

SCENES



Final Report for Publication

SCENES European Transport Scenarios ST 97-RS-2277

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co-ordinator**

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Project

Duration: 01/01/98 to 31/03/01

Date: April 2002

**PROJECT FUNDED BY THE EUROPEAN COMMISSION UNDER THE
TRANSPORT RTD PROGRAMME OF THE 4th FRAMEWORK
PROGRAMME**

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Executive Summary

INTRODUCTION

The SCENES project covers the follow-up research for the Areas 10, 11 and 12 in the Phase B of the Strategic section of the 4th Framework Transport Research Programme (FP IV) of DG TREN. The work was organised into three separately managed Work Areas (WAs), corresponding to Areas 10, 11 and 12.

There were many original objectives of the SCENES project, spanning as it did a wide range of subjects and involving a large consortium of 18 partners. The main objectives and the WAs in which they are located are summarised as follows:

- to develop a databank of variables, covering EU countries and a range of countries in Eastern Europe (WA 10)
- to develop detailed forecasts of factors which will affect transport demand into the future, incorporating institutional factors and studies on breaks in trends. (WA 10)
- to extend to Eastern Europe and enhance with new data a strategic transport model of the EU and to carry out model runs based on the scenarios - this model will be linked to an 'appended' logistics module (WA 11)
- to produce transport demand scenarios for the EU for 2020 and beyond. These scenarios are made up of external, socio economic scenarios, and sets of policy scenarios (WAs 11 and 12)
- (existing) regional transport models will also be run to study the impacts of different scenarios (WA 12).

These objectives have been met in the course of the project. The tasks carried out in each of the WAs are now outlined in turn.

WA 10

The SCENES Internet Database has been set up, which contains base year data for 35 European countries and 31 indicators at the regional level as well as socio-economic forecasts generated within SCENES. This database has enabled an information system which focuses on socio-economic and transport demand-influencing indicators for European regions to be established. It has become a unique, easily accessible, data platform for socio-economic data at the regional level. Experience within the SCENES project has shown that from the transport modellers' point of view, there is a definite need for such a reliable, transparent and user-friendly database system to access regional socio-economic data.

Due to unsolved copyright problems the SCENES Internet Database has so far been accessible only for SCENES project partners and the European Commission. However, many of the transport research projects carried out in Europe depend on data from the same set of socio-economic indicators. Therefore, it would be very helpful to have a *common* and *consolidated* data platform for socio-economic data at the regional level. The establishment of such a medium would not only harmonise the input data for the models applied (and therefore the output of the models as well), but might also be useful in terms of saving resources. By providing a common data platform for research projects, repetition of data mining (which is a time-consuming process) could be avoided. From this perspective, the SCENES Internet Database may serve as a first, but decisive step on the way to a pan-European data information system, with regional (socio-economic) data, whose content is not only relevant for transport modellers, but also for policy-makers and other researchers undertaking regional analyses.

The second main area of research within Work Area 10 has embraced the analysis of drivers of transport demand concerning the following topics:

- generation of forecasts for socio-economic indicators for the year 2020 at regional level and for 2040 at national level
- study on interactions between demand and supply in transport
- analysis of impacts of regulatory systems in the transport sphere
- analysis of changes in trends of transport demand
- research on institutional aspects.

Detailed investigation of the drivers of transport demand has shown that the demand for transport is not solely influenced by the factors that are usually included in transport modelling, such as preferences for mobility, sectoral development of production, or transport supply characteristics. In order to explain long term changes in transport patterns it is also necessary to study the demand/supply effects, which occur in second round interactions between *land-use changes and transport development*.

Another area of great influence on the long term development of transport patterns is the type of *regulation* of the different transport sectors. However, in most cases the regulatory changes within public transport have not led to a substantial increase of patronage, but rather to faster rationalisation and more cost efficiency on the supply side. Without direct initiatives towards the harmonisation of transport markets it is unrealistic to expect substantial shifts from individual motorised transport to public transport.

On the contrary, due to the liberalisation process in the road freight and the airline sector in the European Union, further strong impulses have been given towards those sectors, despite all concerns expressed in Green and White Papers on the environmental consequences of such developments. Looking at the railway sector in some detail one can – after studying the performance of different regulation activities in individual Member States – draw the conclusion that these activities had little effect on changing the trends of traffic development. In the case of long distance transport, the reasons for this are that market conditions have not yet been harmonised, and that strong national barriers still exist which hamper the development of international railway operations.

The *institutional framework* within which transport markets are embedded has proved of great relevance to the development of transport. The institutional framework provides the guidelines for how externalities are dealt with and for how incentive mechanisms are set. It also tackles the problems associated with transaction costs. Thus institutional aspects determine not only the allocation of costs to certain modes, but also the way transport is organised and operated. Thus it has decisive impacts on reliability, quality, efficiency and security of transport services and thereby on transport demand patterns and the relative competitiveness of modes. Although it is rather complex to demonstrate their effects on transport demand indicators, institutional aspects are an important driving factor of transport demand.

WA 11

The main task in WA 11 was the construction of the SCENES European-wide transport forecasting model, building on the earlier STREAMS model. The SCENES model is a network based model of all movements on all transport modes for both passengers and freight, and it also includes intermodal transport. It uses data and analysis from WA 10, for example, the WA 10 forecasts of socio-economic variables. It has been run to test various policy scenarios for analysis within WA 12.

The SCENES transport model comprises separate passenger and freight demand modules, and a compatible passenger and freight transport model. It is a development of the model created during the preceding STREAMS FP IV project for DG TREN.

The structure of the SCENES model is in essence that of a traditional four-stage model, with distinct Generation – Distribution – Modal Split – Assignment components. However, the costs and times of travel which are output from the transport model feed into the demand model in the form of "disutilities" (derived from zone-pair travel costs and times)– thus the system encompasses a full feedback between the two models. In this way, changes in the transport model, be it through transport cost or infrastructure changes, have a bearing on the demand for travel.

The model is designed to produce in the first instance European level transport forecasts. Comprising as it does of a wide range of demographic, economic, socio-economic and transport factors, and being built as a "bottom up" model from the zonal level, a much greater level of spatial detail is however possible, and indeed many country and sector specific results are reported in the project. This level of detail can be achieved because the model comprises all transport and travel, including very short distance trips and slow modes.

The 15 European Union countries and eight Central and Eastern Europe Countries (CEEC) comprise the "internal" modelled area. That is, all travel within this area is modelled. The rest of the world is treated as "external", i.e., passenger travel and freight traffic to and from these external zones is modelled. The internal modelled area is represented by 244 zones based mainly on the NUTS2 definitions, and the external area is represented by 17 "European" zones with 4 zones representing the rest of the World. The exception is that freight traffic within the CEEC area is not modelled – only freight traffic between the CEEC and the EU, i.e., only the EU15 countries are treated as internal for the freight model.

The *passenger demand* model combines highly segmented, zonal level socio-economic and behavioural data to produce a matrix of travel. There are 20 population groups specified in each zone and 10 trip purpose categories. The *freight demand* model is based on a spatial adaptation of a financial input-output structure, in order to represent linkages between industries. These inter-linkages are estimated from zonal final demand. Some 24 economic sectors are used in producing a matrix based on value, which is converted to volumes in an interface module. This freight volume matrix can be combined with the passenger travel matrix and assigned to the modal networks in the common transport module.

The *transport model* contains a representation of the costs and times of travel by all the different modes (at the country level) between all of the model zones, for passenger and freight traffic. This is achieved using comprehensive and detailed multi-modal transport networks for road, rail, air, shipping, inland waterway and pipeline. An innovative treatment of intra-zonal travel for both passengers and freight allows the characteristics of even the shortest trips to be represented.

The purpose of the WA 11 work was to demonstrate the validity of the model structure, both in terms of the 1995 Base Year results, the 2020 reference case results, and the 2020 transport policy scenarios. These policy scenarios are designed to illustrate the nature of the forecasting process that can be undertaken with the model, rather than form a definitive set of European transport forecasts – in this way they do not constitute any "official" view of the future. In order to achieve the latter, forecasting assumptions and model outputs would have to be developed and analysed in much more detail, in the context of, and in consultation with, existing national level assumptions and forecasts.

WA 12

WA 12 explores specific scenarios and uses a set of modelling tools in order to show how alternative hypotheses might influence the transport system in the future.

It builds on the work realised in WA 10 on the collection of information and on the drivers of transport demand, and on the work in WA 11 on the development of a European-wide model. Based on a set of contrasting scenarios the WA 12 focuses on structural changes and spatial development patterns to explore how these affect the different components of the transport system. In that sense WA 12 provides a complementary approach to that in WA 11.

A variety of scenarios have been built up by exploring a series of different dimensions in separate work streams. Then the results of these have been drawn together in a coherent fashion. Scenarios can be produced to give a number of contrasting images of a future situation through the development of different hypotheses. Two major dimensions of the construction of scenarios have been distinguished in this study

The external (socio-economic) dimension: this comprises the range of external factors (economic, institutional, social, behavioural, technological, geographical) that will influence the future pattern of transport. To a large extent the evolution of these factors is outside the control of the transport policy maker, though they may be influenced by policy decisions outside the field of transport.

The transport policy dimension: this comprises the range of policy initiatives within the field of transport, e.g. pricing, regulation, investment, etc. that the transport policy maker may wish to explore.

Within the external dimension the two main aspects that have been investigated are:

- the **spatial** dimension of Europe and the regional spatial dynamics of an extended Europe. For this dimension two main spatial development scenarios were developed: one which is termed the "Euroland" scenario is a radial development scheme in which the industrialised core of the EU is the centre, the contrasting alternative scenario is a "multi-polar" scheme based on the revival of regional links within an enlarged European space
- the dimension of **structural changes in behaviour:** this includes both the behaviour of passengers through changes in car ownership and attitudes to car use, and the behaviour of companies through changes in their forms of organisation and logistics. For this dimension, two main behavioural scenarios were developed: one is termed the "Unrestricted", the alternative is the "Quality of Life" scenario.

The objectives of these two dimensions are to produce contrasting external scenarios on European spatial development, focusing on regional developments; and to analyse and test the implications of behavioural and structural change for passenger and freight transport in Europe.

In the construction of internally consistent scenarios reference is made to two major trends that are relevant to, but uncertain for the future. These trends provide a common framework for the various scenarios and have impacts on many behavioural changes:

- **Globalisation:** this corresponds broadly to the "Radial Development – Core of EU" spatial scenario and to the "Unrestricted" behavioural scenario
- **Regional integration:** this corresponds broadly to the "Multi-Polar Development" spatial scenario and to the "Quality of Life" behavioural scenario.

The trends are based on contrasting globalisation and liberalisation on the one side with local sustainability and protection of the environment on the other side.

This approach is illustrated through the development of transport policy scenarios concerning two major areas of EU policy: the enlargement of Europe towards CEEC countries, and the Transalpine case study.

- For the enlargement to the East, the policy scenario is a combined infrastructure and pricing scenario for the TINA (Transport Infrastructure Needs Assessment) corridors.
- For the Transalpine corridors, the policy scenario investigates harmonisation of national policies as well as initiatives to achieve an increase in rail modal share in order to reach a 50/50 road/rail balance for Transalpine freight crossings.

For both of these case studies specific transport models have been used: the VACLAV model for the TINA corridors, and the TRANSALP model which has been specifically built within the SCENES project.

The extension of East-West corridors from EU countries and major cities through to Eastern countries have also been chosen as application case studies in order to illustrate the spatial dimension for projections up to 20 or 30 years from now, and to show that a link can be made in the long run between a European vision of the future and concrete localised projects. The two corridors that were studied are

- Paris – Brussels – Berlin – Warsaw – Moscow
- Marseilles – Milan – Venice – Ljubljana – Budapest

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations from the range of tasks within the SCENES fall into two main groups: those related to transport policy issues that have been derived through the development of scenarios and the use of analytical procedures, and those related to the analytical procedures themselves developed within the project.

External and Policy Scenarios

The key feature that becomes apparent from the diverse issues that are analysed in the external scenarios is the need for *flexibility* in the transport policies that may be developed. There are major political and social forces (particularly in the countries outside but bordering on the EU) that could radically alter the future travel demand pattern. Accordingly, transport policies should be such that, if and when major breaks in trend occur, the policy can be adjusted so as to still retain its original coherence.

Yes it is important to use good analytical tools to forecast the potential impacts of transport policy measures. However, it is also important that these policy measures do not rely unduly for their success on an ability to accurately forecast future external social and political events across Europe. Policy measures need to be robust to a range of possible future external scenarios.

The other main finding from the analysis of external scenarios is the importance of behavioural and structural change factors for households and firms in determining future transport patterns. Strategic transport studies need to look at a wide range of behavioural and attitudinal issues from outside the transport system that may have a major future impact on transport itself.

The main policy conclusions are drawn from the two transport policy scenario case studies that have been carried out.

The combined infrastructure and pricing scenario applied to the TINA corridors

The combined infrastructure and pricing scenario has shown that most parts of the road and rail infrastructure of the TINA core networks could be financed by charges on the users. However, when comparing the share of rail infrastructure assumed not to be built with the share of road infrastructure assumed not to be built, the approach that was applied of internalising the infrastructure costs, results

in a higher share of rail infrastructure being shown to not be financially viable, than is the case for road infrastructure.

Summarising these results leads to the conclusion that the assumptions made in this policy scenario are ill-adapted to encourage the sustainable development of transport. Quite contrary to the goal of achieving more sustainability in transport, the assumptions of infrastructure building in this policy scenario encourage higher market shares for the modes: private car and air but a decline in the rail share.

The second important finding from this study is that it has proved more difficult for the rail mode to finance its infrastructure from its users than is the case for the road mode. This is due to rail's higher infrastructure building costs and relatively high maintenance costs.

Policy scenarios for Transalpine freight

The clearest outcome of this study is that a new, supra-national, authority should be created, with the mission of co-ordinating global Transalpine issues linked with transport and the environment. This authority should lead to a better harmonisation of policy measures, infrastructure planning, realisation and operation amongst the Alpine countries as well as amongst countries influencing Transalpine transport. The main Transalpine freight issues this new authority should tackle are listed below.

Two interrelated measures would be needed to achieve a proportion of rail freight equal to that on road: first, all new Transalpine rail investment projects linking France, Switzerland and Austria to Italy are needed, not merely for the extra capacity, but also to enable high commercial rail speeds to be achieved; secondly, their realisation should be synchronised with the complete removal of institutional obstacles.

Analysis of the Transalpine relations in the database shows that countries far away from the Alps, primarily on the North-South corridor, are important traffic generators. Indeed, Alpine crossings regulate modal choice far upstream, and also the upstream modal choice influences the selection of the crossing point. Accordingly, the main origin and destination regions should participate – to some extent - to modal shift measures and/or to finance infrastructure. A legal structure has to be developed to enable this to occur.

Consequently, at the larger scale, national policies have to be harmonised with the objective of influencing traffic flows all along the international logistics chain: road freight should not be heavily charged in the locality of the Alpine regions, while at low cost on the rest of the continent.

New large-scale projects aimed at achieving globally more efficient and sustainable Transalpine transport should be financed trans-modally, seeking modal solidarity, over one or two generations, whereas the traditional (unimodal) long-term return on investment approach should be left to the case of local infrastructures, where modal choice is less appropriate. An official framework should be produced, with a clear definition of the objectives, in terms of sustainability, transport efficiency and finance.

Methodological developments

Perhaps the most important methodological outcome is the demonstration that a comprehensive transport model for Europe can be created, which validates well at the national level. Many innovative research features have been developed in the creation of this model.

The usefulness of this SCENES European model has been illustrated through:

- running the model to produce a reference case for 2020 that can provide a baseline set of future transport results across Europe for use as input to other studies
- testing a range of policy scenarios for 2020 on the future evolution of transport costs by mode, both for passengers and freight.

The main aspects in which this model would benefit from future improvements are:

- modifying the assignment procedure to adopt differential sampling of zone pairs in order to increase the level of spatial detail, especially on the road network
- provided that improved coverage and harmonisation of passenger and freight data across the EU can be achieved, the quality of the local calibration in the SCENES model could be improved through the use of this improved data.

This SCENES model is at its strongest when operating to represent strategic issues at the European-wide level, but currently is less suited to analyse specific small-scale initiatives in a particular locality.

In this study the SCENES model focused on policy testing within a single external scenario. In the future, other alternative external scenarios could be developed based on different assumptions regarding the evolution, for example, of GDP and car ownership growth and of the sectoral patterns of future trade. Likewise, a wide range of other transport policy scenarios (e.g. major infrastructure investment, regulation of road vehicle speeds, fuel taxation, etc., applied differentially to some or all regions or parts of the modal networks) could be tested across Europe using this model.

Another important topic in which the SCENES model could be of future value is through use of its comprehensive reporting capability to provide a future transport baseline as a foundation for European transport projections. The potential role of European transport projections is as an agreed background input to studies in related topics, such as energy usage, pollution emissions, accessibility and social exclusion. In the absence of agreed European transport projections such studies are forced currently to make their own projections (often of poor quality), with the resulting disadvantage that they rarely will be common across studies.

It is however clear that a single pan-European model is not sufficient to meet all policy testing and scenario development needs. Accordingly, a range of well-known models from different European countries has been put together within a common framework of analysis to explore behavioural and structural change issues. Each model highlights different specific aspects of the transport system. Through taking this partial modelling approach, in which only a particular corridor or a sub-set of travel movements is analysed in detail, it is possible to analyse the specific topics of interest in greater depth.

However, considerable care needs to be taken with models designed for a specific locality or purpose, when extending their results to provide more general insights across Europe. The ever-present danger when adopting and combining results from an array of different models is that their underlying assumptions and data definitions may differ significantly between the models.

This highlights the need for clear specifications of agreed baseline assumptions when defining scenarios. There is an important role to be played by DG TREN in the future in the development of an agreed baseline set of transport projections and assumptions for use both for studies within DG TREN and elsewhere.

Part A - Objectives

The SCENES project covered the follow-up research for the Areas 10, 11 and 12 in the Phase B of the Strategic section of the 4th Framework Transport Research Programme. In Phase A the research for Area 10 was undertaken by the SCENARIOS (2000) consortium, while Areas 11 and 12 were mainly the responsibility of the STREAMS (2000) consortium, with some contributions from SCENARIOS. The Phase A carried out a number of pilot activities. These activities were subsequently extended and further refined in the follow up Phase B work in the SCENES project that is described here.

There were many original objectives of the SCENES project, spanning as it did a wide range of subjects and involving a large consortium. The Objectives section of the Technical Annex specified the main objectives of SCENES and the tasks to be covered in the project. It is reproduced as follows:

- "to produce transport demand scenarios for the EU for 2020 and beyond. These scenarios are made up of external, socio economic scenarios, and sets of policy scenarios. A detailed method for developing internally consistent EU scenarios will be documented (Work Area 12). The scenarios have been termed "specific scenarios", to contrast them with the "general reference scenario" of Phase A: they are specific in the sense of focussing on certain aspects. The external scenarios are based on the two concepts of "integration and opening of Europe" and "behavioural and structural change". The policy scenarios address the impacts of these two external scenarios.
- to develop detailed forecasts of factors which will affect transport demand into the future, extending the analysis of Scenarios by incorporating institutional factors and studies on breaks in trends. These forecasts are used to inform the development of the scenarios. A databank of variables, covering EU countries (in a more disaggregated form than in Scenarios) and a range of countries in Eastern Europe, will be produced (Work Area 10).
- to extend (to Eastern Europe) and enhance (with a new assignment method and new data) a strategic transport model of the EU and carry out model runs based on the scenarios. This model will be linked to an "appended" module on freight, to demonstrate how the SCENES model can take account of more detailed information from other models, for areas of specific policy interest (Work Area 11).
- (existing) regional transport models will also be run in Work Area 12 to study the impacts of different scenarios, and the results compared with those of the strategic model. Model results will also be compared to other O/D and network databases"

These objectives have been met in the course of the project. The outcomes are reported in this Final Report which provides an overview of the wide range of activities that have been completed within the SCENES project.

Part B - Means used to achieve the project objectives

The means used to achieve these broad objectives were to organise the work into three separately managed Work Areas (WAs), corresponding to Areas 10, 11 and 12. These WAs had their own more detailed objectives that corresponded broadly to individual Work Packages.

- WA 10 was to provide inputs to WA 11 and 12 both in the form of (i) an analytical framework which shows how factors which affect travel demand would evolve under different assumptions and (ii) actual forecasts of factors which influence travel demand.
- WA 11 would address model development and consistency issues, then undertake model runs based on inputs from WA 10 and definitions of specific scenarios from WA 12.
- WA 12 was intended to (i) define specific scenarios for the evolution of EU travel demand, based partly on inputs from WA 10, (ii) undertake simulations using existing models (and incorporate results from WA 11 model runs) and (iii) present results for the evolution of transport demand in Europe.

Each of these Work Areas is now described in more detail, together with the more detailed objectives which were associated with each in the original project specification.

Work Area 10

The focus of WA 10 was on providing data and analysis for WA 11 and baseline material for specific scenario development in WA 12. This would involve identifying and forecasting the main drivers of transport demand at different time horizons, taking into account the institutional context and possible breaks in trends. This WA planned, for the EU and CEEC countries:

- to extend the SCENARIOS databank of socio-economic data, in terms of both geographical coverage and spatial detail. This was to be done for base and forecast years
- to identify the main factors influencing future transport demand (passengers and freight) and develop an analytical framework to forecast how they will change over time, with particular focus on:
 - analysis of supply / demand equilibria, particularly responses to supply changes such as introduction of new infrastructure and technologies
 - assessment of the impacts of different regulatory and pricing regimes in EU countries, including the implications of European-wide implementation of particular regulatory regimes
 - supplementing traditional forecasting approaches by developing a framework to identify future breaks in trends in the correlation between transport demand and explanatory variables and to examine causes of breaks in trends
- establish the extent to which the objectives of the Common Transport Policy can be better achieved through institutional changes rather than through some intervention policy of the state, and to identify which type of institutions would be appropriate for which policy area.

Work Area 11

WA 11 was oriented to develop modelling tools, based partly on inputs from WA 10, to undertake model runs that would be based on WA 12's definition of specific scenarios. The existing STREAMS model was to be expanded and developed to provide the functions of an "umbrella" model - a high level model which gives a strategic point of comparison with the results of other models.

The aims of WA 11 were to:

- Extend (to Eastern Europe) and enhance (for example by adding new and improved data from WA 10) the STREAMS strategic transport model of the EU. The model would then be re-calibrated and validated as the SCENES European Forecasting Model. This work would include the development of a more detailed zoning system for road assignment and the adoption of country specific model parameters, to address some of the weaknesses that had been identified by the previous STREAMS research.
- On the basis of a technical audit of models, develop approaches to tackle problems of consistency between models and produce a software design to demonstrate how these techniques could be applied.
- Develop an appended module to tackle freight demand forecasting in more detail through taking an explicit account of the influence of freight logistics.
- Undertake model forecasting runs of the SCENES European Forecasting Model, based on specific scenarios defined by WA 12.

Work Area 12

Work Area 12 was intended to bring together the work of Areas 10 and 11 as well as to develop new techniques of its own to explore specific scenarios. This was to involve:

- development and description of two high level External Scenarios – based on the integration and opening of Europe as well as on behavioural and structural change in Europe. Each External Scenario was to have variants reflecting the possible degree of change in each, e.g., a greater or lesser degree of integration and opening. These variants would then be combined together to form a number of composite external scenarios
- development and description of a set of Policy Scenarios (e.g., pricing, investment and regulatory) which would tackle the problems identified by the External Scenarios
- a documented process for developing internally consistent scenarios for Europe
- validation of the overall approach with case study examples of Transalpine corridors and East-West priority corridors.

Summary of what was achieved and of the Deliverables that were produced

Figure 1 shows the linkages between the main tasks in the original overall scope of the work, categorised into the three Work Areas within which they were allocated.

WA 10 provides the analysis of the main drivers of transport demand and a databank of socio-economic variables. The main outputs from the WA 10, together with the Deliverables D1, D3a, D3b, D6, within which each output is presented, are as follows:

- an analysis of the drivers of transport demand incorporating new work on the extent to which supply induces demand; an analysis of the impact of different regulatory regimes on transport demand and analysis of breaks in trends in the relationship between the growth in transport demand and the growth in key economic variables (D3a for Western European countries, D3b for Central and Eastern European countries)
- an analysis of the impact of different institutional structures on achieving policy objectives (D3a for Western European countries, D3b for Central and Eastern European countries)
- a databank of base and forecast socio-economic variables covering most of Europe, building on the SCENARIOS databank (D1 for the approach adopted for the CEEC countries, D6 for the databank specification, and the internet site <http://www.iww.uni-karlsruhe.de/SCENES/> for the data itself)

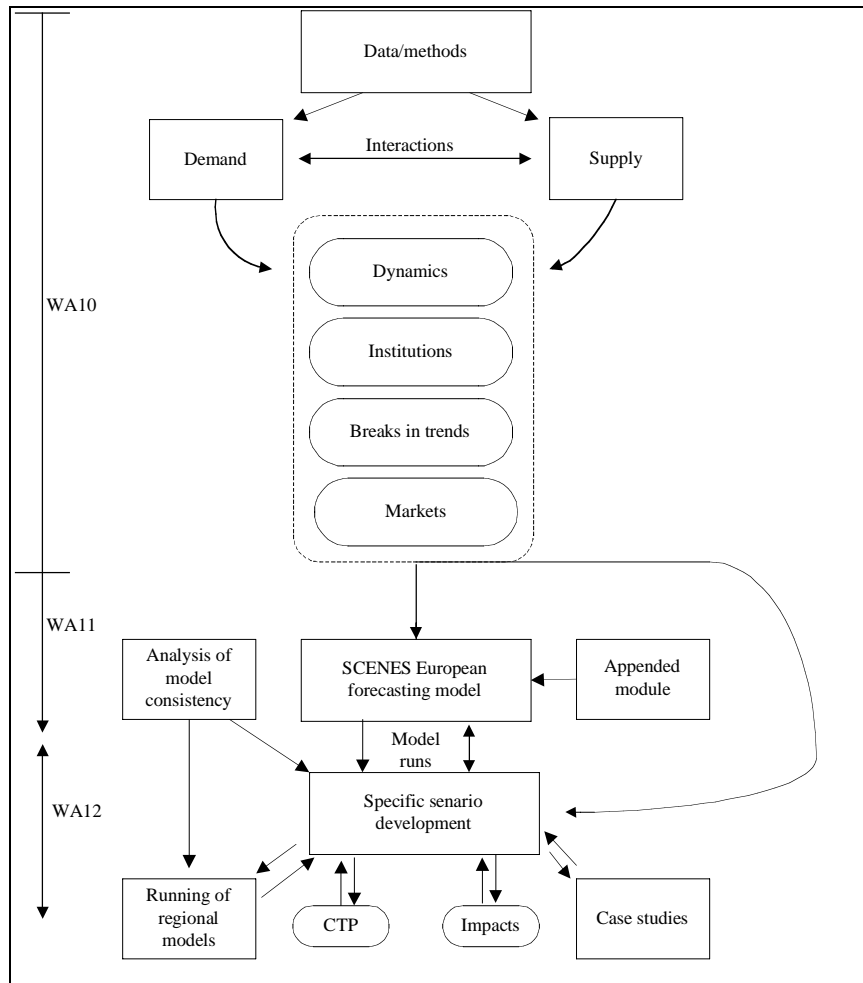


Figure 1: Overall scope of the work

WA 11 developed the SCENES European-wide transport forecasting model, building on the earlier STREAMS model. The SCENES model is a network based model of all movements on all transport modes for both passengers and freight, and it also includes intermodal transport. It uses data and analysis from WA 10, for example, the WA 10 forecasts of socio economic variables. The main outputs from the WA 11 are as follows:

- the SCENES network based transport forecasting model of the EU and adjoining eastern European countries (D4 for description of the model structure, D7 for the calibration details and the model validation results for the base year of 1995)
- the issues of consistency between models have been tackled in two ways. Firstly, a software tool based on residual disutility techniques was developed for use in the calibration process of the regional economic model. This enables the synthetic transport flow matrices within the SCENES model to be constrained to exactly match exogenously supplied matrices. Secondly; a methodology for comparing model results has been constructed and validated (D4, Annex D).
- the SCENES transport model has tested an "appended" freight module that introduces an explicit representation of the choice of logistics pattern for relevant freight movements. This task shows how the SCENES model can take account of more detailed information from other models, for areas of specific policy interest (D2 and D4).
- A set of forecasts of future transport characteristics for all of Europe was produced through running the SCENES model for a future Reference Case and various other scenarios in 2020 (D7).

WA 12 developed External Scenarios that were tested using a number of models that operate at various spatial scales. The main outputs from the WA 12 are as follows:

- The development and description of two high level external scenarios: Spatial Scenarios on the integration and opening of Europe (D5a), and Behavioural and Structural Change Scenarios (D5b)
- quantitative and qualitative forecasts of the impacts of these composite external scenarios on transport in Europe as a whole, and in more detail for particular geographical areas (D5b)
- the development and description of a set of policy scenarios (e.g., pricing, investment and institutional change) which tackle the problems identified by the external scenarios. These have been tested through two case studies: the TINA network, and the Transalpine crossings (D8)
- a documented process for developing internally consistent scenarios for Europe (D9)

The above list of outcomes demonstrates that the original aims of the SCENES project have been successfully attained. The tasks that have been completed provide a sound foundation:

- to aid in understanding the future issues that will confront transport policy makers across Europe, and
- to provide the tools for use in assessing which policy initiatives might effectively solve these future issues.

Part C - Scientific and technical description of the project

This Part C contains the main description of the work undertaken in the SCENES project. It is split into four main sections reflecting, firstly, each of the Work Areas 10, 11 and 12 in turn, followed a synthesis chapter, bringing together the main strands of the work from these three Work Areas, together with a chapter drawing together the main conclusions from the study.

Work Area 10

1 INTRODUCTION TO WA 10

Research within Work Area 10 has set up the basis for the SCENES project in terms of establishing an Internet database for regional socio-economic data, generating forecasts and analysing drivers of transport demand, which are relevant for the long-term development of transport in Europe. The geographical scope of this task has been the whole of Europe – both Western European and Central and Eastern European countries.

The SCENES Internet Database has been set up, which contains base year data for 35 European countries and 31 indicators at regional level as well as socio-economic forecasts generated within SCENES.

Furthermore, research within Work Area 10 has embraced the analysis of drivers of transport demand concerning the following topics:

- Generation of forecasts for socio-economic indicators for the year 2020 at regional level and for 2040 at national level.
- Study on interactions between demand and supply in transport.
- Analysis of impacts of regulatory systems in the transport sphere.
- Analysis of changes in trends of transport demand.
- Research on institutional aspects.

Research within Work Area 10 has been documented in three Deliverables as follows:

SCENES Deliverable D6: **An Information System for Regional Socio-Economic and Transport Demand-Influencing Factors**. December 1999.

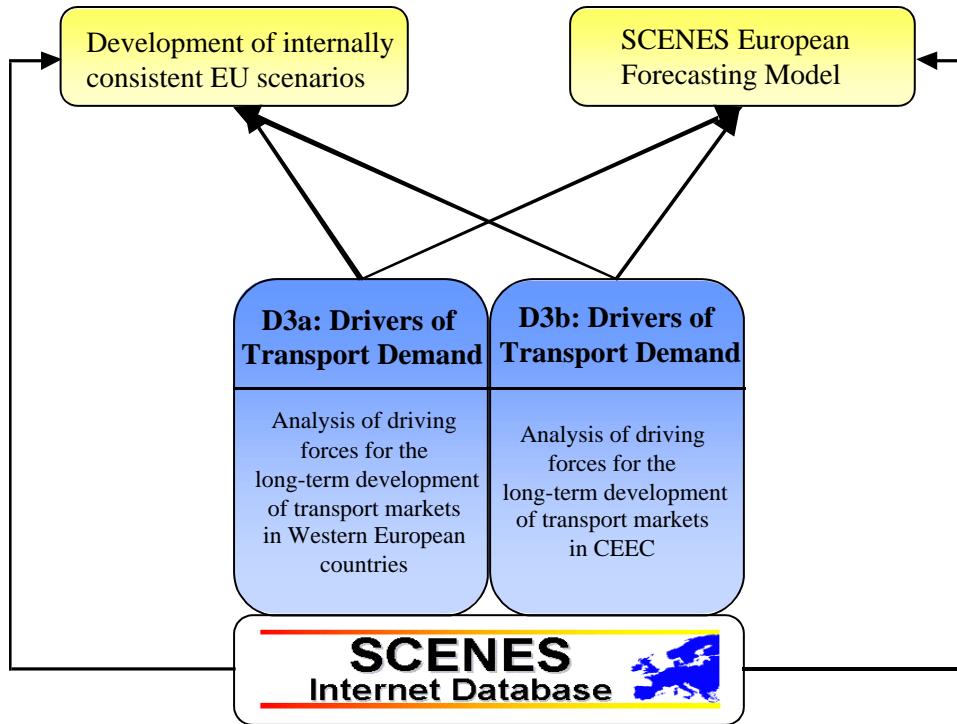
SCENES Deliverable D3a: **Drivers of Transport Demand - Western European Countries**. April 2000.

SCENES Deliverable D3b: **Drivers of Transport Demand - Central and Eastern European Countries (CEEC)**. May 2000.

The Deliverables can be downloaded from the SCENES homepage at

<http://www.iww.uni-karlsruhe.de/SCENES>

The Deliverables on drivers of transport demand are the result of comprehensive research on items relevant for the long-term development of the transport sphere. Together with the SCENES Internet Database, these Deliverables serve as a baseline for the development of internally consistent EU scenarios and provides information for the SCENES European Forecasting Model.



2 THE SCENES INTERNET DATABASE

2.1 Contents of the SCENES Internet Database

In the SCENES Internet Database, most of the European countries – both Western and Eastern European countries – are considered. The information system contains 35 countries, which can be subdivided into four different groups:

- European Union (EU 15) countries
- European Free Trade Association (EFTA) countries
- Central European (CE) countries
- Other Central Eastern European Countries

The regions considered by the SCENES Internet Database are, in most cases, in line with the NUTS regions defined by EUROSTAT. However, the regional data for Bulgaria and the Czech Republic refer to a classification, which differs from the official EUROSTAT classification. In these cases an unofficial regional segmentation has had to be applied. The same holds true for those Eastern European countries, for which an official NUTS classification is not available.

The lowest NUTS level¹ considered in the SCENES Internet Database is NUTS 3 (e.g. "Kreise" in Germany, "départements" in France, "provincias" in Spain, "nomoi" in Greece). Altogether data sets for more than 1,800 regions are available in the SCENES Internet Database.

The regions, which are considered by the SCENES Internet Database are listed in Table 2.1.

The SCENES Internet Database contains base year data for 31 indicators, which belong to the domains population and area, employment, economy, technology, trade, transport and tourism:

- *Population and area:* Area, Population by age and sex, Population by profession, Population by level of education, Pupils and students, Motorisation, Households by size, Disposable income of households, Household expenditures.
- *Employment:* Employment by sectors, Unemployment.
- *Economy:* Gross Domestic Product (GDP), Gross Value Added (GVA) by sectors, Gross capital formation by sectors, Gross Domestic Product in Purchasing Power Standard (PPS).
- *Technology:* R&D expenditures, Patent applications, R&D personnel.
- *Trade:* Import/ export (tons), Import/ export (values).
- *Transport:* Vehicle stock, Infrastructure road, Infrastructure rail, Infrastructure inland waterways, Infrastructure pipelines, Transport volume, Transport performance.
- *Tourism:* Accommodations, beds, rooms, overnight stays.

¹ In the context of the level of the regional structure NUTS 3 level is to be understood as "low" level and NUTS 0 level as "high" level.

