres (x1mln) in 1995, 2000, 2005, 2010, 2015 and 2020 Reference Scenario by country (with trip distances up to 160 km)

Country	1995	2000	2005	2010	2015	2020
Austria	92030	93854	96052	98528	101223	103058
Belgium	121414	125657	128929	131651	135535	138223
Germany	947177	970534	994947	1011637	1034583	1051433
Denmark	60201	63861	65486	66787	69647	70991
Spain	451996	455700	471108	484712	498882	505832
Finland	75013	78796	81030	83472	84452	86098
France	671196	688944	702997	723943	756710	777336
Greece	106257	106638	109942	113991	117075	120778
Ireland	37949	39174	40487	41781	43043	44162
Italy	867283	870852	870812	875032	877991	876988
Luxembourg	6065	6562	7033	7369	7848	8365
Netherlands	162140	169197	176430	182511	188321	192152
Portugal	101855	100342	102853	105169	107600	107479
Sweden	82925	83635	85600	86995	91391	94180
UK	593899	621581	633916	641759	652745	662085
Czech Rep.	78720	75950	71590	67924	67591	65340
Estonia	10238	9882	9209	8429	8940	8420
Hungary	89786	86390	83458	79981	85375	82328
Lithuania	29808	29395	28441	27688	33908	32305
Latvia	18088	17314	16275	15279	16283	15471
Poland	245209	248358	248839	249919	297733	301449
Slovenia	20076	20417	20347	20826	23747	22960
Slovakia	44134	43959	43526	43353	49235	48737
Norway	45147	46686	47927	48781	49455	50148
Switzerland	85248	87351	67600	90770	93454	95259
Grand Total	5043852	5141028	5204833	5308286	5492768	5561577

In Figure 10 are the number of passenger kilometres in 1995 and 2020 as predicted by the meta-model, but now by travel purpose. For all purposes there is an increase in passenger kilometrage between 1995 and 2020, except for education. The latter is caused by the absence of growth in the number of persons in the younger age cohorts. The biggest relative growth takes place for business travel.

The development by distance can be found in Figure 11. Here we observe that the biggest growth within the 0-160 km segment takes place in the distance bands 8-16, 16-40 and 40-80 km trip distance. At distances above 160 the growth rates are considerably higher, as was found in the outcomes of the SCENES model runs.

Figure 10. Passenger kilometres in 1995 and 2020 Reference Scenario by travel purpose (in trips up to 160 km)

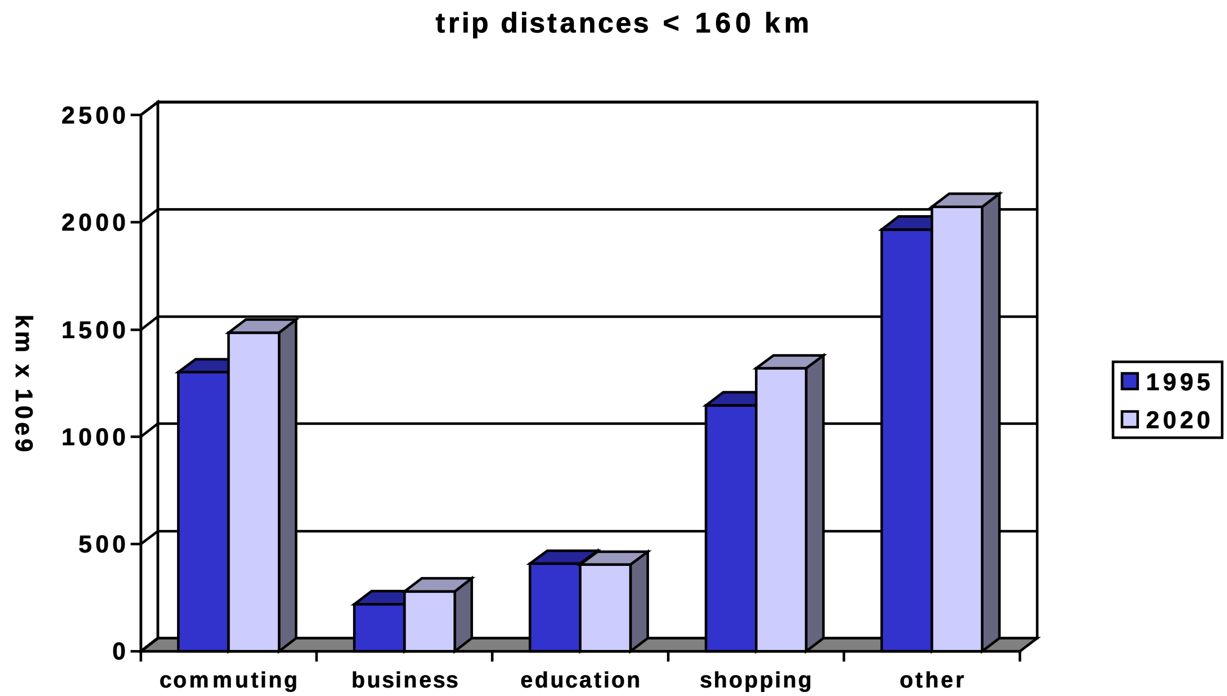
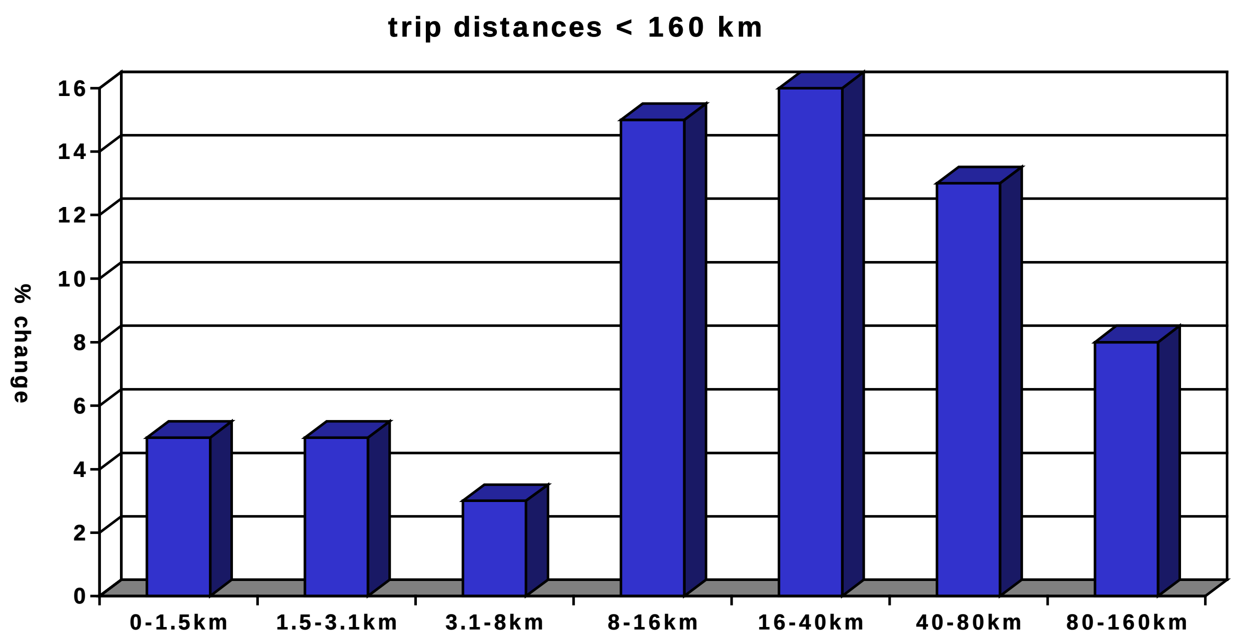


Figure 11. Percentage growth in passenger kilometres between 1995 and 2020 Reference Scenario by trip distance (in trips up to 160 km)



In Figures 12-14, the mode shares in 1995 are given by household income, car ownership and area type.

Figure 12. Mode shares (in percentages of total passenger kilometrage in study area in 1995) by net annual household income

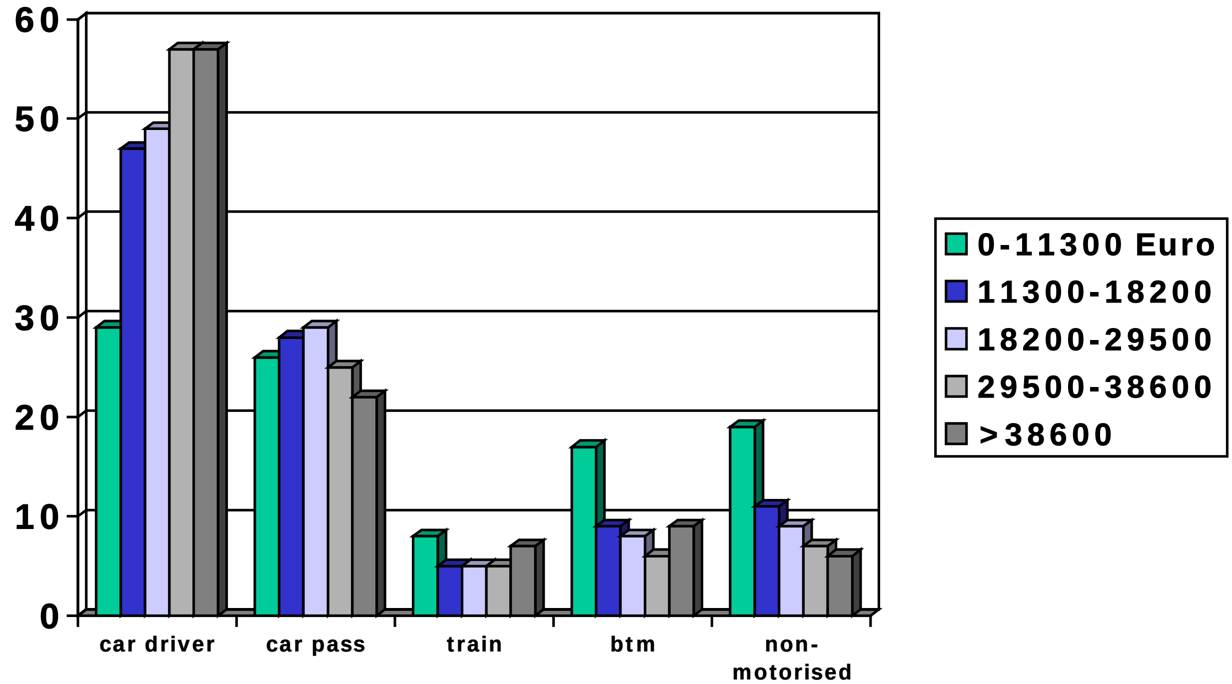


Figure 13. Mode shares (in percentages of total passenger kilometrage in study area in 1995) by type of car ownership

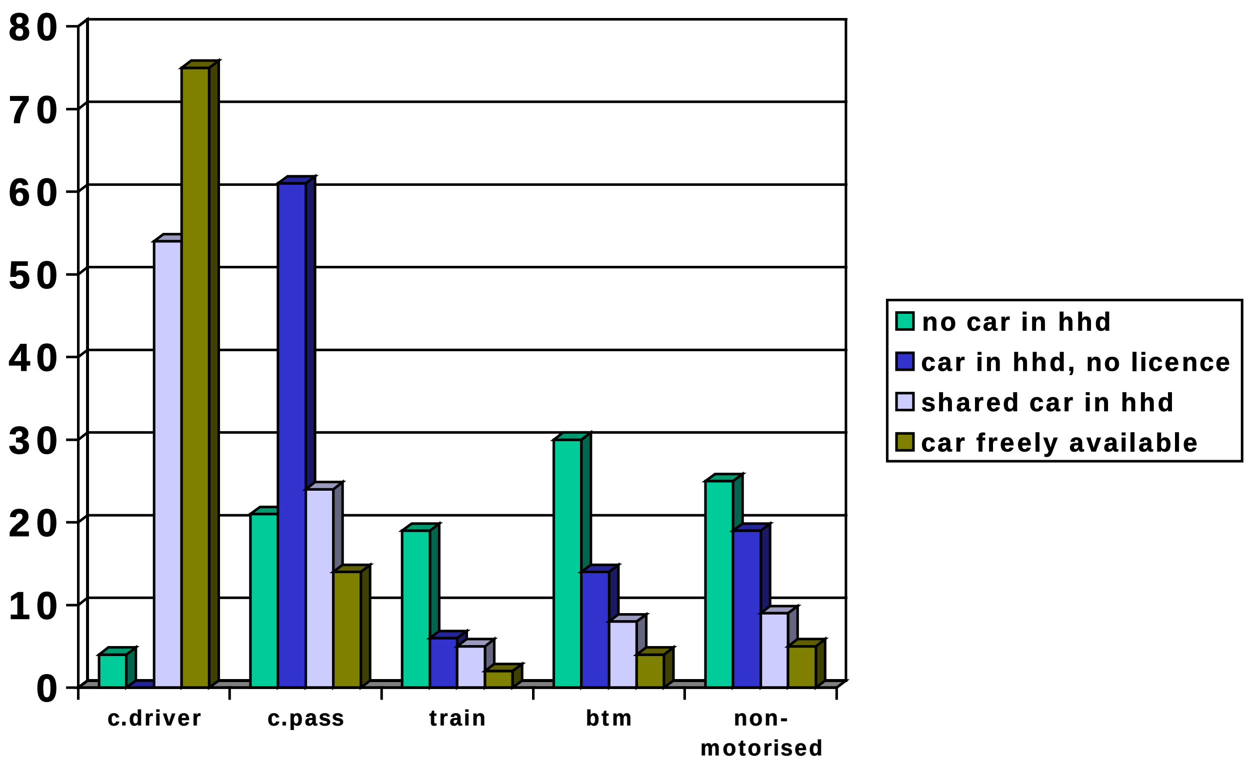
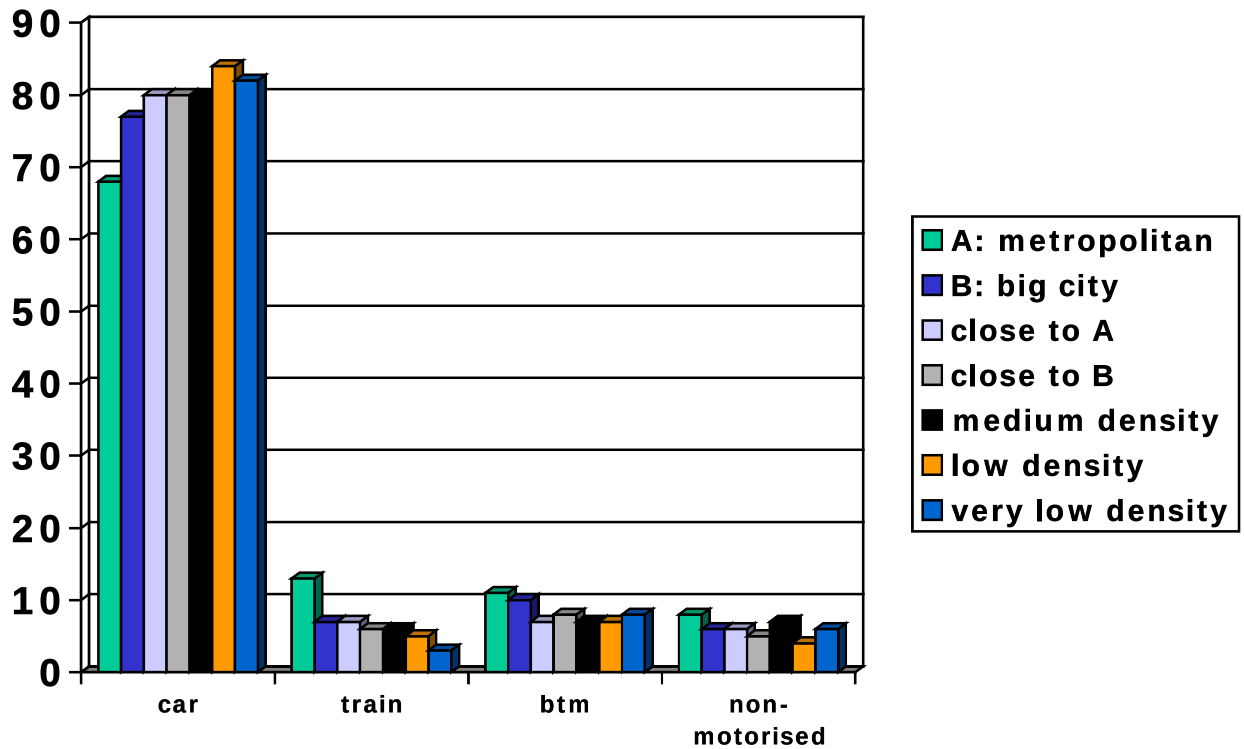


Figure 14. Mode shares, in percentages of total passenger kilometrage, in North-Western Europe in 1995 by area type



In Figure 12 are the mode shares (in percentages) in the 1995 passenger kilometrage in all 25 countries studied, by income class. Income is measured here as net annual household income in Euros of 1995. This graph and the next one are included to give some insights in how the meta-model works in forecasting, and particularly to show why the meta-model predicts big increases in car use in the CEEC. If in Figure 12 one moves from the left to the right within some mode, income goes up. So one can see here that if household income increases, the share of car driver in total kilometrage clearly increases as well. For car passenger, there is no clear pattern with income. For train, the highest mode share is in the lowest income group, but the second highest mode share is in the highest income group. This is also true for bus/tram/metro, but here the lowest income group is relatively more important. The share of non-motorised transport declines with income.