Table 2.1 Regions available in the SCENES Internet Database

Regions in the SCENES Internet Database								
	Co-de	Country	NUTS 1	#	NUTS 2	#	NUTS 3	#
E U C o u n t r i e s	AT	Austria	Gruppen von Bundesländern	3	Bundesländer	9	Gruppen von politischen Bezirken	35
	BE	Belgium	Régions	3	Provinces	11	Arrondissements	43
	DK	Denmark	Danmark	1	Danmark	1	Amter	15
	DE	Germany	Länder	16	Regierungsbezirke	40	Kreise	441
	GR	Greece	Groups of development regions	4	Development regions	13	Nomoi	51
	ES	Spain	Agrupacion de comunidades autonomas	7	Comunidades autonomas +Ceuta y Melilla	17 +1	Provincias +Ceuta y Melilla	50 +2
	FR	France	Z.E.A.T. +DOM	8 1	Régions +DOM	22 +4	Départements +DOM	96 +4
	IE	Ireland	Ireland	1	Regions	2	Regional Authority Regions	8
	IT	Italy	Gruppi di regioni	11	Regioni	20	Provinciae	103
	LU	Luxembourg	Luxembourg	1	Luxembourg	1	Luxembourg	1
	NL	The Netherlands	Landsdelen	4	Provincies	12	COROP regions	40
	PT	Portugal	Continente +Regioes autonomas	1 2	Comissaoes de coordenação regional +Regioes autonomas	5 +2	Grupos de Concelhos +Regioes autonomas	30 +2
	FI	Finland	Manner-Suomi/ Ahvenanmaa	2	Suuralueet	6	Maakunal	20
	SE	Sweden	Sverige	1	Riksområden	8	Län	21
	UK	United Kingdom	Government Office Regions; Countries	12	Counties, Inner and Outer London; Groups of unitary authorities; Country	37	Upper tier authorities or groups of lower tier authorities; Groups of unitary authorities; Groups of districts	133
	E F T A	CH	Switzerland	Schweiz/ Suisse/ Svizzera	1	Grossregionen/ Grandes Régions/ Grandi Regioni	7	Kantone/ Cantons/ Cantoni
	NO	Norway	Norge	1	Landsdeler	7	Fylker	19
C o u n t r i e s	BL	Bulgaria ^{*)}	Bulgaria	1	Regions	3	Regions	9
	CZ	Czech Republic ^{*)}	Czech Republic	1	Administrative regions	8		
	EE	Estonia	Eesti	1	Eesti	1	Groups of Maakond	5
	HU	Hungary	Magyarország	1	Tervezesi-Statistikai Regio	7	Megyek + Budapest	19 +1
	LV	Latvia	Latvija	1	Latvija	1	Regions	5
	LT	Lithuania	Lietuva	1	Lietuva	1	Apskritis	10
	PL	Poland	Poland	1	Poland	1	Wojewodztwa ^{*)}	49
	RO	Romania	Romania	1	Regions	7	Judet +Bucuresti	41 +1
	SK	Slovak Republic	Slovenska Republika	1	Zoskupenia Krajov	4	Kraje	8
SI	Slovenia	Slovenija	1	Slovenija	1	Statisticne Regije	12	
O t h e r s	AL	Albania ^{**)}	Albania	1	Regions	7	-	-
	CR	Croatia ^{**)}	Croatia	1	Croatia	1	Administrative regions	20
	RU	Russia ^{**)}	Groups of oblast	12	Oblast	79	-	-
	YU	Yugoslavia ^{**)}	Yugoslavia	1	Yugoslavia	1	Greater administrative regions	4
	BL	Belarus ^{**)}	Belarus	1	Oblast	7	-	-
	MC	Macedonia ^{**)}	Macedonia	1	Macedonia	1	-	-
	MO	Moldova ^{**)}	Moldova	1	Moldova	1	-	-
	UR	Ukraine ^{**)}	Ukraine	1	Oblast	25	-	-
^{*)} NUTS classifications used are different from the present official classification by EUROSTAT ^{**)} NUTS classifications used have no official status and illustrate only the classification used within the SCENES project								

The base year for the data collection has been 1996. Although some data, especially that which originate from a census (e.g. household expenditures), may refer to 1995 or earlier.

Furthermore, the SCENES Internet Database contains forecast data (average annual growth rates) for the indicators: population, employment, car ownership and GDP, both for the period of time until 2020 at regional level (NUTS 2) and the period of time until 2040 at national level. The way of generating these forecasts is dealt with in Section 3.1.

Many of the indicators available in the SCENES Internet Database can be used for modelling the generation of trips (e.g. population, GDP, households, disposable income of households). Others, such as tourism indicators, can be used to evaluate the distribution of transport demand. Further indicators, like R&D variables, are not directly associated with modelling transport, but give information about the innovative potential and the competitiveness of a region and are therefore useful for assessing the future development of a region.

Figure 2.1 illustrates data availability within the SCENES Internet Database, using a thematic map for the indicator "unemployment rate".

2.2 Functionality

User-friendly functionality and transparency are important features of an information system. The following section contains a description of how user-friendliness and transparency have been realised when setting up the SCENES Internet Database.

User friendliness in the SCENES Internet Database has been realised by establishing clear and straightforward user guidance and providing adequate functionality.

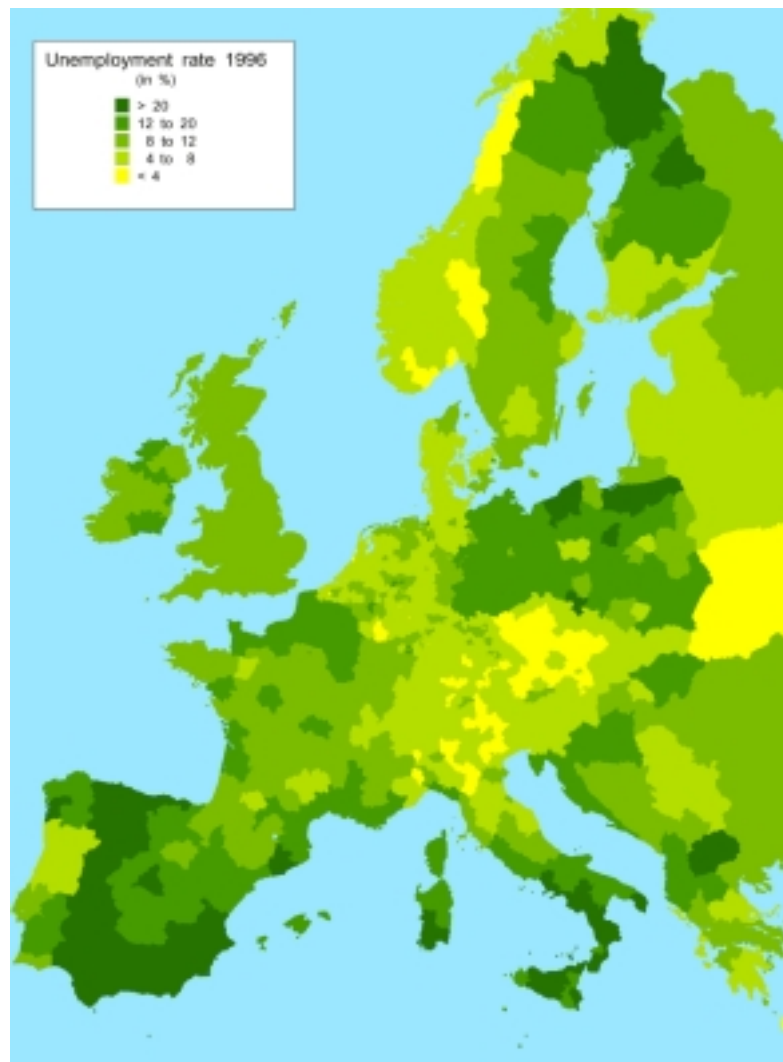


Figure 2.1: Example for data available in the SCENES Internet Database

The SCENES Internet Database offers two alternatives for the extraction of data:

- Data extraction by country
- Data extraction by "comparable indicators"

Furthermore, the user is able to select the regional level, at which the data shall be shown. The system allows the user to receive the country's regions in a hierarchical structure, which gives an overview of the regional structuring of the country or to receive the data for those regions belonging to a certain NUTS level (see Figure 2.2).

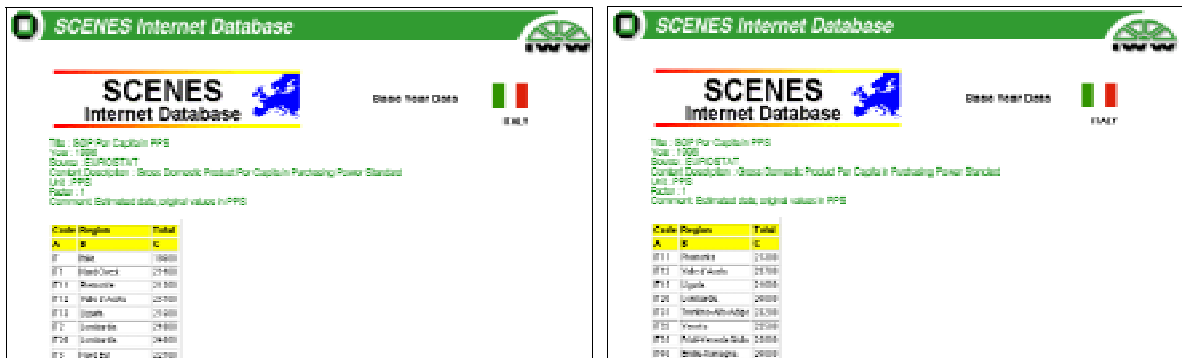


Figure 2.2: Screenshot - Formation of the regions in hierarchical level and by a certain NUTS level

After receiving a table, the user is given the opportunity to formulate a select condition. This feature enables the user to select those data sets, which correspond with the formulated condition. A maximum of three conditions can be formulated and joined with "and" or "or". Figure 2.3 shows the mask for formulating a query, which is situated under each table.

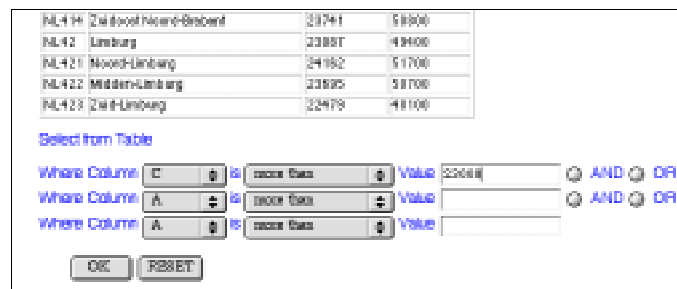


Figure 2.3: Screenshot - Mask for formulating select conditions

All tables available in the SCENES Internet Database can be downloaded as text files and can be used by all common application software.

The Internet is a dynamic medium, whose contents are subject to constant change. The contents of the SCENES Internet Database have also been subject to change, because tables have been updated or new tables have been implemented from time to time. In order to enable the user to quickly obtain an overview of occurred changes and improvements, major development activity is documented online.

To ensure a high level of transparency of the data, the tables provided in the SCENES Internet Database contain all attributes necessary for interpreting the data (see Figure 2.4). The attributes of the

data are situated above the tables. Those tables, whose data sets were calculated, provide online information on the equations applied for calculating the data.

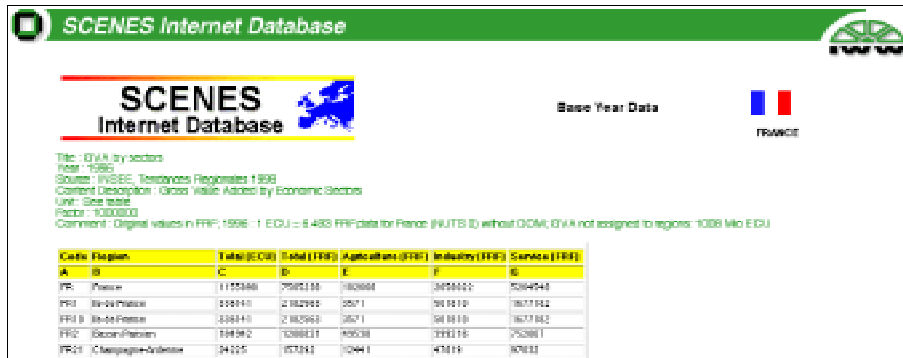


Figure 2.4: Screenshot - Detailed information about the data presented above every table

2.3 Data Availability in the SCENES Internet Database

When describing the data availability in the SCENES Internet Database by country, at least two aspects can be considered: the number of indicators, for which data are available in each country and the extent of *regional* availability of data.

An indicator for the availability of data (DA) at the regional level in country C , can be defined as follows:

$$DA^C = \frac{\sum_{j=1}^n f(I_j^C)}{n},$$

where

$I_1^C, I_2^C, \dots, I_j^C, \dots, I_n^C$ are those indicators, for which data are available in the SCENES Internet Database for country C ,

and

$$f(I_j^C) = \begin{cases} 0 & , \text{lowest available NUTS level for indicator } I_j \text{ in country } C : \text{NUTS } 0 \\ 1 & , \text{lowest available NUTS level for indicator } I_j \text{ in country } C : \text{NUTS } 1 \\ 2 & , \text{lowest available NUTS level for indicator } I_j \text{ in country } C : \text{NUTS } 2 \\ 3 & , \text{lowest available NUTS level for indicator } I_j \text{ in country } C : \text{NUTS } 3 \end{cases}$$

By interpreting the illustration of Figure 2.5, one should take into account that some of the countries considered may have data available on more than one NUTS level - Ireland, Sweden, Switzerland, Norway, Bulgaria, Czech Republic, Hungary, Romania, Slovak Republic, Albania^{*)} and Belarus^{*)} are both NUTS 0 and a NUTS 1 regions. Denmark, Estonia, Latvia, Lithuania, Macedonia^{*)}, Moldova^{*)},

^{*)} The NUTS classification assumed has no official status and illustrates only the classification used within the SCENES project

Poland, Slovenia, Yugoslavia*) and Croatia*) are NUTS 0, NUTS 1 and NUTS 2 regions. Whilst Luxembourg, data is available at all NUTS levels. Thus the DA^C values amount to at least 1.0 for the first group of countries, at least 2.0 for the second group and to at least 3.0 for Luxembourg.

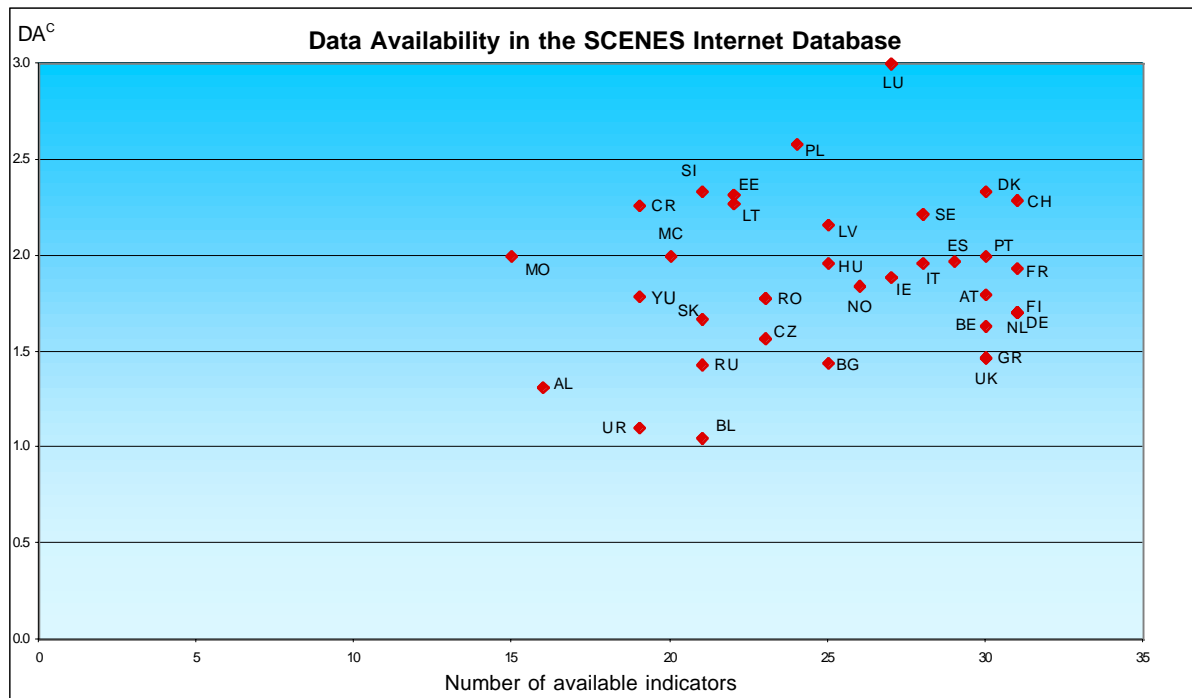


Figure 2.5: Data availability by countries

Generally, the data availability situation for EU and EFTA countries is better than for CE countries; and for accession countries, again it is significantly better than for CEE countries. This imbalance of data availability amongst accession countries can be expected to be overcome in the next few years, hence, the differences between EU/EFTA and CE countries are expected to decrease. However, differences in the level of data availability between EU, EFTA and CE countries on the one hand, and CEE countries (Albania, Belarus, Croatia, Moldova, Macedonia, Russia, Ukraine and Yugoslavia) on the other, are likely to persist for longer.

If data availability by indicators is considered, one can assess data availability in at least two dimensions: The first dimension is, whether data is available for an indicator or not. The second dimension considers the extent of regional availability of data for the considered indicator. In order to define an index for regional data availability by indicators, DA^I , the following equation is applied:

$$DA^I = \frac{\sum_{k=1}^m f(C_k^I)}{m},$$

where

$C_1^I, C_2^I, \dots, C_k^I, \dots, C_m^I$ are those countries, for which data are available in the SCENES Internet Database for indicator I ,

and

$$f(C_k^I) = \begin{cases} 0 & \text{, lowest available NUTS level for indicator } I \text{ in country } C_k : \text{NUTS 0} \\ 1 & \text{, lowest available NUTS level for indicator } I \text{ in country } C_k : \text{NUTS 1} \\ 2 & \text{, lowest available NUTS level for indicator } I \text{ in country } C_k : \text{NUTS 2} \\ 3 & \text{, lowest available NUTS level for indicator } I \text{ in country } C_k : \text{NUTS 3} \end{cases}$$

The abscissa in Figure 2.6 represents the number of countries for which the referring indicator is available. The ordinate shows the values for DA^I .

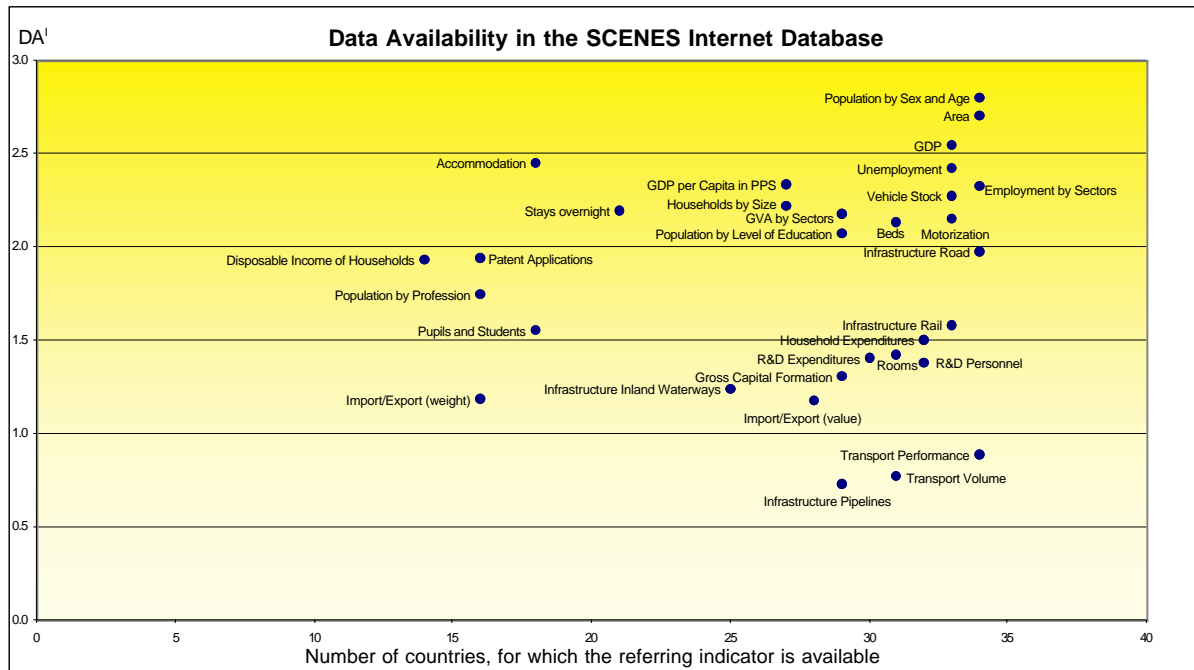


Figure 2.6: Data availability by indicators

2.4 Specific Problem Areas in Setting up a Regional Pan European Information System

Specific problems associated with setting up a pan European information system for regional data can be summarised by the following keywords, which are described briefly in the present section:

- Changes in the regional structure of certain countries.
- Problems of detail and up-to-dateness of regional data.
- Comparability of data for certain indicators.

The regional structuring according to the NUTS nomenclature has been subject to continuous changes. For instance, in 1998 changes in the structure of regions were carried out in Finland, Germany, Ireland, Sweden and the UK. The changes in the regional structuring were rather slight in case of Finland, Germany, Ireland and Sweden. In the UK however, an ample re-structuring has been carried out, with "new" regions being totally disjunct from the "former" regions. Severe changes in the regional structuring, as it has been the case in the UK, can imply a temporary unavailability of data at a lower regional level.

When comparing the availability of data at regional level with the availability of data at national level, one can observe at least two main differences:

- Regional data are often less detailed than national data. It can be said as a matter of principle that the level of detail of the data sets decreases with respect to the NUTS level. As an example, GVA values for Belgium are available at NUTS 3, NUTS 2, NUTS 1 and at national level. At national level GVA values are published for 60 economic sectors. At NUTS 1 level GVA is available by 44 sectors, at NUTS 2 by 17, and at NUTS 3 only by three economic sectors. This scheme of publishing data for GVA by sectors is applied by most of the statistical offices in order to ensure confidentiality and to prevent the end user from assigning the values to a single company. Thus by collecting regional data one often has to trade-off data aggregation against spatial resolution.
- In most cases, regional data is less up-to-date than national data, which is partly due to the fact that statistical offices tend to impose a higher priority upon the delivery of up-to-date data at the national level.

The data mining process for setting up the SCENES Internet Database has shown that it can be rather delicate to compare data provided by different national statistical sources. The way, in which various national statistical sources define indicators is, not yet, entirely homogenised (even among EU countries), which can result in misinterpretations, for instance if figures from national statistical offices are used for a cross-country analysis.

Indeed, significant differences exist in the way, national statistical offices define the following indicators:

- Population by profession: surveys by different occupation groups.
- Disposable income of households: differences in the types of income considered.
- Employment by sectors: differences in the definition of employment.
- Unemployment: differences in the definition of unemployment.
- R&D expenditures: differences in the kind of expenditures assigned to R&D.
- R&D personnel: differences in the allocation of personnel to the R&D sector.
- Tourism indicators, such as accommodation capacity, number of beds, and overnight-stays: differences in the classification of accommodation registered in statistics.

2.5 Summary and outlook

The SCENES Internet Database has enabled an information system which focuses on socio-economic and transport demand-influencing indicators for European regions to be established. It has become a unique, easily accessible, data platform for socio-economic data at the regional level and covers almost all countries in Europe. Experience within the SCENES project has shown that from the transport modellers' point of view, there is a definite need for such a reliable, transparent and user-friendly database system to access regional socio-economic data.

Due to unsolved copyright problems the SCENES Internet Database has so far been accessible only for SCENES project partners and the European Commission. However, many of the transport research projects carried out in Europe depend on data from the same set of socio-economic indicators. Therefore, it would be very helpful to have a common and consolidated data platform for socio-economic data at regional level. The establishment of such a medium would not only harmonise the input data for the models applied (and therefore the output of the models as well), but might also be useful in terms of saving resources. By providing a common data platform for research projects, repetition of data mining (which is a time-consuming process) could be avoided. From this perspective, the SCENES Internet Database may serve as a first, but decisive step on the way to a pan-European data information system, with regional (socio-economic) data, whose content is not only relevant for transport modellers, but also for policy-makers and other researchers undertaking regional analyses..

3 DRIVERS OF TRANSPORT DEMAND

3.1 Generation of forecasts

Within the SCENES project forecasts for the development of GDP, population, employment and car ownership have been generated for 2020 and 2040. The forecasts for 2020 were derived at the regional level (NUTS 2). For Western European countries on the one side and CEE countries on the other, different approaches were applied for the generation of forecasts.

3.1.1 Western European countries

The regional forecasts are based on the forecasts of the SCENARIOS System Dynamics Model (SCENARIOS Deliverable C1, 1998), which were generated at the level of region-types.

Within SCENES, the macro-economic part of the SCENARIOS System Dynamics Model was extended by incorporating the multiplier accelerator model by Samuelson and the IS-LM model by Hicks. The model of Samuelson emphasises the mutual dependency of consumption and output, and of investment and demand. While Samuelson chose to represent investment as a function of change in consumption, it is considered to be a function of desired capital within the SCENES System Dynamics Model. Thus investment depends on the difference between desired and actual capital. The change of capital is defined as the annual difference between investment and depreciation. Since the desired capital is dependent on the interplay of interest rates and money stock, the interest rate influences investment significantly (IS-LM). Generally speaking, increasing interest rates lead to decreasing investments and vice versa. Contrary to the development of investment in the SCENARIOS System Dynamics Model an oscillating development of macro-economic indicators over time can be modelled in SCENES.

The regional forecasts were generated by assigning forecasts for functional NUTS 2 regions – which have been generated within the SCENARIOS project – to the "real" individual regions, by taking into account results of the SCENES System Dynamics Model as well as country-specific characteristics².

3.2 Central and Eastern European countries

For Central European and Eastern European countries, the macro-economic forecasts at the national level were based on endogenous growth theory (Barro R. J., Sasa-i-Martin 1995), which links the long-term development of economic growth with "soft" factors, like development of human capital, level of economic and political stability, conditions for private entrepreneurship and level of state assistance regarding economic growth.³ This theory supports the evolution of real convergence, which implies the ability of a less developed economy to develop faster, so that over time the initial gap in GDP between less developed countries and richer countries diminishes.

The forecasts generated at national level were assigned to regional level by applying a model, which is consistent with the endogenous growth model applied for deriving the forecasts at national level: The theory of modern economic growth explains differences in the speed of regional development in terms of real convergence. Regions with higher GDP per capita tend to grow slower than regions with lower GDP per capita. A particular difficulty with the application of the pure convergence concept to explain regional differences in economic development of transition economies is that the differences tend to intensify during periods of accelerated structural changes, which have occurred in the period of transition. On the other hand, the regional prosperity depends on the ability of a region to adapt to the conditions of the market economy, which is an endogenous factor for the region. The factors stimulating regional development in the model, generally comprise economic factors, often called

² SCENES Deliverable D3a

³ SCENES Deliverable D3b

"hard factors" (natural resources, labour and capital resources, traditional infrastructure as well as capital outlays related to these resources) and non-economic factors – also called "soft factors". This category comprises factors, which first of all spur location decisions. This category of factors embraces the cultural and historical heritage (which increases attractiveness of a region and is the basis of the work ethos) and investments to improve the living conditions in the region (ecological environment, leisure time facilities etc.). Soft factors decide whether a specific region, out of a set of regions with comparable economic factor endowments, will develop faster than other regions.

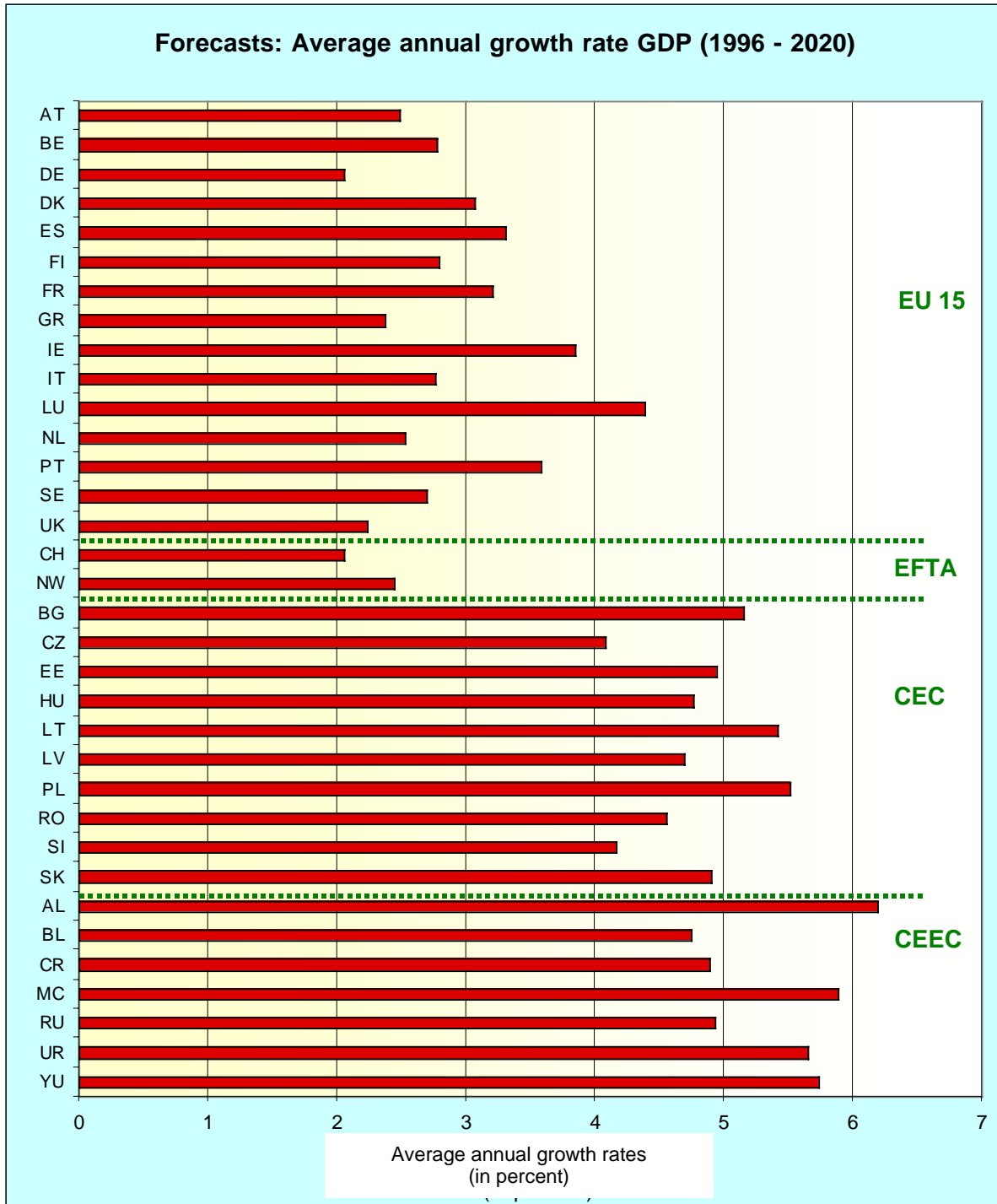


Figure 3.1: Forecasts for GDP growth rates by countries

The Figure 3.1 illustrates one of a number of the forecasts generated within SCENES: it presents the expected average annual growth of GDP until 2020 at the national level for the set of European countries.

3.3 Demand/ supply interaction

3.3.1 Introduction

As illustrated in Figure 3.2, there are various dynamic interrelations between transport supply and demand. Demand depends on supply and supply parameters again influence demand for mobility. Thus applying dynamic models appears to be an appropriate technique for obtaining an insight into these bi-level interrelations.

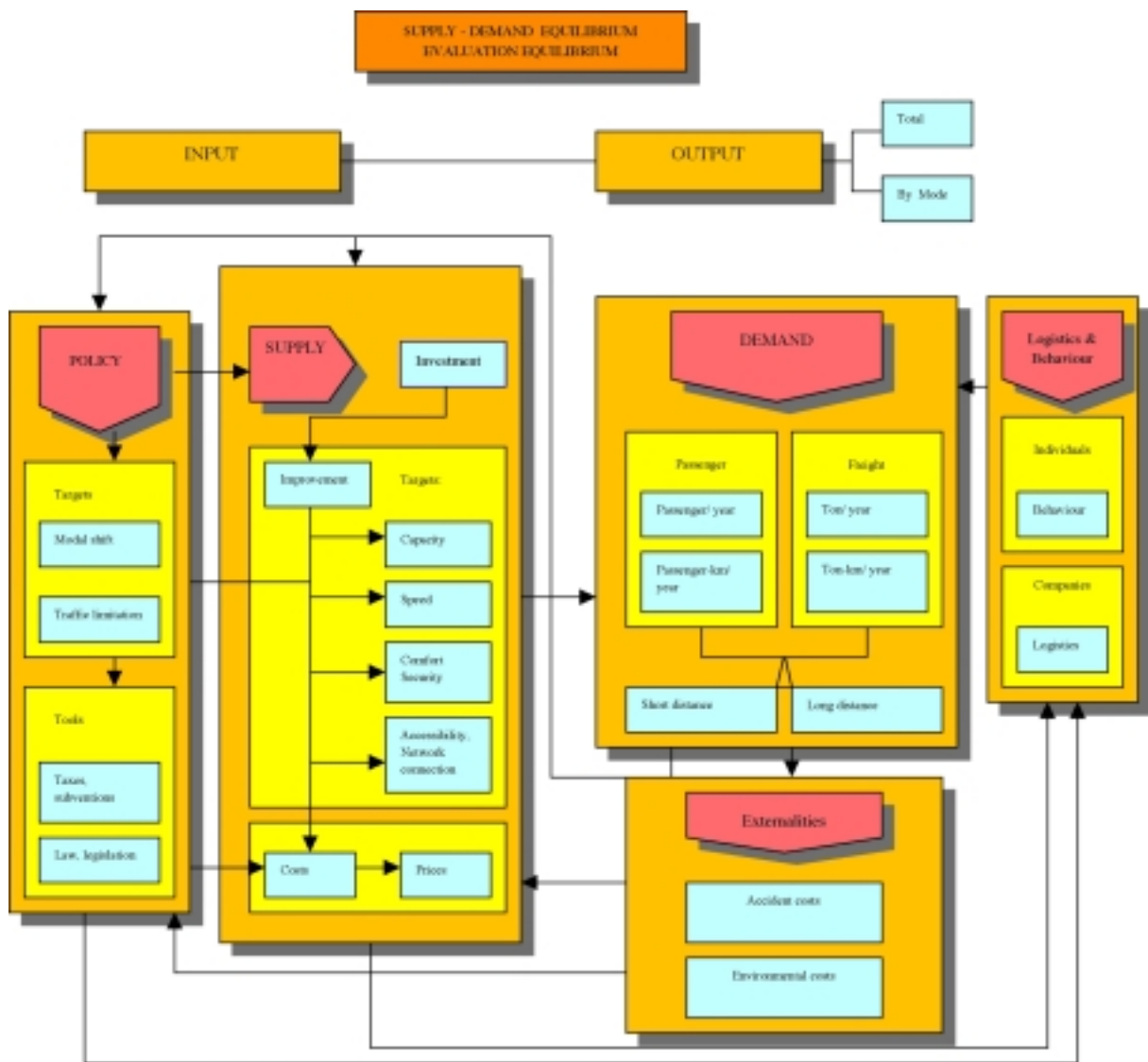


Figure 3.2: Interrelations between demand and supply in transport

The growth of traffic performance and traffic volume, as a result of improved supply parameters, is called *induced traffic*. *Induced traffic* can be defined as the additional demand for mobility, which is a

result from an improvement in one or more supply parameters, such as infrastructure. *Two kinds of induced traffic* can be distinguished:⁴

- *First order effects* (primarily induced traffic, induced traffic in the narrower sense) appear directly after the improvement of supply parameters. Supply side improvements reduce the generalised costs, which directly results in an increase in demand for mobility.
- *Second order effects* (secondary induced traffic, induced traffic in the wider sense) appear on the longer run: improvements of transport supply parameters can result in middle- and long-term changes in the settlement and employment structure. As a consequence of such demographic changes, transport demand increases.

Generally, it is quite difficult to quantify induced traffic. This problem arises firstly because there is no reliable technique available for drawing a clear distinction between induced traffic and traffic pattern changes resulting from independent modal split or assignment alterations; and secondly, as it is also difficult to forecast long-term second-order effects soundly.

Demand-side reactions to variations in certain supply parameters have been analysed through the following concrete cases:

- Impacts of regulations on transalpine freight transport.
- Impacts of tariffs on the demand for local public passenger transport.
- Opportunities of Maglev systems (freight transport Kufstein-Verona, Swissmetro).

3.3.2 Demand/ supply equilibrium in dynamic market segments

Certain passenger transport markets have become increasingly volatile and can be characterised by quick mutual adjustment processes between demand and supply. High volatility can be observed for instance in holiday and leisure transport markets. The level of service within the air passenger transport market is widely demand driven and is adjusted quickly to demand side trends. Also the level of service in the long-distance rail market is expected to become more heavily influenced by demand parameters in the near future. For examining such dynamics in certain market segments, a demand-supply interaction scheme has been developed.

In classical transport models, factors which are said to determine the usage of a travel mode are correlated by the travel modes offered at certain generalised costs (supply) and by the maximum threshold of generalised cost that a user is willing to pay (demand) for any of these modes. In general, demand decreases, as the price raises. On the other hand, supply increases, as the price becomes higher. At the intersection of the downward-sloping demand-graph and the upward-sloping supply-graph the equilibrium solution can be identified. However, such a model neglects the interaction between demand and supply; and due to this interaction, the shaping of the graphs change in each time step.

Therefore, in order to determine whether a model which incorporates this interaction does still exhibit equilibrium solutions, a demand-supply interaction scheme has been developed. This scheme is based on the Markov-chains and interactively represents the evolution of decisions on the supply and the demand side. The model starts with an initial distribution and from this, the situation in the next epoch is computed by incorporating preferences for changing to another mode or continuing with the same one as before (Figure 3.3). The new choice is influenced by "personal" preferences for specific modes,

⁴ See Hautzinger in: Vahlens Großes Logistik-Lexikon. Vahlen 1997.

trends in general consumer behaviour (weighted with values representing willingness to adapt to such trends); and the set of transport choices available to the consumer (weighted by proxy values for the individual's enthusiasm to alter their mode choice according to what is supplied).

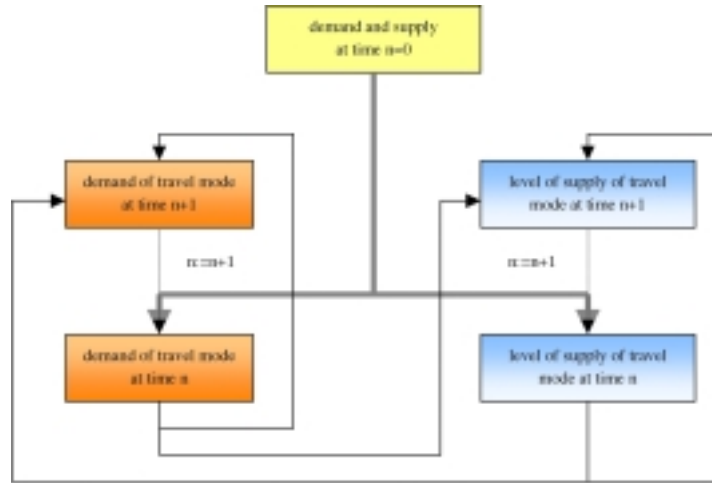


Figure 3.3: Concept of the dynamic supply-demand-interaction scheme

The analyses have shown that it is questionable to search for equilibrium points in a complex non-linear system, as it is presented by demand and supply interaction, since the highly simplified model described hardly offers room for such points. This leaves the inescapable fact that a simple feedback process, such as demand and supply interference, fluctuates in ways which display regularity and randomness simultaneously (see Figure 3.4). Thus any equilibrium, in the sense of balance, can not be detected in this process.

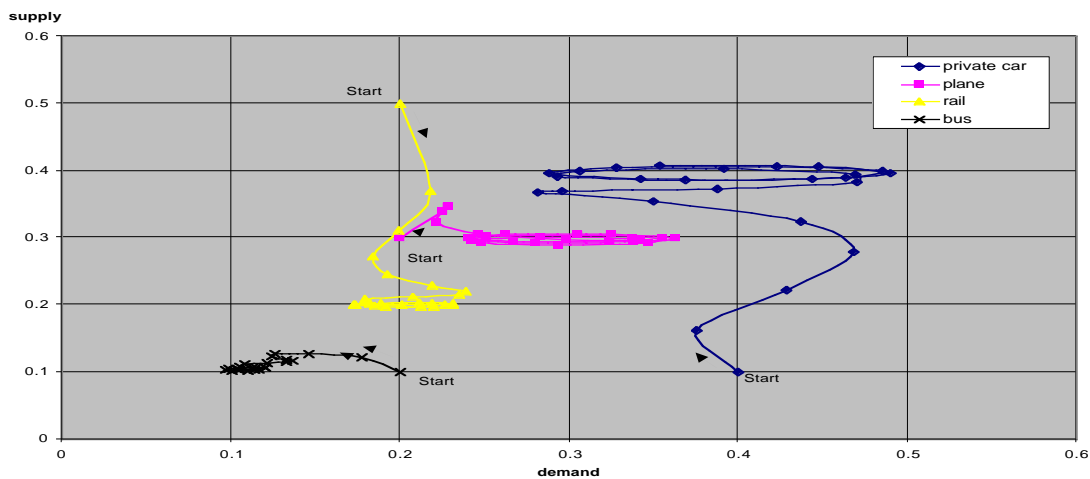


Figure 3.4: Development of demand/supply for a dynamic demand/supply interaction scheme

Perhaps the idea of randomness within the behaviour of the assumed preference functions is wrong. Alternatively, the explanation may be that it is simply our incomplete knowledge that makes them appear random. Then it is Goedel's undecidability theorem that informs us that we will never know.

It can be concluded that in dynamic demand-supply interaction systems there is neither an equilibrium state, in the sense of disappearance of the gradient, nor any reason to expect such a state in the future. However, what the model also illustrates is that guiding the demand for traffic modes into certain directions does not require a direct influence on the mode under consideration. Since demand and supply for different modes effect each other, there is also the option to give a small (and maybe cheaper) impulse to one or more of the other modes and to end up with the desired results as well.

3.3.3 System Dynamics approach

For the analysis of demand/supply interaction with a System Dynamics Model (SDM) the ASTRA model has been applied. The impact mechanism within the ASTRA SDM is illustrated by Figure 3.5.

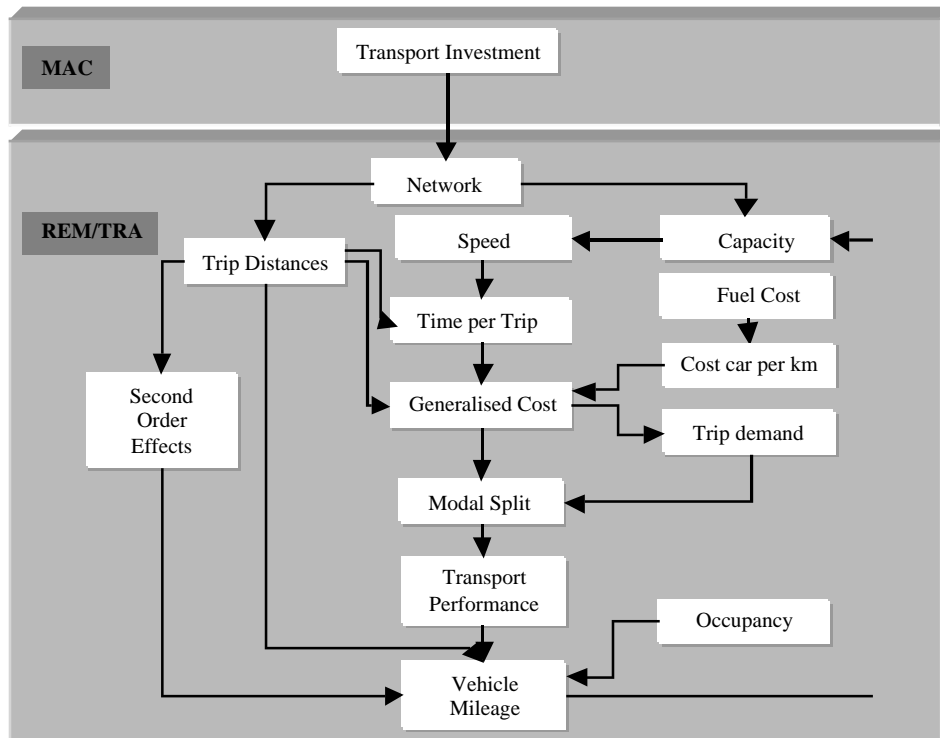


Figure 3.5: Impact mechanism in ASTRA

Apart from the reference scenario (BAU) three policy scenarios have been defined and applied:

- Investment scenario without second round effects (INV)
- Investment scenario with second round effects (SEC)
- Scenario with increase in costs for passenger car use (PRICE)

Both the INV and the SEC scenario is characterised by an increase in the amount of money invested in road transport infrastructure, which results in an increase in the road network, in particular in an increase in motorway infrastructure.

For the SEC scenario, the same changes of road networks as in the INV scenario have been applied. However, in this case, the effect of changes in household location is "set on" while it is "set off" in the INV scenario. In the model, the location of households are represented by the length of an average trip within a distance band. In the INV scenario this length is constant, whereas in the SEC scenario the average travel times by distance bands are subject to change.

The PRICE scenario is used in order to examine the effects of higher variable costs for the usage of passenger cars. The out-of-pocket costs (fuel costs, parking charges and measures to internalise external effects of road transport) are assumed to increase continuously. Compared to the BAU scenario, the variable costs for car usage in 2026 are higher by 16 percent.

The most important results of the model runs are as follows:

With regard to the effects of the PRICE scenario, it can be said that an increase in variable costs for private cars by 16% results in a decrease of passenger transport performance (private cars) by 3.7%: Thus the elasticity amounts to -0.23.

Concerning the INV and SEC scenario, it has been found that the main difference between first order effects and second order effects is the magnitude of the increase in traffic volume (measured in vehicle-km) by different distance bands. For first order effects, the highest magnitude of changes can be recognised in the distance bands over 40 km. Whilst in terms of second order effects, the highest magnitude of changes can be observed in the distance bands below 40 km. The higher values of the first order effects in distance bands over 40 km can be explained by the fact that expansion of infrastructure leads to significant improvements in speed and therefore leads to a reduction in travel times on non-urban roads. The higher values of the second order effects in distance bands under 40 km can be explained by the changes of household locations. If people prefer to live in green areas rather than in cities, these changes are influencing daily private and commuting trips to a greater extent than the longer trips. Altogether, the system dynamics approach has shown that expanding the infrastructure of roads by about 10% leads not only to first order effects, but also to second order effects of more than 1%. Expressed in economic terms, the elasticity for second round effects to infrastructure changes is about +0.1, which is a relevant impact. Negligence of such effects would lead to failures in transport planning.

The exercise has shown that, in order to explain long term changes of transport patterns, it is necessary to consider those demand/supply effects, which occur in second round interactions between land-use changes and transport development. Although impact modelling on land-use-transport interactions is not yet on a satisfactory level, it could be shown by a Systems Dynamics approach with the ASTRA model that second round effects indeed occur.

3.4 Regulatory systems

3.4.1 Introduction

Research on regulatory systems within transport has focused on the scope of deregulation and its impacts upon the development of transport markets.

The analysis has been enriched by the following five case studies, which cover both passenger and freight transport markets:

- Studies of public passenger transport in Frankfurt, London and Lyon.
- Rail freight comparisons of Germany, the UK and the USA.
- A study of freight issues in the North-South corridor, and rail freight freeways.
- Studies of public passenger transport in Budapest and Tricity Gdansk-Sopot-Gdynia.
- Studies of road freight transport in Poland and Hungary.

Organisational and regulatory changes were undertaken during the 90s in several EU countries (France, Germany, Italy, the Netherlands, Portugal, Switzerland and the UK). Furthermore, a survey has been made of organisational changes in CEE countries.

3.4.2 Western European countries

Collective passenger transport: Regulatory and organisational change at EU level

During the 1990s, the European Union issued a series of policy documents, which impact on regulation and organisation in the transport sector. The first was the European Commission "White Paper on the Future Development of the Common Transport Policy: a global approach to the construction of a Community framework for sustainable mobility" (1992), which focused on the elimination of all barriers to the implementation of the Single Market. It also encompassed a wider brief aimed towards the development of the European transport system as a whole and the promotion of sustainable growth. Subsequently, the Commission Communication "The Common Transport Policy: Action Programme 1995-2000" stressed the need for initiatives and policies in three fundamental areas:

- *Quality*: the development of competitive and integrated transport systems that safeguard safety and environment and improve the service towards users.
- *Single Market development*: improvement of the single market's internal functioning.
- *External Dimension*: market expansion to external countries via efficient transport connections and market penetration by European operators.

In 1996 the Citizens' Network Green Paper "fulfilling the potential of public passenger transport in Europe" was published. It sought to put citizens' needs at the core of decision making related to public transport systems and, being mainly concerned with urban mobility, implementation of much of its recommendations would be governed by the subsidiarity principle. In 1998 the follow-up paper to the Citizens' Network was published, entitled "Developing the citizens' network: why good local and regional passenger transport is important and how the European Commission is helping to bring it about." This outlines a set of practical measures for the promotion of sustainable transport.

At the end of 1998 the European Commission published a further Communication entitled "The Common Transport Policy, Sustainable Mobility: perspectives for the future". The document reviews developments over recent years and addresses the future development of the framework for sustainable mobility. It is recognised that progress has been made on issues concerning the Single Market, transport integration, TENs, safety and environment, but that progress has been delayed in certain, politically sensitive areas such as charging regimes for infrastructure use and external costs, working time and, in the maritime arena, on stevedoring working regimes. In addition, external relations, with respect to the air sector, has also experienced some difficulties.

The European Commission has also launched two transport pricing policy documents, "Towards Fair and Efficient Pricing in Transport: policy options for internalising the external costs of transport in the European Union" and "Fair Payment for Infrastructure use: a phased approach to a common transport infrastructure charging framework in the EU". These advocate that the user pays in principle, to support the internalisation of external transport costs, affirm a perspective of pricing as a complement to regulatory and other market policies and recommend pricing to be based on the social marginal cost principle.

One of the EU's most significant influences on passenger transport regulation and organisation throughout the 1990s stems from the EU directive 91/440. This required the separation of rail infrastructure management and operations, at least in accounting terms, and gave rise to a series of successive legislative proposals that aim at a further separation between rail infrastructure management and actual transport operations within the State railway companies. They contain

principles and rules relating to the charges for infrastructure use and also guidelines on allocation of slots to operators.

In addition, there are a number of European legislative proposals that are aimed towards shaping passenger transport's legal framework so as to open the market to competition. These include:

- Proposals on contracts relating to services of general interest and state aid for railways and other types of inland transport.
- Proposals on interoperability, especially those dealing with interoperability in the rail sector, aiming at integrating national railways systems into the TEN network.
- Proposal for a Directive amending Directive 80/723/EEC on the transparency of financial relations between Member states and public undertaking, which could have an important impact on continuing the practice of cross-funding between different sectors of public companies.
- Proposals on cabotage.
- Public procurement directives.

Collective passenger transport: Regulatory and organisational change at national Level

Over the past two decades or so, there has been a trend away from the classical licensing system and a trend towards the introduction of competitive pressures, varying from simple benchmarking to private and liberalised operation of services. Free competition has generally been rejected, in favour of managed competition (tendered/ negotiated) which has been implemented or is envisaged in most countries. There is some evidence that co-operation, between authorities and operators and between operators, has improved and been formalised in some countries. There has been an evolution towards a clearer definition and separation of tasks between authorities and operators and these tasks and the respective risks are increasingly regulated in contractual relationships.

The overview of regulatory and organisational frameworks examined eight countries: France, Germany, Italy, the Netherlands, Portugal, Switzerland and the UK. It showed that the decade of the 1990s was characterised by profound changes in the rail sector. All EU member states have transposed Directive 91/440 into national law and have created or are about to create a separate entity for infrastructure management (though sometimes still under strict government control). This process was accompanied by a restructuring of the state railways, sometimes by dismantling the national public operator and the creation of new operating companies acting under a franchising or licensing regime, sometimes by the transformation into legally private companies (i.e. limited companies) with an accompanying internal restructuring. Privatisation and management reforms within the railway sector have also been on-going in Switzerland. In a few countries there is evidence of an increase in traffic revenues, although the cause is not clear. The UK has been at the forefront of this process, as they were with deregulation of road transport.

In close connection with the restructuring process in the rail sector is the transmission of the competence for transport services of regional interest (normally not only rail) to the regions, which happened in most countries. It is interesting to note that in France a number of regions concluded agreements with the national railway company on an experimental basis for the provision of regional rail transport services. These experiments showed positive results in terms of traffic, revenues, service quality and management of expenses.

The reform process in the public transport sectors was everywhere accompanied with some form of regionalisation or decentralisation. The trend is to transfer the planning and organisational responsibility for collective passenger transport to the authority which is closest to the place where the

service is provided, i.e. urban transport to local authorities, regional transport to regions or "départements". In a number of countries the role and responsibilities of the organising authorities were recently defined or re-defined and emphasis is sometimes placed on system integration, quality, fare policy, etc.

In road passenger transport, the 1990s brought great changes for all countries, though these were relatively less substantial in countries where competition in the market had been introduced earlier, e.g. the UK and France. It is worth mentioning the distinction between delegation of public service and public contracts envisaged in the new French and Swiss public tendering code. It is regulated that the delegation of public services must partly be paid according to the operating results, otherwise the relationship is classified as public contract for which no subsidies are envisaged and competition on the same network is the rule. In the UK the perceived success of the form of regulated tendering in London and the decline of the bus services outside London as well as a trend towards market concentration were recognised. This induced the sector to strive for some kind of voluntary self-regulation or re-regulation, for instance, through quality partnerships. This policy trend seems to be endorsed by the current government.

In the Netherlands, the national government is stimulating a large-scale application of tendering procedures. Before 2010 all bus services in the country should be realised by tendering procedures. Nevertheless, reallocation of bus companies is taking place, as the monopolistic situation of the nationalised group of operating companies was no longer tolerable. Therefore, this had to be split up into various smaller companies and sold off to the private sector. As a result of the imminent submission of regional railway lines to tendering procedures, a new situation arose, in which two bus companies joined forces with the regional railway to provide conjoint transport operations. Hence an overall improvement in bus service quality was achieved.

In the other four countries the 1990s were characterised by important legislative changes mainly aiming at the introduction of some form of competition. In Germany, a distinction was made, with respect to regional passenger transport, between profitable and non-profitable services. For the latter, adjudication according to competitive tendering at minimum cost is required. In Italy, the current public concession system in urban passenger transport has to be replaced by competitive tendering and municipal companies have to be transformed into private companies by the year 2003. Finally, Portugal laid the legal basis for the introduction of some form of competition and the re-qualification of the nature of compensation for public services in 1990 but the executive rules and dispositions for this law are still awaited.

Freight transport: Regulatory and organisational change at EU level

The Commission's efforts, aimed at liberalising the road transport market and reducing access restraints have, thus far, concentrated on international transport. Restrictions on the amount of international traffic between Member States and for traffic in transit from and to Member States were abolished in 1993. EU authorisations for these operations are attainable by any operator of a Member State issued with a license for international road freight transport. In addition, the need for formalities and controls at the internal borders has been eliminated with the introduction of the single customs territory.

Council Regulation No. 3820/85 fixes the minimum age of the driver and the minimum number of driving and rest hours. This was strengthened by a directive, issued by the Council in November 1988, which introduced minimum requirements to check application of the regulation. However, the penalties for failure to observe the requirements are defined by the Member States and frequently are only very minor. On the technical side, the weights and sizes and some other technical characteristics of the vehicles which carry out international transport are regulated for aspects relative to the safety,

such as speed control devices, tyre tread thickness, safety belts, safety glass. Road transport companies in some countries feel at a disadvantage due to a lack of standardisation of operating conditions in the liberalised European market, particularly in relation to taxation matters. Standardisation is underway for matters such as fuel tax, motorway tolls and ownership tax. We are moving in the direction of a vehicle taxation structure which is standardised on the basis of nationality (payment in the country of registration), introducing, in a second phase, a taxation based on methods necessary to calculate, distribute and pay infrastructure costs, taking into account external costs.

Reference has already been made to the attempt, in regulation 91/440, to reform the rail sector by achieving a degree of separation of infrastructure and operations. This was in order to promote new entrants into rail operations. Under that regulation, open access for international freight was provided for inter-modal freight operators and for groups of rail operators for other rail freight services. However, that regulation had relatively little effect. Subsequently, attempts were made to promote entry by creating a set of rail freight freeways, on which attractive international paths were to be marketed on a "one-stop shop" basis. In December 1999, the Council of Ministers agreed a more radical development which would ensure open access on an extensive European Rail Freight network, but this has yet to be implemented.

Freight transport: Regulatory and organisational change at the national Level

Essentially, the provisions referred to above have contributed to the achievement of the single market in road freight transport, the main point of contention being the continuation of very different levels of taxation according to the country in which the vehicle is registered. Germany and the Benelux countries have responded to this by implementing a vignette system of supplementary charges for access to the motorway network.

Progress in liberalising rail freight has been much more limited. In two countries, Britain and Germany, access to the rail freight market has been totally liberalised. The experience of these countries is discussed in detail in the case studies. In the Netherlands, new entry has also been permitted, and a limited amount has occurred. In Sweden, new entry was permitted where SJ declines to provide a service, and again a limited amount occurred. In general new entry has not been permitted elsewhere.

A second problem facing the international rail freight market has been the wide variety of charging systems for use of the rail infrastructure, ranging from access, which was initially free of charge in the Netherlands, and at short run marginal cost in Sweden, to fully commercial negotiated rates in Britain and a commercially based tariff which was seen as a major barrier to entry in Germany. Clearly, such a variety of charging methods distorts the routing of international rail freight and hampers the development of freight to, from or passing through one of the countries with high charges.

Perhaps the most dramatic development in the rail freight market has been the growth of international consortia based on the existing state owned operators. This has been a somewhat unexpected result of the restructuring of railways to separate infrastructure from operations, and freight from passenger operations. German and Netherlands Railways have announced the merger of their freight operations to form a new company (Railion), which also has an agreement with the Bern, Lötschberg, Simplon Railway through Switzerland, whilst Italian and Swiss Railways are also seeking to merge their freight organisations. Alternative groupings are understood to be interested in Polish Railways freight business, which is currently on offer. This development may be seen as the welcome emergence of powerful international players in the rail freight industry, but it is also regarded in some quarters as likely to lead to an even more entrenched monopoly position for the existing operators.

Summary and conclusion

Throughout the EU there has been pressure to increase public transport mode share and to decrease public subsidy. This pressure has stimulated moves to re-examine regulatory and organisational frameworks, including industry ownership, so as to increase competitiveness and improve efficiency within the transport sector. National government and EU policy has manifested this pressure.

Nationally, a variety of models for regulating and organising public passenger transport have emerged across Europe, from the traditional system of licensing services from a public corporation, through various forms of franchising regimes, to free market and deregulated competition. Several case studies show that, in certain countries, regulatory change has coincided with upturns in the demand for public transport. This is particularly true of the introduction of franchising systems rather than outright deregulation. Where this has occurred, however, one should be cautious about directly attributing the upturn in demand to changes in regulation or organisation. Regulatory or organisational change to enhance competition of the public transport sector can reasonably be expected to enhance productive efficiency within the sector but it is unlikely, on its own, to lead to increased demand for public transport. It may do so indirectly, however, by leading to provision of a more favourable fares/service package than could otherwise be afforded. A tendency towards franchising of passenger transport services appears to secure cost reduction.

The liberalisation of road freight seems to improve efficiency and facilitate the development of international operators.

Deregulation of rail freight appears to lead to efficiency improvements and international consolidation. The development of rail freight transport in the US has demonstrated that deregulation of the market can have very positive impacts in terms of competitiveness and efficiency of the rail system. The European international rail freight market has had to face the problem that there is a wide variety of different charging systems for access to the rail infrastructure, which distorts the routing of international rail freight transport and hampers the development of rail freight to, from or passing through one of the countries with high charges.

Much of the EU policy has derived from the Common Transport Policy and has focused on pricing systems. It is important to emphasise that deregulation has been causing significant changes of the institutional framework. These changes should indeed be considered, if appropriate pricing principles are discussed.

3.4.3 Transitional changes in CEE countries

The transformation started at the turn of the 80s and 90s in the whole CEE region. However, it should be stressed that due to numerous ideological, cultural and political reasons the socialistic starting point of the reforms is different in various countries. But generally speaking, the system existing in the CEE countries before 1989 was characterised by certain common features as follows:

- Domination of a ruling communist party as a monopolistic political power.
- Domination of real socialism and its apparatus over all the forms of economic activity.
- Centralisation of economy administration.
- Closed character of the economy and society.

The process of market transformation encompassed all spheres of life and economic practice including the transport sector. The inefficiency of the old structures of transport organisation and administration and considerable technical inertia had resulted in low efficiency of transport. Transport operations in the CEE countries in the late 80s can be characterised as follows:

- Technological backwardness.
- Lack of innovation
- Considerable technical, technological and organisational insufficiency.
- Economic inefficiency.
- Rationing of transport services.
- Non-existence of a transport market in the strict sense of the word.

The restructuring was to be carried out twofold by way of:

- Internal changes – consisting in starting the market mechanism and stabilisation.
- External changes – aimed at forming institutional frameworks of co-operation at domestic and international level.

An analysis of transport policy in different CEE countries concludes that priorities of transport policy are rather similar in different countries. Elements of organisational changes have appeared in most countries. Infrastructure improvement was regarded as a very important issue. Social aspects of transport organisation were considered by postulating high quality services and the protection of human life and the environment.

During the process of transformation on several levels, significant changes occurred in the allocation of institutional power. The most important change has been an increase in importance of international institutions. In most of the countries, especially those located in Central Europe and in the Baltic countries the impact of regulations arising from various international agreements is very high, e.g. regarding market access regulations and harmonisation of technical standards. In other countries, especially in Russia, Ukraine, Moldova or Belarus, the impact of regulations set at international level is considerably smaller.

The importance of central institutions differs significantly between different CEE countries. In some cases the markets are still characterised by a centrally planned economy with only minor changes pointing towards a free market (Russia, Ukraine, Belarus). In other countries, (especially in those aspiring for EU membership) decentralisation processes, including the transport sector, have been pushed forward. In two countries, Poland and Hungary, the weight has considerably moved from almost unlimited powers of central authorities towards an increase in the power of regional and local self-governments. It can be expected that in CEE countries change regarding the allocation of responsibility will proceed in the direction towards decreasing the role of central national institutions and increasing the power of regional and local institutions. However, this will progress at a different pace, depending on external and internal factors.

3.4.4 General effects of regulatory changes in CEE countries

During the period of transformation significant changes occurred concerning the development of freight and passenger transport demand and the modal split of transport. These changes resulted from many general economic internal and external factors and can be summarised as follows:

- Transport demand in the passenger sector increased, whereas freight transport demand decreased.
- Before transformation in most countries bus transport was dominating in the passenger sector. Since the start of the process of transition a considerable decrease in the share of bus and railway transport has occurred, whereas the market share of private passenger cars has increased.
- In the freight sector the domination of railway transport was unquestionable until 1985. During the process of transformation there was a decrease in the share of railway transport and an increase in

the share of road transport. Nevertheless, regarding freight transport the share of the rail mode is still at a relatively high level (e.g. 29% in Hungary and 51% in Poland).

In the transition period, major organisational and regulatory changes, also in the transport sector were determined by transformation of the economy in the CEE countries. Generally speaking, regulatory changes in most of the countries were aimed at creating a market-oriented system and harmonisation with Western European and EU conditions. The advancement of de-monopolisation and deregulation changes depends on the starting point at the beginning of transformation, which differs from country to country.

Summing up it may be said that the deregulation has been effective in those countries where it was well prepared. In the CEE countries the opinions are unanimous that quality regulations must be kept, even though the criteria differ. In some countries it is considered that minimal or referential prices or quantitative regulations should be introduced in order to prevent devastating competition.

Most generally the types of changes which occurred in the CEE countries refer mainly to the road modes and can be summarised as follows:

- Intercity passenger transport (coach) – demonopolisation.
- Urban public transport – decentralisation.
- Freight sector – deregulation.

Moreover, it can be said that deregulation in freight transport has been achieved quicker and on a wider scale in comparison with regulatory changes in the passenger sector.

It is very difficult to estimate the implications of regulatory changes on transport demand. Particularly in CEE countries, where almost the whole economy has been transformed, there are many different determinants of changes in transport demand. But one can identify regulatory changes to be closely connected with changes in transport demand. The most important example seems to be deregulation and privatisation of freight road transport. In the case, when the processes have been well prepared and realised, one can observe the strengthening of the carriers leading to the growth of the sector's share in the total volume of freight transport.

3.5 Changes in trends

3.5.1 Introduction

A "break in a trend" can be thought of as a definitive rupture in past or established regularities in the relation between variables describing the behaviour of the system. This rupture is a discontinuation with a lasting effect on the existing "regularities" as deduced from our observations. It can have internal (changing behaviour of individuals, reaching thresholds like capacity, introduction of new supply alternatives or technological innovations) and external causes (changing regimes of management, social/ environmental events, etc.).

Mathematically a "break in trend" can be defined as follows: The strictest definition of a "break in trend" is a discontinuity in the slope of a curve (the first derivative of the trend is not defined).

A change in trend of a function is more likely to occur, since it is sufficient for the first derivative of the function to reverse its polarity. The definition applied for the present task has focused on "change in trend", which is a subset of a "break in trend": A change in trend does not necessarily require a "rupture". Even the existence of an inflection point could indicate a change in trend. The point of time at which exponential growth becomes logarithmic growth, can be identified by an inflection point. Thus a change in trend can be identified, if one of the following conditions is fulfilled (function $f(t)$ describes the development of a transport demand indicator over time t):

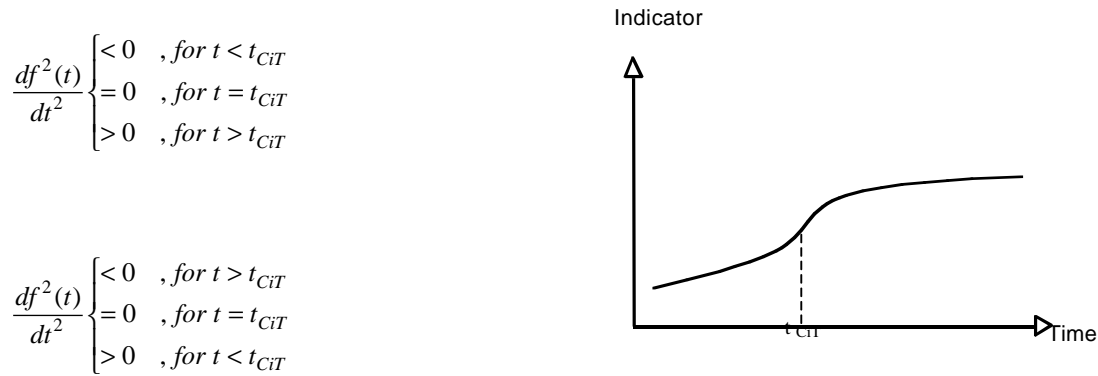


Figure 3.6: Change in trend

The mathematical definition of change in trend has been completed by a more qualitative one: Temporary decrease and increase (e.g. caused by economic crises) does not meet the requirements to indicate a long-term change in trend.

3.5.2 Western European countries

Freight transport markets and results from the decoupling analyses

The evolution of freight transport performance (measured in ton-km) in all EU countries has shown a continual increase over the last decades; for example between 1965 and 1996, transport performance increased in Spain by 376%, in Italy by 273% and in France by 69 percent. Changes in this upward trend have only had temporary character and were caused by external factors, e.g. oil crises.

In contrast to the development of freight transport performance the development of freight transport volume (measured in tons carried) shows more moderate growth rates. Within the period of time between 1965 and 1996 freight transport volume increased in the Netherlands by 62 percent, in Belgium by 51 percent, and in France by only two percent. The evolution in the UK shows a small decrease by two percent. Similar to the patterns evident in freight transport performance development, external disturbances in freight volume have resulted only in a temporary discontinuation of the prevailing trend.

The evolution of the modal split (related to transport performance) has shown clear tendencies since 1965: rail has had to cope with heavy losses, while the road transport has been able to gain market shares. Also the inland waterway mode has had to suffer from market losses – but the losses of inland waterway shipping are not as severe as the losses of the rail mode. The development of the modal share of transport in pipelines shows a less consistent performance.

In 1965 the rail mode attained considerable shares of freight transport, e.g. 44.2% in France, 35.7% in Germany, 31.8% in Belgium and 21.7% in Spain. About 30 years later, however, the rail share in these countries has more than halved. In 1996 it amounted to 21.4% in France, 17.7% in Germany, 12.8% in Belgium and to not more than 5.1% in Spain.

Also inland waterway shipping has lost market shares. In case of the Netherlands the modal share declined from 62.9% in 1965 to 49.1% in 1996. Within the same period of time the share decreased in Germany from 25.2% to 16.2% and in France from 8.9% to 2.4%.

Whilst the benefactor of this decline has been the road mode, which improved its market share between 1965 and 1996, e.g. in Spain from 78.1% to 92.0%, in Great Britain from 72.2% to 84.8%, in Italy from 72.1% to 84.6% and in France from 32.1% to 66.9%.

Road freight transport and, in particular, international road freight transport have been identified as the most dynamic market segments. The following factors have had a substantial influence on the development of demand for freight transport and the evolution of modal split:

- European integration and globalisation, which have significantly increased the demand for international transport.
- Change in the commodity structure, which has substantially increased the share of commodities with high affinity to carriage on the mode road.
- Change in the operational behaviour of companies (procurement and distribution behaviour, application of advanced production technologies), which requires quick, reliable and flexible carriage of consignments, which are often relatively small and with variable size.
- Application of innovative information and communication technologies (ICT), which has been offering new possibilities for optimising freight transport operation (e.g. route scheduling, monitoring of transport).

It is quite obvious, that there is a kind of correlation between economic growth (measured by GDP) and the demand for freight transport. The production and the distribution of goods generate demand for freight transportation. Demand for products again is influenced by the general economic situation.

The energy sector serves as a positive example for decoupling. After the oil crises in the seventies and eighties, decoupling of energy consumption from economic growth was attained in several countries (e.g. in Germany). Decoupling was caused by improved energy efficiency, by the application of advanced technologies and by behavioural changes.

In order to examine the previous development of the demand for freight transport and GDP, the following three approaches have been applied for Belgium, France, Germany, Italy, the Netherlands, Spain and the UK:

- Analysis of transport elasticities
- Analysis of transport intensities
- Regression analysis

The decoupling analyses yielded the following results:

- Decoupling of growth in **freight transport volume** from growth of GDP has already taken place in many Western European countries. The analysis for Belgium, France, Germany, the Netherlands and the United Kingdom have shown that growth rates of freight transport are lower than growth rates of GDP. In all of the analysed countries decoupling has taken place. Nevertheless, there are country-specific differences: in Belgium, Germany and the Netherlands there is a strong positive correlation between transport volume and GDP. In France and Great Britain the generation of transport volume seems to be widely independent from economic growth.
- Decoupling of growth of **freight transport performance** from growth of GDP has to be seen differentiated: The analysis of transport elasticities, transport intensities and the correlation analysis have shown that certain decoupling tendencies are visible in France, the Netherlands and

Great Britain. For these countries the transport elasticities are predominantly below 1.0. The analyses show a weaker growth of transport performance than of GDP. However, the transport elasticities for the most recent period of time are – except for the Netherlands – clearly beyond 1.0. Furthermore, the transport intensities show an increase in 1996 compared to 1990 (although again the Netherlands is an exception).

The results demonstrate that decoupling has definitely not taken place in Germany, Belgium, Italy and Spain; and although certain decoupling tendencies can be recognised in France and Great Britain, decoupling cannot be considered to have been attained. This is because transport intensities and transport elasticities have increased during the most recent period 1990-1996. However, according to the analyses applied, clear decoupling tendencies can be recognised in the Netherlands.

- The analyses clearly show that decoupling of growth of **road transport performance** from economic growth has not taken place. Growth rates of road transport performance have markedly exceeded growth rates of GDP. Among the seven considered countries France, Great Britain and the Netherlands are those countries, which are closest to the attainment of decoupling road freight transport performance growth from economic growth.

Passenger transport market

In the last few decades, transport performance (measured in passenger-km) has shown an upward trend in Western European countries. Although there have been some fluctuations in the development over time, they cannot be seen as changes in trends, as they have been of a temporary nature.

Generally, rail transport performance across EU countries has followed a more or less stagnating development. Since the 90s in several countries slightly tendencies for rail passenger transport performance to increase can be recognised. Concerning road transport the situation is more obvious. All countries show a rather constant growth in transport demand by private passenger cars. In most countries, transport performance grew by a factor of 2 to 3 in the period of time between 1965 and 1996. Italy and Spain demonstrated the highest growth with 1996 performance figures up to 9.2 times the value measured in 1965. Whilst the lowest increase can be observed in Sweden, where road transport performance increased by a factor of 1.99 between 1965 and 1996.

Similar to the situation for the mode road the market for air passenger transport has developed very dramatically. **Figure 3.8** illustrates the development of demand for passenger air transport from Germany to specific destinations during the period of time between 1980 and 1996. Within this period of time, transport demand increased approximately by the factor 3 (in the case of destinations in North America) and up to 7 (in the case of destinations in Turkey).