Figure 13 also gives the mode shares in the total 1995 passenger kilometrage, but now by type of car ownership. There are four car ownership categories in the meta-model:

- persons in households without a car;
- persons who do not have a driving licence, in households with a car;
- persons with a driving licence in households where there are more driving licences than cars, so they have to share (the) car(s);
- persons with a driving licence in households with as least as many cars as driving licences, so they do not have to compete for a car, it is freely available.

If there is no car in the household, there is only little car use (rented car, somebody else's car). If the person does not have a driving licence and the household has a car, there is no car use, but there is a considerable share for the car passenger mode. In the shared car segment and especially in the car freely available segments, the car modes are very important in total kilometrage (89% of all kilometres travelled in the car freely available segment are done as car driver or car passenger). The shares of train, bus/tram/metro and the non-motorised modes decrease as car availability goes up.

Figure 12 and 13 tell the story of the main mechanism in forecasting with the meta-model, especially for predicting for the CEEC. Between 1995 and 2020 persons in the CEEC are (in the Reference Scenario) moving from lower to higher income classes and from car ownership types with limited car availability to types with greater car availability. In the model this is represented by using higher fractions in the expansion for 2020 for the higher income and car ownership categories (the behaviour of the segments will not change, but the importance of the behavioural segments will change). Also in the CEEC the road network performance will increase, whereas the real travel cost will remain the same. Because of these shifts, the use of the car mode (especially as car driver) will increase considerably in the CEEC.

Mode shares in 1995 kilometrage by area type are given in Figure 14. The area types used in the meta-model were based on NUTS3 population, population density and distance to the major centres. The categories for area type are (see section 2.5):

- metropolitan areas;
- other big cities;
- areas close to the metropolitan areas;
- areas close to the other big cities;
- other areas with medium population density;
- other areas with low population density;
- other areas with very low population density.

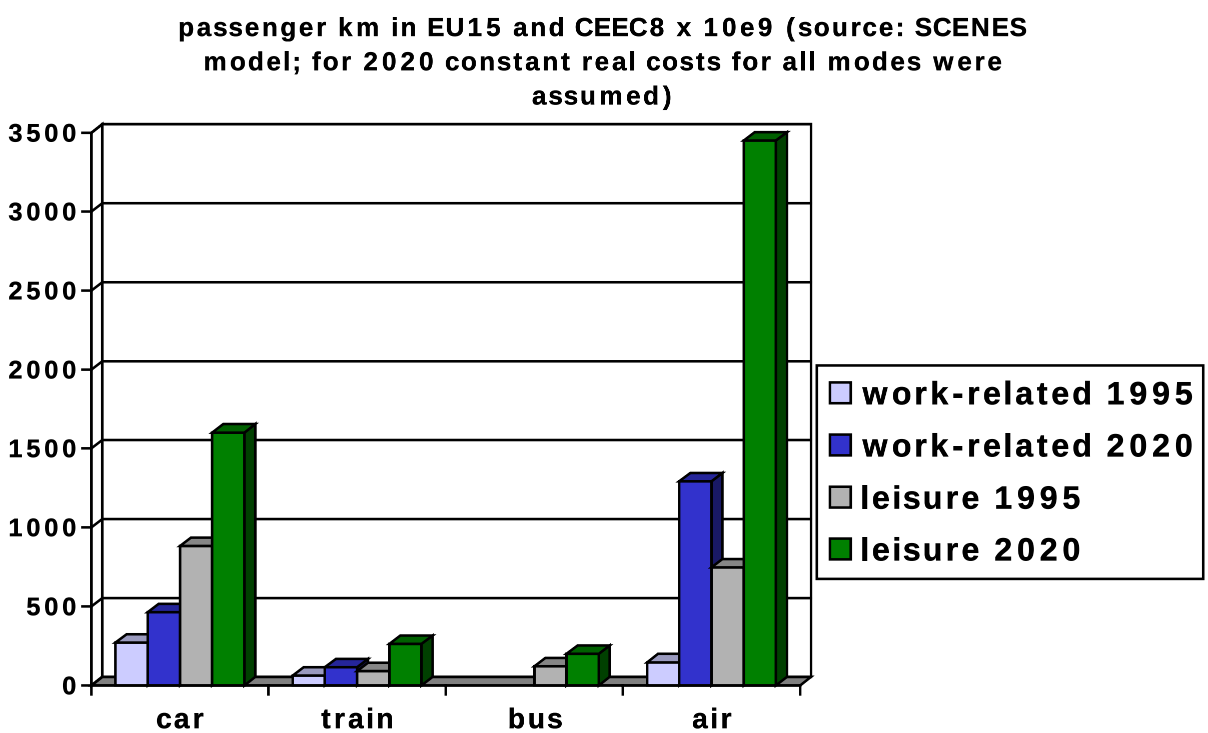
Figure 14 is not for the entire study area, because in that case, the picture would be dominated by the impacts of income and car ownership (see above): many lower density zones in the study area happen to be zones with low income and car ownership. Therefore, Figure 14 was constructed on the basis of data for North-Western Europe only, where there is less variation in income and car ownership.

In Figure 14 one can observe that car use (sum of car driver and car passenger) increases when population density decreases. Train use decreases with decreasing population density. For the use of bus/tram/metro and the non-motorised modes there is not such a clear decreases with decreasing population density, but in area type 1 (metropolitan areas), the use of these modes is clearly higher than in other area types.

9 COMBINING SHORTER DISTANCE RESULTS FROM THE META-MODEL WITH LONG DISTANCE RESULTS FROM SCENES FOR PASSENGERS

The meta-model for freight is not as complex as the meta-model for passenger transport, but it includes all distance bands. The meta-model for passengers on the other hand is only for travel with trip distances up to 160 kilometre. To obtain forecasts for passenger transport for all distance bands, the meta-model results need to be combined with results for the longer distances from the SCENES model. In Figure 15 below are forecasts from the SCENES passenger transport model for 1995 and the 2020 reference for trip distances above 160 kilometre.

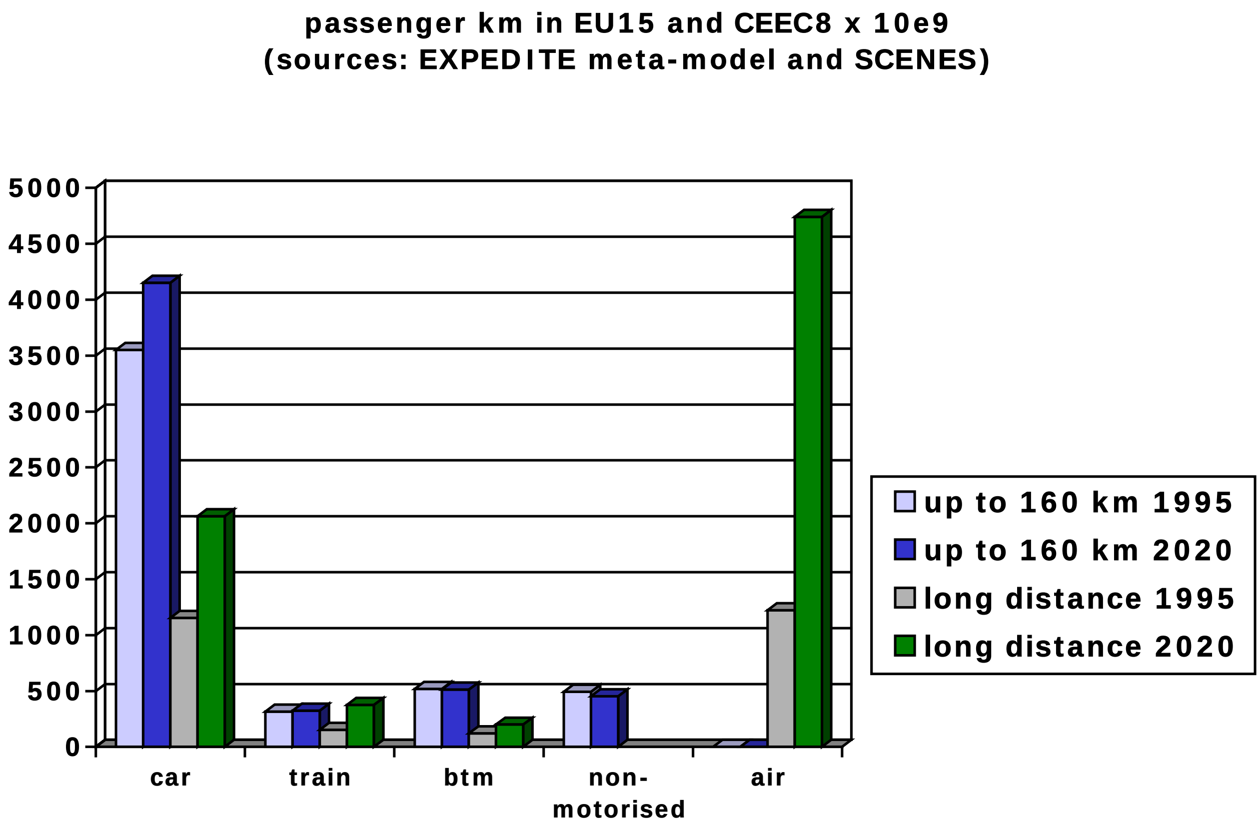
Figure 15. SCENES forecasts of long distance (trips >160 km) passenger kilometrage in 1995 and 2020 Reference



In the SCENES model, there is no distinction between car driver and car passenger; the 'car' mode includes both. For this mode we see both for work-related travel (commuting, business trips) and leisure trips a large increase (much larger than for the shorter distances) in passenger kilometrage between 1995 and 2020 for the longer distances. Also for long distance train transport, a big growth is predicted. For bus transport, there is no significant work-related long-distance travel, but there is for leisure travel. The latter is also predicted to grow considerably. But the largest growth by far (+5.6% per year) is for long distance air travel, both for leisure and work-related travel.

In Figure 16, the outcomes from SCENES for distances above 160 km and the meta-model for distances up to 160 km are combined, to give a complete picture.

Figure 16. SCENES forecasts of long distance (trips >160 km) passenger kilometrage and meta-model forecasts for shorter distances in 1995 and 2020 Reference Scenario



In Figure 16 one can see very clearly that long distance travel (over 160 km) is predicted to grow much faster than travel with trip distances up to 160 km.

10 RESULTS OF POLICY RUNS FOR FREIGHT; SENSITIVE AND INSENSITIVE SEGMENTS; POLICY BUNDLES

10.1 Introduction

The EXPEDITE meta-model for freight was used to simulate the influence of selected policies in the year 2020, one by one, on the amount of tonne-kilometres and tonnes. Results were produced in the following dimensions, for the five modes: lorry, inland waterways, train, combined road-rail transport and short sea shipping:

- Distance band by commodity group and mode;
- Distance band by country and mode (not presented in this report, but used as input for the scoring of the policies).

The selected policies run with the EXPEDITE meta-model are given in Table 59.

Table 59. Policies simulated in the EXPEDITE meta-model for freight

No	Policies to be run	Simulation (for 2020)
1	Intermodality	Rail/combined/sea handling and storage cost –5%, -10%, or Travel time rail/combined/iww/sea –2.5%, -5%
2	Interconnectivity	Rail/combined/sea handling and storage cost –5%, -10%, or Travel time rail/combined/iww/sea –2.5%, -5%
3	Congestion and road pricing	Variable lorry cost +25%, +40% in area types 1, 2 and 1, 2, 3, 4 respectively
4	Parking policies	Lorry cost +25% for trips <100 km in/from area type 1, 2 and 1, 2, 3, 4 respectively
5	Infrastructure tariff	Lorry cost +10%, +25% and rail cost +10%, +25%
6	Rail and fluvial interoperability	Rail/combined times -5% and cost -5%, and IWW times -5% and cost –5%
7	Market liberalization (rail)	Rail cost –5%, -10%
8	Cost internalisation	Lorry cost +25%, +40%
9	Maximum speed limits	Lorry time +10%, +20%
10	Vignette, Eco-points, km charge	Lorry cost +2.5%, +5%, +10% for trips above 200 km
11	Sea motorways	Sea time –10%, -20%
12	Harmonisation of inspections and controls	Lorry cost +2.5%, +5% and lorry time +2.5%, +5%
13	Harmonisation of rules on speeding	Lorry time +5%, +10%
14	Deregulation for sea and IWW	Sea and IWW cost –5%, -10%
15	Fuel price increase	Lorry cost +10%, +25%

All policy runs are related to the EXPEDITE Reference Scenario, where the Reference Scenario is used to illustrate the situation in 2020: a ‘business as usual’ scenario. New policies are not part of the Reference Scenario, since this would disturb the ‘business as usual’ or ‘baseline’ nature of the reference. It should give the most likely development, given that there would be no major policy changes. The outcomes for the Reference Scenario for

Table 60. Tonnes (x 1 mln) in the EXPEDITE freight reference scenario in 2020. Flow by distance class (kilometres).

	0 – 10	0 - 25	25 - 100	100 – 200	200 - 500	500 - 1000	> 1000	Totals	% of totals
Lorry									
Bulk	2658	2407	2671	711	3540	698	275	12961	87%
Petroleum (products)	129	109	155	33	179	26	11	642	61%
General cargo	310	339	604	338	1141	250	77	3060	89%
Inland Waterways									
Bulk	0	1	69	91	117	77	16	381	3%
Petroleum (products)	0	0	4	8	19	20	2	56	5%
General cargo	0	0	1	2	11	3	2	20	1%
Rail									
Bulk	0	0	111	145	473	208	78	1016	7%
Petroleum (products)	0	0	3	10	50	22	4	89	9%
General cargo	0	0	0	2	21	22	19	64	2%
Combined transport									
Bulk	0	0	0	1	29	20	4	54	0%
Petroleum (products)	0	0	0	0	3	3	1	7	1%
General cargo	0	0	1	4	46	47	37	135	4%
Short sea shipping									
Bulk	52	0	2	0	12	54	295	497	3%
Petroleum (products)	38	0	7	1	14	49	125	253	24%
General cargo	4	0	0	0	4	15	132	163	5%

Table 61. Tonne-kilometres (x 1 mln) in the EXPEDITE freight reference scenario in 2020. Flow by distance class (kilometres).