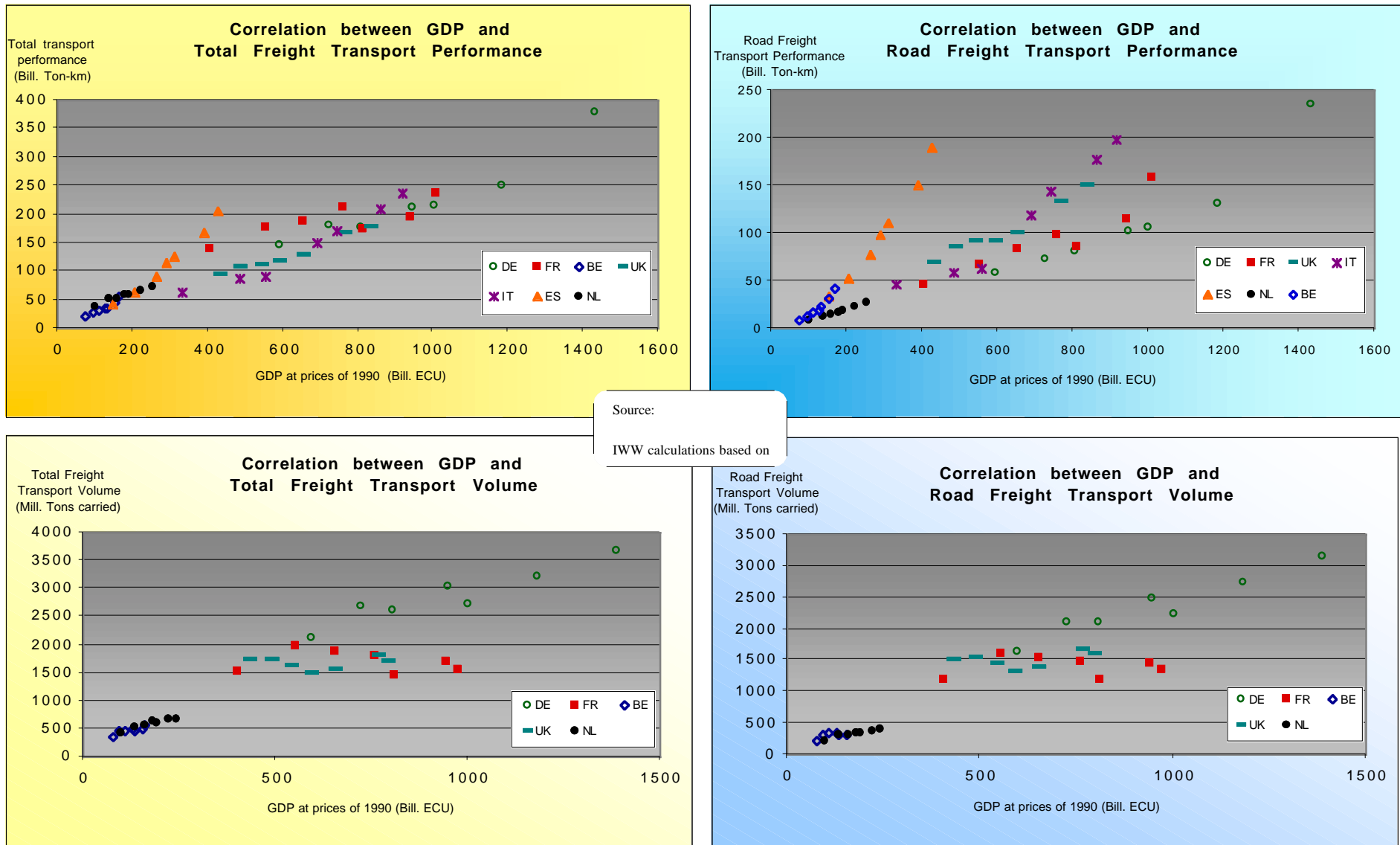


Figure 3.7: Correlation between GDP and (road) freight transport performance/ volume

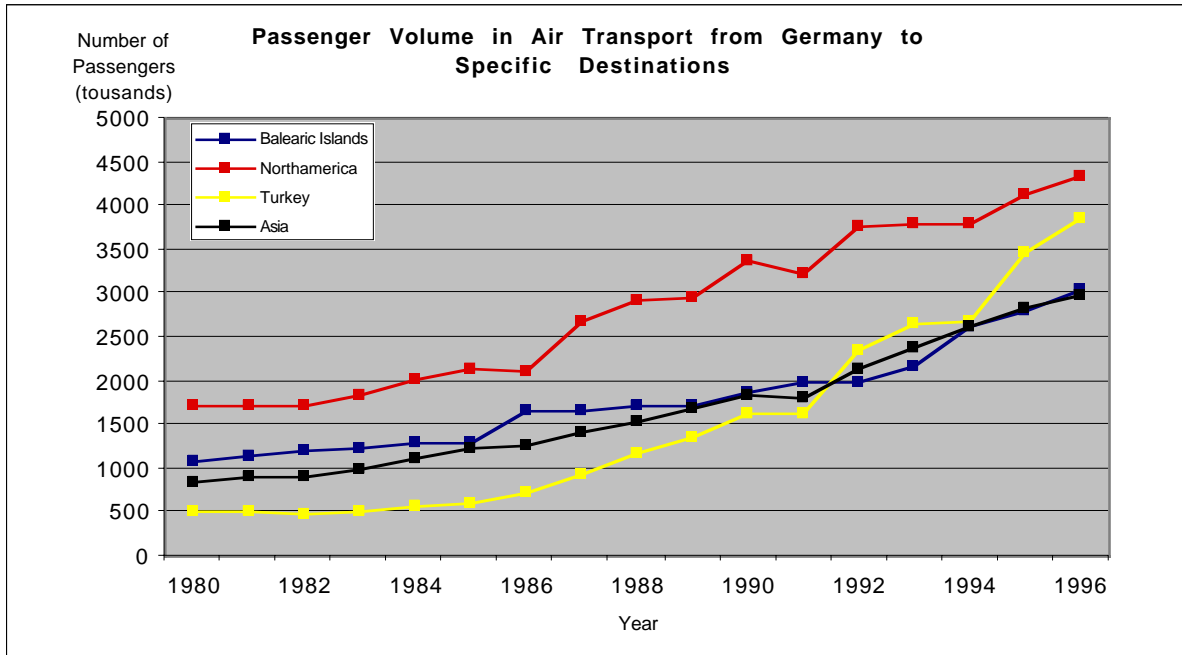


Figure 3.8: Development of demand for air transport from Germany to specific destinations

Source: Statistisches Bundesamt

Furthermore, the patterns of passenger mobility in several French urban areas have been subject to examination. Each area has at least two observation points in time. The data sets stem from Household Travel Surveys conducted over a long period of time (from the mid 70s to the late 90s)⁵.

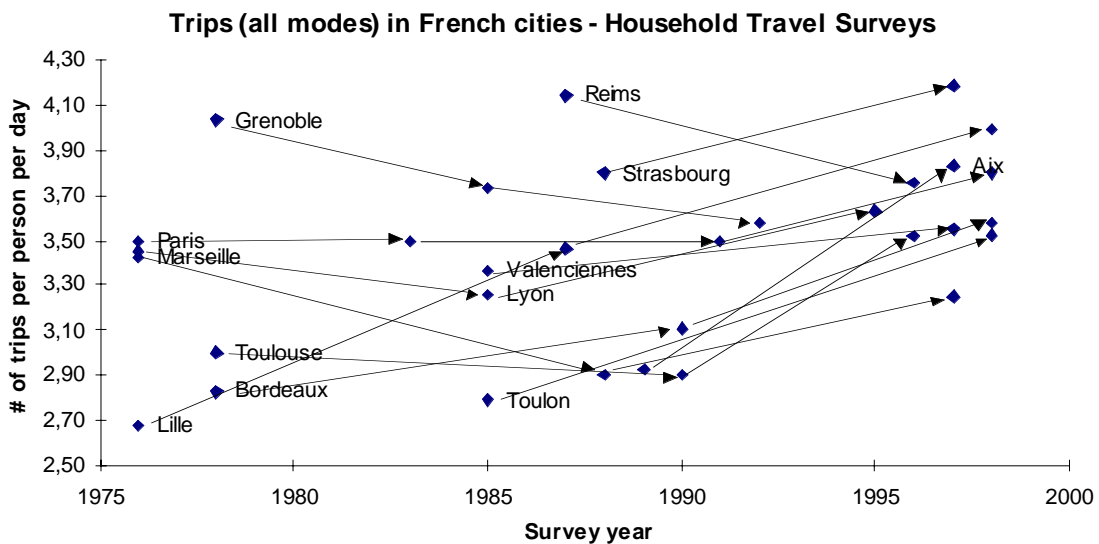


Figure 3.9: Trips (all modes) in French urban areas

⁵ Source: CERTU - CETE Nord Picardie

A survey of evolution of mobility behaviour patterns in French urban areas, identified a decrease in the average number of trips (all modes) per person and day from the late 70s to the late 80s and early 90s in most of the cities (Figure 3.9). Since a point in time between 1985 and 1990 the average number of trips has seen continual increase. The passenger car has remained the dominant mode in personal mobility, and the average number of car trips per person and day has increased continuously over the whole observation period in all of the areas considered. In contrast, the less important mode two-wheels has experienced a continuous decrease over the period, except for the agglomerations Marseille, Aix-en-Provence and Paris, where it stabilised in the late 90s at its level of 1988, 1989 and 1991, respectively.

In most cities the number of trips per person and day by public transport modes has shown upward trends, which can be explained by significant improvements on the supply side.

For walking trips a change in trend can be observed in several French cities in the late 80s or the early 90s. In this period of time the downward trend has turned into a slight upward trend.

Perhaps the most remarkable change is the upturn of the average duration of time devoted to mobility (measured in time per person and day) since the mid-80s (Figure 3.10). Such an increase may be accentuated by the planned reduction of the work duration in France (legally fixed at 35 hours per week), leading to additional free time for other activities. This could be interpreted as evidence against Zahavi's conjecture stating the constancy of total travel time budgets.

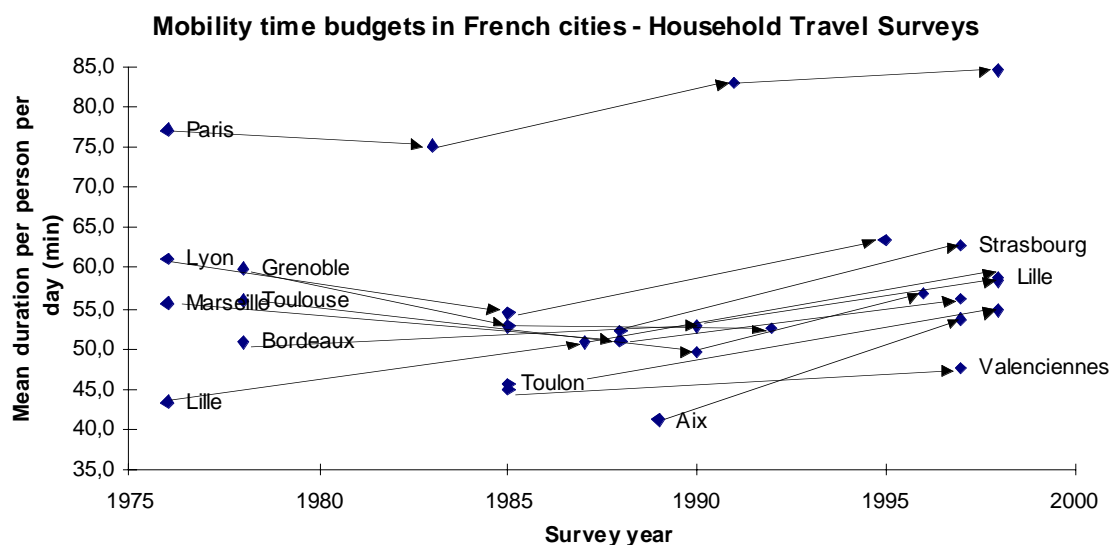


Figure 3.10: Mobility time budgets in French urban areas

When examining trends in the passenger transport market it is important to distinguish between trip purposes. The generation of trips for the purposes work, education and business are compulsive trips, whose generation depends on "hard variables" (e.g. number of employed persons, number of persons in education, economic situation, number of working days) and can be subject to change, if a change in external factors occurs. Future changes in trend are instead more likely to occur as a result of socio-demographic changes in several Western European countries (decline in inhabitants and increase in share of elderly people; decrease in average household size). Short stay personal trips as well as leisure and holiday trips are non-compulsive trips and are not only determined by "hard variables", but also by "soft variables" and are more sensitive with respect to individuals' values, life

style, attitudes and preferences. Thus changes in trends for non-compulsive trips can be expected to be driven considerably by changes in fashion, attitudes, societal values, preferences and changes in life styles.

3.5.3 CEE countries

Freight transport market

The analysis of the evolution of transport intensities in several CEE countries shows a general downward trend starting in the 60s.

In the period of time between 1970 and 1988 a slight decline can be recognised, followed by a rapid decline in the first period of transition (1989-1992). Since 1992 a more stable evolution with slight declines has been prevailing (Figure 3.11). In reality the decline between 1989 and 1992 was larger, since at this time changes also occurred in the methodology employed for data validation. Before the transition period in the majority of the countries under consideration, road freight transport services were, to a large extent, operated by internal transport services of state sector enterprises. Since the operation of such services had not been efficient from an economic point of view, they were shifted within the transition period to independent enterprises. This organisational change resulted in a (statistical) increase in the demand for freight road transport without representing any real change.

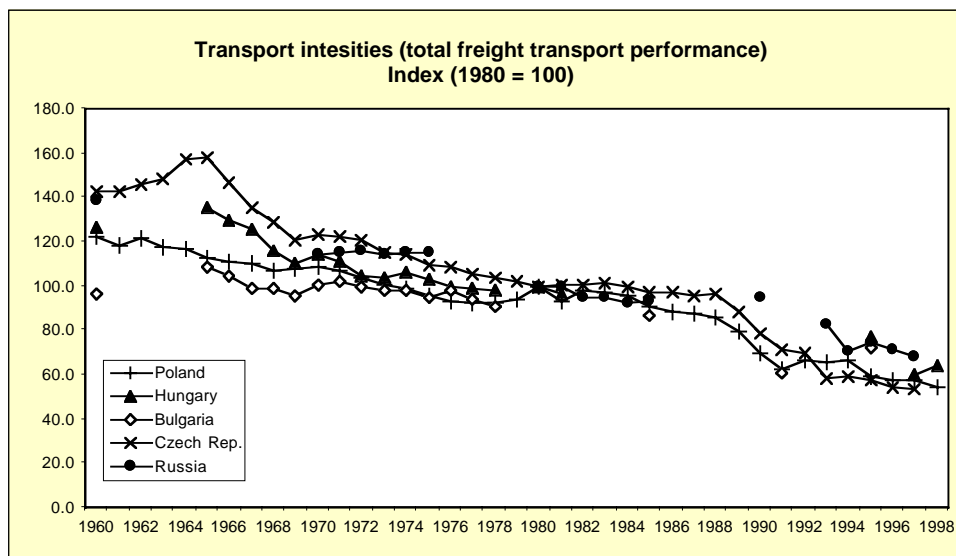


Figure 3.11: Evolution of transport intensities related to total freight transport performance

The most striking feature is the change in the modal split with huge shifts from rail to road after 1990, when the countries in question entered the transition period (Figure 3.12). Only in Russia the ratio has remained on a more or less stable level. The rail mode, the predominant mode in the pre-transition economies, has severely lost market shares, and road transport has started to grow rapidly (except in Russia). One can expect, however, certain saturation tendencies of this process in future years.

According to the evolution paths described above, transport intensities with regard to rail freight transport performance, have shown a constant but moderate decline in the period of time between 1960 and 1989. A change in trend can be identified in the early 90s: the moderate decline is substituted by a period of more pronounced decrease, which is followed by a period of stabilisation. A contrasting development has been identified for the evolution of transport intensities related to freight transport performance on the road. Moderate upward trends can be recognised between 1960 and

1990, with a rather stable period in the 80s and after 1990 a strong increase in transport intensities was evident in all countries except Russia.

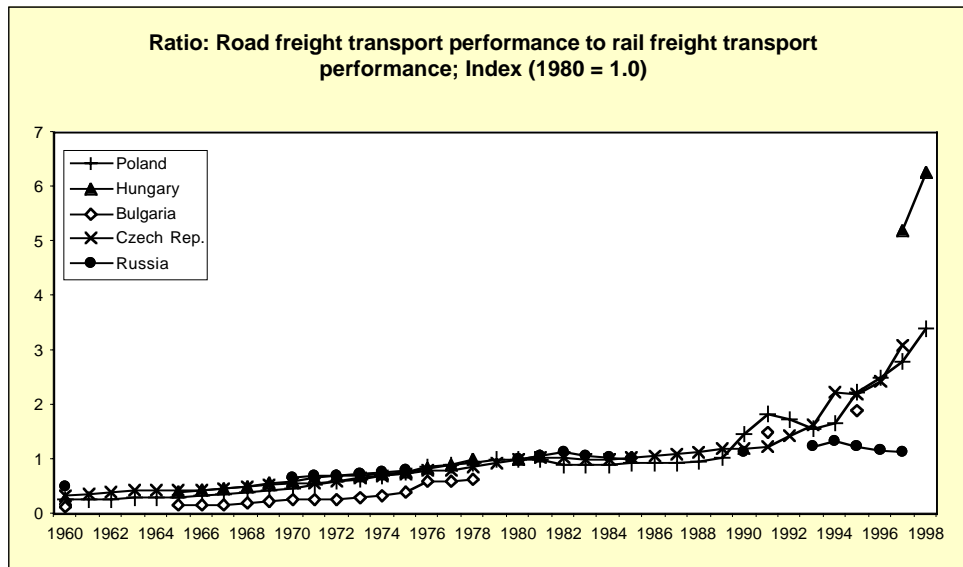


Figure 3.12: Development of road freight versus rail freight

Passenger transport market

The development of passenger transport markets in CEE countries has been characterised by a steady decline in the importance of public transport modes by rail and road.

The evolution of the ratio between passenger transport performance by rail and GDP per capita shows strong downward trends between 1960 and 1980, a rather stable evolution within the 80s, and again downward trends in the period of transition, except for Bulgaria and Russia (Figure 3.13). The loss of importance of public modes has been accompanied by a significant growth in car ownership (Figure 3.14). However, compared with car ownership in Western European countries car ownership is still at a relatively low level.

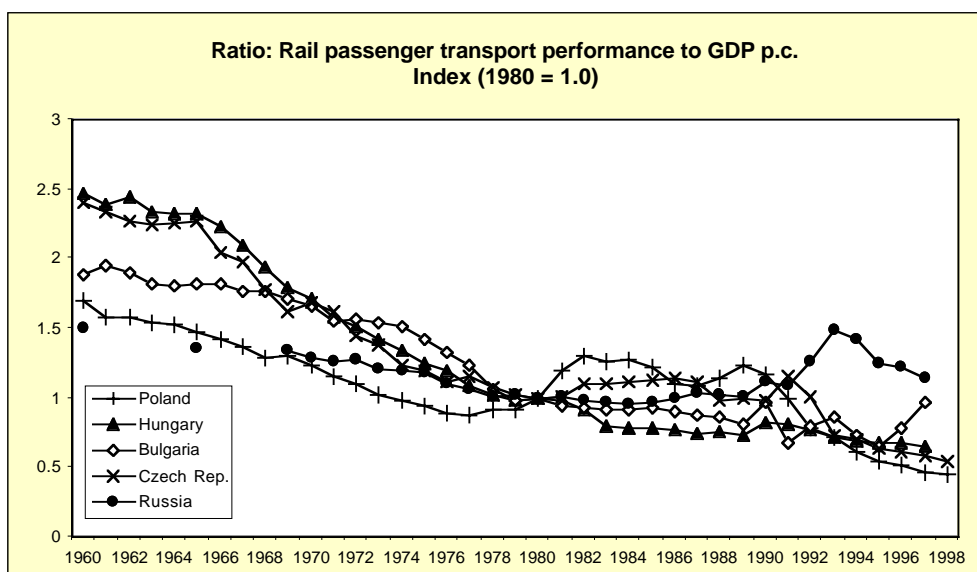
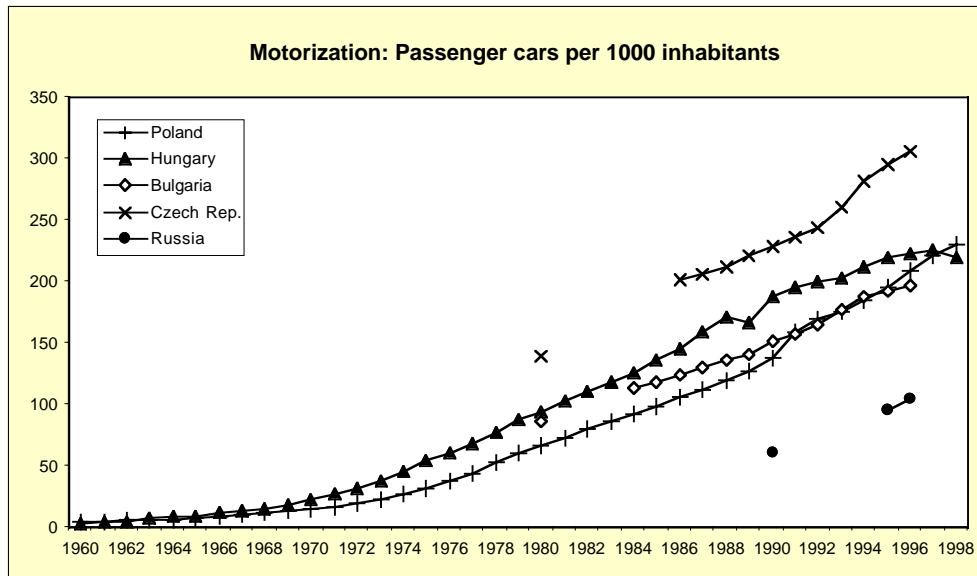


Figure 3.13: Development of passenger rail performance in relation to GDP per capita**Figure 3.14: Evolution of car ownership**

3.5.4 Conclusions

The development of demand for passenger transport has shown the following clear, major trends, which hold true for the majority of European countries (both EU and CEE countries):

- Steady increase in transport demand.
- Shift of market shares from public modes (rail, coach) to individual modes (passenger car).
- Intense growth of air transport.

In the case of Western European countries, the analyses do not support the hypothesis that there have been relevant changes in these trends. There were ruptures in the evolution paths, which, however, were of a temporary nature.

In many CEE countries, the start of the transition process indicated the beginning of a change in trend: The prevailing trends have been being supported and have been continuing in an accelerated way. Since the beginning of the transition process, passenger transport demand in CEE countries has been determined by the new possibilities and freedom, which were enabled by the fall of the "iron curtain", like the possibility of spending holidays in Western countries. The process of transition has substantially enhanced the individuals' mobility radius and has remarkably accelerated the growth in car ownership.

Demand for passenger transport in Western European countries has been driven by European integration, globalisation, increase in economic wealth and a continuous reduction in working hours. To an increasing degree, the main drivers of transport demand in CEEC have been in accordance with those for Western European countries.

However, passenger transport demand has not only been driven by "hard" variables like economic situation, employment or household income, but also by "soft" variables, like attitudes, values and life style. In particular transport demand for non-compulsive trips (private trips, holiday/ leisure trips)

cannot be explained sufficiently by hard variables and has to be subject to further illumination by soft variables.

As far as the development of demand for freight transport is considered, the main trends prevailing in Western European countries can be summarised as follows:

- Intense growth of demand (transport performance, measured in ton-km), with growth rates considerably higher than those for passenger transport. The most dynamic market segment has been international road transport.
- Significant shift of market shares from rail and inland waterways to road.

An occurrence of changes in these trends cannot be confirmed in the case of Western European countries. External disturbances (e.g. oil crises, economic slowdown) have resulted in a temporary discontinuation of prevailing trends only.

The latter main trend holds true also for CEE countries. The development of total demand for freight transport however, has been characterised by a decrease within the period of transition, which has been caused by the decline of heavy industries and a substitution of inefficient state-owned transport operators by private companies. Furthermore, modal shares have been shifted from rail to road. Thus the beginning of the transition period indicates a change in trends indeed, since it marks an inflection point for the development of economic structures as well as for the way freight transport is operated.

In Western European countries the following factors have had substantial influence on the development of demand for freight transport and the evolution of modal split:

- European integration and globalisation, which have significantly increased the demand for international transport.
- Change in the commodity structure, which has substantially increased the share of commodities with high affinity to carriage on the mode road.
- Change in the operational behaviour of companies (procurement and distribution behaviour, application of advanced production technologies), which requires quick, reliable and flexible carriage of consignments, which are often relatively small and with variable size.
- Application of innovative information and communication technologies (ICT), which has been offering new possibilities for optimising freight transport operation (e.g. route scheduling, monitoring of transport).

Within the last decade the demand structure in the group of CEE countries has substantially been influenced by the economic and societal transition process. However, to an increasing degree the main drivers of freight transport demand in CEEC have been being in accordance with those for Western European countries.

The analyses on whether decoupling of freight transport demand from economic growth has taken place in the Western European countries Belgium, France, Germany, Italy, Netherlands, Spain and the UK, has shown following results:

- Decoupling of growth of freight transport volume (tons carried) from growth of GDP has already taken place in many Western European countries.
- Decoupling of growth of freight transport performance (ton-km) from growth of GDP has to be seen differentiated: The results demonstrate that decoupling has definitively not taken place in

Germany, Belgium, Italy and Spain. Although certain decoupling tendencies can be recognised in France and the UK, decoupling has not been attained, as transport intensities and transport elasticities have increased during the most recent period of time. Nevertheless, according to the analyses applied clear decoupling tendencies can be recognised in the Netherlands.

- The analyses have clearly shown that decoupling of growth of road transport performance from economic growth has not taken place. Growth rates of road transport performance have markedly exceeded growth rates of GDP.

Overall, the analyses of changes in trends have illustrated that only severe changes of external circumstances, like the change of the economic and societal system as it occurred in CEEC, have been able to provoke sustainable changes in trends related to the evolution of transport demand structures.

Thus the analyses suggest drawing the conclusion that whenever policy-makers intend either to achieve changes in trends in the development of transport demand, which are lasting and not of temporary nature, or to achieve decoupling of certain transport demand indicators from economic development, major and extensive efforts are required categorically.

3.6 Institutional aspects

3.6.1 Introduction

Within the research on institutional aspects, the manner in which institutions in the transport systems change has been analysed and the ways in which these changes affect the financing and pricing schemes of rail, road and air transport have been identified. SCENES Deliverables D3a and D3b as well as the various working papers provide detailed information about all modes. However, the main focus in this chapter is on the rail sector.

3.6.2 Western European countries

Rail transport

The main objective of this section is to illustrate the institutional changes for the rail sector by reviewing the development in France and the United Kingdom.

The construction of the European Union Common Transport Policy (CTP) is implemented through a framework of reforms, introducing new types of organisation and requiring adaptation to a changing environment. But besides the increasing influence of the EC legal environment upon the national policies, the use of "the market as reference [becomes more and more] the principle justifying the action." (Berant; Ollivier-Trigalo, 1997). In the present analysis, the focus is on the organisational dynamics of the institutions created by implementation of the Directive 91/440.

The readjustment of national state-owned monopolies required by directive 91/440 has occurred at different speeds according to the country. Nevertheless, the trend has clearly been "towards harmonisation of the terms of competition and regulation of subsidies" (Nash, 1999), thus facilitating international transport within the European Union. This is also true for road haulage, bus and air sectors. Although the opening to market competition has been difficult in all transport sectors, it is the rail sector, which has encountered most serious problems.

Britain and France are considered to highlight different approaches to the implementation of the directive for the rail sector. The contrasting approaches can be classified as follows:

- A "factual privatisation" when the new status is a limited company, the British case.
- A "simple separation" when the company remains a public body, the French case.

Factual Privatisation: the British Case

Surely the most complex, and clearly the most innovative, the British model is usually accepted as the most proactive within the European Community. However, recent developments proved that this innovative model did not work sufficiently. The private owner of the network Railtrack, which was often blamed in order to encourage its shareholders to invest into the network, went bankrupt a couple of months ago. While the story is not yet over⁶, the future organisation of British rail infrastructure is discussed lively. A sale of (parts of) the network at auction, or a club based principle, where all operators will be jointly responsible for the network, seem possible. Nothing is certain, but the unbroken intention of the government is to fulfil the required separation of network and operation activities in as strict a regime as possible.

The British framework met and still meets the necessary requirements for a competitive rail market with numerous private stakeholders and public bodies in order to ensure efficient regulation. From the original public company, British Rail, with monopoly status, the rail system has been divided between the network and operations activities. So far, nothing is different from other countries. But the British approach differs in the sense that the government has decided to go further by implementing a "double unbundling".

Indeed, 25 passenger rail franchising undertakings, the so-called "Train Operating Companies" (TOCs) have been created. The TOCs are organised within the Association of the Train Operation Companies (ATOC), which must facilitate the co-operation between the TOCs, in particular the agreements concerning the share of the receipts coming from the commonly operated lines – therefore replacing the single operations branch of the old company, British Rail (BR). The Office of Passengers Rail Franchising (OPRAF) defines the franchising contracts for 7 to 15 years (see below). At the same time and because of the prohibitive cost of entering the rail operation market, the reform created three leasing undertakings, the "Rolling Stock Companies" (ROSCOs). As their name indicates, the ROSCOs are responsible for purchasing the rolling stock, and renting it to the TOCs. It is forbidden to possess a TOC and a ROSCO, since the purchase of one of the ROSCOs by Stagecoach (an operator of two lines).

Management of the network infrastructure that was transferred to "Railtrack" is reorganised at the moment.

To ensure the efficiency of this new system of rail organisation, the reform has been structured, around 3 main entities:

The Office of the Rail Regulator (ORR)

"The Rail Regulator's [...] main aim is to create a better railway for passengers and freight customers, and better value for public funding authorities, through effective regulation in the public interest." The specific objectives of the Office are to "[1] promote the interests of passengers; [2] promote the development of rail freight; [3] ensure that Railtrack acts as a responsible and efficient steward of the national rail network by operating, maintaining, renewing and developing the network to provide the improvements expected by passengers, freight users and funders; [4] ensure that where workable competitive structures can be achieved, and can benefit users, they are promoted and that monopoly is controlled to protect users and deliver benefit to them; [5] ensure that regulated contracts and licenses operate, develop and improve in a manner which promotes the interests of passengers and freight users, making clear where it shall intervene to secure the public interest but minimising unnecessary regulatory intervention in commercial contractual matters." (DETR, 1999)

⁶ Railtrack calls for independent inquiry into 'False Market Allegations' (Nov. 5th, 2001) and explicitly welcomed Tony Blair's comments acknowledging "shareholders will receive something" (Oct. 26th, 2001)

The Office of Passenger Rail Franchising (OPRAF)

In terms of policy, the Franchising Director's mission is to apply the MoT guidelines, which aim to increase the number of passengers travelling by rail, to manage existing franchise agreements in a manner which he considers promote the interests of the passenger; and to secure a progressive improvement in the quality of railway passenger and station services available to railway passengers (DETR, 1999). The Director is then in charge of supervising the TOCs, attributing the slots with a franchising contracts system and checking the operators' terms of reference.

The Health and Safety Commission (HSC)

The mission of this last body is "to ensure that risks to people's health and safety from work activities are properly controlled" (DETR, 1999).

The British approach has been labelled a "surplus recovery logic" (ECMT, 1998), compared with the German "costs covering logic", which is presented below. The tariff system governing access to the network is split up in two different procedures: free negotiation between Railtrack and the operators for the purchase of slots, submitted to the control of ORR, and a fixed toll level for those franchised passengers lines defined by the ORR. One of the difficulties met with this double pricing system concerns the affectation of common costs, to know who pays for what, and whether passenger operators should receive a transfer from the freight companies or vice versa.

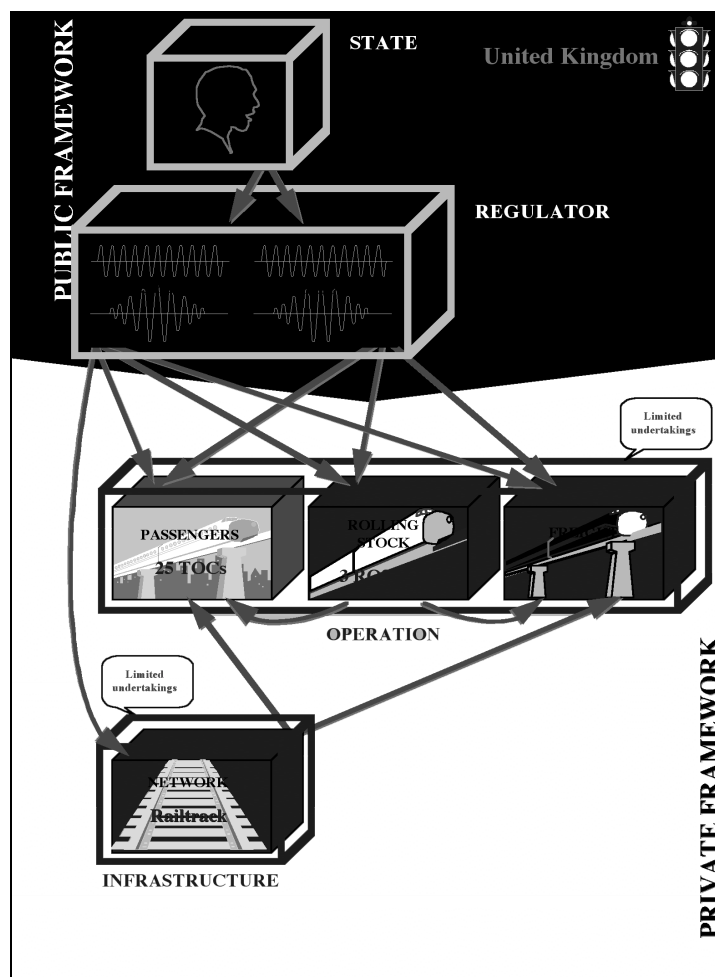


Figure 3.15: The rail organisation in the United Kingdom

Simple Separation: the French Case

France is famous for its centralised state, with power concentrated in Paris. However, in recent years there has been more pressure for decentralisation, with the transfer of power from the central state to the regions. The process of regionalisation is also apparent in the rail sector. At present seven regions are directly responsible for their own rail management, in accordance with their status of local transport authority. The total indebtedness of this system has been unsound for a long period. The challenge to achieve balanced budgets and to implement the Directive 91/440 were transcribed in the 1997 reform which established the Réseau Ferré de France (RFF) for the renewal of rail transport. Compared with the British experience, the French rail re-organisation shows a much simpler structure.

The Ministry of Transport (MoT)

For rail, it appears that there is still a very strong link between the State and the operating company SNCF, that is likely to continue and which is a distinctive feature of the French case. The French policy directions concentrate on the development of the *Trains à Grande Vitesse* (High Speed Trains - HST) increasing the construction of new lines. The MoT also aims to balance investments between construction and the renewal of existing infrastructure. The importance of public authority arrangements with the Contrats de Plan Etat-Région (Planning Agreements between State and the Regions) can also be underlined. For the XI Contrat de Plan, the government has promised to commit 30.5 MEuro per year between 1996 and 2000 for rail investment. This governmental contribution will more than double between 2000 and 2004 to reach an amount of 76.2 MEuro per annum for the XIIth Contrat de Plan.

The Société Nationale des Chemins de Fer français (SNCF)

The SNCF was the original national rail undertaking, and since the institutional separation of infrastructure and operations its new duties concern two different types of operation: trains (SNCF/Carrier) and the network (SNCF/Infrastructure). It possesses the public status of Etablissement public industriel et commercial, i.e. state-owned corporation. Its accounting rules are the same as those used by industrial and commercial companies. Beyond its commercial activities with RFF, the undertaking is responsible for defining projects and making proposals to reach these goals. For all new plans, a financial balance of the public undertakings RFF and SNCF has to be ensured.

Réseau Ferré de France (RFF)

RFF is a new body, which owns and manages the network. Its legal status is the same as that of the SNCF. Three quarters of the SNCF debt has been transferred to the liabilities of RFF, and is assessed at 20.5 billion Euro. As for assets, RFF has received the entire infrastructure, except for stations and the exclusive zones, which are essential to the SNCF's operation. The mission of the RFF is to create new lines, modernise the actual network for the passenger and freight services and to regenerate the network (METL, 1999).

Regional Authorities

Seven regions in France are concerned by regionalisation, whose goal is to evaluate which regions will fulfil the function of Authority in charge of transport when regionalisation becomes fully effective (SNCF, 1999). By the 1995 Law on the Development and Planning of the Territory, the State has transferred responsibility for public transport to the regions, which is now declared a regional asset. This experience is reviewed for a period of three years from January 1997, with the legal obligation to present conclusions at the beginning of 2000. At the present time, the extremely positive experience of regionalisation is expected to be extended to all 22 French regions in the medium-term. The growth rate of traffic has been much higher in those regions with greater autonomy: 3-4% growth compared with 1-2% in regions, where regional traffic is centrally controlled.

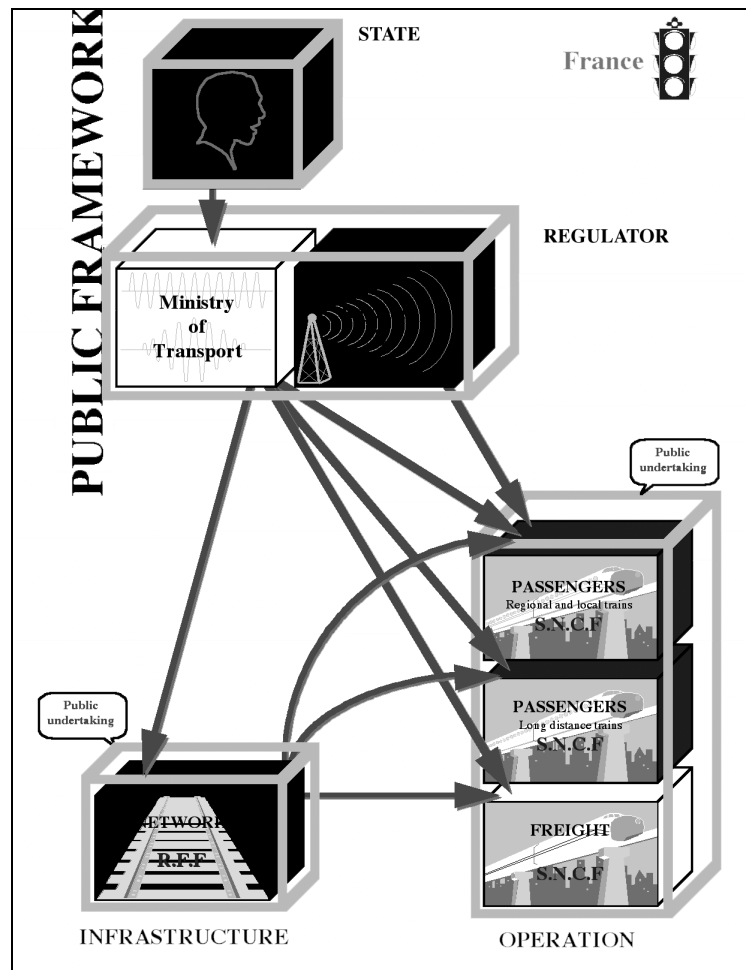


Figure 3.16: The rail organisation in France

The Conseil supérieur du service public ferroviaire

This consultative council was created in 1999 to be involved in the public policies of land planning and to meet sustainable development requirements. It answers directly to the Minister of Transport and its missions are the following: The development and the balanced evolution of the rail sector, the unity of the rail public service, the consistency in the implementation of the governmental policies on transport by the public undertakings RFF and the SNCF, as well as the respect of public service missions by these two undertakings.⁷ The essential objective of the French rail system is to cover all costs. This goal has to be found in income from fees and public grants. RFF makes investments to ensure a certain level of quality and also to re-organise the network by construction or closing lines. Investments reached about 2 billion Euro in 1998. Up to now the structural reform therefore seems more aimed towards providing a sound financial situation for SNCF, than opening up the market to private interests. In practice, only one private enterprise operates on the rail network on two relatively short lines, the Vivendi group with its transportation department, the CGEA.

The analyses of the institutional aspects of rail focus on the application of directive 91/440, which bases on the neo-classical approach and a belief in the virtues of market forces. In order to revitalise the rail sector, the directive proposes to introduce competition (or at least contestability- the possibility of competition) into the rail market, and also to separate service provision from network

⁷ Decret no 99-221 of 19 March 1999 in relation to the Conseil supérieur du service public français

management. In comparison with traditional analysis oriented towards maximisation of profits through the minimisation of production costs, institutional economics aims to economise on the sum of production and transaction costs, and thus to highlight the question of organisational efficiency through exchanges. Yet in practice it is clear that the different Member States have adopted quite different approaches in order to conform to the directive. It seems that the response to implement the required changes will be related to institutional considerations concerning policy and social objectives, and that the required changes can be interpreted in a very broad way. These different models can be analysed through the concepts of transaction costs and property rights. The British case is very interesting in this respect. Britain has initiated the most wide-ranging re-organisation of rail, which aimed to improve its performance in comparison with the nationalised company British Rail. However, the complexity of the relationships between the numerous stakeholders might result in increased costs, which can in turn reduce efficiency. Moreover, the British reform has directly introduced private interests in the rail market, which demand sufficient financial returns. Such expectations may not be in accord with the objectives of the rail management, which are linked to customer satisfaction in the service provision. The divergence of objectives between shareholders who judge on short term returns, and the public who consider the service quality – requiring long term strategies – appears difficult to resolve in particular if recent development, as described above are taken into account.

Since pricing is, "without a doubt, a very useful tool to direct the economic orientations of the multiple stakeholders, as much for the short term operations, as for mid- and long-term investments..." (RFF, 1998) the section about rail transport closes with a brief discussion of suggested and/ or applied pricing principles. Pricing policy effectively concerns customers, infrastructure owners and managers, the regions or other local authorities responsible for transport and subsidies, the State (responsible for the national regulation) and all the actors who possess an interest in competition and co-operation between the modes.

Further on pricing has given rise to a theoretical debate with the principle of "social marginal cost" proposed by the Commission in 1998. However, important questions remain unsolved within such a pricing scheme, regarding long-term investment as well as pricing adjustments relating to time and space (for regional cohesion). Social marginal development cost, a "second best" solution (based on budgetary equilibrium) might bring some improvements to the social marginal cost principle, but still lacks the insight of institutional economics, which recognises that transport policies cannot be reduced to pricing alone.

The costs affected by the operation of a network assumed by the infrastructure manager must be understood in a different manner according to whether the costs are fixed or variable. Fixed costs are not linked to the number of trains operated. Generally these costs are much higher for rail transport than for those of the competitive road mode.

Concerning European pricing policy it can be recalled that the "marginal cost pricing" principle was proposed at European level over twenty years ago and still remains under discussion, partly because of difficulties of implementation and of introducing long term targets through pricing.

In fact such a pricing policy might even introduce *new distortions* in the competition with road, since the relative importance between full and marginal cost for rail and road differ considerably. In other words pricing must be simplified, clarified and harmonised to avoid unfair competition.

The chosen pricing system must therefore be elaborated in such a way that it gives a strong enough signal concerning the scarcity of slots to provide an incentive for a better use. It should take into account economic costs as well as social costs, e.g. the external costs. The stakeholders involved in the attribution of slots are then aware of a trade-off aiming towards better system management. However, it is important to be aware that costs within rail operations are often not very well known. Thus any option that reveals the real costs, and promotes the most efficient use has a significant

shortcoming: the data collection. "It would be a lie to explain that one can assess precisely a marginal cost or a full cost" (RFF, 1998).

The institution of a pricing system requires the establishment of a framework that can take into account the specific elements that the regulator wants to influence. For example, the British regulator, considers that a suitable pricing framework should cover the following items:

- **Comprehensibility** - the structure should be understood by the industry participants.
- **Transparency** - the structure should provide clear information to industry participants.
- **Stability** - charges should not fluctuate or alter in arbitrary or unpredictable ways.
- **Cost reflectivity** - in order to meet the Regulator's efficiency and funding objectives for charging structures, charges will need to be cost-reflective (ORR, 1999).

Air transport

To understand the institutional structure of the sector it is useful to present a schematic view of the basic elements of the air transport system regarding the functional organisation of this system. Figure 3.17 schematically illustrates the core elements of the air transport system. The system is characterised by its disintegrated institutional structure.

- The provision of infrastructure capacities including the provision of ground handling services (airports),
- provision of transport services (airlines),
- responsibility for safety aspects (ATC) and
- the regulatory function (State)

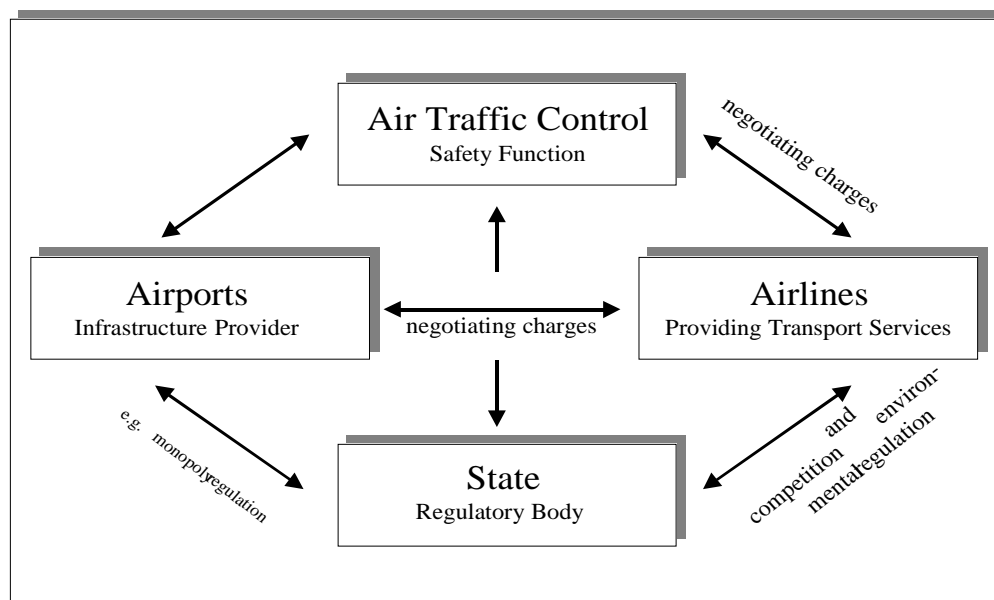


Figure 3.17: Schematic illustration of the basic elements in the air transport system

are traditionally organised in independent legal bodies. Their relations among each other are based on negotiations on one hand and legal orders on the other.

In SCENES Deliverable D3a the role of any actor is elaborated in detail. The following sections will concentrate on institutional changes for airlines and air traffic control. It must be mentioned that again (see Railtrack) recent developments could not have been foreseen, when the above mentioned Deliverable was written. As a consequence of the terror attacks against the U.S. several airlines face serious problems. While an ever faster growing number of passengers characterised the development of the air transport in recent years, it is hardly possible to predict future growth or decreases of passenger, tariffs or ton-kilometres in a market burdened with so many uncertainties.

Liberalisation and Privatisation Trends in International Aviation - Airlines

Institutional change in the air transport sector can be described by presenting regulatory changes in the last two decades: Airline regulation has traditionally been dominated by the general judgement of the markets' ability to reach transport related public goals. In the early days of commercial aviation the "non-competition"-thesis was dominating: the public interest would best be served if a market-oriented organisation with privately owned airlines in combination with open markets was avoided. Not speaking about airports or air traffic control – for a long time there was no idea of liberalising and privatising these infrastructure-providing actors.

However, since the early 70s institutional changes have been dominating the international aviation sector, with widespread consequences for the sector. Although the final stage of this process is not reached yet, there are several aspects, which can be subsumed under this institutional impact. Rapid changes and innovations in the field of airline organisation can be identified, just to mention the key words of co-operations, alliances or mergers. It is no exaggeration to identify institutional changes, understood as changes in the regulatory framework, as the driving forces presenting the air transport sector as one of the most dynamic markets at the edge of the 21st century.

The US has been the first country to liberalise the airline industry. Coming back to the international level of institutional change: US-liberalisation swapped over to Europe, pushed by the US government to insure their airlines the advantages of improved efficiencies also in the international context. The first steps on the way were the successful implementation of the so called "open skies" agreements between the US and European countries, the liberal revision of the bilateral agreements between the UK and the Netherlands, and the initiatives of the EC to liberalise the European airline sector. To give a short outline of the liberalisation process the four liberalisation packages between 1988 and 1997 now in force are summarised. These packages present an insight into the changing framework in the European air transport sector and may help to fill out the notion "institutional change":

1st package (January 1988)

- Revision of capacity allocation.
- Marginal automatic approval of the 5th freedom right.
- More flexibility of fares.
- Application of EC competition rules to the aviation sector.

2nd package (November 1990)

- Compulsory award of concession to any new airline satisfying normal aviation criteria.
- Right for any airline in the EC to fly to any international airport in EC.
- Further revisions of capacity allocations.
- Relaxation of the 5th freedom right.

- More flexibility in fares.

3rd package (January 1993)

- Almost entire freedom of tariffs for charter, cargo and scheduled flights.
- Basis for flag carrier privatisation; their shares have – in majority – to be owned by EU citizens.
- Free market access, except for cabotage.

4th package (April 1997)

- Freedom of cabotage.
- Entire liberalisation of the European aviation sector.
- Extension to those countries, which are not members of the EU, like Norway, Switzerland and the medium term to the six Central-European countries.

While the liberalisation process solved some urgent problems it is also responsible for some new emerging problems, as there are capacity problems because of the dynamic growth of demand, shifting problems from the airlines to airports and ATC. Efficient airport management and the efficient provision of infrastructure capacities seem to induce further institutional adjustments in the air transport system. An important economic aspect could not be solved yet: reinforcing competition in the airline market has not resulted in a regulation free and working competition. The oligopolistic market structures with competition problems are dominating today like they were twenty five years ago.

Liberalisation and Privatisation Trends in International Aviation - Air Traffic Control (ATC)

ATC-bodies provide essential functions in the air transport system: they provide the airside infrastructure of the air transport system, are involved in the appointment of runway capacities (co-ordination data) and they are responsible for safety aspects in the air transport. The importance of ATC-output becomes clear if we look at the "ground-air-interface" in the system, where ATC capacities as a dominant system bottleneck are made responsible for the delay-crisis that has come to a historical peak in 1999.

ATC bodies are directly involved in the determination of the capacities of the air transport system. They actively take part in defining the airport with regard to runway (ground-based) capacities and they also define the airside capacity of the air transport system, especially the provision of routes through the international co-ordination and the technological development of the ATC-systems.

One result of the new freedom was the appearance of new entrants, in particular on the airline side. Simultaneously with the opening of the Common European Market the notion of national carriers lost importance. Global alliances promise cost reduction and thus increase competitiveness. The effort of integrating airline networks is nearly as old as the airline industry itself. The first attempts resulted in the establishment of the former Air Union, in which all the European airlines should merge. Even then, it was not a problem of efficiency that averted a realisation, but a problem of optimal owner structure. The countries could not come to an agreement about the reasonable capital share of the different participating states. For the same reason the integration of several European national airlines failed. However, besides the bad experiences successful examples can be found. The form and the depth of the integration vary by a wide range. However, a parallel trend of disintegration accompanies the increasing co-operation of the carriers. Disintegration occurs in the field of outsourcing of services. Established European carriers, especially the former national airlines, generally speaking have relatively high labour costs, quite higher than those of newcomers on the market. In a service industry labour costs have a great influence, such that from this point of view outsourcing could be helpful. The question, whether or not outsourcing processes will continue, depends last but not least on the image an airline wants to maintain. Can Lufthansa or Air France afford to lease planes and or

crews, if any safety problem would cause serious problems immediately? They can, as long as the confidence of their customers is not hurt and as long as they have the impression of flying with a plane and a pilot of the chosen airline. The possibilities of outsourcing enable the airline industry to form virtual airlines, which only consist of an administration department. Even then it might be possible to outsource several issues that finally only the strategy is formed within this airline.

Recently efficiency of air traffic control has significantly increased. Despite the current delays the air traffic control will – technically – not be a constraining factor for the growth of air traffic. Economic incentives can be identified, which determine the airlines' interests in the extension of ATC capacities: ATC bottlenecks cause considerable delays, which lead to additional airline costs and a loss of reputation concerning the general ability of the system to offer transport services on time. In other words the airlines (and the passengers) are beneficiaries of the extension of ATC capacities. But expanding capacities needs to be funded. Obviously the extension of ATC capacities is too expensive for the ATC, because they do not see any possibility to depreciate the investments without matching charges. This would mean a lack of incentive for providing optimal ATC capacities. The problem occurs how to ensure efficient co-ordination of possibly opposed incentives of two or more independent actors. Based on economic theory an institutional arrangement including elements of co-operation and negotiation to reinforce an efficient provision of ATC capacities seems appropriate. A view on German experiences (which are partly informal) supports this suggestion. Airlines and the German Air Traffic Control (DFS), both independent players in the air transport system, use a co-operative approach besides the legal framework determining ATC charges. Within this approach they define measures concerning ATC capacities and "negotiate" some aspects of ATC charges. Recurring on economic theory a "club-model" can be identified, where the club members, i.e. the users of the ATC output, are directly involved in the decisions about price and quantity of the provided goods. The allocation of full cost strictly bound to a cost ceiling.

Road transport

Recently the majority of the applied financing policies were based on public funding. Few states have in fact adopted or admitted the principle of tax allocations and only single examples can be found for concession systems and private funds.

As long as the investment levels required to adapt road infrastructure to demand were within reasonable limits of the general state budgets full public financing has proved to be possible - not necessarily reasonable or fair. However, a change in orientation has occurred over recent years marked by a tendency to open up policies and to include private funding systems. Inflation, public deficit and national debt are some of the problems facing the public sector. The immediate outcome of this scenario has been a lessening of the budget assignments for public investment. In addition, the European Union treaty imposed a demanding economic and budgetary discipline on member states by way of essential entry condition for the Economic and Monetary Union and the access to the latest stage of the European Union. This convergence policy has entailed a restrictive budget policy that has given rise to a further shrinking of the public funds earmarked for infrastructure. States are currently arbitrating new systems to mobilise the necessary funds covering infrastructure needs without, at the same time, ceasing to meet Maastricht convergence requisites.

Road Authorities will be encountering important changes in the future. Though the road network cannot expand at the same pace as before, new investments are needed, both for building and maintenance, whereby the focus must shift from building to maintaining. Parallel other modes of transport must provide spare capacity that will cut down strain on the road system. Still the amount of funds required maintaining the existing network can not be met by the public purse alone.

A further shift of investment can be expected with rapidly growing implementation of (expensive) information systems, which will guide the traffic in the future. This may result in higher users charges; however, it will in turn also force policy-makers to consider infrastructure user as "customers" rather than as "traffic". Consequently customers' opinions will influence policies more than before.

Though the answer to all these problems will largely depend on each country's own particular features, some clear patterns are emerging that seem to be of a general nature.

While the classical approach of obtaining funds from taxes will remain very important, it will be complemented with private funds, under different schemes. Further on new financial systems will require new partners, innovative schemes and, accordingly, new institutions.

Road Authorities will focus on management and maintenance, while planning must be left to the upper administrative levels (the Ministries or Departments of Transport).

3.6.3 CEE countries

Rail transport

East and Central European states have made mixed progress in implementing the access provisions of 91/440. The majority of countries have implemented an accounting separation of infrastructure or are in the process of doing it. Many have made legal provisions for access, although detailed regulations and track access fees have been defined only in Czech Republic, Poland and Slovakia. In most countries the national carrier retains its monopoly and access would only be granted at its discretion. This can not be regarded as non-discriminatory access, although the situation is evolving rapidly in many countries.

The more general problems for the railways in CEE countries do not vary considerably compared with the railways in EU. The magnitude and intensity of the problems are, however, larger and there is a necessity to solve them in quicker time than that which the EU railways have granted themselves.

All railways in CEEC have common problems:

- The technical and operational standards of the railways are insufficient and this results in bad transport quality.
- Consequently the railway operator can not attract financially strong customers, but are forced to serve the 'market of lemons', which in turn makes the already poor financial situation worse.
- The commercial freedom of the management is restricted.

The adoption of EU Directive 91/440 will not solve these problems, but it will make it easier for parties concerned to develop sustainable rules for the game. A majority of the CEE countries have or will adapt their legislation to the Directive. There is also a clear trend to clarify relations between the State – as a buyer of transport services – and the railway through contracts. The railways' public service obligation will continue to exist during a foreseeable future.

Air transport

Institutional changes should be understood as new organisational solutions in the relations between state public authorities on the one side and air enterprises and airport management boards operating on a commercial basis on the other side. Those changes do not occur as a result of market processes but in consequence of effecting new legal solutions based on new doctrines and a new air policy. In the CEE countries there is a need to decrease the state's direct interference with the operations of the civil aviation sector, especially in respect of production, commercial and financial issues. However, it is beyond doubts that in all countries the state has to have a legally guaranteed possibility of performing actions, e.g. in respect of improvement of safety, certification, control of fair competition, customer protection and natural environment protection. The following areas can be distinguished:

Airlines - the most important change in that respect is adopting liberal and non-discriminatory rules of licensing air carriers and specifying legal regulations for agencies appointed to grant such licenses. In view of larger technical risk air transport must be governed by stricter rules than transport by other

modes (e.g. road). It requires both having higher financial and technical resources and certified air personnel.

Air Traffic Control - air traffic management includes (1) providing air traffic services, (2) air space management, and (3) air traffic flow management. In each of the CEE countries there are appropriate agencies performing functions in those three areas.

On the basis of the foregoing analysis of an institutional evolution of the air sector in the CEE countries in the years 1990-2000 it is possible to say that the process of adjusting the structures and procedures to European and international solutions has occurred (regardless of aspirations for EU membership). The role of public authority becomes limited to a necessary minimum resulting from the necessity of ensuring safety control, non-discrimination, fair competition, and consumer protection. Privatisation of state-owned transport and airport enterprises has been carried out in different forms and at various paces. Traffic control agencies start to operate in a way ensuring better co-ordination on a European scale.

Road transport

Before transformation the road administration system in the CEE countries was characterised by totally centralised road network management and financing system.

Changes in respect of road administration in the CEE countries consisted in:

- Decreasing the scope of powers of state agencies in the area of the management of specific production and service activities relating the renovation and maintenance of road and bridge surfaces.
- Modernisation of facilities and new investments.
- Decentralising activities in the area of road financing and management (decentralisation processes have been carried out only in some CEE countries).
- New approach to the financing of the infrastructure from public resources.
- External lending sources: EIB, EBRD, World Bank.
- Grant funding, especially PHARE and TACIS funds.
- Public private partnership.

From the point of view of an institutional analysis changes concerning new elements in the public financing system of the infrastructure and public-private partnership seem to be the most important.

At the first phase of market transformation in the CEE countries an economic crisis occurred. It manifested itself also in a breakdown of public financing of the road infrastructure. The economic depression, combined with structural reform and inflation, resulted in severe drop in public revenues in real terms between 1989 and 1993. The decline can be quantified as being between -20 and -30% (for Hungary and the Czech Republic and between -50 and -60% (for Bulgaria and Romania). The unavoidable consequence was a squeeze on public expenditure for infrastructure investments and maintenance (Gaspard 1996).

The breakdown of the road financing system from state budget resources only resulted in the necessity to look for other financing sources. One of them is PPP (public private partnership).

PPP has been a popular investing form in the transport sector on the European forum in the recent years. However, many threats arising out of such financing form (e.g. political) can be shown. In transition economies, market risks associated with toll road investments are further aggravated because of following reasons:

- Traffic volumes are low (at least when compared to Western European level).
- Consumers have a relatively low purchasing power (which makes road users reluctant or unable to pay full cost recovery toll in the future).
- There is an apparently free-access (i.e. publicly financed) non-congested road alternative, which competes with toll road (Timar, 1998).

Despite the challenges and difficulties, governments in Central and Eastern Europe remain interested in attracting private capital to be invested into toll roads. Governments would like to achieve private sector efficiency gains in design, operation and maintenance, and benefit from the partial transfer of commercial risks to the private sector.

3.6.4 Conclusions

As transport modelling is dominated by neo-classical approaches, little emphasis is given to the importance of the institutional framework and the particular externalities, transaction costs and incentive mechanisms, which are associated with institutions. Institutional economics give a framework for studying such effects, for which it is difficult to define data-based empirical estimations.

Institutional arrangements firstly have a big influence on the types and magnitudes of external economies or diseconomies occurring. This insight has already been gained in the early twenties when Frank Knight discovered that external costs of congestion can not only be treated with Pigou taxes but also through a privatisation scheme, allocating the property rights of scarce road resources to private enterprises. The latter will price the roads according to scarcity and willingness to pay of the users. As soon as infrastructure capacities become overused they have no longer the property of public goods because rival views about the valuable and scarce capacity resources occurs. As these rival opinions coincide in market economies with positive willingness-to-pay, pricing schemes is the appropriate response to optimise the use of capacity. But pricing schemes can be developed either on the idea of central welfare maximisation, which corresponds to the Pigou-solution and leads to optimal taxation strategy, or to a market type solution through shifting property rights for managing scarce and valuable sources to the private sector.

Allocation of property rights is closely related to transaction costs of the institutional schemes. In the example of the different road management solutions of Pigou and Knight different types of transaction costs occur which have to be compared to prepare the best choice to be made. In the case of the Pigou solution the public has to set up an organisation to impose the tax and manage the capacities appropriately. Side effects may occur in terms of undesired diversion of traffic demand to other facilities (e.g. from motorways to secondary roads) or by inefficiency of the public management. In the Knight solution the external costs of congestion vanish and also the transaction costs for management and organisation are internalised, but on the other hand transaction costs for monitoring and controlling the scheme occur (e.g. by a regulation authority). According to Sappington and Stiglitz (1983) the optimal solution is not known a priori, but has to be filtered out by benefit-cost analysis (a suggestion which also corresponds to the findings of Coase, 1960, in the case of external diseconomies).

The reason why changing institutions can be more efficient in the dynamic sense than interventions of the State through pricing policy lies to a wide part in a setting of right incentives. Although it is known that one can develop optimal solutions for state intervention through normative welfare maximisation calculus it is also evident from positive and institutional economics that neither politicians nor users or stakeholders behave according to the normative rules. One example for a normative welfare maximising scheme, which can hardly be successful in practice, is the suggestion

of the Commission published in their White Paper on fair payment for infrastructure use, to introduce an optimal infrastructure pricing scheme, which in itself is completely independent of issues of finance or optimal investment. Finance of the infrastructure would be provided by the State and the choices on optimal infrastructure capacity would be prepared by benefit-cost analyses. This scheme suffers from the deficiency that all responsibility for economic efficiency is allocated to the State. The State should be a most efficient infrastructure and financial manager and control the activities in the transport system through setting optimal prices (according to social marginal costs). But according to the insights of positive economic theory the State is a most inefficient manager, and a part of public finance theory deals with describing the different types of wrong incentives in State management schemes, which lead to the so-called X-inefficiency of the State.

Other examples for creating dynamic efficiency through changing the institutional arrangement are the railway reforms. In Japan, the United States, the United Kingdom, Sweden or Germany different ways of railway reforms have been chosen. One can derive the conclusion from the observation of the developments after the reforms that arrangements with allocations of clear responsibilities to the private sector guarantee for high financial success. This does not hold true for the outcome with respect to other social objectives. With respect to environmental protection or social objectives management schemes, which include a higher influence of the State are more successful. But also in the case of dominating social goals, like for instance for local and regional public transport, it is possible to construct arrangements with strong public governance and clear responsibilities for private actors (e.g. through tendering of public services) such that financial efficiency can come along with improved public service. For the railways of the European Union the institutional discussion leads to the conclusion that one cannot expect a prosperous development of the railways unless the national boundaries of the railway companies have been removed and the management decisions in the companies are free from national political influences. From the point of view of single railway companies the European idea to construct a unified interoperable railway network and to manage the network according to common rules (e.g. according to the provision of air-traffic routes by traffic control agencies) is not in their interest, because they would prefer to control the production of services on all levels of production. So from the standpoint of railway companies a vertically integrated railway system would be preferable, while the European idea would prefer separation of network provision from the operation on the networks to foster intra-modal competition. It can be expected that unless the European Union will be able to establish clear rules for the common provision and use of the railway infrastructure the big railway companies will generate their own realities, which cannot be changed in the next decade. These realities will tend to increase monopoly positions of politically established "grandfathers" and prevent newcomers from competition.

4 SUMMARY AND CONCLUSIONS OF WORK AREA 10

Experiences when setting up the SCENES Internet database have shown that from the transport modellers' point of view there is a need for a reliable, transparent and user-friendly database system with regional socio-economic data. Since many of the transport research projects carried out in Europe depend on data for the same socio-economic indicators, it would be very helpful to have a common and consolidated data platform for socio-economic data at regional level being accessible at least by all parties involved in European projects. The establishment of a common and consolidated data platform would not only harmonise the input data for the models applied (and therefore the output of the models as well), but might also be useful in terms of saving resources. The SCENES Internet Database may serve as a first, but decisive step on the way to a pan European data information system with regional data, whose contents are not only relevant for transport modellers, but also for policy-makers and for the field of regional analyses.

The socio-economic forecasts generated within the SCENES project suggest that there are significant differences across Europe (average annual growth rate of GDP until 2020: Western European countries – 2.5%; CE countries – 4.9%; other CEE countries – 5.1%). The strongest dynamic of economic growth in Europe is expected to emanate from the accession countries and Eastern European countries, which in the long run will result in a higher level of parity of wealth and cohesion in Europe. A similar contrasting development is expected for car ownership growth. In some Western European regions, where a high level of car ownership has already been attained, car ownership is expected to be rather close to a level of saturation with moderate average annual growth rates. In contrast in most regions of CEE countries further intense increase is forecast (average annual growth rates above 5-6 percent).

Detailed investigation of the drivers of transport demand has shown that the demand for transport is not solely influenced by the factors that are usually included in transport modelling, such as preferences for mobility, sectoral development of production, or transport supply characteristics. In order to explain long term changes in transport patterns it is also necessary to study the demand/supply effects, which occur in second round interactions between *land-use changes and transport development*. Although the modelling of land-use-transport interactions is not yet at a satisfactory level, it could be shown by a System Dynamics approach that second round effects indeed occur and have a significant magnitude. Neglecting such effects would lead to failures in transport planning.

Furthermore, it has been shown that in transport markets, in which supply parameters (e.g. costs, level of service) are flexibly adjusted to demand structures, like in the air market and increasingly also in the long-distance rail market, a state of total equilibrium between demand and supply will never be achieved. The application of a demand-supply-interaction scheme has also illustrated that guiding the demand for transport modes into certain directions does not necessarily require a direct influence on the mode under consideration. Since demand and supply for different modes affect each other, there is also the option to give a small (and maybe cheaper) impulse to one or more of the other modes and to end up with the desired results as well.

The results of research on demand-supply interaction underline the requirement for an integrated transport policy, which is characterised by a consistent approach to handling the long-term interrelations between transport policy measures and land use, and which also pursues an integrated approach when designing policy measures in order to guide modal split in the required directions.

Another area of great influence on the long term development of transport patterns is the type of *regulation* of the different transport sectors. In the EU countries, changes in the regulatory systems and changes of organisation in the transport sector have been stimulated, in particular after 1985, in order to improve allocation efficiency and competitiveness. Different concepts for regulating and

organising public passenger transport have emerged across Europe. Several case studies have shown that, in certain countries, regulatory change has gone in parallel with growing demand for public transport. This holds true in particular for the introduction of franchising systems rather than outright deregulation. However, in most cases the regulatory changes within public transport have not led to a substantial increase of patronage, but rather to faster rationalisation and more cost efficiency on the supply side. Without direct initiatives towards the harmonisation of transport markets it is unrealistic to expect substantial shifts from individual motorised transport to public transport.

On the contrary, due to the liberalisation process in the road freight and the airline sector in the European Union, further strong impulses have been given towards those sectors, despite all concerns expressed in Green and White Papers on the environmental consequences of such developments. Looking at the railway sector in some detail one can – after studying the performance of different regulation activities in individual Member States – draw the conclusion that these activities had little effect on changing the trends of traffic development. In the case of long distance transport, the reasons for this are that market conditions have not yet been harmonised, and that strong national barriers still exist which hamper the development of international railway operations.

Regulatory changes in CEE countries have been most effective for the mode road. The types of changes that have occurred related to the road mode can be summarised by demonopolisation (intercity passenger transport by coach operators), decentralisation (urban public transport) and deregulation (freight market). Generally speaking, deregulation in freight transport has been achieved quicker and on a wider basis than regulatory changes in the passenger market. Regarding deregulation of the rail sector in the accession countries the adoption of EU directives (e.g. 91/440/EC and 2001/12/EC) has caused problems similar to those observed in EU countries.

It is very difficult to estimate the implications of regulatory changes on transport demand – particularly in CEE countries where the whole economy and society had been transformed, and where transport demand has been driven by many different determinants. Nevertheless, regulatory changes can be shown to be closely connected to changes on transport markets. The most obvious example is the deregulation of the road freight transport market: this market segment has profited most strongly from the transition process – a development, which is underlined by the enormous increase in market shares of road freight transport.

In particular the development of freight transport is heavily dependent on *trends in the spatial organisation of production*. This leads to particular requirements for logistics with respect to supply chains and inventory holding which in the past have not been integrated within the usual top-down modelling approaches of freight transport. However, an innovative approach to this has been tested within the appended module of the SCENES European model. The following factors have had a substantial influence on the development of demand for freight transport and the evolution of modal split:

- European integration and globalisation, which have significantly increased the demand for international transport.
- Change in the commodity structure, which has substantially increased the share of commodities with a high affinity to carriage on the mode road.
- Change in the operational behaviour of companies (procurement and distribution behaviour, application of advanced production technologies) which requires quick, reliable and flexible carriage of consignments, which are often relatively small and with variable sizes.
- Application of innovative information and communication technologies (ICT), which have been offering new possibilities for optimising freight transport operation (e.g. route scheduling, monitoring of transport). Until now, modern communication technology has been applied in the first instance to air traffic and partly for road freight transport, which has contributed to enhance the competitive advantages of these modes.

Also for passenger transport the economic development, European integration, globalisation and the evolution of international relationships have widely influenced the pattern of business, holiday and leisure traffic. Upcoming new technologies in the communication sector have contributed more to increasing physical travel demand rather than substituting travelling by Internet surfing.

Large external changes, like the transition process taking place in CEE countries, have been able to provoke changes in trends in transport demand patterns, whereas other less striking external disturbances have only resulted in a temporary discontinuation of prevailing trends. Thus the analyses of changes in trends suggest the conclusion that: whenever policy-makers intend either to achieve permanent changes from the current trends in transport demand growth, or to achieve decoupling of certain transport demand indicators from economic development, then major and extensive efforts will certainly be required.

The *institutional framework* within which transport markets are embedded has proved of great relevance to the development of transport. The institutional framework provides the guidelines for how externalities are dealt with and for how incentive mechanisms are set. It also tackles the problems associated with transaction costs. Thus institutional aspects determine not only the allocation of costs to certain modes, but also the way transport is organised and operated. Thus it has decisive impacts on reliability, quality, efficiency and security of transport services and thereby on transport demand patterns and the relative competitiveness of modes. Although it is rather complex to demonstrate their effects on transport demand indicators, institutional aspects are an important driving factor of transport demand.

Research on drivers of transport demand has shown that the ongoing internal and external trends have had decisive influence on demand structures and on the relative competitiveness of modes. This can be recognised most clearly in the freight market when analysing the evolution of competitiveness between the modes road and rail:

- *Differences in the process of deregulation of transport markets/ differences in the institutional framework:* deregulation of the road (freight) markets has been particularly effective, whereas the deregulation of the rail freight market has shown only relatively slight and slow-going progress. Due to border impediments railfreight could not take advantage of the emerging market segment of international freight transport, although rail should have – due to the long-distance character of such carriage – a relatively high competitiveness within this market segment.
- *Demand side developments:* The road mode has been able to benefit from changes in the commodity structure and in the operational behaviour of companies and has been able to strengthen its competitiveness in its core market segments. On the contrary, rail has lost demand volume on its core markets for bulk commodities due to changes in the demand structure and has not been successful in operating long-distance international freight transport services due to administrative and technical impediments at national borders.
- *Differences in adoption of technology:* Road freight operators have taken advantage of innovative information and communication technologies, whereas railfreight operators have applied such technologies at most in a limited manner.

The example above shows that transport demand patterns have been driven by various developments, which are partly internal and partly external to the transport sphere. Both the external developments (e.g. progress of deregulation, changes in demand structures) and the internal developments (e.g. application of innovative information and communication technologies) have acted in favour of the modes road and air but have been stacked against the mode rail. This is problematic since, in the opinion of many policy-makers, rail is the mode that most needs to increase if sustainable transport systems are to be achieved. The studies have shown that only radical changes in circumstances can provoke changes in the prevailing trends in transport demand patterns. Therefore in order to push certain modes, on the one hand comprehensive and integrated policy measures are required, on the other hand a high level of innovation is required on the transport operators' side.

Work Area 11

5 INTRODUCTION TO WA 11

The original four aims of WA 11 were:

1. to extend (to Eastern Europe) and enhance (for example by adding new data from WA 10) the STREAMS strategic transport model of the EU. The model will then be re-calibrated and validated as a SCENES European Forecasting Model. This work would include the development of a more detailed zoning system for road assignment, to address some of the findings of the STREAMS research,
2. on the basis of a technical audit of models, to develop approaches to tackle problems of consistency between models and produce a software design to demonstrate how these techniques could be applied,
3. to develop appended modules to tackle freight demand forecasting in more detail, and
4. to undertake model forecasting runs of the SCENES European Forecasting Model and appended modules, based on specific scenarios defined by WA 12.

As the project progressed, and in particular, in the light of the level of interest with which the predecessor STREAMS model had been received, it was inevitable that the key focus was on firstly Objective 1, then Objective 4. The Appended freight module (Objective 3) was also developed and tested, but was not integrated within the normal model running procedures. This work is reported separately in a SCENES Working Paper of March 2001.

Objective 2 was scaled down in scope due to limitations on availability of documentation, and the resources were largely switched instead into the model development work. The issues of consistency between models have been tackled in two ways. Firstly, a software tool based on residual disutility techniques was developed for use in the calibration process of the regional economic model. This enables the synthetic transport flow matrices within the SCENES model to be constrained to exactly match exogenously supplied matrices. In this manner the values estimated in one model can be forced to be consistent with a set of control values that have been supplied from another model or observed dataset. Secondly, a methodology for comparing model results has been constructed and validated (D4, Annex D).

The starting point of WA 11 was therefore essentially the STREAMS transport model, combined with the knowledge and experience gained from the use of this model in the "Forecasts of EU / TEN-T Transport and Emissions: A Pilot Study" project. The use of the model in this project made clear that there was a need and appetite for a quantitative transport forecasting tool within the European Commission. So in the design of the SCENES model, a decision was made to address those issues raised in the application of the STREAMS model which had proved problematic when using the model in a practical policy context.

This meant that the redesign work entailed in going from one model to the next was perhaps greater than had originally been anticipated. The initial thoughts had been that the expansion of the model would be the most significant part of this work, as opposed to the enhancement, but this did not prove to be the case. The largest single element of work was the incorporation of many parameters at the country level, rather than at an EU level. This included national input-output tables for freight, and national cost functions and values of time for the passenger model.

With the inclusion of the 8 CEE countries in the passenger model, the flexibility of the country specific parameters meant that there were in effect 23 separate models to be calibrated, validated, and linked together for international traffic. The benefit of this approach is of course, a far more representative model, the downside is the very much greater resources of time and data required to set the model up. It was in this way that the model became more of a framework – where more detailed data could easily be incorporated within the structure, as and when it becomes available.

The remainder of this WA 11 Section firstly provides an overview of the SCENES model structure and some of the key model validation results. The specification of the forecast scenarios is then described, before the main results of these forecasts are reported. The main linkages for WA 11 have been between WA 10 and WA 11. The base year and forecast year data developed within WA 10 were used in the model development and forecasting work. The forecast Scenarios used however, were independent of the work carried out in WA 12.

5.1 SCENES Model Structure - Overview

The SCENES transport model comprises separate passenger and freight demand modules, and a compatible passenger and freight transport model. As outlined above, it was itself a development of the model developed during the preceding STREAMS project. The STREAMS model was essentially a test-bed, developed to experiment with the data, methodologies, and, approaches required to model the totality of European transport within one over-arching framework.

The structure of the SCENES model is in essence that of a traditional four-stage model, with distinct Generation – Distribution – Modal Split – Assignment components. However, the costs and times of travel which are output from the transport model feed into the demand model in the form of "disutilities" (derived from zone-pair travel costs and times)– thus the system encompasses a full feedback between the two models. In this way, changes in the transport model, be it through transport cost or infrastructure changes, have a bearing on the demand for travel. Note that this feedback effect does not apply to the number of trips made, or tonnes moved, but to the length of trips, and thus person kilometres and tonne kilometres moved.

The model is designed to produce in the first instance European level transport forecasts. Comprising as it does of a wide range of demographic, economic, socio-economic and transport factors, and being built as a "bottom up" model from the zonal level, a much greater level of spatial detail is however possible, and indeed many country and sector specific results are reported in the project. This level of detail can be achieved because the model comprises all transport and travel, including very short distance trips and slow modes.