	0 – 10	10 - 25	25 - 100	100 - 200	200 - 500	500 - 1000	> 1000	Total	% of totals
Lorry									
Bulk	11987	30272	125098	105673	1071042	482213	408313	2234599	60%
Petroleum (products)	618	1373	6942	4819	54493	17968	17184	103397	19%
General cargo	1261	4296	30817	50963	347497	169960	108915	713708	54%
Inland waterways									
Bulk	0	14	3296	14096	38133	52344	21338	129222	3%
Petroleum (products)	0	1	238	1186	6390	13836	2793	24444	4%
General cargo	0	0	61	275	3510	2292	2422	8560	1%
Train									
Bulk	0	0	6378	22359	155092	146470	112546	442846	12%
Petroleum (products)	0	0	198	1557	16861	14692	7272	40582	7%
General cargo	0	0	6	274	7515	16104	30622	54521	4%
Combined transport									
Bulk	0	0	14	101	9769	13897	5618	29398	1%
Petroleum (products)	0	0	3	21	1165	1851	1297	4338	1%
General cargo	0	0	74	737	16718	33504	59882	110914	8%
Short sea shipping									
Bulk	412	4	124	26	4892	40194	836894	882546	24%
Petroleum (products)	305	0	480	98	5225	36403	341235	383747	69%
General cargo	34	0	0	7	1624	11098	419500	432263	33%

2020 are specified for tonnes and tonne-km in Table 60 and 61 in the dimension flow by distance class and mode.

Table 60 illustrates that lorry is the most used mode on short distances for all commodity groups. For both general cargo and bulk, more than 85% of tonnes transported are transported by lorry, while for petroleum products 60% is transported by lorry, 10% by rail or combined transport, whilst 30% are transported by inland waterways or short sea shipping.

Looking at the distribution in tonne-kilometres (Table 61) compared to tonnes, lorry has significantly lower shares of the totals: for bulk 60 % of tonne kilometres are by lorry, for general cargo 54 % and only 19 % for petroleum products. The lower shares for lorry in tonnes than in tonne-kilometres illustrate that average trip lengths by lorry are much shorter than for sea transport.

The main outcomes from the policy runs with the EXPEDITE freight model are represented in this chapter. For reasons of space in the tables we refer to the scenario numbers in Table 59, and have only used the first letter in each mode where the cost are changed. We have used the character C for changes in variable costs, TT for changes in travel time, H&S for changes in handling and storage costs, and AT refers to area types.

10.2 Changes in tonnes according to the meta-model

The main outputs from the model runs in tonnes are represented in this section 10.2. Table 62 illustrates the influence of a decrease of 5 and 10 % in handling and storage costs for rail, combined and sea transport, a decrease of 3 and 5 % in travel time for rail, combined, inland waterways and short sea shipping (policy 1 and 2) and an increase of 25 and 40 % for variable lorry costs in area types 1 to 4 (policy 3). The table illustrates that the decrease in handling and storage costs gives a higher decrease in tonnes transported by lorry than the decrease in travel time by all non-road modes. The increase in variable lorry costs, where the increase in costs are only related to area types 1 to 4 (the high density areas), also reduces lorry tonnage considerably.

Table 63 illustrates the outcomes of an increase of 25 % in variable lorry costs in area types 1 to 4 on distances shorter than 100 km (policy 4), an increase of 10 and 25 % in variable costs for lorry and rail (policy 5) and a decrease of 5 % for rail travel time and costs (policy 6). The table shows that percentage changes in lorry costs for distances shorter than 100 km and area types 1 to 4 only have a marginal effect on the mode shares, and nearly all changes go from lorry to rail transport and inland waterways. An increase of 25 % in lorry and rail variable costs for all distances gives a big change in the modal distribution in terms of tonnes, mainly from rail to inland waterways and short sea shipping, but also lorry loses tonnes.

Table 62. Change in tonnes (in %) policy 1 to 3.

	Policy 1 = Policy 2				Policy 3	
	RCS H&S -5%	RCS H&S -10%	RCIS TT -3%	RCIS TT –5%	LC +25% AT 1-4	LC +40% AT 1-4
Lorry						
Bulk	-1.41 %	-2.81 %	-0.14 %	-0.23 %	-0.8	-0.5
Petroleum (products)	-1.37 %	-2.72 %	-0.12 %	-0.20 %	-0.9	-1.1
General cargo	-2.04 %	-4.06 %	-0.25 %	-0.42 %	-1.2	-1.3
Inland waterways						
Bulk	-0.99 %	-1.99 %	-0.61 %	-1.03 %	4.4	7.1
Petroleum (products)	-1.1 0%	-2.21 %	-0.38 %	-0.64 %	2.3	3.7
General cargo	-1.15 %	-2.32 %	0.46 %	0.75 %	3.0	4.9
Train						
Bulk	6.42 %	12.19 %	1.84 %	3.06 %	3.9	6.4
Petroleum (products)	6.32 %	11.97 %	3.48 %	5.79 %	2.2	3.6
General cargo	0.00 %	0.00 %	0.00 %	0.00 %	3.5	8.7
Combined transport						
Bulk	0.00 %	0.00 %	0.00 %	0.0 %	0.0	0.0
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.0 %	0.0	0.0
General cargo	6.35 %	12.04 %	3.51 %	5.85 %	3.0	7.4
Short sea shipping						
Bulk	0.38 %	0.76 %	0.34 %	0.56 %	0.5	1.1
Petroleum (products)	0.43 %	0.85 %	0.00 %	-0.01 %	-1.3	0.6
General cargo	0.47 %	0.94 %	0.00 %	0.01 %	-0.1	0.3

Table 63. Change in tonnes (in %) policy 4 to 6.

	Policy 4	Policy 5		Policy 6
	LC +25% AT 1 2 3 4 <100 km	LRC +25%	LRC +10%	RTTC -5%
Lorry				
Bulk	-0.64 %	-1.26	-0.49	-0.42 %
Petroleum (products)	-0.67 %	-3.28	-1.30	-0.60 %
General cargo	-0.36 %	-3.18	-1.26	-0.64 %
Inland waterways				
Bulk	1.01 %	37.45	14.23	-2.56 %
Petroleum (products)	0.18 %	27.72	10.73	-2.58 %
General cargo	0.09 %	19.08	7.42	1.10 %
Train				
Bulk	0.90 %	-7.95	-1.35	8.98 %
Petroleum (products)	0.58 %	-17.27	-5.53	8.98 %
General cargo	0.01 %	-13.59	-4.19	11.62 %
Combined transport				
Bulk	0.00 %	0.00	0.00	0.00 %
Petroleum (products)	0.00 %	0.00	0.00	0.00 %
General cargo	0.00 %	2.71	1.69	8.56 %
Short sea shipping				
Bulk	0.00 %	5.40	2.14	-0.39 %
Petroleum (products)	-0.51 %	2.22	0.88	-0.22 %
General cargo	0.00 %	3.67	1.46	-0.98 %

Table 64. Change in tonnes (in %) policy 7 to 9.

	Policy 7		Policy 8		Policy 9	
	RC -10%	RC -5%	LC +25%	LC +40%	LTT +10%	LTT +20%
Lorry						
Bulk	-0.40 %	-0.20 %	-2.21 %	-3.54 %	-0.77 %	-1.54 %
Petroleum (products)	-0.31 %	-0.15 %	-4.00 %	-6.39 %	-1.20 %	-2.40 %
General cargo	-0.34 %	-0.17 %	-3.98 %	-6.36 %	-1.61 %	-3.21 %
Inland waterways						
Bulk	-6.99 %	-3.49 %	16.85 %	26.95 %	4.85 %	9.69 %
Petroleum (products)	-7.33 %	-3.67 %	7.89 %	12.62 %	2.18 %	4.36 %
General cargo	-3.29 %	-1.65 %	9.95 %	15.92 %	3.76 %	7.52 %
Train						
Bulk	11.06 %	5.53 %	27.34 %	43.74 %	10.40 %	20.80 %
Petroleum (products)	12.16 %	6.08 %	18.87 %	30.19 %	7.52 %	15.05 %
General cargo	10.90 %	5.45 %	18.87 %	30.20 %	3.68 %	7.36 %
Combined transport						
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	5.32 %	2.66 %	18.55 %	29.68 %	9.36 %	18.73 %
Short sea shipping						
Bulk	-0.67 %	-0.33 %	3.65 %	5.84 %	0.16 %	0.32 %
Petroleum (products)	-0.28 %	-0.14 %	1.49 %	2.39 %	0.14 %	0.28 %
General cargo	-1.02 %	-0.51 %	1.09 %	1.74 %	0.83 %	1.67 %

Table 64 presents the outcomes of a decrease of 5 and 10 % in variable rail costs (policy 7), an increase of 25 and 40 % in variable costs for lorry (policy 8) and an increase of 10 and 20 % for lorry travel time (policy 9). The table illustrates that a percentage shift in rail costs gives a bigger change in tonnes transported by rail than a shift in lorry costs with the same percentage, and vice versa for shifts in lorry costs. A shift in variable lorry costs also gives a bigger shift in mode shares than a shift in travel times by the same percentage

Table 65 presents the outcomes of an increase of 3, 5 and 10 % in variable lorry costs (policy 10), a decrease of 10 and 20 % in travel time for short sea shipping (policy 11) and an increase of 3 and 5 % for lorry variable costs and travel time (policy 12). The table illustrates that an increase in lorry costs for trips above 200 km gives a bigger change in mode shares for all modes except short sea shipping, than a change in sea time. An increase in lorry costs and travel time would give a significant increase to train but also to inland waterways.

Table 65. Change in tonnes (in %) policy 10 to 12.

	Policy 10			Policy 11		Policy 12	
	LC +3% >200 km	LC +5% >200 km	LC +10% >200 km	ST -10%	ST -20%	LCTT +3%	LCTT +5%
Lorry							
Bulk	-0.18 %	-0.29 %	-0.59 %	-0.14 %	-0.27 %	-0.49 %	-0.82 %
Petroleum (products)	-0.26 %	-0.43 %	-0.87 %	0.00 %	0.00 %	-0.84 %	-1.39 %
General cargo	-0.32 %	-0.54 %	-1.07 %	-0.16 %	-0.32 %	-0.96 %	-1.59 %
Inland waterways							
Bulk	1.19 %	1.98 %	3.97 %	-0.12 %	-0.23 %	3.51 %	5.88 %
Petroleum (products)	0.73 %	1.22 %	2.44 %	0.00 %	0.00 %	1.61 %	2.69 %
General cargo	1.07 %	1.79 %	3.57 %	-0.14 %	-0.27 %	2.34 %	3.91 %
Train							
Bulk	2.57 %	4.29 %	8.58 %	-0.35 %	-0.69 %	6.51 %	10.96 %
Petroleum (products)	1.89 %	3.15 %	6.31 %	-0.06 %	-0.11 %	4.57 %	7.68 %
General cargo	2.23 %	3.72 %	7.43 %	-0.30 %	-0.61 %	3.39 %	5.68 %
Combined transport							
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	2.18 %	3.63 %	7.27 %	0.00 %	0.00 %	5.10 %	8.57 %
Short sea shipping							
Bulk	0.44 %	0.73 %	1.45 %	1.23 %	2.45 %	0.49 %	0.81 %
Petroleum (products)	0.17 %	0.29 %	0.58 %	0.10 %	0.20 %	0.22 %	0.37 %
General cargo	0.13 %	0.22 %	0.44 %	0.97 %	1.93 %	0.38 %	0.64 %

Table 66 provides the outcomes of an increase of 5 and 10 % in travel time for lorry (policy 13), a decrease of 5 and 10 % in variable costs for short sea shipping and inland waterways (policy 14), and an increase of 10 and 25 % for variable lorry costs (policy 15). The table illustrates that a change in lorry travel time has more effect on the mode shares than a proportional shift (but with opposite sign) in variable costs for short sea shipping and inland waterways. The table also shows that a percentage shift in variable costs for lorry has the biggest effects on all other modes.

Table 66. Change in tonnes (in %) policy 13 to 15.

	Policy 13		Policy 14		Policy 15	
	LTT +10%	LTT +5%	SIWWC -5%	SIWWC -10%	LC +25%	LC +10%
Lorry						
Bulk	-0.77 %	-0.38 %	-0.12 %	-0.24 %	-2.21 %	-0.88 %
Petroleum (products)	-1.20 %	-0.60 %	-0.27 %	-0.53 %	-4.00 %	-1.60 %
General cargo	-1.61 %	-0.80 %	-0.20 %	-0.41 %	-3.98 %	-1.59 %
Inland waterways						
Bulk	4.85 %	2.42 %	1.86 %	3.72 %	16.85 %	6.74 %
Petroleum (products)	2.18 %	1.09 %	1.75 %	3.50 %	7.89 %	3.16 %
General cargo	3.76 %	1.88 %	1.88 %	3.76 %	9.95 %	3.98 %
Train						
Bulk	10.40 %	5.20 %	-0.56 %	-1.11 %	27.34 %	10.94 %
Petroleum (products)	7.52 %	3.76 %	-0.41 %	-0.82 %	18.87 %	7.55 %
General cargo	3.68 %	1.84 %	-0.38 %	-0.76 %	18.87 %	7.55 %
Combined transport						
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	9.36 %	4.68 %	-0.10 %	-0.20 %	18.55 %	7.42 %
Short sea shipping						
Bulk	0.16 %	0.08 %	0.55 %	1.10 %	3.65 %	1.46 %
Petroleum (products)	0.14 %	0.07 %	0.18 %	0.37 %	1.49 %	0.60 %
General cargo	0.83 %	0.42 %	0.59 %	1.18 %	1.09 %	0.44 %

10.3 Changes in tonne-kilometres according to the meta-model

The main outputs from the model runs in tonne-kilometres are represented in this section 10.3. Table 67 illustrates the influence of a decrease of 5 and 10 % in handling and storage costs for rail, combined and sea transport, a decrease of 3 and 5 % in travel time for rail, combined, inland waterways and short sea shipping (policy 1 and 2) and an increase of 25 and 40 % for variable lorry costs in area types 1 to 4 (policy 3).

By comparing Table 67 to Table 62, the first thing to notice is that changes in tonne-kilometres have the same sign, but are much bigger than the changes in tonnes for some modes, everything else equal. The difference between changes in tonnes and tonne-kilometres are largest for lorry and combined transport, while changes are almost equal in tonne and tonne-kilometres for rail and inland waterways. The interpretation of this is that tonnes transferred from lorry to other modes would first of all affect trips with longer haulage than average. This gives reduced average trip distance for road transport, whilst average distance for rail would not be so much changed.

Intermodality and interconnectivity, in the form of a reduction in the handling and storage cost for train, combined transport and sea transport by 5 or 10%, is quite effective in reducing the lorry tonne-kilometrage. Please note that practically all the reductions in tonne-kilometrage take place at trip distances above 100 kilometres. This is generally true for all policies to promote substitution from road to the other modes. The modes that are benefitting most are conventional train (for all commodity groups distinguished) and combined road/rail transport for general cargo. A decrease in travel time of 3 or 5% by all non-road modes also reduces lorry tonne-kilometrage, but to a smaller extent. The effect of an increase in lorry cost by 25 or 40% in area types 1-4 (to simulate congestion and road pricing) on lorry tonne-kilometrage is also considerable and all non-road modes benefit from this (train and combined transport most, then inland waterways transport, then sea transport).

Table 67. Change in tonne-kilometres (in %) policy 1 to 3.