The 15 European Union countries and eight Central and Eastern Europe Countries (CEEC) comprise the "internal" modelled area. That is, all travel within this area is modelled. The rest of the world is treated as 'external', i.e., passenger travel and freight traffic to and from these external zones is modelled. The internal modelled area is represented by 244 zones based mainly on the NUTS2 definitions, and the external area is represented by 17 "European" zones with 4 zones representing the rest of the World. The exception is that freight traffic within the CEEC area is not modelled – only freight traffic between the CEEC and the EU, i.e., only the EU15 countries are treated as internal for the freight model.

The *passenger demand* model combines highly segmented, zonal level socio-economic and behavioural data to produce a matrix of travel. There are 20 population groups specified in each zone and 10 trip purpose categories. The *freight demand* model is based on a spatial adaptation of a financial input-output structure, in order to represent linkages between industries. These inter-linkages are estimated from zonal final demand. Some 24 economic sectors are used in producing a matrix based on value, which is converted to volumes in an interface module. This freight volume matrix can be combined with the passenger travel matrix and assigned to the modal networks in the common transport module.

The *transport model* contains a representation of the costs and times of travel by all the different modes (at the country level) between all of the model zones, for passenger and freight traffic. This is achieved using comprehensive and detailed multi-modal transport networks for road, rail, air, shipping, inland waterway and pipeline. An innovative treatment of intra-zonal travel for both passengers and freight allows the characteristics of even the shortest trips to be represented.

Many of the detailed information regarding the model structure and its underlying data can be found in SCENES Deliverable 4 – "SCENES European Transport Forecasting Model and Appended Module: Technical Description."

The purpose of the WA 11 work was to demonstrate the validity of the model structure, both in terms of the 1995 Base Year results, the 2020 reference case results, and the 2020 transport policy scenarios. These policy scenarios are designed to illustrate the nature of the forecasting process that can be undertaken with the model, rather than form a definitive set of European transport forecasts – in this way they do not constitute any 'official' view of the future. In order to achieve the latter, forecasting assumptions and model outputs would have to be developed and analysed in much more detail, in the context of, and in consultation with, existing national level assumptions and forecasts.

6 PASSENGER MODEL STRUCTURE AND CALIBRATION

6.1 Passenger Model Structure

The main features of the passenger model structure are described here. Table 6.1 shows the disaggregated structure of the passenger model. *Trip Generation* is built up from the zonal level using population groups based on age, employment and personal car availability, and trip rates by purpose. Detailed data were extracted from the UK National Travel Survey (NTS) and, after analysis of other European NTS, it was clear that there were not significant differences in behaviour between European countries. These trip rates were used directly – but for some countries all rates were factored up or down during the calibration. Separate country specific trip rates for both domestic and international holidays were developed.

Columns 1 and 2, of Table 6.1 show the 20 population groups and 10 travel purposes for which trip rate data were originally obtained, i.e., trip rates for each purpose by each population group (trips per person per year). The population groups combine age, with employment (full time / part time / not in employment) and car availability. Personal car availability is based on the number of adults and the number of cars in the household.

The 10 original travel purposes were split into 20 separate trip rates for trips less than 40km and trips greater than 40km for each purpose. Purposes with similar characteristics were then grouped together to form 10 new purposes, split into 3 "short" distance and 7 "long" distance purposes – these purposes are shown in Column 3 of Table 6.1. It is this group of 10 purposes for which a trip rate is calculated and entered into the model for each of the 20 population groups.

The zonal population data which are used in conjunction with the trip rates are obtained from Eurostat in the main, although some adjustments and estimates were required to obtain consistency. The five population groups are estimated outside the model, and entered separately for each zone. Car stock per zone was also obtained from Eurostat – again this data suffered from inconsistency. The model internally divides each of the 5 population groups at the zonal level into estimates of the 4 car availability / household composition categories, as this data is clearly not available at the European NUTS2 level.

For *Trip Distribution*, the 200 possible population group / trip purpose combinations are aggregated into '24 Travel Groups', shown in Column 4 of Table 6.1. In the Table, the group names are shown, together with the constituent travel purposes (a-j) / population groups (1-20) which comprise this each travel group.

Trip distribution, for each of the 24 Travel Groups in the "demand" model is then built up using published data for the spread of trips / person / year over different distances. In the model, calibration parameters are used to set up this spread of trips, and constraints are used over the short distances to control the very large number of trips which occur over the shortest distances, and are intra-zonal in the model. "Attractors" such as Gross Value Added (GVA), population and tourism arrivals are also used in determining the inter-zonal pattern of trips, together with transport disutilities and the calibration parameters. The distribution model is based on a logit model formulation.

This marks the output of the "demand model" - a matrix of trips / annum, expressed in terms of these Travel Groups. This matrix is then transformed in an interface program into a matrix of trips / day, expressed in terms of Transport Flows. This new matrix is used in the Transport Model where mode split and assignment are undertaken. The Transport Flows are an aggregation of the Travel Groups, and are shown in Column 5 of Table 6.1.

Table 6.1 Scenes passenger model structure

Column 1	Column 2	Column 3	Column 4	Column 5
Original Population groups	Original NTS purposes	Trip Generation Stage - Purposes	Trip Distribution Stage – Travel Groups [purpose / population group]	Mode Split Stage – Flows
1. Under 16 yrs / 1+ adults / no car		SHORT<40km	SHORT<40km	SHORT<40km
2. Under 16 yrs / 1 adult / 1+ cars	Commuting	a. Commuting / business	c&b – all / 0 car [a / 1, 5, 9, 13]	1
3. Under 16 yrs / 2+ adults / 1 car	Business	b. Shopping / personal business / education / other escort	c&b - FT emp / part car [a / 7]	2
4. Under 16 yrs / 2+ adults / 2+ cars	Education	c. Visiting friends and relatives / day trip / sport & entertainment	c&b - FT emp / full car [a / 6, 8]	3
5. 16-64 employed / 1+ adults / no car	Shopping	LONG >40km	C&b - not FT emp / part car [a / 3, 11, 15, 19]	2
6. 16-64 employed / 1+ adults / 1+ cars	Personal business	d. Visiting friends and relatives / sport & entertainment	c&b - not FT emp / full car [a / 2, 4 10, 12, 14, 16, 18, 20]	3
7. 16-64 employed / 2+ adults / 1 car	Sport & entertainment	e. Day trip / shopping / personal business / education / other escort	Shop&pb&ed - <15 / all [b / 1, 2, 3, 4]	4
8. 16-64 employed / 2+ adults / 2+ cars	Visiting friends and relatives	f. International holiday	Shop&pb&ed – adult / 0 car [b / 5, 9, 13, 17]	5
9. 16-64 EMP-PT / 1+ adults / no car	Day trip	g. Domestic holiday	Shop&pb&ed – adult / part car [b / 7, 11, 15, 19]	6
10. 16-64 EMP-PT / 1 adult / 1+ cars	Other / escort	h. Commuting / business, 40-160km	Shop&pb&ed – adult / full car [b / 6, 8, 10, 12, 14, 16, 18, 20]	7
11. 16-64 EMP-PT / 2+ adults / 1 car	Holiday	i. Commuting / business, >160km	Visits&other – all / 0 car [c / 1, 5, 9, 13, 17]	5
12. 16-64 EMP-PT / 2+ adults / 2+ cars		j. International business (1+ night)	Visits&other – all / part & full car [c, 2-4, 6-8, 10-12, 14-16, 17-20]	6
13. 16-64 not in employment / 1+ adults / no car			LONG >40km	LONG >40km
14. 16-64 not in employment / 1 adult / 1+ cars			vfr – all / 0 car [d, / 1, 5, 9, 13, 17]	8
15. 16-64 not in employment / 2+ adults / 1 car			vfr – all / part & full car [d / 2-4, 6-8, 10-12, 14-16, 17-20]	9
16. 16-64 not in employment / 2+ adults / 2+ cars			Day trip & other – all / 0 car [e, / 1, 5, 9, 13, 17]	8
17. 65 & over / 1+ adults / no car			Day trip & other – all / part & full car [e / 2-4, 6-8, 10-12, 14-16, 17-20]	9
18. 65 & over / 1 adult / 1+ cars			Dom hol – all / 0 car [g / 1, 5, 9, 13, 17]	14
19. 65 & over / 2+ adults / 1 car			Dom hol – all / part car [g / 3, 7, 11, 15, 19]	15
20. 65 & over / 2+ adults / 2+ cars			Dom hol – all / full car [g / 2, 4, 6, 8, 10, 12, 14, 16, 18, 20]	15
			Int hol – all / 0 car [f / 1, 5, 9, 13, 17]	12
			Int hol – all / part car [f / 3, 7, 11, 15, 19]	13
			Int hol – all / full car [f / 2, 4, 6, 8, 10, 12, 14, 16, 18, 20]	13
			c&b mid distance – all [h, 1-20]	10
			c&b long – all [i, 1-20]	10
			c&b int – all [j, 1-20]	11

In order to undertake the *mode split* and *assignment*, there needs to be a full representation of the modal transport costs and times faced by all the travellers in the modelled system. Transport cost functions are specified in the model for each mode of travel: car, business car, local bus, long distance coach, train (1st and 2nd class), high speed train, and, air (business and leisure).

These cost functions are specified for each of the 23 internal countries in the model. The functions are based as much as possible on ‘baskets’ of fares, fuel prices, and car operating costs for each of the countries. In addition, values of time (based on average incomes by country) by purpose (Transport Flow) are also specified for each of the 23 countries – these costs and values of time feed back into the distribution model from the transport model.

In addition to the cost functions used for inter-zonal travel, the intra-zonal network is further differentiated by:

- 6 zone types - representing settlement patterns, and typical transport conditions therein
- number of intra-zonal dummy zones connected (representing zone size)
- intra-zonal link speeds which vary with distance, mode, and zone type – in vehicle and whole journey times are explicitly represented,
- modal availability, determined by zone type.

The above, combined with model calibration parameters provide input for the modal split calculations, based on a multi-level logit formulation. Disutility functions are used in the form of generalised time.

Finally, a further aggregation of Transport Flows to only 4 groups is used for *Assignment*. The assignment is a stochastic assignment, and there are 24 hour capacity-restraint functions in place on the road networks.

6.2 Passenger Model Validation

The main thrust of setting the model up (calibration) has been to essentially reconcile two things:

1. the general travel and trip making characteristics of different population groups for different trip purposes (which we know from National Travel Surveys) and,
2. the aggregate transport indicators of person kilometres travelled by mode at the European Union nation state level, and at the overall European level.

Much of the detailed data relating to travel behaviour comes in the first instance from UK National Travel Survey data. This is used to establish the broad behavioural characteristics of the model. During the calibration, it is of course necessary to make adjustments to reflect the circumstances in each country – using the UK data as a context.

In terms of Validation, each country’s results are then compared with known aggregate transport indicators (e.g., person-km by mode). Adjustments are made to costs / trip rates / disutility function parameters (by transport flow, country and mode) to bring the aggregate transport results by country and mode into line with the "observed" totals. SCENES Deliverable 7 reports the Calibration and Validation process in detail.

Various sources were used to establish the "observed" base year aggregates by country and mode. These are Eurostat’s ‘Transport in Figures’ (various editions), ECMT (various publications) and publications from the Auto-Oil programme. These sources can publish conflicting figures for the same mode / country / year. Therefore a view was taken as to which figure seemed most appropriate

based on factors such as model output, other countries' figures, and the implications of the observed data for the average trip length and / or trip rate by country etc.

A further issue relating to the "observed" data set is the extent to which it comprises wholly domestic travel, or includes international travel - this issue is treated inconsistently between countries. The approach taken was to calibrate the modelled domestic person-km to be between 90% and 100% of the published "observed" figure. This allows some international travel to make up the difference. Given the margin for error associated with the "observed" data, it was felt that this degree of accuracy was sufficient. Table 6.2 below shows the resulting aggregate domestic travel by country and mode (domestic here meaning wholly within individual countries).

Table 6.2 Modelled Passenger Travel – 1995 EU Domestic (billion pkm / year)

	Car	Coach	Train	Slow	Air	Total
Austria	65.8	12.4	8.9	3.1	0.02	90.1
Belgium	85.0	12.5	5.8	4.2	0.00	107.5
Denmark	52.5	10.9	4.6	4.9	0.00	72.8
Finland	49.4	8.1	3.2	2.2	1.49	64.3
France	642.8	47.5	58.7	34.3	8.20	791.5
Germany	900.8	80.9	64.3	46.7	6.34	1,099.1
Greece	52.6	9.7	1.4	3.5	1.32	68.6
Ireland	27.5	5.3	1.2	2.0	0.00	36.0
Italy	591.0	91.5	52.4	37.9	5.16	778.1
Luxembourg	4.2	0.4	0.0	0.2	0.00	4.8
Netherlands	142.6	16.3	13.8	14.3	0.00	187.0
Portugal	64.9	12.8	4.8	3.8	0.08	86.3
Spain	300.3	42.0	16.3	11.8	4.91	375.4
Sweden	83.0	9.5	6.1	6.3	1.97	106.8
UK	606.3	46.0	31.3	34.6	4.80	723.0
TOTAL EU15	3,668.9	405.8	272.8	209.7	34.3	4,591.4

Of this 4,591 billion passenger km, some 3,034 billion are treated as intra-zonal in the SCENES model, that is two thirds of EU domestic person km. In terms of countries, this figure ranges from 100% (Luxembourg, 1 zone) down to 52% for the UK, where the zones are relatively large.

Table 6.3 shows the Table 6.2 modelled volumes for Car, Coach and Train as a proportion of the final "Observed" figures for each country. In virtually all cases, these proportions lie between 0.9 and 1.0. This was one of the main model validation indicators.

Table 6.3 1995 EU Domestic Modelled / 'Observed' passenger km values

	Car	Coach	Train		Car	Coach	Train
Austria	0.94	0.95	0.90	Italy	0.96	0.99	1.00
Belgium	0.92	0.94	0.86	Luxembourg	0.90	0.98	-
Denmark	0.95	1.03	0.91	Netherlands	0.95	1.03	0.99
Finland	0.97	0.96	0.99	Portugal	0.98	0.94	0.99
France	0.95	0.95	1.00	Spain	0.92	0.96	1.02
Germany	0.94	0.94	0.93	Sweden	0.94	0.93	0.98
Greece	0.92	0.96	0.91	UK	0.99	0.90	1.04
Ireland	0.94	1.01	0.94				

Table 6.4 below shows the aggregate domestic travel volumes by mode for the CEEC8 countries. Table 6.5 then gives a comparison between these values and the published data for these countries. There are no published estimates for Car travel in any of the Baltic States, or Slovenia.

Table 6.4 Modelled Passenger Travel – 1995 CEEC8 Domestic (billion pkm / year)

	Car	Coach	Train	Slow	Air	Total
Czech	50.8	17.4	8.1	4.4	0.00	80.7
Estonia	4.2	2.1	0.5	0.7	0.00	7.5
Hungary	42.4	15.7	7.8	4.3	0.00	70.2
Lithuania	11.9	3.4	1.1	1.9	0.00	18.3
Latvia	6.5	1.9	1.3	1.1	0.00	10.9
Poland	179.4	39.8	24.1	17.2	0.00	260.6
Slovenia	7.6	2.2	0.5	0.9	0.00	11.2
Slovakia	14.9	10.2	3.3	2.6	0.02	31.1
TOTAL CEEC8	317.9	92.8	46.8	32.9	0.02	490.5

Table 6.5 1995 CEEC Domestic Modelled / ‘Observed’ passenger km values

	Car	Coach	Train
Czech	0.93	0.88	1.01
Estonia	NA	0.85	1.08
Hungary	0.96	0.96	0.94
Lithuania	NA	1.02	0.94
Latvia	NA	1.04	0.98
Poland	0.92	0.91	0.91
Slovenia	NA	0.87	0.90
Slovakia	1.00	0.91	0.79

Again the 1995 modelled values are generally in line with the published data for the CEEC8. The match is not quite as good as in the EU countries, but the quality of the observed data for the CEEC8 is likely to be poor in comparison to some of the EU countries. Nevertheless, the model does represent the base year passenger travel situation in the CEEC8 to a good level, considering the limited data available.

Finally in this section, **Figure 6.1** illustrates the modelled kilometres travelled per person per year, by mode and country. These figures include international travel within the EU and CEEC8.

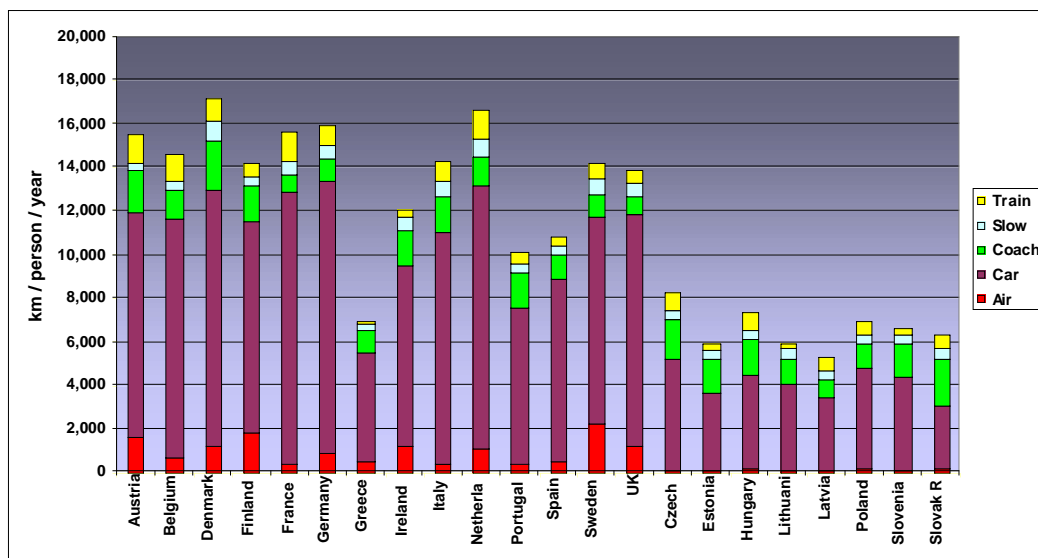


Figure 6.1 EU15 & CEEC8, km / person / year, by mode, 1995

7 FREIGHT MODEL STRUCTURE AND CALIBRATION

7.1 Freight Model Structure

The freight model comprises three main parts: a Regional Economic Model (REM) which establishes the trade matrix; an Interface module which translates this monetary trade into transport volumes; and a Transport model, which assigns these flows to transport networks and undertakes the modal split.

The REM is a spatial Input-Output (IO) model. It is driven by zonal final demand for a given year, and estimates the demand for industry outputs by sector. It calculates the demand for each industry in each zone, using the national average IO coefficients applicable to that zone. This demand is then met by suppliers from the home zone (intra-zonal) as well as other zones, based on generalised cost of transport, factory gate production cost at the supply zone, and a residual attractiveness of the supply zone estimated for the base year. The REM outputs matrices of trade flows between zones, for the freight transport model to assign to the networks.

EUROSTAT 1995 IO tables are used as the basis for each EU15 country. The data required some modification to generate the input for the SCENES model. This included modification of the IO tables to the 24 branches of industries used in SCENES, and the allocation of national totals to individual zones based on the GVA and other socio-economic data per zone.

The original IO tables required a significant amount of modification to achieve the SCENES categorisation – many of the sectors had to be disaggregated, and others combined. For Denmark, Germany, Spain, France and Italy, the 1985 59-sector national tables were used directly to modify the IO tables. For Belgium, the Netherlands, Luxembourg, Austria, Sweden, Finland, Greece and Portugal, the same basic procedure was used though with the 59-sector table from one of the five preceding countries being used. Finally, for the UK and Ireland, the expansion was based on the 1990 UK 123 sector IOT.

To achieve the required disaggregation from the country level to the zonal level, two sources of information were used. These were, firstly, intra-EU freight matrices derived from the trade data, and, secondly, a set of GVA and socio-economic data by zone. This gives a full disaggregation of estimated country-level production data to the level of SCENES zones for the base year 1995.

The main inputs to the REM are:

- inter-industry technical coefficients by country and industry
- total domestic production by zone by industry
- public consumption, investment and change in stocks by zone by industry
- private consumption per capita by country and industry
- imports from third countries, by third country and industry
- exports from third countries, by third country and industry

The links between the REM and the Freight transport model are two way:

- The REM produces the matrices of trade, which are converted (using a series of detailed value-to-volume ratios) by an interface program to tonnes of freight to input to the transport model
- The transport model produces monetary and generalised transport costs (the latter including a valuation of time and other non-monetary costs of transport) for the REM. The REM may then use the monetary costs for cost accounting, and generalised costs for modelling the spatial distribution of trades.

Table 7.1 shows how the trades generated in the REM are related to the transport flows. The SCENES freight transport model takes the trade matrices after they have been through the Interface module, and performs modal split and network assignment.

For the SCENES freight model, thirteen flows are defined, as shown below. This is a balance between the desire for, computer power, and limitations caused by the availability of data.

Table 7.1 Correspondence between Industries and Freight Flows

	Regional Economic Model 'Factors'		Transport Model 'flows'
1	Agriculture, forestry and fishery products	1	Agricultural products
2	Coal, coke and lignite	4	Solid fuels and ores
3	Extraction of crude petroleum and gas	-	-
4	Manufactured fuel	5	Petroleum products
5	Other fuels	-	-
6	Ferrous and non-ferrous ores	4	Solid fuels and ores
7	Metals	6	Metal products
8	Cement and building materials	7	Manufactured building materials
9	Glass and ceramic materials	13	Miscellaneous articles
10	Other non-metallic mineral products	8	Crude building materials
11	Basic chemicals	9	Basic chemicals
12	Fertilisers and chemical products	10	Fertilisers, plastics and other chemicals
13	Metal products except machinery	13	Miscellaneous articles
14	Agricultural and industrial machinery	11	Large machinery
15	Electrical products	12	Small machinery
16	Transport equipment	11	Large machinery
17	Food, beverages and tobacco – consumer	2	Consumer food
18	Food, beverages and tobacco – conditioned	3	Conditioned food
19	Textiles, clothing, leather and footwear	13	Miscellaneous articles
20	Paper pulp	10	Fertilisers, plastics and other chemicals
21	Printing products	13	Miscellaneous articles
22	Other manufactured products	13	Miscellaneous articles
23	Other chemical products	10	Fertilisers, plastics and other chemicals

Table 7.2 shows the SCENES Transport Flows in relation to some standard freight classifications.

Table 7.2 SCENES Transport flows & standard freight classifications

Transport Model Flow	NST/R group	Group of Goods	Handling category
1- Cereals and agricult. Products	00 01 04 05 06 09 17 18	1 3 4 5 part of 6 7	General cargo
2 – Consumer food	02 11 12 13 16	Part of 2 Part of 6	Unitised
3 – Conditioned food	03 14	Part of 2 Part of 6	Unitised
4 – Solid fuels and ores	21 22 23 41 45 46	8 11 12	Solid Bulk
5 – Petroleum products	32 33 34	10	Liquid Bulk
6 – Metal products	51 52 53 54 55 56	13	General Cargo
7 – Cement and manuf. Build mat.	64 69	14	Unitised
8 – Crude building materials	61 62 63 65	15	Solid Bulk
9 – Basic chemicals	81 83	17 part of 18	Solid Bulk
10 – Fertil., plastic and oth. Chem.	71 72 82 84 89	16 part of 18 19	General Cargo
11 – Large Machinery	91 92 939	part of 20	General Cargo
12 – Small Machinery	931	part of 20	Unitised
13 – Miscell. Manufact. Articles	94 95 96 97 99	21 22 23 24	Unitised

Ten main modes are implemented in the model:

Heavy Goods Vehicle (HGV), Light Goods Vehicle (LGV), bulk rail, bulk ship, bulk waterway, product pipelines, air freight, container rail, container ship, container waterway, and shuttle rail.

In addition, there are nine intra-zonal modes (representing trips of different length and by different modes). Each mode is available to a set of flows, according to its specific features with respect to the nature of the flows, which are grouped into four handling categories with similar requirements:

Solid bulk (B); Liquid bulk (L); General Cargo (G); and Unitised freight (U).

Modal split is performed using a multinomial nested logit model.

Some of the other important parameters used in the SCENES freight model are the specification of load factors for trucks only, cost functions for all modes in the model, and values of time specified for each transport flow. The calibration of the SCENES freight model included essentially three steps:

- calibration of paths;
- general calibration of modal shares;
- calibration of modal shares by country and by flow.

7.2 Freight Model Validation

The end point of the calibration and validation is a freight model which reproduces the observed Base Year freight patterns in the following key ways:

- domestic tonnes by transport flow, country and mode
- country pair tonnages by transport flow, intra-EU and EU – external / external – EU, by mode
- domestic tonne-km by transport flow, country and mode
- tonne-km by mode of freight moved on national territories (i.e., domestic plus international within the borders of individual countries)
- modal share by distance
- mode choice elasticity with respect to costs by mode

These results are all reported in detail in SCENES Deliverable 7 – some aggregated example tables are shown below for illustrative purposes. Table 7.3 shows the derived observed and modelled total tonnes by country (national plus international received) for 1995. It also shows these tonnes figures aggregated for all 15 countries by main mode of delivery.

Table 7.3 Total national+international freight traffic by country, 1995 ('000 tonnes/year)

	Observed Volumes	Modelled Volumes		Observed Volumes	% Share	Modelled Volumes	% share
AUT	279,041	278,031	Road	10,430,807	83%	10,663,561	85%
B-LUX	568,851	568,149	Rail	709,224	6%	703,760	6%
DEN	226,338	226,176	IWW	328,423	3%	324,603	3%
FIN	406,505	407,545	Sea	973,511	8%	763,603	6%
FRA	1,624,739	1,625,379	Other	73,686	1%	70,933	1%
GER	3,748,880	3,746,358	Total	12,515,651	100%	12,526,449	100%
GRE	210,249	202,073					
IRE	81,968	81,218					
ITA	1 458 773	1,454,001					
NED	638 684	628,933					
POR	301 609	300,736					
SPA	720 423	707,442					
SWE	386 278	443,629					
UK	1 863 312	1,856,781					

Table 7.4 overleaf shows the derived observed and modelled domestic, or national tonnes for each EU country. It also shows these tonnes by main mode, aggregated across the 15 EU countries.

Table 7.4 Domestic freight traffic by country ('000 Tonnes / year)

	Observed Volumes	Modelled Volumes		Observed Volumes	% share	Modelled Volumes	% share
AUT	235,935	235,537	Road	9,666,749	91%	9,797,006	92%
B-LUX	377,560	376,886	Rail	540,258	5%	532,047	5%
DEN	176,912	176,670	IWW	175,582	2%	181,712	2%
FIN	361,521	360,892	Sea	233,976	2%	105,046	1%
FRA	1,366,280	1,364,950	Other	-	0%	40,050	0%
GER	3,325,792	3,322,116	Total	10,616,564	100%	10,655,851	100%
GRE	177,688	176,748					
IRE	65,667	65,601					
ITA	1,230,021	1,228,988					
NED	429,562	426,741					
POR	267,669	267,523					
SPA	580,476	579,663					
SWE	326,103	381,288					
UK	1,695,379	1,692,249					

The final validation measure presented here is, in many ways the most difficult one to hit. The measure is tonne-km by mode on the territory of individual countries. This includes national, international and transit traffic. The observed data in this case may also differ in the methodology used to derive the figures, so there is likely to be inconsistency between countries. Nevertheless this measure is a key indicator of the volume and distribution of freight modelled in the base year. Table 7.5 shows the results.

Table 7.5 Observed/Modelled freight on national territories by mode 1995 (tkm*10⁶/annum)

		Observed data		Modelled data				Observed data		Modelled data	
		Volumes	% share	Volumes	% share			Volumes	% share	Volumes	% share
AUT	Road	14 900	50%	26 891	62%	ITA	Road	194 800	90%	189 470	86%
	Rail	13 200	44%	14 417	33%		Rail	21 700	10%	32 067	14%
	IWW	2 000	7%	2 075	5%		IWW	-	0%	13	0%
	Total	30 100	100%	43 383	100%		Total	216 500	100%	221 550	100%
B-LUX	Road	38 500	73%	56 481	74%	NED	Road	42 200	52%	48 625	58%
	Rail	8 200	16%	13 000	17%		Rail	3 100	4%	4 070	5%
	IWW	6 100	12%	7 154	9%		IWW	35 500	44%	31 110	37%
	Total	52 800	100%	76 635	100%		Total	80 800	100%	83 805	100%
DEN	Road	14 700	88%	9 383	89%	POR	Road	13 000	58%	14 361	80%
	Rail	2 000	12%	1 183	11%		Rail	9 600	42%	3 496	20%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Total	16 700	100%	10 566	100%		Total	22 600	100%	17 858	100%
FIN	Road	23 200	71%	23 012	63%	SPA	Road	94 600	90%	115 864	88%
	Rail	9 600	29%	13 725	37%		Rail	10 400	10%	16 150	12%
	IWW	-	0%	-	0%		IWW	-	0%	-	0%
	Total	32 800	100%	36 737	100%		Total	105 000	100%	132 014	100%
FRA	Road	232 800	81%	227 683	78%	SWE	Road	29 300	60%	41 524	70%
	Rail	48 100	17%	53 754	18%		Rail	19 400	40%	17 966	30%
	IWW	5 900	2%	10 494	4%		IWW	-	0%	-	0%
	Total	286 800	100%	291 931	100%		Total	48 700	100%	59 491	100%
GER	Road	279 700	68%	295 814	66%	UK	Road	146 700	92%	175 355	87%
	Rail	68 800	17%	83 955	19%		Rail	13 300	8%	25 782	13%
	IWW	64 000	16%	66 379	15%		IWW	-	0%	-	0%
	Total	412 500	100%	446 148	100%		Total	160 000	100%	201 137	100%
GRE	Road	14 800	98%	17 138	90%	TOT	Road	1 144 600	77%	1 248 099	76%
	Rail	300	2%	1 976	10%		Rail	228 300	15%	283 532	17%
	IWW	-	0%	-	0%		IWW	113 500	8%	117 225	7%
	Total	15 100	100%	19 114	100%		Total	1 486 400	100%	1 648 856	100%
IRE	Road	5 400	90%	6 498	77%						
	Rail	600	10%	1 989	23%						
	IWW	-	0%	-	0%						
	Total	6 000	100%	8 487	100%						

The data by country compare well in general, especially for larger countries like Germany, France, and Italy. The model produces larger figures for Austria, Belgium, Greece, Ireland, Spain and UK. For Austria the difference is entirely due to road and could be explained by transit traffic which is subjected to restrictions which cannot be currently represented in the model. For other countries sea-borne traffic could explain the overestimation of the model, either in terms of excess of tonnes passing through ports (e.g., in Belgium) or in terms of higher distances required in the model to reach the limited number of ports represented in the network.

Overall, the model performs well, when viewed against this most demanding of measures.

7.3 Road Network Flows

The SCENES model uses a detailed representation of the transport network for all modes in the EU and the CEEC8. These networks are specified to contain all of the most significant links in terms of medium and long distance travel between the NUTS2 zones. The links are given their real attributes by length, type and speed etc. They are therefore "real" and not "corridor" representations. The road networks features speed / flow relationships based on 24-hour flow profiles for different types of road – these were firstly developed in the STREAMS project.

The presence in the model of these detailed transport networks inevitably raises expectations of an accurate portrayal of road traffic in particular at the link level. However, it should be noted that the primary purpose of having detailed networks is to build up an accurate representation of the costs and times associated with travelling within and between zones in the model. This allows modal split calculations to be made on as "real world" a basis as possible.

Given that there are no observed NUTS2 travel matrices to build the model on, the distribution of travel is based on theoretical expectations and knowledge of the general distribution of trips by distance, rather than hard data (i.e., synthetic). With this in mind, it should not be expected that a model of this nature can produce an exact match to traffic flows on the European transport networks. However, significant efforts were made to reduce the problems of gross road network overloading that were seen to occur in places during applications of the predecessor STREAMS model.

With this in mind a large number of new road links were added to the networks in the evolution of the model from STREAMS into SCENES. To illustrate the progress which has been made, the STREAMS 1994 Base Year summary network results are reproduced below, as reported in STREAMS D8/D10, together with an equivalent table for the SCENES 1995 Base Year.

Table 7.6 STREAMS 1994 / SCENES 1995 EU road network km by flow / capacity ratio

Test / Road Type	Flow / Capacity Ratio					Length (km)
	<.25	.25 - .50	.50 - .75	.75 - 1.00	1+	
STREAMS 1994 Base						
Toll Motorway	42.2	37.4	15.5	3.7	1.2	29,590
Motorway	12.7	24.4	32.2	19.9	10.8	47,342
Dual Carriageway	56.3	29.6	9.2	2.8	2.0	30,125
Other Road	57.1	21.7	10.8	5.0	5.4	78,951
Total	52.0	26.7	12.3	4.9	4.1	186,009
SCENES 1995 Base						
Toll Motorway	86.7	11.7	1.5	0.1	0.0	29,432
Motorway	50.9	32.9	11.8	3.4	1.0	50,119
Dual Carriageway	81.6	13.1	3.4	1.4	0.6	36,541
Other Road	61.7	19.5	10.0	4.8	3.9	154,786
Total	65.1	20.3	8.5	3.6	2.5	270,876

The straight flow / capacity ratios output by the model (based on 24-hour single direction flows and capacities) were adjusted to a more meaningful indicator as follows. The capacity coded on to the

road networks represents a 24-hour capacity. This was necessary since the capacity restraint functions were formulated from 24-hour capacity figures, where the functions were adjusted in line with the hourly profile of traffic throughout the day. Analysis of traffic data indicated that approximately 90% of traffic flow occurs within the period 0600 – 2200 hours. The 24-hour link flow and capacity data were therefore adjusted accordingly and new flow / capacity ratios determined. It is these "adjusted" figures which appear in Table 7.6 above.

The extent of the additional network can be seen in the Table. As the previous STREAMS networks contained virtually all of the EU toll motorway, motorway and dual carriageways, it is the "other" links which have increased significantly. The objective of the exercise was to add this secondary network, across zone boundaries in particular, to provide the alternative routes to the motorway and dual carriageway routes, since clearly this secondary network plays a significant role in reality.

The effect of adding this network has been to significantly reduce the kilometres of toll motorway, motorway and dual carriageway road network in the model where the adjusted flow / capacity ratio was in the higher groups, e.g., greater than 0.5.

In further reporting of network flows, this method of presentation is abandoned and replaced by a measure of the percentage of network kilometres by road type and country that have different levels of transport flow, in terms of "passenger car units"⁸ (pcus) per day. These figures now refer to the 2-way combined all-day flow on the links. Table 7.7 below shows the SCENES 1995 model results using this new measure, for the EU as a whole, by road type.

Table 7.7 Percent of EU road network km by road traffic flow (2-way) and road type

% km	'000 pcu / day							Network km
	<10	10-20	20-30	30-50	50-70	70-100	100+	
Toll-M-way	21.8	29.4	18.1	19.3	6.7	2.3	2.4	14,716
M-way	9.7	10.8	12.6	22.3	15.0	16.6	13.0	25,201
Dual carr.	30.6	27.4	17.0	13.9	5.3	2.9	2.9	18,270
Other	52.2	22.8	11.1	11.1	2.0	0.6	0.3	77,393
TOTAL	38.1	21.9	12.9	14.5	5.4	4.1	3.2	135,580
TOTAL UN / CEC	35.6	26.4	12.1	12.6	7.4	3.9	2.0	73,812

Table 7.7 therefore says, e.g., 52.2% of EU "other" road-km experiences traffic flows of less than 10,000 pcu per day (AADT – Annual Average Daily Traffic, i.e., Annual traffic / 365). At the other end of the scale, 13.0% of motorway kilometres have traffic loads of greater than 100,000 pcu / day.

It is possible to make a broad comparison between these results and real data, using the UN / CEC road traffic census. The traffic counts included in this traffic census are incorporated into the SCENES model files, the flows representing traffic at zone boundaries as far as possible. Processing this observed data in the same way as the modelled above, gives the results shown in the bottom row of the above table. As can be seen from this total network kilometres, the coverage of the UN / CEC is slightly over half that of the modelled network. The proportions of modelled and observed road-km in each of the flow categories do however match well. In the aggregate, the model therefore does clearly produce a volume and pattern of traffic which is not markedly out of step with the observed situation.

⁸ Passenger car units measure cars as "1" and trucks as "2.5" etc.

8 FORECAST SCENARIOS FOR 2020

The SCENES Scenarios for 2020 comprise two main elements – an External Scenario and a range of Transport Policy Scenarios. The External Scenario is common to both the passenger and freight model, and comprises assumptions regarding the following:

- Population by group (young / old / employed pt / employed ft / not in employment), by zone, derived from country total projections
- Car ownership rates by country / zone
- Income growth by country – inferred from GDP
- Improvements to the transport infrastructure networks
- Trends in vehicle occupancy
- Trends in international trip rates, and other trip rates

These assumptions are based on forecasts made within and outside the SCENES project. Once established, these are treated as fixed – it follows that there is only one external scenario. The Transport Policy Scenarios are based on differing assumptions regarding the future evolution of transport costs, and how these changes in costs might differ between modes. By definition, these Transport Scenarios must be developed separately for the passenger and freight models. The main inputs to the External Scenario and Transport Scenarios are now presented in this section.

The zonal estimates of the five population groups are based on NUTS2 forecasts of population and employment, which were produced as part of SCENES and reported in Deliverable D3. The final national total produced for each country is then compared to the Eurostat Baseline 2020 forecast – an overall adjustment is made to all the population groups in the relevant country to bring the SCENES forecast into line with Eurostat national totals.

Table 8.1 shows the forecast 2020 population levels at the country level, together with the levels of forecast employment used as input to determining the population groups.

Table 8.1 SCENES 2020 External Scenario – Population and Employment

	Population ¹	Employment ²		Population ²	Employment ²
Austria	8,443	3,991	Czech Rep.	9,743	4,611
Belgium	10,658	4,296	Estonia	1,170	589
Germany	84,670	37,856	Hungary	9,167	4,003
Denmark	5,526	3,118	Lithuania	3,465	1,673
Spain	38,668	12,640	Latvia	1,999	985
Finland	5,350	2,066	Poland	39,318	17,250
France	62,831	25,353	Slovenia	1,871	867
Greece	11,269	3,748	Slovak Rep.	5,446	2,496
Ireland	3,909	1,461			
Italy	56,543	21,313			
Luxembourg	501	264			
Netherlands	17,204	7,459			
Portugal	9,959	4,132			
Sweden	9,470	4,327			
UK	61,038	25,921			
EU Total	386,039	157,945	CEEC Total	74,199	32,474

¹ Source – Eurostat "Baseline" 2020 Forecast

² Source – SCENES Project Deliverable 3a and 3b, "Drivers of Transport Demand"

It should be noted that the population forecasts for 2020 imply a reduction in the population levels for all the CEE Countries with the exception of Poland and the Slovak Republic. Within the EU countries, only Italy is forecast to see a reduction in population levels.

Forecasts of zonal car stock are also required for 2020. A similar approach to that above was taken, in that the SCENES zonal growth forecasts in motorisation were used in the first instance. An overall adjustment was then made based on the forecasts used in the DGTREN PRIMES study. This is principally to ensure a level of consistency between DGTREN projects. Separate SCENES produced forecasts were used for the CEEC8. Table 8.2 presents these forecasts in the form of cars / 1000 persons, at the country level.

Table 8.2 SCENES 2020 External Scenario – Car Ownership levels

	Cars / 1000 ¹		Cars / 1000 ¹		Cars / 1000 ²
Austria	639	Ireland	445	Czech Rep.	462
Belgium	721	Italy	865	Estonia	469
Germany	742	Luxembourg		Hungary	412
Denmark	411	Netherlands	573	Lithuania	403
Spain	580	Portugal	610	Latvia	327
Finland	537	Sweden	576	Poland	390
France	636	UK	519	Slovenia	510
Greece	354			Slovak Rep.	370

¹ Source – DGTREN PRIMES Study

² Source – SCENES Project Deliverable 3b, "Drivers of Transport Demand"

The final socio-economic component of the External Scenario is the GDP forecast data. This is shown in Table 8.3 below, and again uses PRIMES and SCENES data sources.

Table 8.3 SCENES 2020 External Scenario – GDP (% pa growth)

	1995-2010 ¹	2010-2020 ¹	1995-2020		1995-2010 ²	2010-2020 ²	1995-2020
Austria	2.31	1.66	2.05	Czech Rep.	3.9	4.3	4.06
Belgium	2.37	1.75	2.12	Estonia	4.8	5.1	4.92
Germany	2.36	1.73	2.11	Hungary	5.0	4.5	4.80
Denmark	2.35	1.52	2.02	Lithuania	5.1	5.8	5.38
Spain	3.03	2.29	2.73	Latvia	4.0	5.0	4.40
Finland	2.99	1.73	2.48	Poland	5.9	5.1	5.58
France	2.37	1.76	2.13	Slovenia	4.6	3.9	4.32
Greece	3.55	2.95	3.31	Slovak Rep.	5.2	4.5	4.92
Ireland	5.11	2.08	3.89				
Italy	2.12	1.71	1.96				
Luxembourg			4.40				
Netherlands	2.82	1.99	2.49				
Portugal	3.72	2.97	3.42				
Sweden	2.15	1.47	1.88				
UK	2.51	1.84	2.24				

¹ Source – DGTREN PRIMES Study

² Source – SCENES Project Deliverable 3a and 3b, "Drivers of Transport Demand"

The significance of the GDP forecasts in the passenger model is that they are used as a proxy for income growth. For the EU countries, average income value of time elasticities are used. These have been shown to be necessary to prevent the full impact of income growth being reflected in the values of time used in the model.

The Transport Networks used in 2020 are also common to all tests. These networks include planned national and international transport infrastructure developments. One of the main data sources used to specify these networks was the Commission's "TENs Implementation Report", which assesses the planned Trans-European Transport Networks for their progress and likely date of implementation, or completion.

8.1 Transport Scenarios

A number of Transport Scenarios are then developed. These are based on the previous work undertaken in the STREAMS and Pilot SEA projects, as well as the 2010 Common Transport Policy model runs undertaken in the Autumn of 2000.

The specification of the transport scenarios is based on a number of hypotheses as to how transport costs by mode will change in the future, in real terms (i.e. after inflation is taken into account). Clearly, the specification of these hypotheses would be greatly helped if the past trends in transport costs in European countries were known with some certainty. The only data source of this nature which has been found to date relates to the UK. **Figure 8.1** below shows changes in real terms in the cost of transport in the UK from 1974-2000, together with disposable income over this period.

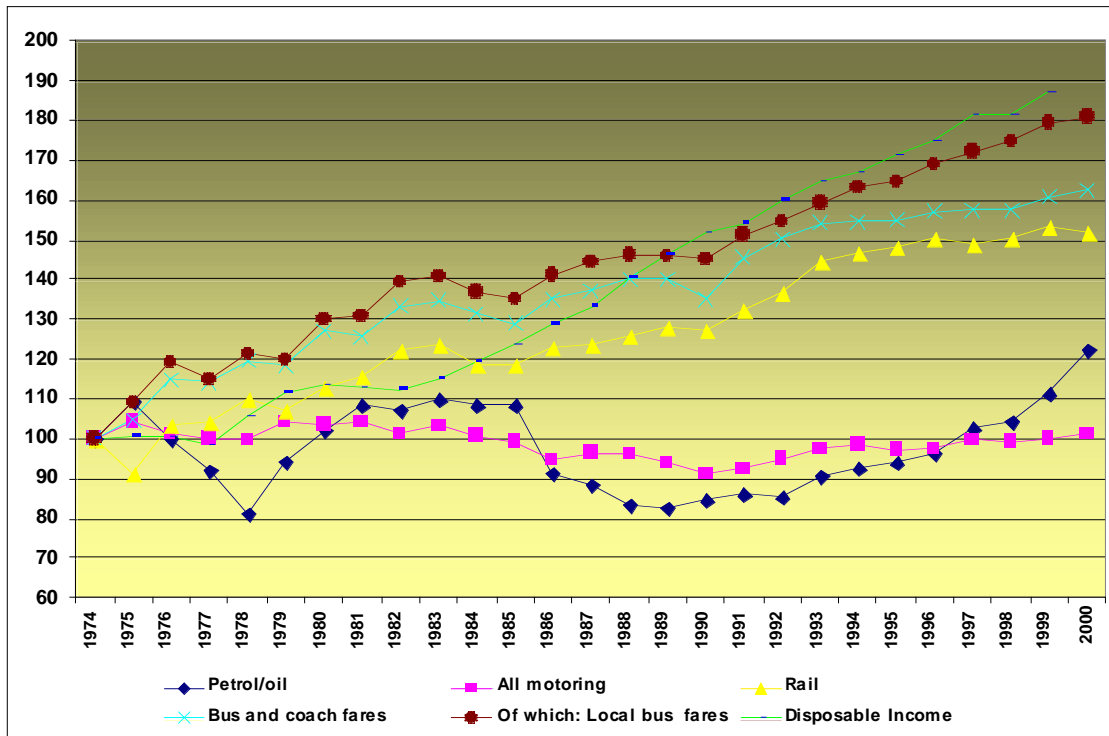


Figure 8.1 Real changes in transport costs, UK 1974-2000 (1974=100)

Source – Transport Trends, 2001 Edition, UK DTLR

A clear pattern emerges when historical transport costs are considered over this long time period. Basically the real cost of motoring, when all costs are considered has remained remarkably unchanged over 26 years, and has often been below the level of 1974. Fuel prices in isolation appear rather more cyclical. The other modes over the period have seen significant and more steady rises in costs, although still less than the change in disposable income. So overall, the real costs of transport relative to income have reduced across all modes over a long period. This is one of the key reasons for the increase in the distances travelled which have occurred.

Some of these changes can be illustrated by looking at the cost changes during different elements of the overall time period shown above.

The overall trend between 1974 and 2000 shows all motoring costs rising at only .04% above inflation. During this period rail travel has increased in cost by 1.61% per annum, and bus travel has gone up by between 1.9% and 2.3% per annum. The effect of the "fuel price escalator" policy which was recently used by UK Governments can be seen in the 5.43% per annum real growth in petrol / oil prices between 1995-2000, and the 2.11% figure for 1990-95 (the policy was introduced during this period). The stated objective of this policy was to assist in meeting emissions Kyoto agreements by bringing UK fuel prices (then amongst the cheaper in Europe) into line with other comparable countries. This escalator policy has now ceased, partly due to increasingly stiff public opposition.

Lessons can be drawn from these figures for the generation of Transport Scenarios for SCENES 2020. The PRIMES GDP 2020 forecasts are being used as proxy for "disposable income" so are in line with broad past trends for most of the major European countries at least (the GDP rates are typically in the range of 2-3% per annum). The splitting of car costs into "all motoring" and "petrol / oil" allows differential growth rates to be applied in the model. Business car travel in the model is based on "all motoring" costs, whilst leisure comprises only "out of pocket" expenses, which in this case is "petrol / oil". For leisure, the other costs are regarded as essentially sunk costs – they are implied in the car

ownership forecasts, and once a car is bought, the 'out of pocket' expenses are what typically governs mode choice etc.

The key issue in any Transport Cost scenario is the extent to which transport costs rise in relation to the growth in incomes. The previous SCENES 2010 CTP Transport Scenarios, which generally reflected the previous Pilot SEA Transport Scenarios are reproduced below in Table 8.4. Also shown is the UK 1974-94 (i.e. pre escalator) trend for comparison:

Table 8.4 Transport cost Scenarios for CTP SCENES runs (% per annum, 1995-2010)

Transport Mode	Reference Scenario / Scenario Tendanciel	Scenario 'Radical'	Scenario 'Voluntariste'	UK 1974-94
Car	+1.0%	+2.5%	+1.5%	-.39% ¹ -.07% ²
Local bus	+1.0%	-0.5%	-1.0%	+2.48%
Long distance coach	-1.0%	-0.5%	-0.5%	+2.20%
Rail – conventional	+1.0%	+0.5%	+0.75%	+1.95%
Rail – high speed	+1.0%	-0.5%	-0.75%	NA
Air	-0.5%	+0.5%	+0%	NA

1 – Petrol and oil only

2 – All motoring costs

These CTP Scenarios show a major shift in favour of the public transport modes compared to the UK 20 year trend discussed above. Unfortunately comparable data for other countries is unavailable at this stage – in particular it is likely that some other countries, with a stronger tradition of public subsidy, have maybe not seen such high growth in public transport charges. There is however, no real reason to believe that most other countries have not seem similar patterns of car costs over this period.

A further issue is the political acceptability of fuel prices increasing at above inflation rates over a sustained period. The wave of demonstrations seen in many European countries in the Autumn of 2000 against the level of fuel tax was significant, regardless of the motivation. It also initially had a high level of public support. For example, an increase of 2.5% per year (as suggested in the Scenario Radical above), for 25 years would see 1995 fuel prices increase by 85% over and above inflation. This sort of increase would also out-strip the growth in disposable income in some countries.

The Transport Scenarios developed for SCENES are as follows:

- Constant Cost Scenario. This test involves keeping transport costs for all modes constant in real terms.
- Income Tracking Scenario. Here, transport costs for all modes will rise in line with average EU incomes over the 1995-2020 period.
- Long Term Trend Scenario. This scenario uses the UK trend by mode between 1974 and 1994, i.e., before the fuel price escalator was introduced. This can be viewed as a "free-market" scenario.
- Radical Scenario. This test repeats the CTP Radical cost regime for the period up to 2020, and implies intervention in balancing the costs between modes.

These scenarios are selected to represent the range of possibilities and eventualities for the countries of the EU. Clearly, in reality different countries may well, in essence, adopt different scenarios. Results from all these tests are reported here at the country level, so it is possible to "mix and match" results to some extent if required, given the domestic nature of the vast majority of travel.

For the CEE Countries, one alternative Transport Scenario is defined. This Illustrative Scenario is based on (i) decreasing car costs, following Western European precedents in the early stages of expansion of car ownership, and (ii) increasing public transport costs – as state subsidy decreases and privatisation occurs, public transport prices will approach their "market" value. The purpose of this

Scenario is again to demonstrate the SCENES model’s approach to forecasting in the CEEC context. The values used are:

- Car and Air: -.05% per annum
- Bus / Coach, & Train: +4% per annum
- Freight Transport Scenarios

The freight transport costs scenarios are defined on the basis both of the observed past trend of freight rates and of assumptions already made in previous projects - STREAMS and Pilot SEA.

It is difficult to identify the historical trend of freight rates in EU countries given that even data calculation for a single year requires a substantial amount of work. This is because rates are often considered as confidential data and official figures are often unreliable. In the course of a study carried out in Italy about the cost of international transport (on behalf of the Italian Exchange Office) in order to estimate the Balance of Payment for transport services, a historical series of rates was estimated on the basis of survey among carries and forwarders. The estimation concerns only Italian transport to / from abroad, but there are not reasons to believe that the other countries experienced a very different path, with the exception of rail transport as explained below.

The following **Figure 8.2** shows the trend of the rates in the period 1989-1999, while Table 8.5 summarises the yearly percentage changes.

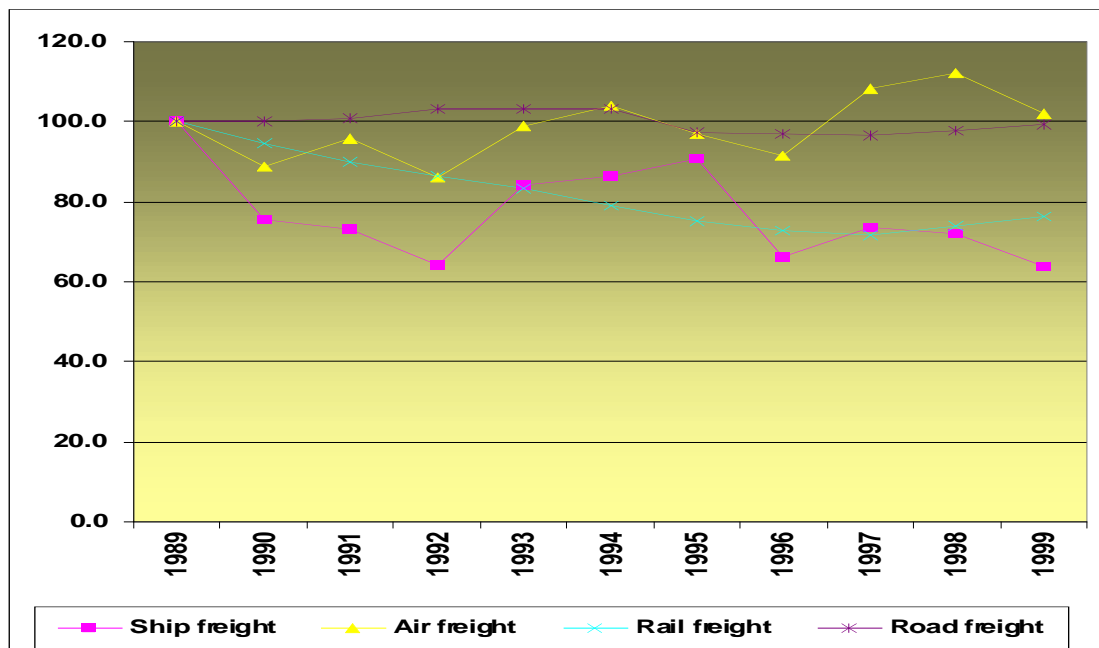


Figure 8.2 Index of freight rates 1989-1999 (International traffic to/from Italy; 1989=100)

Source: TRT elaboration on data reported in UIC, *Indagine campionaria su trasporto internazionale merci e passeggeri* (A sample survey on international transport of goods and passengers), Roma, 2000.

Table 8.5 Percent per annum real cost changes in Italian international freight transport by mode

Period	Road Freight	Rail Freight	Air freight	Ship freight
1989-99	-0.06	-2.64	+0.2	-4.37
1997-99		+3.25		

From the graph it is apparent that rates of road and air freight (but the latter plays a negligible role in freight transport) have remained substantially unchanged during the period 1989-1999. Shipping rates has decreased by over 4% per year from 1989, but this average rate is misleading on the light of the significant oscillations observed during the period - indeed, shipping rates change very frequently according to market conditions. Furthermore, the shipping rates trend observed in **Figure 8.2** can also be partially explained by the Lira / US\$ exchange rate which also has shown changes in the period observed.

For rail freight the average change of -2.6% per year is strongly influenced by the particular conditions of Italian railways, which has been (and still is) heavily subsidised. Only in recent years a more market-oriented policy was assumed and the effects on rates can be appreciated if the period 1997-99 is considered, with an increment of 3.25% per annum. Summing up, the observed past trends say that road freight rates are unchanged, ship rates show an overall decreasing tendency but with several oscillations and rail freight fares are probably increasing under the requirements to balance budgets following the liberalisation of services.

The second element for the definition of freight transport scenarios is represented by the assumptions made in previous projects STREAMS and Pilot SEA. Such assumptions are summarised in Table 8.6.

Table 8.6 Comparisons of past trend and previous projects assumptions (% change/year)

Mode of transport	Italian International traffic Past trend (1989-1999)	STREAMS assumptions	Pilot SEA assumptions
Heavy Goods Vehicles		-2	-1
Light Goods Vehicles	-0.06	0	+0.5
Rail bulk		0	+2
Rail unitised	-2.6 ¹ +3.25 ²	0	+1.5
Ship	-4.37	-0.5	-1
Inland navigation	NA	-0.5	+1

¹ 1989-1999, ² 1997-1999

In general terms, the assumptions made in previous projects were consistent with the past trend in terms of direction whereas the size of changes is generally different. However, the observed trend is calculated over ten years only so that the percentage change of ship rates could be overestimated, as well as the rail rates could be considered to be peculiar to the Italian case. For inland navigation a comparison is not possible. From the analysis above, in the same manner as for passengers, four alternative freight transport scenarios are defined as follows:

- Constant Cost Scenario. This test involves keeping transport costs for all modes constant in real terms.
- Basic Scenario. The Pilot-SEA assumptions are retained over the 1995-2020 period.
- Observed Trend Scenario. This scenario adopts the observed change rates for Italian international traffic with the exception of shipping where just half of the observed variation is used and rail where the rate is half of the trend of the last three years.
- Intervention Scenario. This scenario assumes interventions on different modes with the aim of reducing road share for environmental reasons, etc.

The Scenarios are summarised in **Table 8.7** below. As for the passenger model, results from all these tests are reported here at the country level.

Table 8.7 Freight Transport Scenarios (% per annum transport cost change, 1995-2020)

Mode of transport	Constant Scenario	Base Scenario	Trend Scenario	Intervention Scenario
Heavy Goods Vehicles	0	-1	0	+1.5
Light Goods Vehicles	0	+0.5	0	+1
Rail bulk	0	+2	+1.5	0
Rail unitised	0	+1.5	+1.5	0
Ship	0	-1	-2	-2
Inland navigation	0	+1	+1	0

8.2 SCENES 2020 Passenger Forecasts

The results of the 2020 forecasts can be presented in two ways, either in relatively aggregate form, or in terms of the underlying characteristics of trip making and travel.

8.2.1 Aggregate results

Looking first at the aggregated model outputs, these give the forecasts for the four 2020 Scenarios, in terms of person-km per annum, by mode, for the EU as a whole, then aggregated across modes for each of the EU countries. Both types of results are considered here are for all domestic plus intra-EU international travel combined.

Table 8.8 shows the forecast 2020 transport levels by mode, aggregated across the EU.

Table 8.8 EU Domestic plus intra-EU international passenger travel, 2020 (10⁹ person-km/annum)

Scenario	Car	Coach	Train	Slow	Air	Total	Total mechanised*
Constant Cost	5,713.4	511.8	619.5	184.3	992.1	8,021.1	6,844.70
Income tracking	5,598.0	361.3	323.5	203.5	316.7	6,802.9	6,282.80
Long-term trend	6,140.6	312.3	240.4	191.9	953.9	7,839.1	6,693.30
Radical	4,755.8	667.5	652.7	194.9	194.9	7,268.3	6,076.00
1995 Base	3,986.8	430.6	317.8	209.7	276.5	5,221.4	4,735.20
CC % pa	1.45	0.69	2.71	-0.52	5.24	1.73	1.48
IT % pa	1.37	-0.70	0.07	-0.12	0.54	1.06	1.14
LTT % pa	1.74	-1.28	-1.11	-0.35	5.08	1.64	1.39
Rad. % pa	0.71	1.77	2.92	-0.29	-1.39	1.33	1.00

* comprising car, bus / coach, train

The forecasts of total volume of person-km travelled range from an increase of 30% and 54% between 1995 and 2020 depending on the Scenario adopted. The rates of transport growth therefore differ markedly between the Scenarios – they were specified in this way to encompass the broad range of possible future trends. The "Income Tracking" Scenario sees the least amount of overall growth. In this Scenario, transport costs keep pace with income growth, thus a key source of previous growth in transport, where incomes rise faster than transport costs, is not present. The increase seen here will be mostly due to the growth in car ownership. Conversely, the highest growth is seen in the "Constant Cost" Scenario. In this case, transport costs for all modes remain the same in real terms in 2020 (i.e., accounting for inflation) as they are in 1995, and incomes are rising at approximately 2.5% per annum, again in real terms. Thus there is a big differential between transport costs and income growth and transport becomes very much cheaper, relative to incomes.

The "Long Term Trend" Scenario encounters only slightly less growth than "Constant Cost", but the distribution of this growth between modes is very different. The "Long Term Trend" Scenario sees car costs reducing slightly over time, while costs for other modes keep a much closer pace with income. Thus the growth in car person-km is greatest for this Scenario. The Rail and Bus-Coach modes see a decline in use, as has been the case in some EU countries in the last 25 years.

The "Radical" Scenario cost regime penalises Car at the expense of the other modes. Hence the overall growth is the second lowest of the four Scenarios, but the growth in Car person-km is the least of the four tests.

If the "mechanised only" modes are considered, the overall rates of growth in travel are slightly higher, since the slow mode trips (which are excluded) decline in each case. However, this definition excludes Air traffic, which often grows at a faster rate than other modes. To aid interpretation, **Figure 8.3** shows the percentage per annum changes for each mode and Scenario.

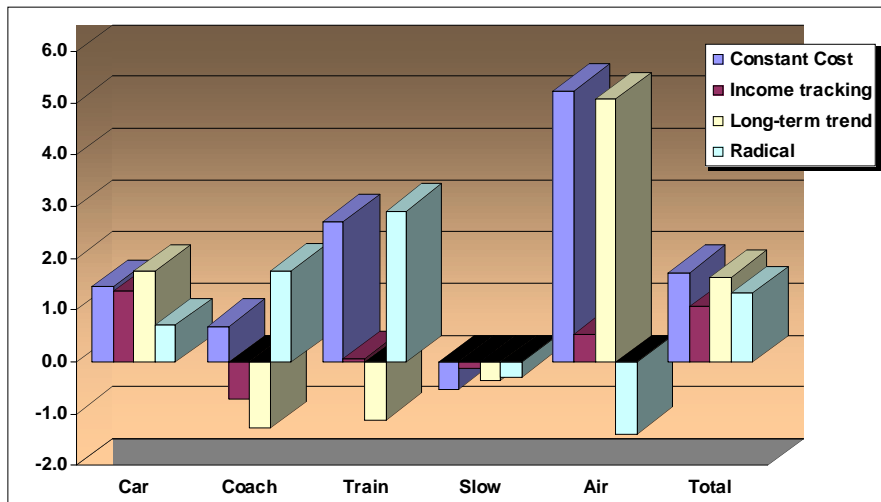


Figure 8.3 Passenger Scenarios, 1995-2020 %/annum change by mode, domestic & intra-EU international

The following Figure 8.4 now contains the rates of transport growth for each of the EU countries for each of the four Scenarios. Only national, or domestic travel is included in this chart to illustrate the differing domestic characteristics. The countries have been ordered by the average growth across the four scenarios (not shown), to aid interpretation.

Looking at these results for domestic travel, Austria, Italy and Germany generally have the lowest levels of growth. Portugal, Greece, Ireland and surprisingly Finland comprise the countries with higher growth rates. Much of this differential growth can be attributed to differential growth in car ownership. Countries such as Germany and Austria, with high car ownership in 1995, see less growth than those countries such as Greece and Portugal who are "catching up" to some extent.

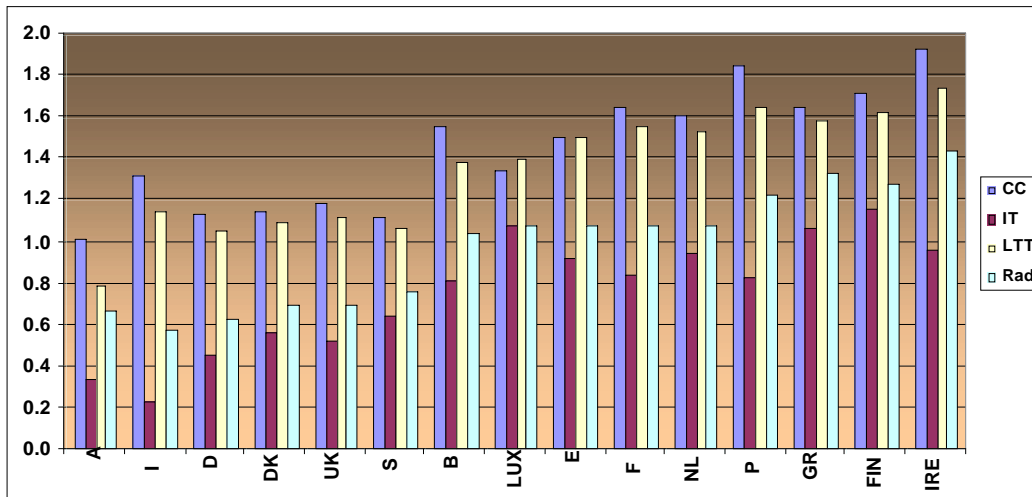


Figure 8.4 Passenger Scenarios, 1995-2020 % /annum growth by country, EU domestic, all modes

Figure 8.5 now shows the total travel with origins and destinations within the EU for the Base Year and the four 2020 Scenarios. Here, the domestic and international modal elements are separated out to illustrate the relative contribution of each to the total.

The purpose of this chart is to illustrate the very significant rises which are forecast for international travel in particular. Overall though the dominance of domestic car travel, constituting the largest proportion of all travel remains the case.

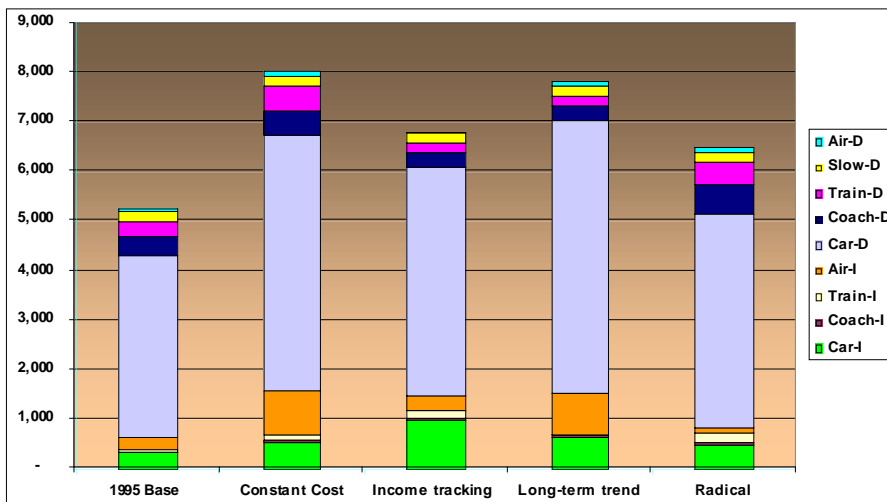


Figure 8.5 Passenger Scenarios, domestic & intra-EU international person-km, 10⁹ by mode

Turning to the model forecasts for the illustrative 2020 External and Transport Scenario which has been applied in the CEE countries, in general, its to be expected that the growth in transport will of course be greater in the CEE countries than will be the case with the EU countries. This is expected to be the case as these countries are, to some extent, catching up with trends in Western Europe. This general pattern is indeed seen in the model results.

Looking initially at the growth in CEEC domestic travel, Table 8.9 below shows the results aggregated across the eight CEE countries contained in the model.

Table 8.9 CEEC Domestic passenger travel, 2020 10⁹ person-km / annum

Scenario	Car	Bus-Coach	Train	Slow	Air	Total	Total mechanised*
2020 CEEC	700.3	102.8	52.5	19.3	.8	875.7	855.6
1995 Base	317.8	92.8	46.8	32.9	.02	490.7	457.50
% <i>pa</i>	3.21	0.41	0.46	-2.12	15	2.35	2.54

* comprising car, bus / coach, train

Although at first sight, these growth rates may seem below expectation, a comparison can be made between domestic kilometres travelled per person per day for the EU countries and the CEE countries in both years. In the 1995 model, the figure for the EU is 34.0 km per person per day – for the CEEC, the equivalent figure is 18.2. By 2020, the modelled figure for the CEEC is 33.2km, whilst the EU figures range from 37.9km to 45.7km, depending on the Scenario. So in 1995 the CEEC volume of travel was only 53% of the EU value, whilst in 2020, this proportion ranges from 73% to 88%, again depending on the Scenario.

By 2020, the CEEC volume of travel is therefore very much closer to that of the EU than is the case for 1995, although it has not quite "caught up". The growth rates in terms of person kilometres travelled per year are shown at the CEE country level in Table 8.10 below.

The largest growth in car use for the Illustrative Scenario is therefore seen in Poland, Hungary, and Lithuania. Growth in the other modes is much more modest, or indeed negative. All countries see a significant decline in the slow modes. The significantly declining population in many of these countries must also be taken into account when considering the expectations for transport growth.

Table 8.10 CEEC Growth in Domestic passenger travel by country, person km % pa, 1995-2020

	Car	Coach	Train	Slow	Total	Total mechanised*
Czech	2.13	-0.39	-1.29	-1.61	1.27	1.38
Estonia	1.08	0.35	-0.86	-2.59	0.54	0.75
Hungary	3.26	0.11	-0.60	-2.63	2.16	2.34
Lithuania	3.11	0.27	-0.17	-2.64	2.17	2.49
Latvia	2.74	0.31	-1.26	-3.47	1.62	1.95
Poland	3.66	0.83	1.32	-2.24	2.91	3.11
Slovenia	2.21	0.34	0.75	-2.18	1.61	1.81
Slovakia	1.59	0.42	0.06	-0.70	0.94	1.04

* comprises car, bus / coach, train

8.2.2 Underlying changes in the characteristics of transport

Having reported the more aggregate results above, this section looks at the changes in travel behaviour which underlie these aggregate figures. Firstly the basic components of transport demand are reported – namely changes in the number of trips and average trip distances.

Number of Trips

As there is only one External Scenario, the actual number of trips in the 2020 modelled system is common to all four of the Scenario tests. Also the only trip rates which are changed in moving from 1995-2020 are the international tourism trips (holidays and business). Here, there is clear evidence, and existing forecasts, that the number of trips made will continue to rise. For the other types of travel, the evidence is that trip rates stay relatively stable through time, if the analysis is conducted with an appropriate degree of segmentation of the population.

Applying the new car ownership levels and employment / demographic changes for the 2020 External Scenario gives rise to a new set of implied trip rates for each country. Table 8.11 below shows these rates in full, together with the percentage increase in trip rates between 1995 and 2020.

Table 8.11 Country level trip rates, 1995 and 2020 trips / person / year

Country	1995 Trips / person annum	2020 Trips / person annum	% increase	Country	1995 Trips / person annum	2020 Trips / person annum	% increase
Austria	1063.5	1107.1	4.1	Spain	1056.7	1106.6	4.7
Belgium	1068.8	1178.1	10.2	Sweden	1050.7	1083.6	3.1
Denmark	1055.3	1101.0	4.3	UK	1075.4	1110.2	3.2
Finland	1060.3	1111.8	4.9	Czech	1039.6	1100.3	5.8
France	1073.3	1147.3	6.9	Estonia	1015.7	1112.5	9.5
Germany	1050.7	1130.8	7.6	Hungary	1004.9	1090.9	8.5
Greece	977.3	1021.4	4.5	Lithuania	995.8	1087.6	9.2
Ireland	1072.4	1102.1	2.8	Latvia	961.1	1058.4	10.1
Italy	1094.9	1231.2	12.4	Poland	987.9	1078.6	9.2
Luxembourg	1136.3	1185.7	4.3	Slovenia	1058.9	1130.7	6.8
Netherlands	1207.6	1316.4	9.0	Slovakia	997.9	1073.7	7.6
Portugal	1066.8	1133.2	6.2	Total	1059.89	1136.6	7.2

Overall, the changes in car ownership and demographics have increased the trip rates by around 7%. This is seen to vary quite widely by country, with Italy seeing the largest rise. This is in the main due to the high car ownership levels forecast for Italy.

Average Trip Distance

If an increase in the number of trips is one source of growth in transport, increases in the average trip distance has also been a significant component of the growth in transport. The SCENES model incorporates incomes in the utility functions. As incomes rise, the amount of "disutility" incurred for a particular cost declines – this reduction in disutility leads systematically to a lengthening of trips in the model. Table 8.12 below shows average trip distances considered for all modes added together and domestic trips only.

Table 8.12 Country level Domestic Average Trips Distances, 1995 and 2020 Scenarios (km/trip)

Country	1995 Base	CC 2020	IT 2020	LTT 2020	Radical 2020	Country	1995 Base	CC 2020	IT 2020	LTT 2020	Radical 2020
Austria	10.63	12.58	10.60	11.87	11.52	Spain	9.46	12.77	11.06	12.77	11.51
Belgium	10.06	12.85	10.65	12.30	11.28	Sweden	11.58	13.89	12.36	13.72	12.72
Denmark	13.29	16.27	14.04	16.07	14.56	UK	11.52	14.36	12.19	14.14	12.74
Finland	11.87	16.56	14.41	16.17	14.85	Czech	7.54	10.38	10.49	10.37	10.54
France	12.80	16.69	13.64	16.31	14.48	Estonia	5.06	6.60	6.60	6.60	6.61
Germany	12.89	15.33	12.96	15.01	13.53	Hungary	7.00	11.94	11.97	11.97	11.97
Greece	6.71	8.97	7.75	8.82	8.28	Lithuania	4.95	8.29	8.30	8.29	8.30
Ireland	9.36	13.51	10.64	12.93	12.01	Latvia	4.57	7.73	7.73	7.72	7.73
Italy	12.44	15.56	11.89	14.92	12.98	Poland	6.83	12.71	12.88	12.67	12.85
Luxemburg	11.09	12.34	11.51	12.50	11.53	Slovenia	5.34	7.95	7.97	7.95	7.97
Netherlands	10.04	12.53	10.63	12.29	10.99	Slovakia	5.82	6.72	6.89	6.71	6.88
Portugal	8.60	12.10	9.40	11.53	10.37	Total	10.85	14.14	12.02	13.84	12.61

The increases between 1995 and the four 2020 Scenarios follow the same pattern as the aggregate results. Even the test with the slowest growth (IT – Income Tracking) however, sees a 10% increase in average domestic trip distance. On the other hand, the Constant Costs Scenario sees an increase of over 30%. It is therefore clear that increases in the average trip distance is a more significant factor than the increase in the number of trips, in accounting for the growth in transport in these tests. The figures are presented for domestic travel only, as they become less meaningful when international travel is included, where the average can be distorted by the presence of very long trips.

Modal Split

Modal split is initially considered by of two basic measures - number of trips, and person-kilometres travelled. The variation in modal split by distance is then analysed. Given that there are four Scenarios being tested, five basic modes, and 23 countries, a lot of information is produced from the model output. Firstly Table 8.13 gives the basic modal split for each of the Scenarios, in terms of the number of trips.

Table 8.13 Basic Modal Split, 1995 and 2020 Scenarios (% all trips), EU & CEEC

	Car -Business	Car	Coach	HST	Air	Slow	Rail
1995 Base	1.27	55.07	10.88	0.02	0.12	30.84	1.79
2020 CC	1.25	64.21	10.68	0.08	0.29	21.12	2.37
2020 IT	1.35	62.07	10.81	0.02	0.10	24.35	1.30
2020 LTT	1.32	65.45	9.97	0.03	0.29	21.51	1.43
2020 Radical	1.24	61.09	11.63	0.09	0.25	23.58	2.13

The main modal shift in all cases is away from the slow modes to the private car. The rise in the proportion of car trips varies between 6 percentage points in the Scenario Radical and 10 percentage points for the Long-Term-Trend Scenario. High speed rail has a large growth in the proportion of trips made in both the Constant Cost and Radical Scenarios. The other two scenarios see the proportion remaining stable.

The modal split is more usefully viewed at the national level. The results have been split into the short / long denominations used before (< and > approximately 40km) for the EU15 countries and the four 2020 Scenarios. Figure 8.6a-d below shows the mode split for the long trips. Here, each mode, car, coach, train and air is shown in its own chart. The modal proportion for each mode for each Scenario and country can be seen in these figures.