	Policy 1 = Policy 2				Policy 3	
	RCS H&S -5%	RCS H&S -10%	RCIS TT -3%	RCIS TT -5%	LC +25% AT 1-4	LC +40% AT 1-4
Lorry						
Bulk	-3.14 %	-6.24 %	-1.07 %	-1.78 %	-1.38 %	-2.21
Petroleum (products)	-3.10 %	-6.16 %	-0.87 %	-1.44 %	-2.10 %	-3.36
General cargo	-3.22 %	-6.39 %	-1.13 %	-1.88 %	-2.80 %	-4.48
Inland waterways						
Bulk	-1.22 %	-2.45 %	-0.63 %	-1.07 %	5.45 %	8.73
Petroleum (products)	-1.24 %	-2.49 %	-0.20 %	-0.37 %	3.53 %	5.64
General cargo	-1.24 %	-2.50 %	0.97 %	1.60 %	3.96 %	6.34
Train						
Bulk	6.33 %	12.00 %	2.74 %	4.55 %	4.25 %	6.81
Petroleum (products)	6.32 %	11.96 %	5.10 %	8.49 %	1.72 %	2.75
General cargo	0.00 %	0.00 %	0.00 %	0.00 %	8.10 %	12.96
Combined transport						
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00
General cargo	6.32 %	11.97 %	5.16 %	8.59 %	7.04 %	11.26
Short sea shipping						
Bulk	0.50 %	1.00 %	0.35 %	0.58 %	1.51 %	2.41
Petroleum (products)	0.51 %	1.02 %	0.00 %	-0.01 %	0.49 %	0.78
General cargo	0.50 %	1.00 %	-0.04 %	-0.07 %	0.48 %	0.76

Table 68. Change in tonne-kilometres (in %) policy 4 to 6.

	Policy 4	Policy 5		Policy 6
	LC +25% AT 1 2 3 4 <100 km	LRC +25%	LRC +10%	RTC -5%
Lorry				
Bulk	-0.29 %	-5.04 %	-1.76 %	-3.08 %
Petroleum (products)	-0.84 %	-9.33 %	-3.49 %	-2.98 %
General cargo	-0.32 %	-10.12 %	-3.85 %	-2.95 %
Inland waterways				
Bulk	0.51 %	47.11 %	17.73 %	-3.36 %
Petroleum (products)	0.12 %	34.98 %	13.40 %	-1.97 %
General cargo	0.05 %	21.16 %	8.21 %	3.04 %
Train				
Bulk	0.36 %	-16.90 %	-3.30 %	13.98 %
Petroleum (products)	0.24 %	-29.64 %	-9.31 %	13.20 %
General cargo	0.00 %	-19.69 %	-5.37 %	16.57 %
Combined transport				
Bulk	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	0.01 %	1.94 %	2.10 %	12.73 %
Short sea shipping				
Bulk	0.00 %	9.73 %	3.86 %	-0.47 %
Petroleum (products)	0.00 %	2.99 %	1.19 %	-0.23 %
General cargo	0.00 %	5.20 %	2.06 %	-1.01 %

Table 68 presents the outcomes of an increase of 25 % in variable lorry costs in area types 1 to 4 on distances shorter than 100 km (policy 4), an increase of 10 and 25 % in variable costs for lorry and rail (policy 5) and a decrease of 5 % for rail travel time and costs (policy 6).

In Table 68, we see that policies that only affect transports below 100 km (parking policies were simulated like this, for longer transports, the parking cost increase is a negligible part of the total transport cost), are not very effective to shift tonne-kilometres from road to the other modes. As we have seen before, policies that increase the lorry cost on all distances (such as an infrastructure tariff, which increases cost for road and rail) do result in a considerable shift away from lorry. For this particular policy, rail transport also becomes less attractive and most of the substitution goes to inland waterways transport. A reduction in the travel times for rail, combined transport and inland waterways (as in the rail and fluvial interoperability policy) reduces the use of road transport, but there are also reductions for inland waterways and short sea shipping.

Table 69 gives the outcomes of a decrease of 5 and 10 % in variable rail costs (policy 7), an increase of 25 and 40 % in variable costs for lorry (policy 8) and an increase of 10 and 20 % for lorry travel time (policy 9).

Table 69. Change in tonne-kilometres (in %) policy 7 to 9.

	Policy 7		Policy 8		Policy 9	
	RC -10%	RC -5%	LC +25%	LC +40%	LT +10%	LT +20%
Lorry						
Bulk	-2.97 %	-1.48 %	-11.39 %	-18.22 %	-4.72 %	-9.44 %
Petroleum (products)	-2.41 %	-1.20 %	-14.34 %	-22.94 %	-5.71 %	-11.42 %
General cargo	-2.02 %	-1.01 %	-14.34 %	-22.95 %	-6.54 %	-13.08 %
Inland waterways						
Bulk	-8.40 %	-4.20 %	21.47 %	34.36 %	6.62 %	13.24 %
Petroleum (products)	-8.21 %	-4.10 %	12.01 %	19.22 %	3.18 %	6.36 %
General cargo	-3.11 %	-1.56 %	12.31 %	19.70 %	4.07 %	8.13 %
Train						
Bulk	15.58 %	7.79 %	36.46 %	58.34 %	15.51 %	31.02 %
Petroleum (products)	17.34 %	8.67 %	24.34 %	38.94 %	10.72 %	21.44 %
General cargo	14.83 %	7.41 %	27.81 %	44.49 %	9.56 %	19.12 %
Combined transport						
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	7.91 %	3.96 %	27.23 %	43.57 %	12.88 %	25.77 %
Short sea shipping						
Bulk	-0.83 %	-0.42 %	7.50 %	11.99 %	0.31 %	0.61 %
Petroleum (products)	-0.32 %	-0.16 %	2.17 %	3.47 %	0.21 %	0.42 %
General cargo	-1.03 %	-0.51 %	2.56 %	4.10 %	1.00 %	2.00 %

Rail liberalisation (see Table 69) leads to increases in the use of rail and combined transport and some reduction in lorry use. But rail transport also attracts shipments away from inland waterways transport and short sea shipping. An increase in the lorry cost for all area types and distance classes (policy 8: cost internalisation) is quite effective for substitution for all commodity groups distinguished here from road to rail, combined, inland waterways and to a lesser degree to sea transport. An increase in lorry time (maximum speed limits) is also an effective measure to shift tonne-kilometres from road to other modes (especially to train and combined transport).

Table 70 provides the outcomes of an increase of 3, 5 and 10 % in variable lorry costs (policy 10), a decrease of 10 and 20 % in travel time for short sea shipping (policy 10) and an increase of 3 and 5 % for lorry variable costs and travel time (policy 11).

Table 70. Change in tonne-kilometres (in %) policy 10 to 12.

	Policy 10			Policy 11		Policy 12	
	LC +3% >200 km	LC +5% >200 km	LC +10% >200 km	ST –10%	ST -20%	LCTT +3%	LCTT +5%
Lorry							
Bulk	-1.30 %	-2.17 %	-4.34 %	-0.74 %	-1.49 %	-2.75 %	-4.56 %
Petroleum (products)	-1.55 %	-2.58 %	-5.17 %	-0.02 %	-0.03 %	-3.40 %	-5.63 %
General cargo	-1.60 %	-2.66 %	-5.32 %	-0.53 %	-1.06 %	-3.64 %	-6.03 %
Inland waterways							
Bulk	2.22 %	3.70 %	7.40 %	-0.28 %	-0.56 %	4.62 %	7.75 %
Petroleum (products)	1.37 %	2.28 %	4.56 %	0.00 %	0.00 %	2.41 %	4.03 %
General cargo	1.43 %	2.39 %	4.77 %	-0.24 %	-0.48 %	2.72 %	4.56 %
Train							
Bulk	4.15 %	6.92 %	13.83 %	-0.88 %	-1.77 %	9.24 %	15.63 %
Petroleum (products)	2.80 %	4.67 %	9.33 %	-0.27 %	-0.54 %	6.23 %	10.49 %
General cargo	3.33 %	5.55 %	11.09 %	-0.35 %	-0.69 %	6.30 %	10.61 %
Combined transport							
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	3.26 %	5.43 %	10.86 %	0.00 %	0.00 %	7.26 %	12.25 %
Short sea shipping							
Bulk	0.90 %	1.50 %	3.00 %	1.26 %	2.52 %	0.99 %	1.65 %
Petroleum (products)	0.26 %	0.43 %	0.87 %	0.11 %	0.22 %	0.32 %	0.54 %
General cargo	0.31 %	0.51 %	1.03 %	0.86 %	1.72 %	0.61 %	1.02 %

In Table 70 we see that an increase in lorry cost for trips above 200 km (vignette, ecopoints, kilometre charging) is also an effective policy for modal shift away from lorry. The sea motorways are less effective in reducing road transport (especially for petroleum and petroleum products). This policy also leads to a decrease of rail and inland waterways transport. If harmonisation of inspections and controls would lead to 3 or 5% increase in lorry transport time and cost, this policy would also lead to a substantial shift from road to the other modes (again mostly to train and combined).

Table 71 represents the outcomes of an increase of 5 and 10 % in travel time for lorry (policy 13), a decrease of 5 and 10 % in variable costs for short sea shipping and inland waterways (policy 14), and an increase of 10 and 25 % for variable lorry costs (policy 15).

Harmonisation of rules on speeding, simulated as an 5 or 10% increase in lorry time, also has the desired modal split effect, as has a fuel price increase for road transport (policy 13 and 15 respectively). Deregulation for sea and inland waterways transport is less effective in reducing lorry use; it also reduces train use.

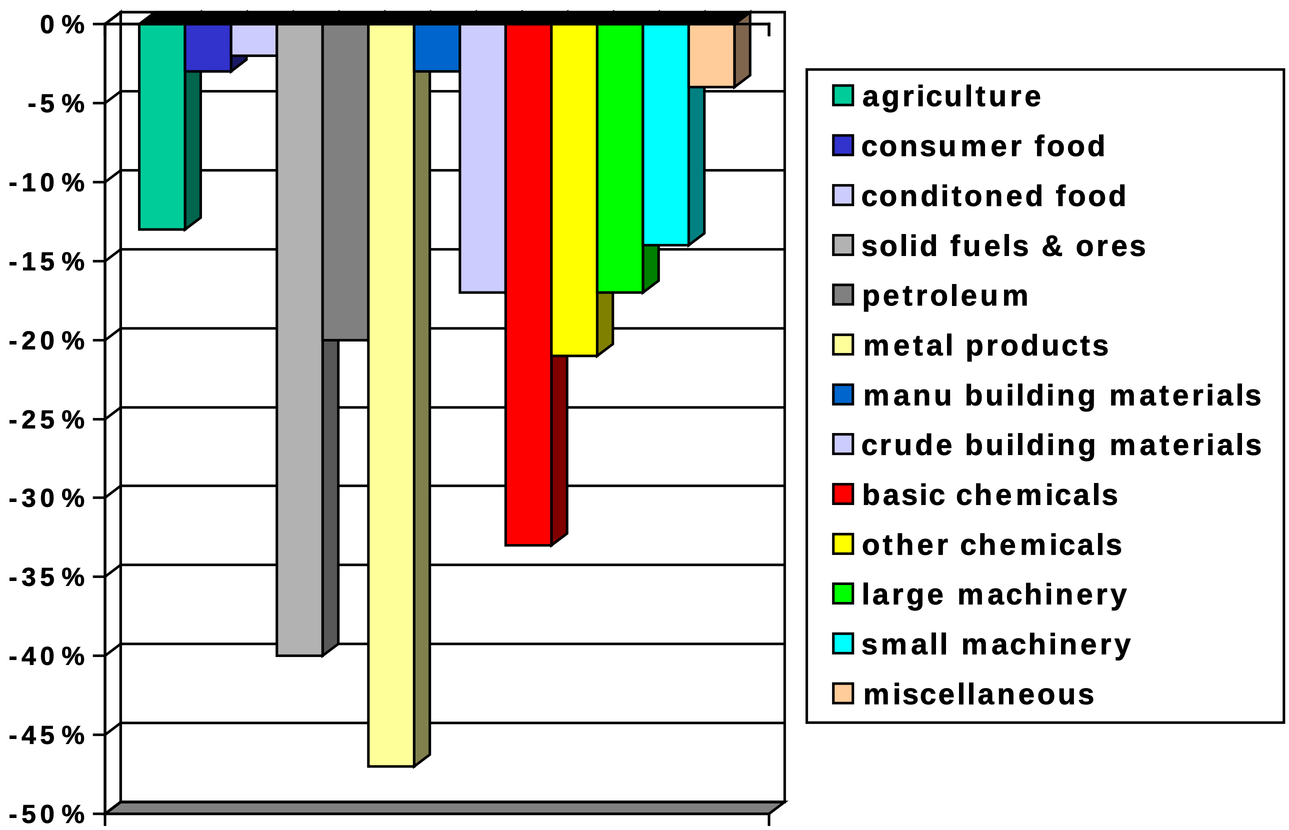
Table 71. Change in tonne-kilometres (in %) policy 13 to 15.

	Policy 13		Policy 14		Policy 15	
	LTT +10%	LTT +5%	SIWWC -5%	SIWWC -10%	LC +25%	LC +10%
Lorry						
Bulk	-4.72 %	-2.36 %	-0.53 %	-1.06 %	-11.39 %	-4.34 %
Petroleum (products)	-5.71 %	-2.85 %	-0.46 %	-0.91 %	-14.34 %	-5.17 %
General cargo	-6.54 %	-3.27 %	-0.62 %	-1.23 %	-14.34 %	-5.32 %
Inland waterways						
Bulk	6.62 %	3.31 %	1.68 %	3.35 %	21.47 %	7.40 %
Petroleum (products)	3.18 %	1.59 %	2.52 %	5.04 %	12.01 %	4.56 %
General cargo	4.07 %	2.03 %	2.72 %	5.42 %	12.31 %	4.77 %
Train						
Bulk	15.51 %	7.75 %	-1.02 %	-2.04 %	36.46 %	13.83 %
Petroleum (products)	10.72 %	5.36 %	-0.62 %	-1.25 %	24.34 %	9.33 %
General cargo	9.56 %	4.78 %	-0.91 %	-1.81 %	27.81 %	11.09 %
Combined transport						
Bulk	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Petroleum (products)	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
General cargo	12.88 %	6.44 %	-0.15 %	-0.30 %	27.23 %	10.86 %
Short sea shipping						
Bulk	0.31 %	0.15 %	0.57 %	1.14 %	7.50 %	3.00 %
Petroleum (products)	0.21 %	0.11 %	0.18 %	0.36 %	2.17 %	0.87 %
General cargo	1.00 %	0.50 %	0.53 %	1.07 %	2.56 %	1.03 %

10.4 Some additional insights from runs with the SCENES model

The SCENES model uses 13 commodity types. The sensitivity to policy changes for each of those commodity types was studied by running the SCENES model for an increase in the lorry cost and for reductions in the time and cost by rail and combined road-rail transport.

Figure 17. Relative change in lorry tonne-kilometrage, by commodity type, if the cost of lorry transport increase by 20% (source: SCENES model)



If the transport cost by lorry increases, the reduction in road tonne-kilometrage takes place mostly for solid fuels and ores, metal products and chemicals, not so much for food products, manufactured building materials and miscellaneous goods.

If rail/combined transport cost or time decrease, then for fuels and ores, metal products, basic and other chemicals and large machinery (but only above 100 km) there will be a significant decline in lorry tonne-kilometrage, but also a shift from inland waterways transport.

10.5 Conclusions on policy effectiveness, sensitive and insensitive segments and policy bundles

A policy is called 'effective' if it changes the modal split substantially (for freight: from road to non-road modes). From the model results on freight transport, the following conclusions on policy effectiveness and the policy sensitivity of segments can be drawn:

- If lorry costs increase, there will only be significant shifts at trip distances above 100 kilometres. Below 100 kilometres, road transport is the dominant mode (except for some small niche segments, e.g. shipments between firms with rail sidings or inland waterways or sea terminals at both origin and destination). Policy measures are unable to change this situation below 100 kilometres: it is an insensitive market segment. This is not generally true for shipments with trip distances above 100 kilometres. Here, an increase in lorry cost can lead to substitution, mainly to inland waterways transport (where available) and train.

- If the lorry transport time goes up, there will also be only significant mode shifts for consignments above 100 kilometres. For this change in transport conditions, most of the substitution is towards combined road-rail transport, but also to conventional rail transport.
- If the rail/combined transport cost or time decreases, then for fuels and ores, metal products, basic and other chemicals, large machinery (but only above 100 kilometres) there will be a significant decline in lorry tonne-kilometrage, but a shift will also take place from inland waterways transport (where this mode exists).
- If the cost or time of inland waterways transport decrease, then there will only be a significant reduction of lorry transport for specific countries (where inland waterways transport is a viable option, such as The Netherlands, Belgium, Germany and France).
- If the sea shipping cost or time goes down, there will only be small shifts towards sea transport and no significant reduction for lorry.
- In passenger transport an increase in transport time by x% has a bigger impact than an increase in transport cost by x%. This is not generally true in freight transport; in many situations an x% change in cost has a bigger impact than an x% change in time.
- Elasticities keep increasing with distance after 100 kilometres (especially time elasticities).
- Changes in tonne-kilometres are bigger than changes in tonnes for lorry, while the changes are close to being equal in tonnes and tonne-kilometres for rail and inland waterways. This shows that goods would mostly be transferred between modes in consignments where trip lengths are longer than average lorry trips.
- The most effective policy measures to achieve substitution from road to other modes are (without implying that these are the best policies for society; that depends on the outcomes of the overall evaluation; see the last three bullet points for freight):
    - Increases in lorry cost for all or the higher distances (congestion and road pricing, infrastructure tariff, cost internalisation, kilometre charging, fuel price increase);
    - Increase in lorry time (maximum speed limits, harmonisation of rules on speeding);
    - Decrease in non-road handling and storage cost (intermodality and interconnectivity).
- Policies that make the non-road modes cheaper or reduce the travel times on the non-road networks are less effective for reducing lorry tonne-kilometrage; often they also lead to substitution between the non-road modes.
- Effective policy bundles should contain elements of the three most effective policies (increased cost and time for road, lower non-road handling and storage cost). Decreasing the non-road travel times and cost can only have a substantial effect on substitution away from the road mode if the bundle includes measures that make all non-road modes more attractive. Otherwise, there will be a large amount of substitution between the non-road modes.
- To make polices effective the target segment should be shipments above 100 kilometres. Also policies targetted at bulky products are more effective for substitution from road to the other modes than policies focussing on other commodities.

10.6 Scoring of policies for freight

In the above sections of chapter 10, results were presented for the effects of policies on tonnes and tonne-kilometres in freight transport. In this section 10.6, we study the evaluation results for freight (including external effects), which were derived by applying the evaluation module described in chapter 4 to the outcomes (in tonne-kilometres by mode and country) of the EXPEDITE meta-model for freight.

Table 72 contains a summary of results of the evaluation. For each policy run, carried out with the meta-model for freight, four changes are given:

- The sum of the change in driving cost, time cost and external cost;
- The change in driving cost (the monetary cost of the mode used);
- The change in time cost (the transport time change multiplied by appropriate values of time);
- The change in external cost (emissions, noise, accidents, road damage).

All costs are measured in millions of ECU (now EURO) of 1995. A negative number means that the costs to society are reduced; in this respect the lowest value (most negative) is the best.

The cost of investment, operation and maintenance of the infrastructure (except road damage) are not included in this table. A qualitative categorisation of policies on these costs can be found in chapter 4.

The policies that involve an increase in the lorry cost were found to be effective in terms of substitution from road to other modes. But in Table 72 we can see that these policies (congestion and road pricing, parking policies (but this one was not particularly effective), infrastructure tariff, cost internalisation, vignette/ecopoints/kilometre charging and a fuel price increase) all lead to an increase in the internal plus external cost of transport, of sometimes more than 10%. This is caused by an increase in the driving cost: all lorry transports that do not shift to unaffected modes have to pay a higher cost. For these policies this is not compensated by the decrease in the time cost and the external cost. The time cost decrease here because the value of time is mode-specific: substitution from road to rail, combined, sea or inland waterways transport means that the shipment will use a slower mode, but also a mode with a lower value of time (see the discussion on this in chapter 4). If we would have used a fixed value of time for the substitution (not mode-specific), then the time cost would have increased as well for these policies. The external cost are reduced if tonne-kilometres are shifted from road to the other modes, but this is not sufficient here to reduce the total cost. On the other hand, in these policies there will also be a benefit for the government (higher revenues from fuel tax, or other form of charging), which is not accounted for in the above total cost change. This is a shift from the transport users to government. In a first-best world (without externalities), such a shift is a distortion of the free markets, that reduces overall welfare. In a second-best situation, where externalities already distort the picture, such shifts might be justifiable.

Intermodality and interconnectivity were also quite effective in influencing the modal split and these policies lead to a reduction of the total internal and external cost of transport. So, unlike the policies that increase the lorry cost, mentioned above, these policies combine

Table 72. Summary of evaluation results for the policies for freight transport

		Total	Driving	Time	External
Policy	Scenario	MECU95	MECU95	MECU95	MECU95
		%diff	%diff	%diff	%diff
1. Intermodality	1 Handling and storage costs -5% (rail, combined and sea)	-1.8%	-2.0%	-1.1%	-1.7%
	2 Handling and storage costs -10% (rail, combined and sea)	-3.5%	-4.1%	-2.3%	-3.4%
	3 Travel time -3% (rail, combined, IWW and sea)	-0.5%	-0.5%	-0.7%	-0.5%
	4 Travel time -5% (rail, combined, IWW and sea)	-0.9%	-0.8%	-1.1%	-0.8%
2. Interconnectivity	1 Handling and storage costs -5% (rail, combined and sea)	-1.8%	-2.0%	-1.1%	-1.7%
	2 Handling and storage costs -10% (rail, combined and sea)	-3.5%	-4.1%	-2.3%	-3.4%
	3 Travel time -3% (rail, combined, IWW and sea)	-0.5%	-0.5%	-0.7%	-0.5%
	4 Travel time -5% (rail, combined, IWW and sea)	-0.9%	-0.8%	-1.1%	-0.8%
3. Congestion and road pricing	1 Variable lorry costs +25%; area types 1,2,3,4	11.6%	17.7%	-0.8%	-0.9%
	2 Variable lorry costs +40%; area types 1,2,3,4	18.4%	28.0%	-1.3%	-1.4%
4. Parking policies	1 VLC +25%; area types 1,2,3,4; trips <100km	12.3%	18.5%	-0.5%	-0.3%
5. Infrastructure tariff	1 Lorry and rail transport costs +25%	9.1%	15.8%	-4.5%	-4.9%
	2 Lorry and rail transport costs +10%	4.3%	7.2%	-1.5%	-1.6%
6. Rail and fluvial interoperality	1 Rail combined IWW travel time and transport costs -5%	-1.8%	-2.1%	-1.1%	-1.3%
7. Market liberalisation	1 Rail transport costs -10%	-1.7%	-2.2%	-0.5%	-1.1%
	2 Rail transport costs -5%	-0.8%	-1.1%	-0.3%	-0.5%
8. Cost internalisation	1 Lorry transport costs +25%	6.1%	11.4%	-4.5%	-6.2%
	2 Lorry transport costs +40%	8.2%	16.0%	-7.3%	-10.0%
9. Maximum speed limits	1 Lorry time +10%	0.0%	-2.3%	6.6%	-2.6%
	2 Lorry time +20%	-0.1%	-4.7%	12.7%	-5.3%
10. Vignette Eco-points	1 Lorry transport costs +3%	1.0%	1.6%	-0.4%	-0.6%
	2 Lorry transport costs + 5%	1.6%	2.7%	-0.6%	-1.0%
	3 Lorry transport costs +10%	3.0%	103.0%	203.0%	303.0%
11. Sea motorways	1 Sea travel time -10%	-0.6%	-0.5%	-0.8%	-0.4%
	2 Sea travel time -20%	-1.2%	-1.0%	-1.7%	-0.8%
12. Harmonisation of inspections and controls	1 Lorry transport costs and travel time +3%	0.9%	0.9%	1.5%	-1.5%
	2 Lorry transport costs and travel time +5%	1.5%	1.5%	2.5%	-2.5%
13. Harmonisation of rules on speeding	1 Lorry travel time + 10%	0.0%	-2.3%	6.6%	-2.6%
	2 Lorry travel time + 5%	0.0%	-1.2%	3.4%	-1.3%
14. Deregulation for sea and IWW	1 Sea and IWW transport costs -5%	-0.9%	-1.2%	-0.3%	-0.4%
	2 Sea and IWW transport costs -10%	-1.8%	-2.4%	-0.6%	-0.7%
15. Fuel price increase	1 Lorry fuel cost +10%	2.8%	5.1%	-1.8%	-2.5%
	2 Lorry fuel cost +25%	6.1%	11.4%	-4.5%	-6.2%

Policy: 1. Intermodality

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Handling and storage costs -5% (rail, combined and sea)	1 524 894	1 022 691	404 085	98 118
Difference	-27 306	-21 007	-4 597	-1 703
%diff	-1.8%	-2.0%	-1.1%	-1.7%
2 Handeling and storage costs -10% (rail, combined and sea)	1 497 104	1 001 317	399 383	96 404
Difference	-55 096	-42 381	-9 298	-3 417
%diff	-3.5%	-4.1%	-2.3%	-3.4%
3 Travel time -3% (rail, combined, IWW and sea)	1 543 847	1 038 497	405 995	99 355
Difference	-8 353	-5 201	-2 687	-465
%diff	-0.5%	-0.5%	-0.7%	-0.5%
4 Travel time -5% (rail, combined, IWW and sea)	1 538 256	1 035 040	404 169	99 047
Difference	-13 944	-8 658	-4 512	-774
%diff	-0.9%	-0.8%	-1.1%	-0.8%

Policy: 2. Interconnectivity

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Handling and storage costs -5% (rail, combined and sea)	1 524 894	1 022 691	404 085	98 118
Difference	-27 306	-21 007	-4 597	-1 703
%diff	-1.8%	-2.0%	-1.1%	-1.7%
2 Handling and storage costs -10% (rail, combined and sea)	1 497 104	1 001 317	399 383	96 404
Difference	-55 096	-42 381	-9 298	-3 417
%diff	-3.5%	-4.1%	-2.3%	-3.4%
3 Travel time -3% (rail, combined, IWW and sea)	1 543 847	1 038 497	405 995	99 355
Difference	-8 353	-5 201	-2 687	-465
%diff	-0.5%	-0.5%	-0.7%	-0.5%
4 Travel time -5% (rail, combined, IWW and sea)	1 538 256	1 035 040	404 169	99 047
Difference	-13 944	-8 658	-4 512	-774
%diff	-0.9%	-0.8%	-1.1%	-0.8%

Policy: 3. Congestion and road pricing

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Variable lorry costs +25%; area types 1,2,3,4	1 732 620	1 228 191	405 476	98 953
Difference	180 419	184 492	-3 206	-867
%diff	11.6%	17.7%	-0.8%	-0.9%
2 Variable lorry costs +40%; area types 1,2,3,4	1 837 564	1 335 579	403 552	98 433
Difference	285 364	291 880	-5 129	-1 388
%diff	18.4%	28.0%	-1.3%	-1.4%

Policy: 4. Parking policies

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Variable lorry costs +25%; area types 1,2,3,4; trips <100km	1 742 550	1 236 540	406 504	99 506
Difference	190 349	192 842	-2 178	-315
%diff	12.3%	18.5%	-0.5%	-0.3%

Policy: 5. Infrastructure tariff

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry and rail transport costs +25%	1 693 951	1 208 890	390 089	94 972
Difference	141 750	165 191	-18 592	-4 849
%diff	9.1%	15.8%	-4.5%	-4.9%
2 Lorry and rail transport costs +10%	1 619 130	1 118 413	402 517	98 199
Difference	66 930	74 715	-6 164	-1 621
%diff	4.3%	7.2%	-1.5%	-1.6%

Policy: 6. Rail and fluvial interoperality

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Rail combined IWW travel time and transport costs -5%	1 524 147	1 021 287	404 291	98 569
Difference	-28 053	-22 411	-4 390	-1 252
%diff	-1.8%	-2.1%	-1.1%	-1.3%

Policy :7. Market liberalisation

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Rail transport costs -10%	1 525 608	1 020 303	406 567	98 737
Difference	-26 593	-23 395	-2 114	-1 084
%diff	-1.7%	-2.2%	-0.5%	-1.1%
2 Rail transport costs -5%	1 539 219	1 032 316	407 624	99 279
Difference	-12 981	-11 382	-1 057	-542
%diff	-0.8%	-1.1%	-0.3%	-0.5%

Policy: 8. Cost internalisation

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry transport costs +25%	1 646 694	1 162 999	390 106	93 589
Difference	94 494	119 300	-18 575	-6 231
%diff	6.1%	11.4%	-4.5%	-6.2%
2 Lorry transport costs +40%	1 679 759	1 210 948	378 961	89 851
Difference	127 559	167 249	-29 720	-9 970
%diff	8.2%	16.0%	-7.3%	-10.0%

Policy: 9. Maximum speed limits

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry travel time +10%	1 552 328	1 019 369	435 760	97 199
Difference	128	-24 330	27 078	-2 621
%diff	0.0%	-2.3%	6.6%	-2.6%
2 Lorry travel time +20%	1 550 136	995 039	460 519	94 578
Difference	-2 064	-48 659	51 838	-5 243
%diff	-0.1%	-4.7%	12.7%	-5.3%

Policy: 10. Vignette Eco-points, km chagre

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry transport costs +3%	1 567 165	1 060 749	407 216	99 200
Difference	14 965	17 051	-1 465	-621
%diff	1.0%	1.6%	-0.4%	-0.6%
2 Lorry transport costs + 5%	1 576 763	1 071 738	406 239	98 786
Difference	24 562	28 040	-2 442	-1 035
%diff	1.6%	2.7%	-0.6%	-1.0%
3 Lorry transport costs +10%	1 599 432	1 097 884	403 796	97 751
Difference	47 231	54 186	-4 885	-2 070
%diff	3.0%	5.2%	-1.2%	-2.1%

Policy: 11. Sea motorways

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Sea travel time -10%	1 543 143	1 038 419	405 309	99 415
Difference	-9 057	-5 279	-3 372	-405
%diff	-0.6%	-0.5%	-0.8%	-0.4%
2 Sea travel time -20%	1 534 050	1 033 140	401 901	99 010
Difference	-18 150	-10 559	-6 781	-811
%diff	-1.2%	-1.0%	-1.7%	-0.8%

Policy: 12. Harmonisation of inspections and controls

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry transport costs and travel time +3%	1 566 546	1 053 398	414 831	98 317
Difference	14 345	9 700	6 149	-1 504
%diff	0.9%	0.9%	1.5%	-1.5%
2 Lorry transport costs and travel time +5%	1 575 755	1 059 577	418 830	97 349
Difference	23 555	15 878	10 149	-2 472
%diff	1.5%	1.5%	2.5%	-2.5%

Policy: 13. Harmonisation of rules on speeding

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry travel time + 10%	1 552 328	1 019 369	435 760	97 199
Difference	128	-24 330	27 078	-2 621
%diff	0.0%	-2.3%	6.6%	-2.6%
2 Lorry travel time + 5%	1 552 554	1 031 534	422 510	98 510
Difference	354	-12 165	13 829	-1 311
%diff	0.0%	-1.2%	3.4%	-1.3%

Policy: 14. Deregulation for sea and IWW

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Sea and IWW transport costs -5%	1 538 361	1 031 391	407 510	99 460
Difference	-13 839	-12 308	-1 172	-360
%diff	-0.9%	-1.2%	-0.3%	-0.4%
2 Sea and IWW transport costs -10%	1 524 381	1 018 937	406 343	99 102
Difference	-27 819	-24 761	-2 339	-719
%diff	-1.8%	-2.4%	-0.6%	-0.7%

Policy: 15. Fuel price increase

	Total MECU95	Driving MECU95	Time MECU95	External MECU95
Reference	1 552 200	1 043 698	408 681	99 821
1 Lorry fuel cost +10%	1 595 906	1 097 326	401 251	97 328
Difference	43 705	53 628	-7 430	-2 492
%diff	2.8%	5.1%	-1.8%	-2.5%
2 Lorry fuel cost +25%	1 646 694	1 162 999	390 106	93 589
Difference	94 494	119 300	-18 575	-6 231
%diff	6.1%	11.4%	-4.5%	-6.2%

effectiveness with low cost for the transport users. But as was mentioned in chapter 4, intermodality and interconnectivity require a medium amount of investment in infrastructure and do not generate government revenue, whereas the polices on lorry cost require lower investment costs and produce revenue for the government.

The policies that try to make the non-road modes cheaper and/or faster (rail and fluvial interoperability, rail market liberalisation, sea motorways and deregulation for sea and inland waterways) had a limited effect on the transport volumes by mode and also have a limited effect on the total internal and external cost of transport.

The policies that make road transport slower also had a sizeable impact on the mode split, but the cost impacts are rather small. There is an increase in the time cost (since all road transport is affected, also the lorry transports that stay on the road), but this is completely or largely compensated by gains in driving cost (because of substitution to cheaper modes) and in external cost.

The above results are summarised in Table 73.

Table 73. Overall assessment of the policies for freight

	Effectiveness (modal shift from road to other modes)	**Change in internal and external transport cost**	**Required investment and operation and maintenance cost**
Intermodality	High	Small user cost reduction	Medium
Interconnectivity	High	Small user cost reduction	Medium
Congestion and road pricing	High	Big user cost increase	Low and government revenues
Parking policies	Low	Big user cost increase	Low and government revenues
Infrastructure tariff	High	Big user cost increase	Low and government revenues
Rail and fluvial interoperability	Medium	Small user cost reduction	Medium
Market liberalization (rail)	Medium	Small user cost reduction	Low
Cost internalisation	High	Big user cost increase	Low and government revenues
Maximum speed limits	High	No change in user cost	Low
Vignette, Eco-points, km charge	High	Small user cost increase	Low
Sea motorways	Low	Small user cost reduction	Low
Harmonisation of inspections and controls	High	Small user cost increase	Low
Harmonisation of rules on speeding	High	No change in user cost	Low
Deregulation for sea and IWW	Low	Small user cost reduction	Low
Fuel price increase	High	Big user cost increase	Low and government revenues

11 RESULTS OF POLICY RUNS FOR PASSENGERS; SENSITIVE AND INSENSITIVE SEGMENTS; POLICY BUNDLES

11.1 Introduction

The EXPEDITE meta-model for freight was used to simulate a large number of policies, one by one on top of the Reference Scenario for 2020. Furthermore the SCENES passenger model was used for a subset of these policies (the policies where the SCENES model is appropriate), to give additional evidence. The results for both models are reported in this chapter 11.

11.2 Results from the meta-model for passenger transport

This section describes the main results concerning the impacts of the policies simulated for passenger transport, using the EXPEDITE meta-model. The transport policies simulated are the following ones:

(1) Intermodality and interconnectivity;
(2) Fuel price increase;
(3) Public transport pricing;
(4) Rail and fluvial interoperability;
(5) Market liberalization (rail);
(6) Cost internalisation;
(7) New urban public transport;
(8) Congestion and road pricing and parking policies;
(9) Maximum speed limits and harmonization of rules on speeding;
(10) Housing densification and employment densification.

Each policy, e.g. "(enhancing) intermodality and interconnectivity", has been analysed through the following steps:

- Creating a 'policy scenario' for 2020, assuming percentage changes in level of services attributes, e.g. in order to simulate the enhancement of intermodality and interconnectivity, rail and BTM (bus/tram/metro) access/egress and wait times are decreased by certain percentages;
- Running the meta-model in the 'policy scenario';
- Comparing the results in term of passenger km with respect to the Reference Scenario.

In the following, the results reported are relative to Reference Scenario 2020.

(1) "Intermodality and interconnectivity" policy

This policy is simulated assuming the following changes in level of service attributes:

- Rail and BTM access/egress time –5%, -10% and
- Rail and BTM wait and transfer time –5%, -10%.

For sake of brevity, in the following tables results are reported only for the percentage changes of -5%.

Table 74 contains the percentage variations in terms of passenger km for each transport mode by income band (the classes for net annual household income were: 0-11300, 11300-18200, 18200-29500, 29500-38600, more than 38600 Euro). As can be seen, intermediate income bands are slightly more sensitive to the level of service attributes (12-14% versus 10-12%); moreover, as income band increases, percentage variations of train will exceed those of BTM.

Table 74. Percentage variations (in passenger km) by mode and income band for "intermodality and interconnectivity" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	0%	0%	0%	0%	0%
Car passenger	-2%	-1%	-1%	-2%	-3%
Train	10%	12%	14%	14%	12%
BTM	12%	13%	13%	12%	12%
Non-motorised	-4%	-2%	-2%	-2%	-3%

Table 75 reports the percentage variations in terms of passenger km for each transport mode by car ownership class, i.e. 1) no car in household, 2) car in household but the person has no licence, 3) several licenced persons competing for one of more cars in the household, 4) car freely available. No general conclusions can be drawn from the results obtained. The –4% in the carown1 segment relates to a very small base amount of car driver kilometres, since this type of household has no car of its own. Therefore this –4% constitutes a very small change.

Table 75. Percentage variations (in passenger km) by mode and car ownership class for "intermodality and interconnectivity" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-4%	-	0%	0%
Car passenger	-6%	-1%	-2%	-2%
Train	9%	13%	14%	13%
BTM	13%	13%	10%	13%
Slow	-6%	-3%	-2%	-2%

Table 76 shows the percentage variations in terms of passenger km for each transport mode by area type (as defined in chapter 8). As can be seen, there are no significant differences in percentage variation.

Table 76. Percentage variations (in passenger km) by mode and area type for "intermodality and interconnectivity" policy

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	0%	0%	0%	0%	0%	0%	0%
Car passenger	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Train	12%	12%	12%	13%	12%	12%	12%
BTM	12%	12%	12%	13%	12%	12%	12%
Non-motorised	-3%	-3%	-3%	-3%	-3%	-3%	-3%

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A further analysis has been carried out disaggregating the results of the simulation by EU country. In this case no significant variations have been observed with the only exception of Italy, France, Germany, the Netherlands, Sweden, UK, which are slightly more sensitive to the simulated policy.

The general conclusion on intermodality and interconnectivity (reduction of wait and transfer time for train and bus/tram/metro) is that, although the use of train and bus/tram/metro is increased considerably, it has a very small impact on the car driver mode.

(2) "Fuel price increase" policy

This policy is simulated assuming the following changes in level of service attributes:

- Car cost of 10%, 25% and 40% respectively.

For sake of brevity, in the following tables results are reported only for a percentage change of 10%.

Table 77 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, the impact of the policy simulated on public transport increases somewhat as income increases.

Table 77. Percentage variations (in passenger km) by mode and income band for "Fuel price increase" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	-2%	-2%	-2%	-2%	-2%
Car passenger	0%	-1%	-2%	-1%	0%
Train	1%	1%	2%	2%	2%
BTM	1%	2%	2%	2%	2%
Non-motorised	0%	1%	1%	1%	0%

Table 78 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; no general conclusions can be drawn from the results obtained.

Table 78. Percentage variations (in passenger km) by mode and car ownership class for "Fuel price increase" policy.

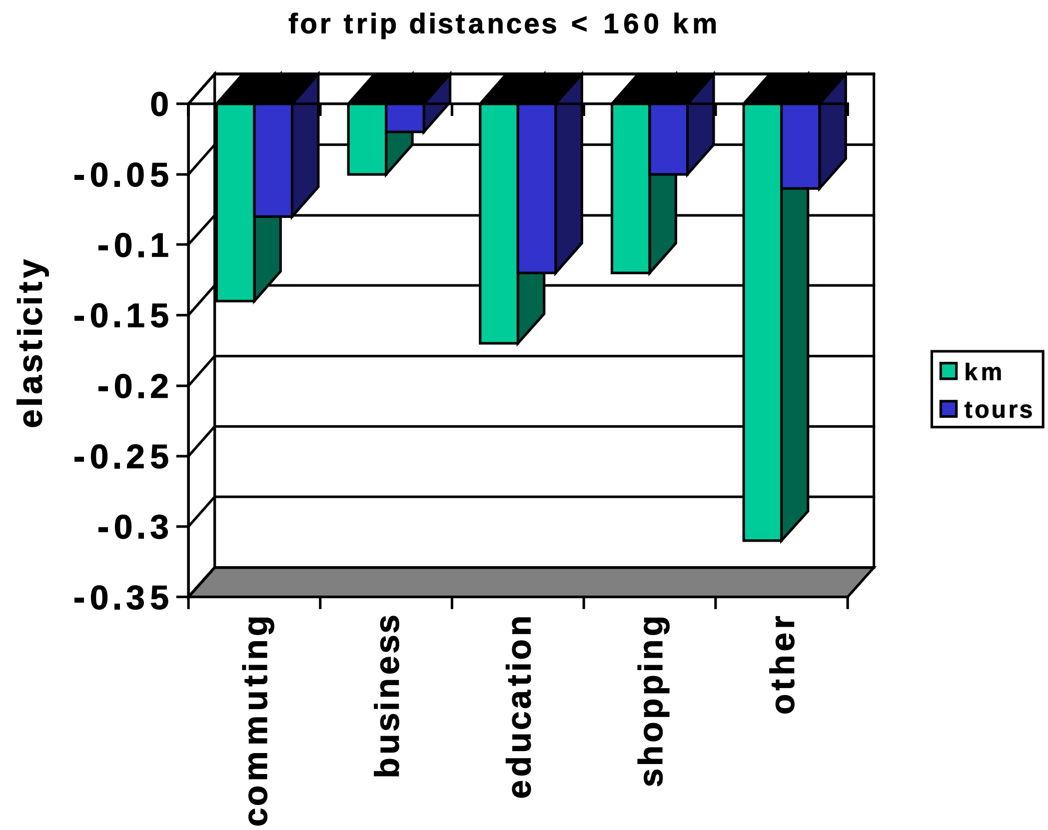
	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-3%	-	-2%	-2%
Car passenger	-1%	-3%	0%	1%
Train	0%	1%	2%	2%
BTM	1%	1%	2%	2%
Non-motorised	0%	1%	0%	1%

Table 79 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, there are no significant differences in percentage variation.

Table 79. Percentage variations (in passenger km) by mode and area type for "Fuel price increase" policy

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	-1%	-2%	-2%	-1%	-2%	-2%	-2%
Car passenger	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Train	1%	1%	1%	1%	1%	1%	1%
BTM	1%	1%	1%	2%	1%	1%	1%
Non-motorised	1%	1%	1%	1%	1%	1%	0%

Figure 18. Changes (expressed as elasticities) in the number of tours and passenger kilometres as car driver by purpose for changes in car cost



A further analysis has been carried out disaggregating the results of the simulation by EU country; percentages show that Northern European countries are less sensitive to the fuel price increase than other ones.

The general conclusion on this policy of fuel price increase is that in the long run it has a modest, but non-marginal effect on the amount of car driver kilometres. But this effect is not so much the result of modal split effects, it is mainly a destination choice effect: if the car cost increase, in the long run travellers will choose to go to destinations closer to their home, especially for shopping and 'other' (social/recreational) travel purposes. Because of this, the effects on the number of car driver tours is fairly small, but the effects on car driver kilometrage (including the reduction of tour lengths) are not so small, certainly not negligible (also see Figure 18). Figure 18 also shows that the fuel price increase effects on car kilometrage are biggest for 'other' (social, recreational) travel and smallest for business travel.

(3) "Public transport pricing" policy

This policy is simulated assuming the following changes in level of service attributes:

- Rail and BTM cost –10% and –30%.

For sake of brevity, in the following tables results reported only for a percentage change of -30%.

Table 80 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, the car driver and car passenger kilometrage in the lowest income band are more sensitive than the other income bands. Train gains most in income band 3 and 4 and bus/tram/metro grows most in income band 2 and 3.

Table 80. Percentage variations (in passenger km) by mode and income band for "Public transport pricing" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	-5%	-2%	-1%	-2%	-2%
Car passenger	-7%	-4%	-3%	-3%	-5%
Train	32%	38%	43%	40%	33%
BTM	27%	35%	37%	32%	25%
Non-motorised	-8%	-5%	-4%	-4%	-6%

Table 81 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; it shows that in car-owning segments the relative increases in public transport use are greater than in the no car segment.

Table 81. Percentage variations (in passenger km) by mode and car ownership class for "Public transport pricing" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-9%	-	-2%	-2%
Car passenger	-12%	-4%	-4%	-4%
Train	28%	37%	39%	39%
BTM	28%	32%	26%	31%
Non-motorised	-11%	-5%	-4%	-3%

Table 82 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, there are no significant differences in percentage variation.

Table 82. Percentage variations (in passenger km) by mode and area type for "Public transport pricing" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Car passenger	-4%	-5%	-4%	-5%	-4%	-4%	-4%
Train	35%	36%	35%	36%	36%	35%	34%
BTM	29%	29%	29%	29%	29%	29%	29%
Non-motorised	-5%	-6%	-5%	-5%	-5%	-6%	-6%

Country variation percentages are smaller than average for Sweden, Slovenia and Greece.

The general conclusion is that a big decrease in public transport cost can have a non-marginal effect on car driver kilometrage, but the cross-elasticities here are quite low: it takes a big stimulus to have a noticeable impact on car use.

(4) "Rail and fluvial interoperability" policy

This policy is simulated assuming the following changes in level of service attributes:

- Rail times and costs –5%.

Table 83 contains the percentage variations in terms of passenger km for each transport mode by income band. No clear patterns can be discerned.

Table 83. Percentage variations (in passenger km) by mode and income band for "Rail and fluvial interoperability" policy

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	0%	0%	0%	0%	0%
Car passenger	-1%	-1%	0%	-1%	-1%
Train	8%	9%	10%	10%	9%
BTM	3%	4%	3%	3%	3%
Non-motorised	-1%	-1%	-1%	-1%	-1%

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Table 84 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; it shows that in car-owning segments the increase in train use is greater than in the no car segment.

Table 84. Percentage variations (in passenger km) by mode and car ownership class for "Rail and fluvial interoperability" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-1%	-	0%	0%
Car passenger	-2%	0%	-1%	-1%
Train	7%	10%	10%	9%
BTM	4%	3%	3%	3%
Non-motorised	-2%	-1%	-1%	-1%

Table 85 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, there are no significant differences in percentage variation.

Table 85. Percentage variations (in passenger km) by mode and area type for "Rail and fluvial interoperability" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	0%	0%	0%	0%	0%	0%	0%
Car passenger	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Train	9%	9%	9%	9%	9%	9%	9%
BTM	3%	3%	3%	3%	3%	3%	3%
Non-motorised	-1%	-1%	-1%	-1%	-1%	-1%	-1%

There are no significant differences in variation percentages disaggregated by country.

The general conclusion is that this policy does not succeed in reducing car use.

(5) "Market liberalization" policy

This policy is simulated assuming the following changes in level of service attributes:

- Rail cost –5% and –10%.

For sake of brevity, in the following tables results are reported only for a percentage change of -10%.

Table 86 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, income bands do not differ substantially in the variation percentages.

Table 86. Percentage variations (in passenger km) by mode and income band for "Market liberalization" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	0%	0%	0%	0%	0%
Car passenger	-1%	0%	0%	0%	-1%
Train	7%	8%	8%	7%	7%
BTM	3%	4%	4%	4%	3%
Non-motorised	-1%	-1%	0%	0%	-1%

Table 87 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class. As it can be seen, no significant differences arise.

Table 87. Percentage variations (in passenger km) by mode and car ownership class for "Market liberalization" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	0%	-	0%	0%
Car passenger	-1%	0%	-1%	-1%
Train	7%	7%	7%	7%
BTM	3%	4%	3%	4%
Non-motorised	-1%	0%	-1%	0%

Table 88 shows the percentage variations in terms of passenger km for each transport mode by area type. There are no significant differences for the car ownership classes considered**.**

Table 88. Percentage variations (in passenger km) by mode and area type for "Market liberalization" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	0%	0%	0%	0%	0%	0%	0%
Car passenger	0%	0%	0%	-1%	0%	0%	0%
Train	7%	7%	7%	7%	7%	7%	7%
BTM	3%	3%	3%	3%	3%	3%	3%
Non-motorised	-1%	-1%	-1%	-1%	-1%	-1%	-1%

All country percentages are similar to the EU average value.

Again, the general conclusion is that this policy does not succeed in reducing car use.

(6) "Cost internalisation" policy

This policy is simulated assuming the following changes in level of service attributes:

- Car cost +25% and bus cost +10%;
- Car cost +40% and bus cost +25%.

For sake of brevity, in the following tables results are reported only for the increase in car cost of 40% and bus cost of 25%.

Table 89 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, the lower income bands are slightly more sensitive to the policy.

Table 89. Percentage variations (in passenger km) by mode and income band for "Cost internalisation" policy

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	-5%	-5%	-5%	-4%	-4%
Car passenger	2%	-1%	-3%	-1%	2%
Train	-3%	0%	0%	0%	-3%
BTM	-8%	-7%	-5%	-4%	-6%
Non-motorised	4%	7%	8%	7%	4%

Table 90 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; with increasing car ownership the percentage reduction in public transport use decreases.

Table 90. Percentage variations (in passenger km) by mode and car ownership class for "Cost internalisation" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-7%	-	-5%	-4%
Car passenger	1%	-7%	4%	6%
Train	-3%	-3%	-1%	2%
BTM	-10%	-8%	-2%	-2%
Non-motorised	2%	8%	5%	7%

Table 91 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, changes are bigger for the lowest density area types (with the higher area type category numbers).

Table 91. Percentage variations (in passenger km) by mode and area type for "Cost internalisation" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	-3%	-4%	-4%	-4%	-5%	-5%	-5%
Car passenger	0%	0%	0%	0%	0%	0%	0%
Train	-2%	-2%	-1%	-1%	-1%	-2%	-2%
BTM	-6%	-6%	-6%	-5%	-6%	-6%	-6%
Non-motorised	6%	6%	6%	6%	6%	6%	5%

Variation percentages are higher for all the countries that include zones in the lower density area types (5-7) and are smaller for the others.

The general conclusion is that cost internalisation can decrease car use considerably (note however that the stimulus included a large increase in car cost: +40%). This is not in the first place a mode choice effect, but a destination choice effect (as for the fuel price increase).

(7) "New urban public transport" policy

This policy is simulated assuming the following changes in level of service attributes (in area types 1-4):

- Bus/tram/metro travel times -10%;
- Bus/tram/metro travel times -25%.

For sake of brevity, in the following tables results are reported only for the latter level of service changes (-25%).

Table 92 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, the changes are very similar across income bands.

Table 92. Percentage variations (in passenger km) by mode and income band for "New urban public transport" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	0%	0%	0%	0%	0%
Car passenger	0%	0%	0%	0%	0%
Train	1%	1%	1%	1%	1%
BTM	4%	5%	6%	6%	6%
Non-motorised	0%	0%	0%	0%	-1%

Table 93 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; it does not show significant differences between car ownership segments.

Table 93. Percentage variations (in passenger km) by mode and car ownership class for "New urban public transport" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	0%	-	0%	0%
Car passenger	-1%	0%	0%	0%
Train	1%	1%	1%	1%
BTM	5%	6%	6%	6%
Non-motorised	-1%	0%	0%	0%

Table 94 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, changes only take place in the highest density area types 1-4.

Table 94. Percentage variations (in passenger km) by mode and area type for "New urban public transport" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	0%	0%	0%	0%	0%	0%	0%
Car passenger	-1%	-1%	-1%	-1%	0%	0%	0%
Train	2%	2%	2%	2%	0%	0%	0%
BTM	16%	16%	16%	16%	0%	0%	0%
Non-motorised	-1%	-1%	-1%	-1%	0%	0%	0%

The general conclusion is that offering new urban public transport is not an effective policy for reducing car use.

(8) "Congestion and road pricing and parking policies" policy

This policy is simulated assuming the following changes in level of service attributes (in area types 1-4):

- Car cost +25%;
- Car cost +40%.

For sake of brevity, in the following tables results are reported only for the latter percentages.

Table 95 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, there are only few and small differences between the income bands.

Table 95. Percentage variations (in passenger km) by mode and income band for "Congestion and road pricing and parking" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	-1%	-1%	-1%	-1%	-1%
Car passenger	0%	-1%	-1%	-1%	0%
Train	1%	1%	2%	2%	1%
BTM	0%	1%	2%	2%	1%
Non-motorised	0%	1%	1%	1%	0%

Table 96 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; the reaction in the car ownership classes 3 and 4 in terms of public transport use is somewhat stronger.

Table 96. Percentage variations (in passenger km) by mode and car ownership class for "Congestion and road pricing and parking" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-2%	-	-1%	-1%
Car passenger	0%	-2%	0%	1%
Train	0%	1%	2%	2%
BTM	0%	1%	2%	2%
Non-motorised	0%	1%	1%	1%

Table 97 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, changes only occur for the area types 1 to 4.

Table 97. Percentage variations (in passenger km) by mode and area type for "Congestion and road pricing and parking" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	-3%	-4%	-4%	-3%	0%	0%	0%
Car passenger	-2%	-2%	-2%	-2%	0%	0%	0%
Train	3%	3%	3%	3%	0%	0%	0%
BTM	3%	3%	3%	3%	0%	0%	0%
Non-motorised	2%	2%	2%	2%	0%	0%	0%

In general one can conclude that this policy is effective in reducing car kilometrage (again mainly through destination shift, not so much through mode shift).

(9) "Maximum speed limits and harmonization of rules on speeding" policy

This policy is simulated assuming the following changes in level of service attributes:

- Car time + 10%, + 20% (Maximum speed limits);
- Car time + 5%, + 10% (Harmonization of rules on speeding).

For sake of brevity, in the following tables results are reported only for a 10% change in car time.

Table 98 contains the percentage variations in terms of passenger km for each transport mode by income band. As it can be seen, intermediate income bands have a somewhat smaller decrease in car passenger kilometrage and a bigger increase for public transport and non-motorised modes.

Table 98. Percentage variations (in passenger km) by mode and income band for "Maximum speed limits and Harmonization of rules on speeding" policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	-5%	-5%	-5%	-5%	-6%
Car passenger	-12%	-11%	-10%	-11%	-12%
Train	4%	6%	8%	9%	6%
BTM	5%	7%	8%	9%	7%
Non-motorised	5%	6%	7%	7%	6%

Table 99 reports the percentage variations in terms of passenger km for each transport mode by car ownerships class; it suggests that the car ownership categories 3 and 4 react slightly more in terms of public transport use.

Table 99. Percentage variations (in passenger km) by mode and car ownership class for "Maximum speed limits and Harmonization of rules on speeding" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-9%	-	-6%	-5%
Car passenger	-15%	-10%	-12%	-11%
Train	3%	6%	9%	9%
BTM	4%	6%	9%	10%
Non-motorised	3%	6%	7%	8%

Table 100 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, there are no significant differences between area types.

Table 100. Percentage variations (in passenger km) by mode and area type for “Maximum speed limits and Harmonization of rules on speeding” policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	-4%	-5%	-5%	-5%	-6%	-6%	-6%
Car passenger	-11%	-11%	-11%	-11%	-11%	-11%	-12%
Train	7%	7%	7%	7%	7%	6%	6%
BTM	7%	7%	7%	7%	7%	7%	7%
Non-motorised	6%	6%	6%	7%	6%	6%	6%

Variation percentages are higher for Northern Europe countries.

The general conclusion on this policy (as simulated through car time increases) is that it is very effective in reducing car use. The main mechanism behind this is change of destination, not of mode.

(10) “Housing densification and employment densification” policy

This policy is simulated assuming the following changes, not in level of service attributes but in the expansion factors for 2020:

- Housing densification: 10% of the population of area types 5-7 is shifted to area types 1-4 (both split proportionally to the distribution in the 2020 Reference Scenario); the total population stays the same as in the Reference;
- Employment densification: 10% of the employed population of area types 5-7 is shifted to area types 1-4 (both split proportionally to the distribution in the 2020 Reference Scenario); total employment is the same is in the Reference.

For sake of brevity, in the following tables results are reported only for the former shift.

Table 101 contains the percentage variations in terms of passenger km for each transport mode by income band. As can be seen, there are hardly any differences between the income bands.

Table 101. Percentage variations (in passenger km) by mode and income band for “Housing densification” policy.

	Income band 1	Income band 2	Income band 3	Income band 4	Income band 5
Car driver	-1%	-1%	-1%	-1%	-1%
Car passenger	-1%	-1%	-1%	-1%	-1%
Train	3%	3%	3%	3%	3%
BTM	0%	0%	0%	0%	1%
Non-motorised	1%	1%	1%	1%	1%

Table 102 reports the percentage variations in terms of passenger km for each transport mode by car ownership class; they show few and small differences between the car ownership categories.

Table 102. Percentage variations (in passenger km) by mode and car ownership class for "Housing densification" policy.

	Carown 1	Carown 2	Carown 3	Carown 4
Car driver	-1%	-	-1%	-1%
Car passenger	-1%	-1%	-1%	-1%
Train	4%	3%	3%	3%
BTM	0%	0%	0%	1%
Non-motorised	0%	1%	1%	2%

Table 103 shows the percentage variations in terms of passenger km for each transport mode by area type. As can be seen, the changes in passenger km closely follow the shifts in population from area type 5-7 to 1-4.

Table 103. Percentage variations (in passenger km) by mode and area type for "Housing densification" policy.

	Areatype 1	Areatype 2	Areatype 3	Areatype 4	Areatype 5	Areatype 6	Areatype 7
Car driver	20%	20%	19%	19%	-10%	-10%	-10%
Car passenger	20%	21%	19%	19%	-10%	-10%	-10%
Train	20%	21%	18%	18%	-10%	-10%	-10%
BTM	20%	21%	18%	18%	-10%	-10%	-10%
Non-motorised	21%	23%	19%	19%	-10%	-10%	-10%

The general conclusion on this policy is that it only slightly reduces car use and increases the use of public transport and the non-motorised modes. The shift in employment population is even less effective.

11.3 Additional results from the SCENES passenger model

In the following tables are outcomes both in terms of trips (since SCENES uses trips, not tours) and passenger-km for policy measures from the SCENES passenger model. The first set of results (three tables) refers to the fuel price increase policy, in which both the car cost and air fares were increased.

Table 104. Effects of fuel price increase on passenger kilometrage (all distance classes) according to the SCENES model; car cost and air fares +10%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.3%	+3.5%	+1.1%	+0.3%	-16.2%	0%
Passenger km	-1.5%	+5.7%	+3.4%	+1.7%	-11.7%	-1.1%

Table 105. Effects of fuel price increase on passenger kilometrage (all distance classes) according to the SCENES model; car cost and air fares +25%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.7%	+7.0%	+2.6%	+0.5%	-33.3%	0%
Passenger km	-3.7%	+14.8%	+8.7%	+4.5%	-28.0%	-2.4%

Table 106. Effects of fuel price increase on passenger kilometrage (all distance classes) according to the SCENES model; car cost and air fares +40%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-1.3%	+11.1%	+4.8%	+0.6%	-54.3%	0%
Passenger km	-5.7%	+24.0%	+13.8%	+7.7%	-48.3%	-3.5%

From the above three tables it can be concluded that air transport is very sensitive to price changes. This holds especially for the leisure segment of air travel, business travellers are less sensitive to the fare levels and more time-sensitive. The fuel price increases lead to a substitution away from car and especially away from air transport, mostly towards train, but also towards bus/coach and to a lesser degree towards non-motorised transport. For these modes the changes in passenger-km are bigger than in trips, since the shift concerns trips with larger average distances. Also there is a decline in total (all modes) passenger kilometrage (a decrease in the average trip distance).

Table 107. Effects of public transport pricing on passenger kilometrage (all distance classes) according to the SCENES model; rail and bus/coach travel cost -10%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.6%	+11.4%	+2.2%	-0.1%	0%	0%
Passenger km	-1.0%	+12.2%	+5.5%	-1.2%	-0.2%	+0.3%

Table 108. Effects of public transport pricing on passenger kilometrage (all distance classes) according to the SCENES model; rail and bus/coach travel cost -30%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-2.1%	+39.2%	+7.5%	-0.6%	0%	0%
Passenger km	-3.6%	+44.8%	+17.9%	-4.6%	-0.2%	+1.0%

A small decrease (10%) in the rail and bus/coach travel cost has only a small impact on car use. The impact of a 30% cost reduction on car use no longer is small according to the SCENES model.

Table 109. Effects of rail and fluvial interoperability on passenger kilometrage (all distance classes) according to the SCENES model; rail travel times and cost -5%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.2%	+9.7%	-0.3%	0%	-0.7%	0%
Passenger km	-0.5%	11.2%	-0.7%	-0.3%	-0.4%	+0.2%

Table 110. Effects of market liberalisation (rail) on passenger kilometrage (all distance classes) according to the SCENES model; rail travel cost -5%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.1%	+6.0%	-0.2%	0%	0%	0%
Passenger km	-0.3%	+6.6%	-0.4%	-0.2%	0%	+0.1%

Table 111. Effects of market liberalisation (rail) on passenger kilometrage (all distance classes) according to the SCENES model; rail travel cost -10%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.3%	+12.0%	-0.4%	0%	0%	0%
Passenger km	-0.6%	+13.1%	-0.8%	-0.5%	+0.1%	+0.2%

The above three tables show that rail and fluvial interoperability and market liberalisation for rail, as implemented here and following the SCENES model, have only limited impacts on the use of the car. The use of the train grows considerably, but this has hardly any effect across the board on the car mode.

Table 112. Effects of cost internalisation on passenger kilometrage (all distance classes) according to the SCENES model; car cost and air fares +25% and bus fares +10%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.4%	+8.1%	-0.1%	+0.8%	-33.3%	0%
Passenger km	-3.3%	+15.7%	+2.3%	+5.4%	-28.0%	-2.5%

Table 113. Effects of cost internalisation on passenger kilometrage (all distance classes) according to the SCENES model; car cost and air fares +40% and bus fares +25%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.4%	+13.9%	-2.5%	+1.3%	-54.3%	0%
Passenger km	-4.9%	+26.1%	-1.7%	+10.0%	-48.1%	-3.7%

These two tables make clear that cost internalisation can lead to a substantial shift (but only if car cost increase considerably) from car and air transport to non-motorised transport and especially to train. However most of the reduction in car passenger km is not due to modal shift, but to changes in the distribution: shorter trip distances. Therefore the number of car trips hardly changes and the number of passenger kilometres by car reduces considerably.

Table 114. Effects of maximum speed limits on passenger kilometrage (all distance classes) according to the SCENES model; car time +10%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-1.7%	+8.5%	+5.3%	+1.5%	+4.3%	0%
Passenger km	-3.6%	+8.5%	+8.3%	+6.8%	+4.1%	-1.0%

Table 115. Effects of maximum speed limits on passenger kilometrage (all distance classes) according to the SCENES model; car time +20%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-3.6%	+17.2%	+9.8%	+2.8%	+11.4%	0%
Passenger km	-7.2%	+17.4%	+17.2%	+14.6%	+8.4%	-2.0%

Table 116. Effects of harmonisation of rules on speeding on passenger kilometrage (all distance classes) according to the SCENES model; car time +5%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-0.8%	+4.3%	+2.7%	+0.8%	+2.2%	0%
Passenger km	-1.8%	+4.3%	+4.2%	+3.4%	+2.1%	-0.5%

Table 117. Effects of harmonisation of rules on speeding on passenger kilometrage (all distance classes) according to the SCENES model; car time +10%

Trips or passenger km	Car	Train	Bus/coach	Non-motorised	Air	Total
Trips	-1.7%	+8.5%	+5.3%	+1.5%	+4.3%	0%
Passenger km	-3.6%	+8.5%	+8.3%	+6.8%	+4.1%	-1.0%

From the above four tables we can conclude that according to SCENES, policy measures that increase the car time are effective in the sense that they lead to a shift from car to the other modes (but also including air transport).

11.4 Conclusions on policy effectiveness, sensitive and insensitive segments and policy bundles

The following conclusions are based on the outcomes from the meta-model for passenger transport and the SCENES passenger model, presented above:

- Policies that increase the car cost (fuel price increase, congestion and road pricing, parking policies, infrastructure tariff, cost internalisation), will only have limited mode shift effects, especially for business travel. There will be non-marginal reductions of car use, but most of the impact on car kilometrage is due to destination shift. The biggest reduction in car kilometrage is found for 'other' purposes (social and recreational traffic)
- Policies that lead to an increase in car time (speed limits, speed controls) are relatively effective means of reducing car use (again mainly through destination shift, not mode shift). This does not automatically imply that these are the most desirable polices for passenger transport; this also depends on the other impacts (see the evaluation outcomes below) of the measures than just the impacts on the transport volumes.
- Air transport (especially the leisure segment) is very sensitive to the level of the air fares.
- Increasing travel time by x% has a larger impact than increasing travel cost by x%. This goes for changes in cost and time for all modes.
- Policies that decrease the public transport cost or time (intermodality, interconnectivity, public transport pricing, rail and fluvial interoperability, rail market liberalisation), will have a large impact on kilometrage for the mode itself (or these modes themselves), but a very limited impact on car use.
- Elasticities (in absolute values) increase with distance.
- None of the policies simulated was really effective in shifting passengers from car driver to the non-car modes. Policies that increase the car cost or time are most effective in reducing car kilometres (mainly through destination shifts, not much modal shift). To be effective in reducing car use, a policy bundle should include elements of a car cost and/or car time increase. At the same time, such a policy could be complemented by policies that make public transport more attractive (also for equity purposes and to provide accessibility to lower income groups).
- Segments of the passenger transport market that might be targeted because of their higher than average sensitivity for policy measures are long distance travel and social/recreational travel (and by definition for policies that make car less attractive: car owning-households). We did not find clear differences between the responsiveness of different income groups, area types and countries.

11.5 Scoring of policies for passenger transport

The scoring method for passenger transport was described in chapter 5. In Table 118 below the outcomes for the policies are given in terms of the change in the sum of the internal and external cost of transport. A reduction means that the cost to society are reduced.

The best policies (on this aggregates cost measure) are the ones that make public transport cheaper or faster, such as public transport pricing, intermodality, interconnectivity, new urban public transport, interoperability and rail market liberalisation. Such policies increase the user benefits (measured through the logsum) from transport, because the public transport users have lower fares or lower time costs, and at the same time these policies

Table 118. Summary of the evaluation results of the policy measures for passenger transport (change w.r.t. the 2020 Reference Scenario in internal and external cost of transport in billions of Euros)

Policy	Total change	Internal cost change	External cost change			
			total	emissions	noise	accidents
Intermodality/ Interconnectivity, low	-42.47	-41.23	-1.24	-0.31	0.06	-1.00
Intermodality/ Interconnectivity, high	-101.45	-97.50	-3.94	-0.89	-0.17	-2.89
Rail and fluvial interoperability	-13.55	-13.14	-0.40	-0.12	0.10	-0.39
Cost internalisation, low	109.74	113.97	-4.24	-0.77	-0.95	-2.51
Fuel price increase 10%	38.28	41.27	-3.00	-0.55	-0.64	-1.81
Fuel price increase 25%	76.45	83.40	-6.94	-1.28	-1.48	-4.18
Fuel price increase 40%	111.35	121.60	-10.25	-1.89	-2.18	-6.18
Public transport pricing, low	-18.68	-17.37	-1.31	-0.30	-0.03	-0.98
Public transport pricing, high	-130.98	-126.42	-4.56	-1.05	-0.09	-3.42
Cost internalisation, high	173.86	179.84	-5.98	-1.07	-1.43	-3.49
Market liberalization (rail), low	-2.18	-2.12	-0.06	-0.03	0.07	-0.09
Market liberalization (rail), high	-4.60	-4.48	-0.12	-0.06	0.13	-0.20
New urban public transport, low	-12.67	-12.54	-0.13	-0.04	0.04	-0.13
New urban public transport, high	-38.79	-38.37	-0.42	-0.13	0.10	-0.39
Harmonisation of rules on speeding, low	65.36	72.62	-7.27	-1.34	-1.54	-4.38
Harmonisation of rules on speeding, high; Maximum speed limits, low	128.16	142.60	-14.44	-2.67	-3.06	-8.71
Maximum speed limits, high	217.21	243.25	-26.04	-4.82	-5.50	-15.71
Congestion and road pricing, or parking, low	28.78	30.52	-1.74	-0.34	-0.35	-1.04
Congestion and road pricing, high	42.19	44.75	-2.56	-0.50	-0.51	-1.54
Promoting housing densification	71.47	73.51	-2.05	-0.23	-0.44	-1.38
Promoting employment densification	39.53	40.72	-1.19	-0.13	-0.26	-0.80

(slightly) decrease the external effects. All these policies lead to a reduction in the total internal and external cost of transport. Not taken into account here is that the revenues of the public transport operator might decrease when the fares are reduced.

Cost internalisation, congestion pricing, road pricing, parking policies, harmonisation of rules on speeding, maximum speed limits and fuel price increases all make car more expensive or slower. This leads to a substantial increase in the user cost (measured by the change in the logsum, and converted into money units), which is not outweighted by the reduction in the external cost. Therefore all these policies lead to an increase in the total internal and external cost of transport. Not taken into account here is that the policy measures that increase the cost for transport users also increases the government revenues (there is a shift of taxes or charges from the transport users to the government).

Promoting housing densification or employment densification leads to a decrease in the external costs, but the increase in internal cost for the travellers dominates the picture.

Most policies that make public transport policy more attractive are in the category with 'medium' investment, operation and maintenance cost (see chapter 5). Most policies that make car less attractive are in the 'low' category for this. In Table 119 is an overall assessment of the policies.

Table 119. Overall assessment of the policies for passenger transport

	Effectiveness (modal shift from road to other modes)	**Change in internal and external transport cost**	**Required investment and operation and maintenance cost**
Intermodality	Low	Big reduction	Medium
Interconnectivity	Low	Big reduction	Medium
Congestion and road pricing	High	Medium increase	Low and government revenues
Parking policies	High	Medium increase	Low and government revenues
Rail and fluvial interoperability	Low	Small reduction	Medium
Market liberalization (rail)	Low	Small reduction	Medium
Cost internalisation	High	Big increase	Low and government revenues
Maximum speed limits	High	Big increase	Low
Harmonisation of rules on speeding	High	Big increase	Low
Public transport pricing	Low	Big reduction	Medium
New urban public transport	Low	Medium reduction	Medium
Fuel price increase	High	Big increase	Low and government revenues
Housing and employment densification	Low	Big increase	Medium

12 SUMMARY AND CONCLUSIONS

The EXPEDITE project has been carried out for the European Commission, Directorate-General for Energy and Transport (DGTREN) by a consortium of consultants and institutes, coordinated by RAND Europe, as part of the 5th Framework.

The objectives of EXPEDITE were to generate forecasts for both passenger and freight transport for Europe for 2005, 2010, 2015 and 2020, to show which policies can be effective to reach substitution from car and lorry and air transport to other modes and to identify market segments that are sensitive (and those that are insensitive) to policy measures.

In previous deliverables in this project, we have reviewed existing national and international transport models, presented the base-year (1995) data, defined a Reference Scenario for 2020 and the intermediate years, defined policies to be simulated, and carried out runs with existing models (the SCENES European model and a number of national models for passenger and freight transport). On the basis of this information we created two new models, the EXPEDITE meta-model for passenger transport and the EXPEDITE meta-model for freight transport.

In this EXPEDITE Final Report, we present the main outcomes of the entire project. In particular we give the results of runs with the meta-models and the SCENES models for the Reference Scenario. Furthermore, we report on the policy runs carried out with those models and the evaluation of these policies in EXPEDITE. On the basis of these policy runs we have also reached conclusions on the effectiveness of policy measures and on (in)sensitive market segments.

Conclusions on freight transport:

- In the period 1995-2020, under the assumptions of the Reference Scenario, the number of tonnes lifted in the study area will increase by 44% (lorry +39%) and tonne-kilometrage will grow by 79% (lorry +89%). A higher growth is predicted for the Central and Eastern European Countries (CEEC), for long distance transport and for general cargo.
- If lorry costs increase, there will only be significant shifts at trip distances above 100 kilometres. Below 100 kilometres, road transport is the dominant mode (except for some small niche segments, e.g. shipments between firms with rail sidings or inland waterways or sea terminals at both origin and destination). Policy measures are unable to change this situation below 100 kilometres: it is an insensitive market segment. This is not generally true for shipments with trip distances above 100 kilometres. Here, an increase in lorry cost can lead to substitution, mainly to inland waterways transport (where available) and train.
- If the lorry transport time goes up, there will also be only significant mode shifts for consignments above 100 kilometres. For this change in transport conditions, most of the substitution is towards combined road-rail transport, but also to conventional rail transport.
- If the rail/combined transport cost or time decreases, then for fuels and ores, metal products, basic and other chemicals, large machinery (but only above 100 kilometres) there will be a significant decline in lorry tonne-kilometrage, but a shift will also take place from inland waterways transport (where this mode exists).

- If the cost or time of inland waterways transport decrease, then there will only be a significant reduction of lorry transport for specific countries (where inland waterways transport is a viable option, such as The Netherlands, Belgium, Germany and France).
- If the sea shipping cost or time goes down, there will only be small shifts towards sea transport and no significant reduction for lorry.
- In passenger transport an increase in transport time by x% has a bigger impact than an increase in transport cost by x%. This is not generally true in freight transport; in many situations an x% change in cost has a bigger impact than an x% change in time.
- Elasticities keep increasing with distance after 100 kilometres (especially time elasticities).
- Changes in tonne-kilometres are bigger than changes in tonnes for lorry, while the changes are close to being equal in tonnes and tonne-kilometres for rail and inland waterways. This shows that goods would mostly be transferred between modes in consignments where trip lengths are longer than average lorry trips.
- The most effective policy measures to achieve substitution from road to other modes are (without implying that these are the best policies for society; that depends on the outcomes of the overall evaluation; see the last three bullet points for freight):
    - Increases in lorry cost for all or the higher distances (congestion and road pricing, infrastructure tariff, cost internalisation, kilometre charging, fuel price increase);
    - Increase in lorry time (maximum speed limits, harmonisation of rules on speeding);
    - Decrease in non-road handling and storage cost (intermodality and interconnectivity).
- Policies that make the non-road modes cheaper or reduce the travel times on the non-road networks are less effective for reducing lorry tonne-kilometrage; often they also lead to substitution between the non-road modes.
- Effective policy bundles should contain elements of the three most effective policies (increased cost and time for road, lower non-road handling and storage cost). Decreasing the non-road travel times and cost can only have a substantial effect on substitution away from the road mode if the bundle includes measures that make all non-road modes more attractive. Otherwise, there will be a large amount of substitution between the non-road modes.
- To make polices effective the target segment should be shipments above 100 kilometres. Also policies targetted at bulky products are more effective for substitution from road to the other modes than policies focussing on other commodities.
- Increasing the lorry cost (one of the three effective types of policy mentioned above) leads to increases in the cost for the users of transport, which according to the evaluation carried out, are not compensated by the reduction in external cost for society as a whole (emissions, noise, accidents). On the other hand this type of policy increases government revenues.
- Policies that increase the lorry transport time (another of the three effective types of policies) increase the time cost of transport users, but decrease the driving cost of the user and the external cost (because of substitution from road to modes that are cheaper and have lower external cost). The total internal and external costs remain more or less the same, according to our evaluation.
- Intermodality and interconnectivity, simulated as a decrease in handling and storage cost (the third of the above effective policies) reduce both internal user cost and external cost

of transport. These policies however require substantial investments in infrastructure and do not generate government revenues.

Conclusions on passenger transport:

- In the period 1995-2020 in the Reference Scenario, the meta-model predicts for short-distance travel (trip distances up to 160 kilometre) that the number of tours will grow by 5% (car driver +22%) and passenger kilometrage will increase by 10% (car driver +24%). There will be a much higher growth in the CEEC.
- Long distance travel (above 160 kilometres) increases much faster (car, train and especially air) than short distance transport.
- Policies that increase the car cost (fuel price increase, congestion and road pricing, parking policies, infrastructure tariff, cost internalisation), will only have limited mode shift effects, especially for business travel. There will be non-marginal reductions of car use, but most of the impact on car kilometrage is due to destination shift. The biggest reduction in car kilometrage is found for 'other' purposes (social and recreational traffic)
- Policies that lead to an increase in car time (speed limits, speed controls) are relatively effective means of reducing car use (again mainly through destination shift, not mode shift). This does not automatically imply that these are the most desirable polices for passenger transport; this also depends on the other impacts (see the evaluation outcomes below) of the measures than just the impacts on the transport volumes.
- Air transport (especially the leisure segment) is very sensitive to the level of the air fares.
- Increasing travel time by x% has a larger impact than increasing travel cost by x%. This goes for changes in cost and time for all modes.
- Policies that decrease the public transport cost or time (intermodality, interconnectivity, public transport pricing, rail and fluvial interoperability, rail market liberalisation), will have a large impact on kilometrage for the mode itself (or these modes themselves), but a very limited impact on car use.
- Elasticities (in absolute values) increase with distance.
- None of the policies simulated was really effective in shifting passengers from car driver to the non-car modes. Policies that increase the car cost or time are most effective in reducing car kilometres (mainly through destination shifts, not much modal shift), but considerable increases in car cost or time are needed for this. To be effective in reducing car use, a policy bundle should include elements of a car cost and/or car time increase. At the same time, such a policy could be complemented by policies that make public transport more attractive (also for equity purposes and to provide accessibility to lower income groups).
- Segments of the passenger transport market that might be targeted because of their higher than average sensitivity for policy measures are long distance travel and social/recreational travel (and by definition for policies that make car less attractive: car owning-households). We did not find clear differences between the responsiveness of different income groups, area types and countries.
- Policies that make public transport cheaper or faster, such as public transport pricing, intermodality, interconnectivity, new urban public transport, interoperability and rail market liberalisation lead to a reduction in the total internal and external cost of transport. Such policies increase the user benefits from transport, because the public transport users have lower fares or lower time costs, and at the same time (slightly) decrease the external effects. Not taken into account here is that the revenues of the public transport operator

might decrease when the fares are reduced. Most policies that make public transport more attractive require substantial investment and/or operation costs.

- Promoting housing densification or employment densification leads to a decrease in the external costs, but the increase in internal cost for the travellers dominates the picture.
- Cost internalisation, congestion pricing, road pricing, parking policies, harmonisation of rules on speeding, maximum speed limits and fuel price increases all make car more expensive or slower. This leads to a substantial increase in the user cost (the travellers have to pay more or incur higher time costs), which is not outweighted by the reduction in the external cost for society as a whole. Therefore all these policies lead to an increase in the total internal and external cost of transport. Not taken into account here is that the policy measures that increase the cost for transport users also increases government revenues (there is a shift of taxes or charges from the transport users to the government). Moreover, policies that make car less attractive usually have lower investment cost than policies that make public transport more attractive.

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