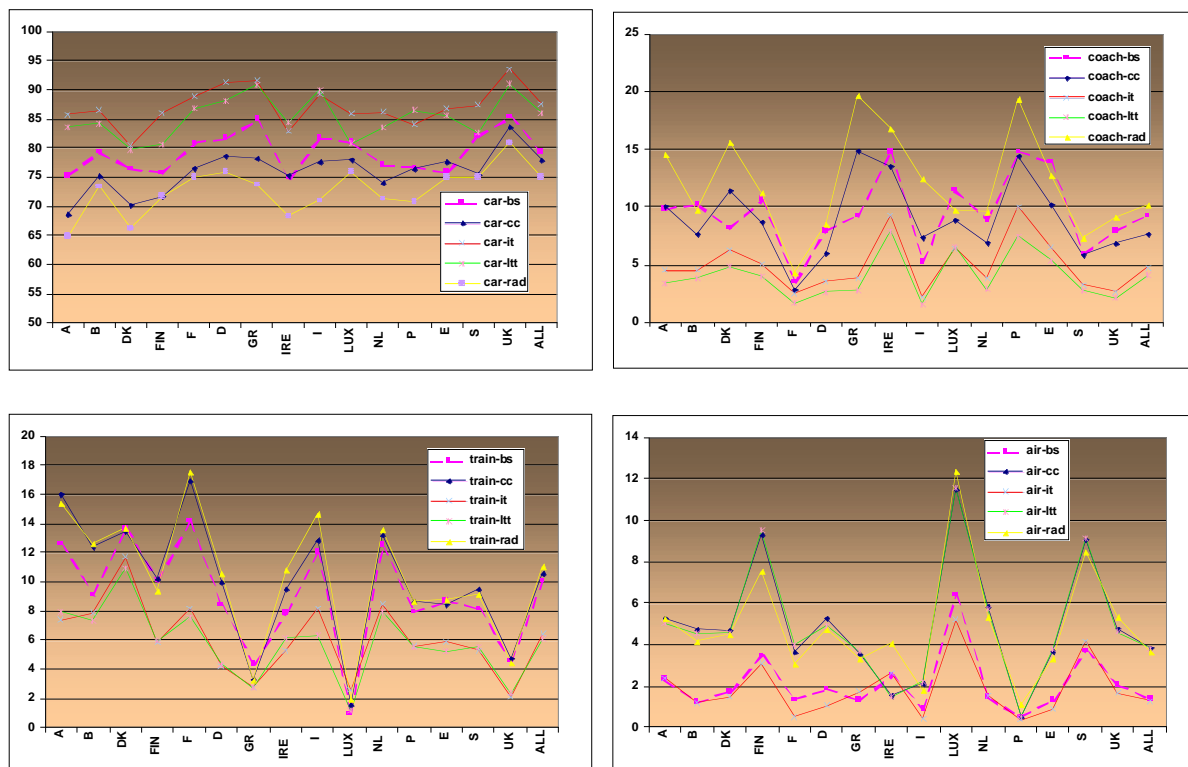


Figure 8.6 a-d: Modal Split (% trips) long trips, 1995 & 2020, EU countries, car, coach, train, air

There are more significant modal shifts apparent when looking at these "long" transport flows in the model. In the above figures, the 1995 Base year modal proportions are shown in the heavy, dotted

pink line. For all countries the Scenario Radical sees significant reductions in the car's modal share, whilst Long-term-trend and Income Tracking see the modal share of car increase significantly. It is clear from these figures that the model does produce results which do differ substantially between countries.

Figure 8.7 overleaf, shows the person kilometres travelled for each EU country and mode, for the base year and each of the four Scenarios being tested. In each case, the base year person-kilometre figure is also shown for comparison (shown against the country code only). The order in which the countries appear has been changed to reflect the overall level of travel – this makes the presentation and scaling more clear. The inclusion of intra-EU international trips here makes the air mode much more significant than when domestic travel only is included.

Mode Split by Distance

Having looked at the modal split in terms of number of trips and person kilometres travelled, this section shows the changes in modal split by different distance bands. All trips are considered together here – i.e., the results are not country or flow specific. This means that EU and CEEC figures are included in these charts. Here, mode split by distance is shown for car, bus / coach, rail and air over fairly long distance bands. Figure 8.8 also overleaf shows the mode split by distance (percentage of all trips in each distance band) for car, coach, train and air.

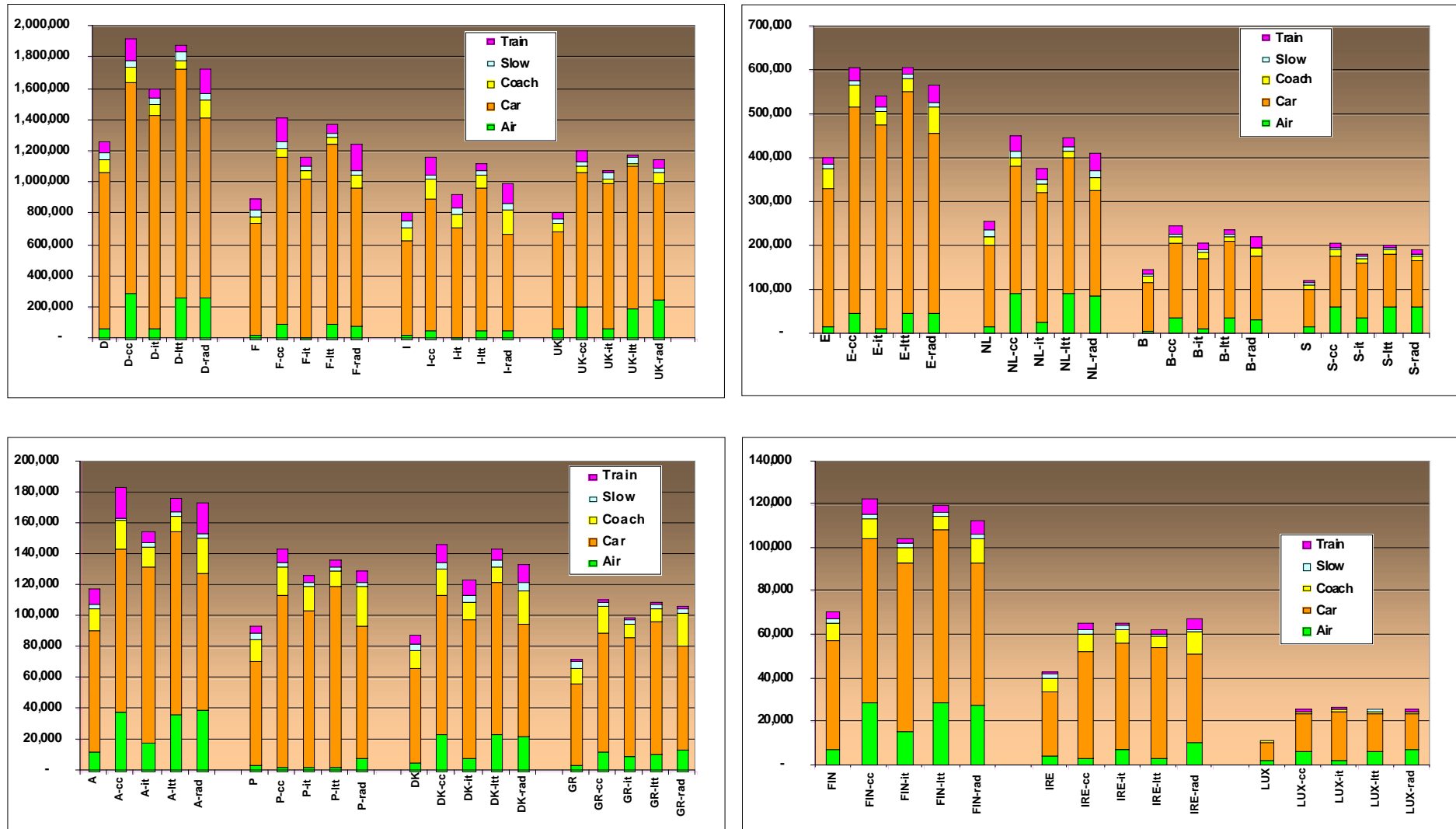


Figure 8.7 EU domestic & intra-EU international, pkm*10⁶/annum by mode & country

Note: 'CC' – Constant cost scenario, 'IT' – Income tracking scenario, 'LTT' – Long term trend scenario, 'rad' – Radical scenario

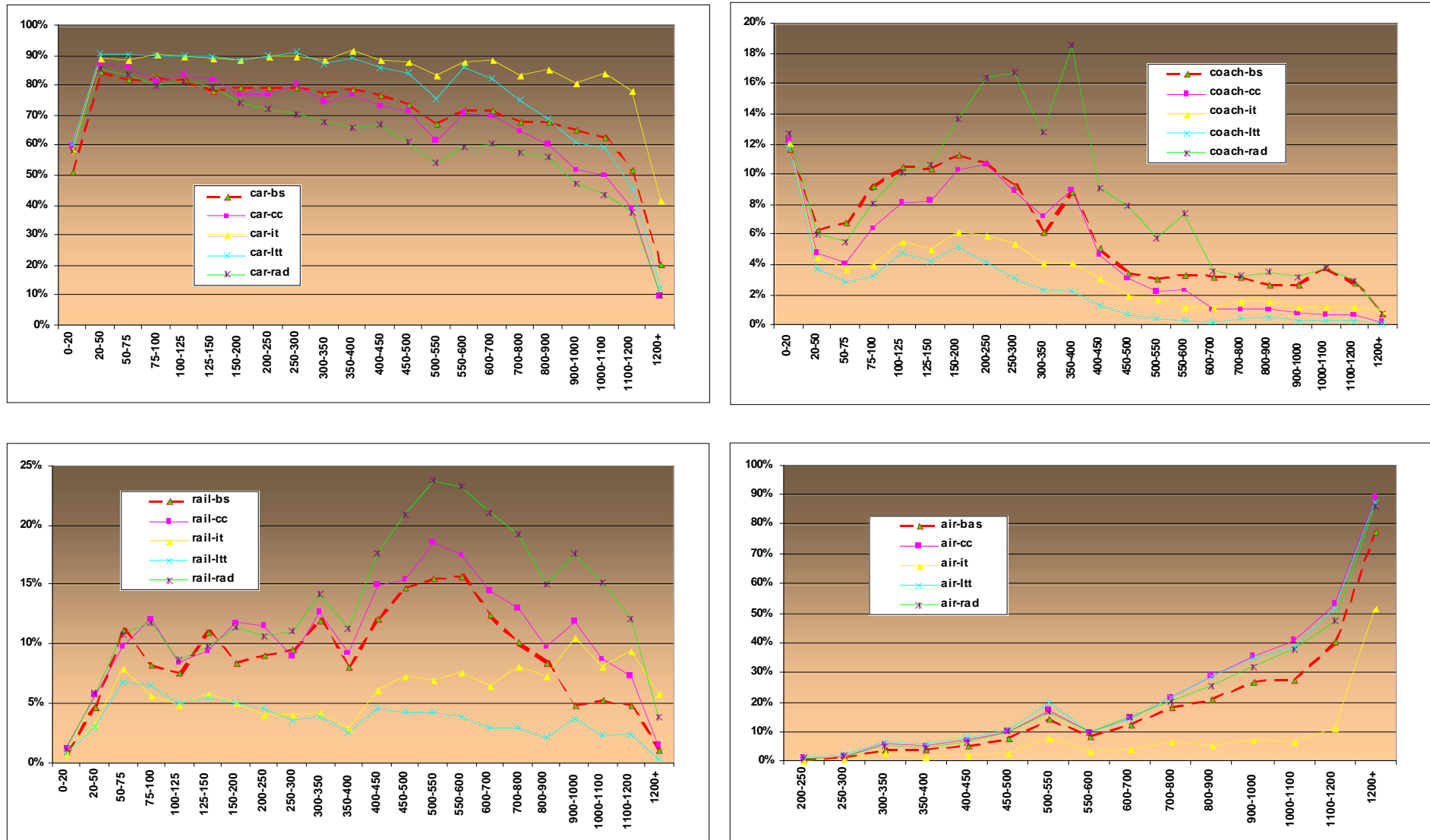


Figure 8.8 Mode split by distance band and mode (% trips), 1995&2020 Scenarios

Again, it is the Scenario Radical which has the greatest effect on the modal share of Car when viewed over these longer distance ranges. Perhaps surprisingly, the Income Tracking Scenario sees the largest Car modal share, as the other modes are disproportionately affected by the large cost increases applied in this test. It should be remembered that this is a higher modal share of a smaller overall volume of travel however, as the cost changes in this Scenario do have a major effect in limiting the growth of travel. The LTT Scenario also sees significant increases in the modal share of car, except over the very longest distances. The Scenario Radical is seen to have a major effect on Coach modal share between 150 and 700km. All the other Scenarios see a reduction in the modal share of Coach, most significantly in the case of the LTT Scenario.

Very large variations are seen in the modal share of rail (including high-speed train) between the four Scenarios and the Base Year. The LTT Scenario, where Rail costs increase significantly whilst Car costs remain stable, results in a very significant loss in Rail's modal share over all distances. On the other hand, the Scenario Radical, which is almost the reverse of LTT, results in large gains in the modal share of Rail. The CC Scenario also sees some gains for rail over the medium and longer distances. In this case, all other things being equal, increases in incomes lead to more people choosing the faster modes – this may explain this tendency here.

The modal share changes for Air are perhaps less than for the other modes. The exception is the IT Scenario. Here, across the board transport costs increases affect the most expensive mode significantly, leading to a dramatic loss in modal share for the Air mode.

Trip purpose by Distance

This section briefly looks at the changes in trip purpose over different distance bands forecast for 2020. Figure 8.9 shows the proportions of all trips made over different distances, split by the aggregated business / non-business travel purposes, for each of the four Scenarios and the base year.

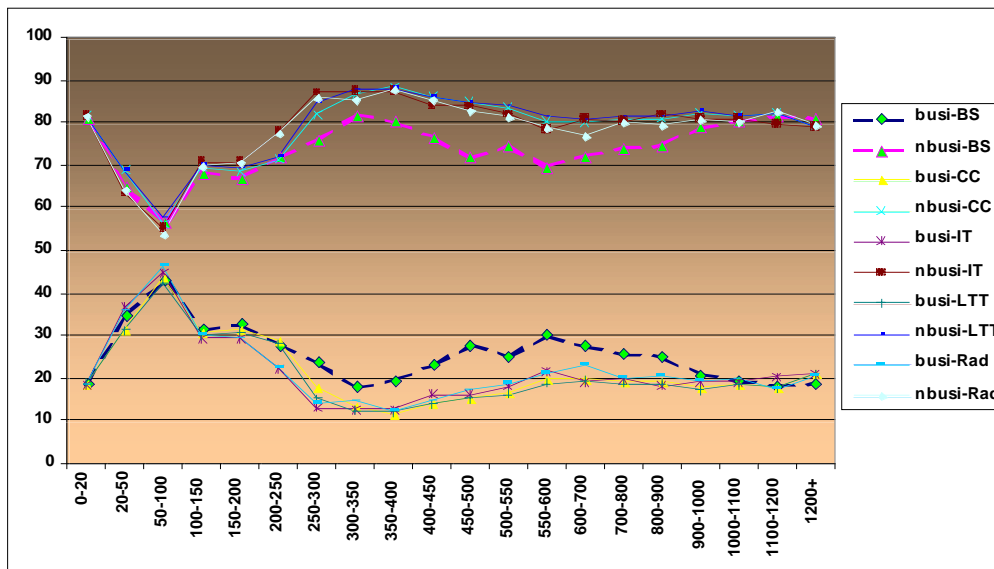


Figure 8.9 Broad trip purpose by distance, (% trips), 1995&2020 Scenarios

A clear pattern emerges when the trips are considered in this way. Firstly, there are not great differences between each of the four 2020 Scenarios in this regard. However between the 1995 base year and the 2020 Scenarios, there is a higher proportion of leisure trips over the middle distance ranges. This difference disappears over the very longest distances. This is because these trips will largely comprise the international "tourism" trips – these are both business and holiday trips which include at least one overnight stay. The same growth rate was applied to both these trip rates in the model, in line with World Tourism Organisation forecasts.

For the other trips, the increased car availability in 2020 leads to a higher growth in leisure trips than business and commuting trips. This explains the increase in the proportion of leisure trips over the short and medium distance ranges.

8.3 SCENES 2020 Freight Forecasts

This section presents the results of the four freight Transport Scenario forecasts. The main model outputs are tonnes lifted and tonne-km moved, by mode and by Transport Flow, also looked at from different geographical aspects. The three main aspects of the results reported here are:

- the total freight tonnages in the modelled system,
- the freight tonnes lifted by each main mode, by country and Transport Flow for each 2020 Scenario, and
- the freight tonne-km by mode resulting from these freight movements, overall and by country, for each 2020 Scenario.

8.3.1 Total freight tonnages – 2020 Scenarios

As outlined above, there is one "External" Scenario which is used for the 2020 tests. In the freight model, this External Scenario is applied to the Regional Economic Model and it is this which determines the tonnes in the modelled system for 2020. The influence of the different transport cost regimes between the Scenarios determines the length of haul and hence the tonne-km moved, but does not affect the actual tonnages lifted. This section, which considers only the tonnages, does not therefore differentiate between the Scenarios, as the tonnages are effectively common to all.

Looking at the total amount of tonnes in the modelled system, Table 8.14 shows the main aggregate 2020 Scenario results. The "intra-EU15 total" figure is the combination of the "EU National" and "Intra-EU15 international" tonnages.

Table 8.14 Total freight tonnages by movement, 1995 & 2020 ('000 / annum)

	TREX 'observed'	1995 Modelled	2020 Modelled	1995-2020 <i>Pa growth</i>
Intra-EU15 total	11,418,021	11,424,424	14,604,528	0.99
EU15 national	10,653,388	10,638,725	13,116,210	0.84
Intra-EU15 international	764,633	785,699	1,488,318	2.59
CEEC – EU15	98,227	103,376	245,022	3.51
EU15 – CEEC	25,588	26,105	60,270	3.40
Rest Europe - EU15	191,426	190,953	453,161	3.52
EU15 – rest Europe	79,891	74,711	163,471	3.18
Rest World – EU15	544,016	542,551	1,171,908	3.13
EU15 – rest World	179,210	182,732	427,821	3.46

Table 8.14 therefore shows the modelled and "observed" values for 1995, together with the 2020 forecast, and the percentage per annum growth rates in each case. The main trend is that international tonnages are growing at a much faster rate than national tonnages. In addition the tonnages imported and exported to / from the EU are growing at a slightly faster rate than international tonnages within the EU. The dominance of the national markets in terms of tonnes is still clear from these figures in 2020, accounting for more than three quarters of the tonnes lifted here.

Table 8.15 goes on to show these increases in tonnages disaggregated to the 13 Transport Flows used in the freight model. Also shown in this table is the freight handling category. This helps to illustrate how the highest growth rates are seen away from the Solid Bulk flows.

Table 8.15 Growth in freight tonnes lifted by Transport Flow: 1995-2020 % per annum

	Transport Flow (% pa growth, tonnes)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Handling Category	GC	U	U	SB	LB	GC	U	SB	SB	GC	GC	U	U
Intra-EU15 total	.40	1.0	.90	.84	.83	1.6	.86	.84	1.1	1.4	2.4	2.7	1.3
EU15 national	.15	.92	.81	1.0	.46	1.3	.82	.85	.80	1.0	1.8	1.9	1.0
Intra-EU15 International	2.5	2.2	1.9	-1.1	2.5	2.9	2.1	.44	2.3	3.0	4.8	5.3	4.2
CEEC – EU15	3.0	5.0	3.6	3.2	2.9	3.9	3.2	3.2	3.2	3.6	5.2	5.2	4.5
EU15 – CEEC	2.7	3.5	3.7	2.0	2.3	3.9	.46	3.9	3.2	3.6	5.0	5.0	4.0
Rest Europe – EU15	3.7	5.0	4.6	3.6	2.7	4.1	3.1	3.4	3.4	3.9	5.6	6.8	5.6
EU15 – rest Europe	2.9	4.9	3.9	1.5	1.8	3.9	-2.2	3.2	3.4	3.4	4.9	4.8	4.0
Rest World – EU15	2.8	3.5	3.6	3.1	2.9	3.5	3.0	3.3	3.2	3.0	4.5	4.5	3.9
EU15 – rest World	2.9	6.4	3.9	3.0	1.9	3.9	-4.6	3.3	3.5	3.0	4.9	5.1	4.2

Transport Flows: 1 - Agricultural products, 2 - Consumer food, 3 - Conditioned food, 4 - Solid fuels and ores, 5 - Petroleum products, 6 - Metal products, 7 - Manufactured building materials, 8 - Crude building materials, 9 - Basic chemicals, 10 - Fertilisers, plastics and other chemicals, 11 - Large machinery, 12 - Small machinery, 13 - Miscellaneous articles

Handling Category: GC – General Cargo, U – Unitised, SB – Solid Bulk, LB – Liquid bulk

The Transport Flows that generally see the highest rates of growth are Flows 11 and 12 – these are Large and Small Machinery flows respectively. This represents the higher value products which are forecast to grow at a faster rate than the bulk products, e.g., Flows 4 and 8 (solid fuels and ores, and crude building materials) see much smaller rates of growth within the EU, at less than 1% per annum. The agriculture and food related flows (Flows 1, 2 and 3) also see smaller rates of volume growth.

8.3.2 Freight tonnes by main mode

This section considers the freight Scenario results in terms of tonnes lifted by main mode. The first part looks at modal split overall and by country, and the second considers the modal share by individual Transport Flow.

This section looks at the modal share by "main" mode, for 1995 and the four 2020 Scenarios. "Main" mode means the mode attributed in the model to a consignment (or part consignment) between any origin – destination (OD) pair. This is based on a modal hierarchy as follows:

- Truck (LGV, HGV) – Level 1
- Railway (bulk, container, shuttle services) – Level 2
- Inland waterway (bulk and container) – Level 3
- Shipping (bulk and container) – Level 4
- Air Freight – Level 5
- Pipeline – Level 5

The mode attributed to a consignment in the matrix is the mode which is highest in this hierarchy for any given OD pair, so for example, where the mode "Shipping" is attributed, this could be a combination of Truck and / or Rail and / or Inland Waterway and Shipping.

As explained above the absolute amount of tonnes in the system does not change significantly between the different 2020 Scenarios, but the modal share does. The modal shares are presented here in Table 8.16 for both national tonnes, and for intra-EU international tonnes (BF – Base Forecast Scenario, CC – Constant Cost Scenario, Int – Intervention Scenario, Tr – Trend Scenario).

Table 8.16 Modal share of tonnes lifted (% tonnes), 1995 and 2020 Scenarios

Test	National Tonnes (%)					Intra-EU International Tonnes (%)			
	Truck	Rail	Shipping	IWW	Other	Truck	Rail	Shipping	IWW
1995 Base	92.4	4.3	1.1	1.8	0.3	45.0	9.0	33.1	12.9
2020 BF	94.1	2.2	0.9	2.4	0.3	59.0	2.6	29.3	9.1
2020 CC	91.8	4.9	0.8	2.1	0.3	48.3	11.6	30.3	9.8
2020 Trend	93.0	2.8	1.0	2.8	0.3	50.2	4.4	34.2	11.2
2020 Intervention	88.6	6.8	1.2	3.1	0.3	31.5	18.7	36.4	13.5

There are significant differences in the modal share of national tonnages between the Scenarios. As might be expected the Constant Cost Scenario sees the smallest change from 1995, and the Intervention Scenario sees the greatest change. Indeed the Intervention Scenario sees a significant reduction in the share of Truck, down by over 4 percentage points from 1995. The modal share of Rail declines in both the Base Forecast and Trend Scenarios. The larger distances involved in the international tonnages exacerbates the effects of the different transport cost regimes of the Scenarios. The modal share of Truck is drastically reduced in the Intervention Scenario when the results are viewed in this form. Otherwise Truck's modal share increases in all cases between 1995 and 2020, with Rail seeing a large drop in both the Base Forecast and the Trend Scenarios.

The intra-EU international modal tonnages are shown at the country level in the following Figure 8.10 and Figure 8.11 which show the percentage modal share of Truck & Train, and Inland Waterway & Shipping respectively for tonnes lifted (by country of receipt). The results are shown for the base year and the four scenario tests. Note that in these definitions, a truck which travels by ferry is still regarded as a Truck trip.

Geography dictates to a large degree some of the international modal share characteristics. For example, for EU trade with Finland, road transport is not an attractive option. Similarly for Greece, Ireland and Sweden. By contrast, more landlocked countries such as Austria, have a very high proportion of Truck use. This chart allows a comparison of the modal share of Truck for each of the 2020 Scenarios with each other and the base year. For example, in the Intervention Scenario, the modal share of Truck declines substantially relative to the 1995 figure. On the whole though, the proportion of Truck tonnes increases significantly for all other Scenarios and countries, with the odd exception.

Looking at the modal share of international Rail, there is again a wide range of results for the different countries. Of the major countries, Austria has the highest share of Rail tonnes in the base year – this figure grows to nearly 50% in the Intervention Scenario. The effect of the Base Forecats Scenario in sharply reducing the share of international rail tonnes is clearly seen in all countries.

Belgium and the Netherlands are clearly the most significant countries for Inland Waterway tonnages although Germany and Luxembourg also have a large volume of tonnes. In most countries, the only test which increases the proportion of IWW international tonnages is the Intervention Scenario, whilst the other scenarios see a reduction in modal share.

Coastal shipping clearly plays a very significant role in EU international freight, particularly so for Finland, Greece, Ireland, Sweden and the UK. The picture for the Scenarios is mixed, although most countries see a decline from the 1995 position in modal share in all Scenarios, even in some cases for the Intervention Scenario, such as Finland, Portugal, and Spain.

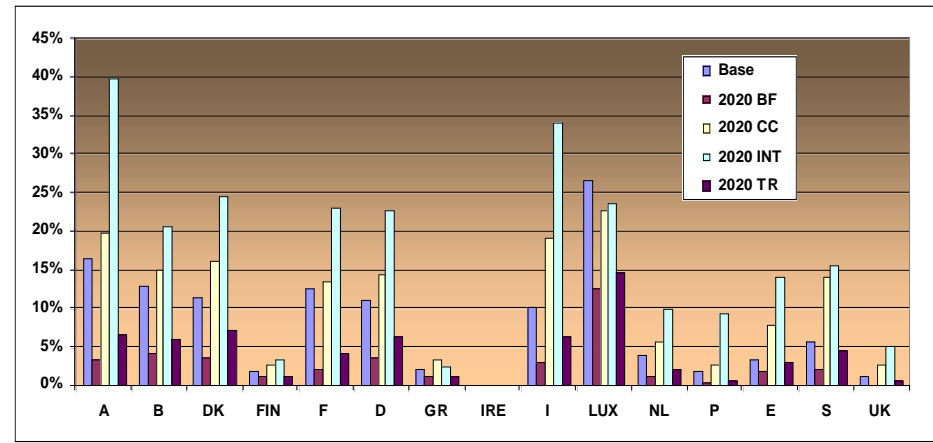
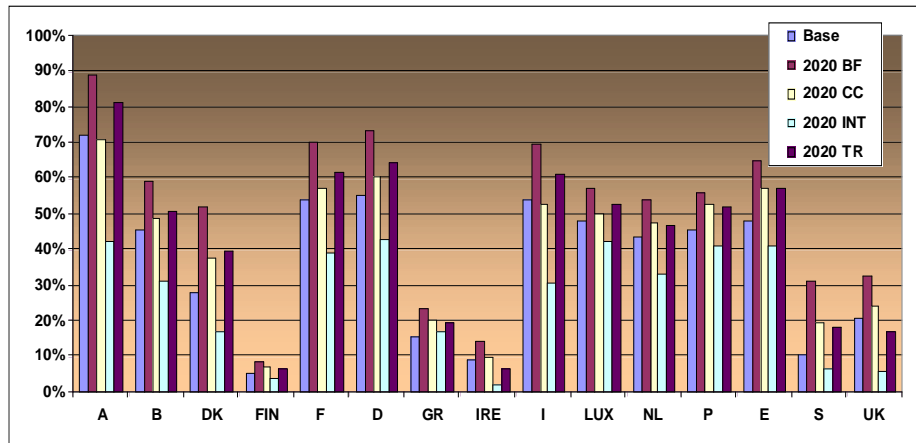


Figure 8.10 Intra-EU international - Mode split by country of receipt, Truck, Train

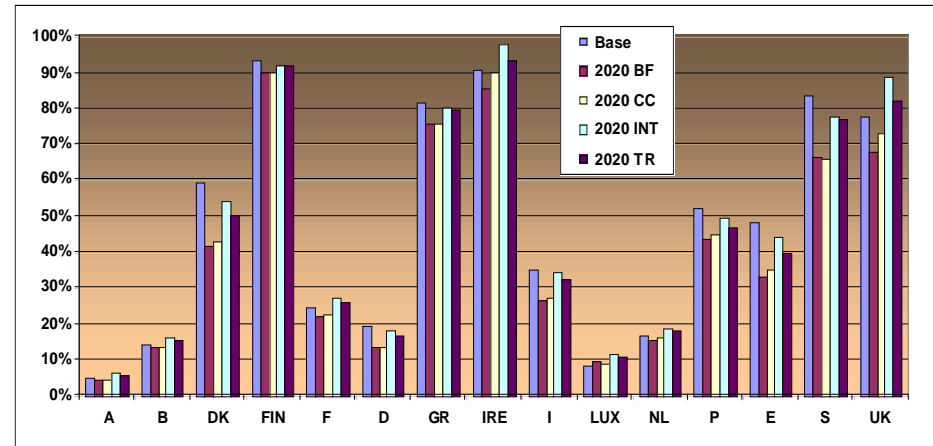
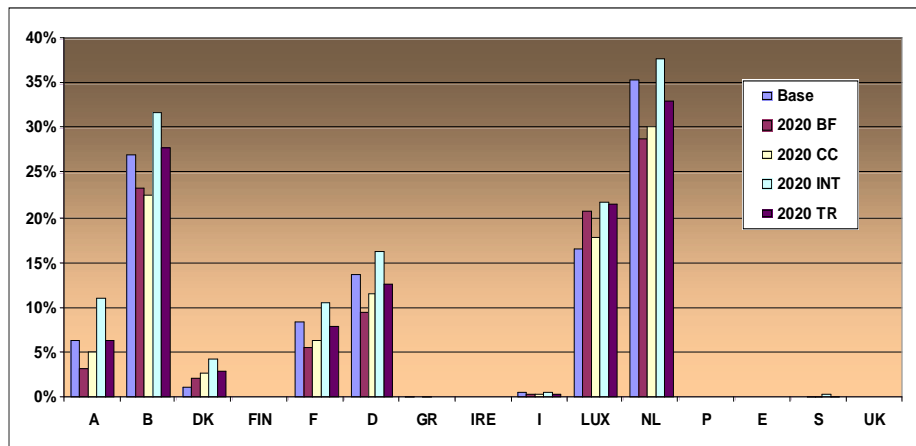


Figure 8.11 Intra-EU international - Mode split by country of receipt, inland waterway & coastal

Finally in this Section, Figure 8.12 shows the average length of haul (simply tonne-km divided by tonnes) associated with each Transport Flow for this EU national and intra-EU international traffic.

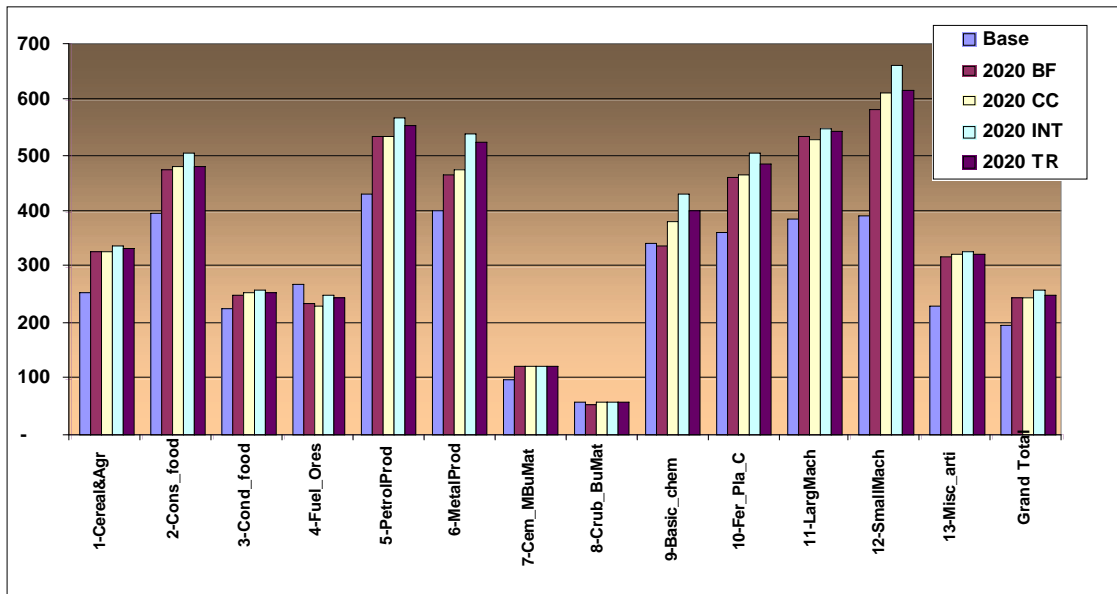


Figure 8.12 Intra-EU international and national freight by Transport Flow, average distance (km)

The increases in average distance vary widely between the 13 Transport Flows. Flows 11 and 12 in particular see large increases, whilst the bulk Flows 7 and 8 see much smaller increases. The "Total" figure above has increased from around 200 km in 1995 to approximately 250 km in 2020. This increase, together with the increase in tonnes in the modelled system gives rise to the changes in tonne-km which are reported in the next Section, 8.3.

8.3.3 Freight tonne-km by mode

This Section reports the freight Scenarios in terms of tonne-km moved on the transport networks. This can be considered by mode and country. Results by mode for each of the Transport Flows are not reported, as modes are attributed in the model based on the modal hierarchy described above. This leads to the potential for misinterpretation, e.g., a journey from Austria to the UK which uses Truck and Shipping would attribute the full distance between Austria and the UK to Shipping, rather than just the Shipping element. The tonne-km results are therefore extracted from network based rather than matrix based results, and these cannot easily distinguish between individual Transport Flows.

Figure 8.13 below shows the main results, i.e., the total tonne-km by mode travelled on EU territory for the 1995 base year and the four 2020 Scenarios. These figures include the tonne-km travelled on EU territory by import and export traffic from and to outside the EU. Also shown in Figure 8.13 are the equivalent estimates of "Observed" figures for 1995, obtained from the Eurostat "Transport in Figures" (2000) publication.

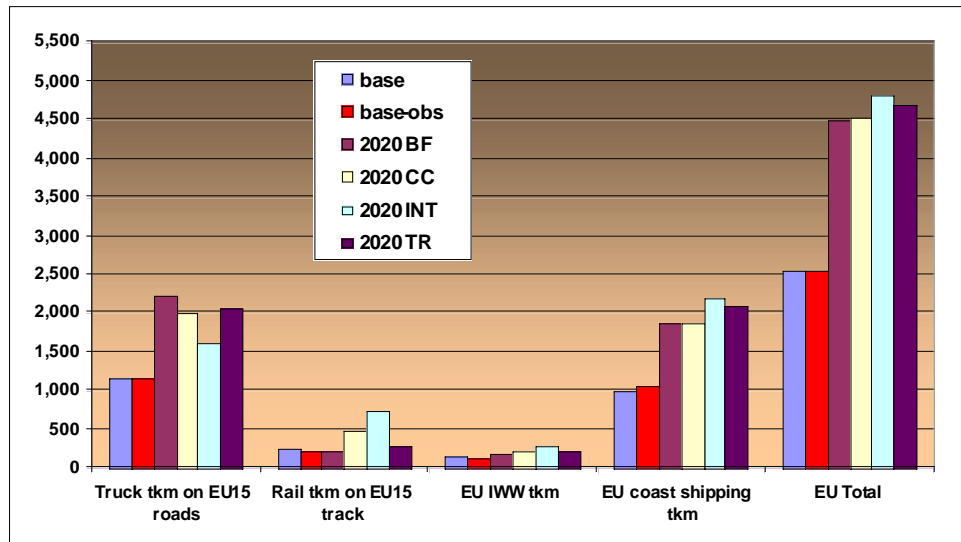


Figure 8.13 Tonne-km travelled on EU territory, 1995 & 2020, by mode (tonne-km *10⁹/annum)

This figure shows the very considerable increase which is forecast for tonne-km travelled on EU transport networks in each of the four 2020 Scenarios. Overall, the total tonne-km travelled nearly doubles between 1995 and 2020. It is initially surprising that the Scenario which sees the greatest overall volume of tonne-km is the Intervention Scenario. Detailed analysis of the results shows that with Truck being heavily penalised in this Scenario, much of the volume is diverted onto cheaper, but less direct modes such as Train and Shipping in particular. This results in a net increase in EU tonne-km for this test.

The large increase in Shipping tonne-km for all Scenarios can be attributed to the growth in international freight movements, relative to national freight which (as shown above) is forecast to grow much more slowly. The comparison between the 1995 modelled and observed figures shows that the model reproduces the base year situation well. There are also major modal differences between the four 2020 Scenarios, reflecting the cost regimes in each case. The Base Forecast Scenario sees the largest increase in Truck tonne-km and a reduction in Train tonne-km relative to the 1995 Base Year position.

The changes from 1995-2020 are shown below in Figure 8.14 as percent per annum changes in tonne-km by mode. This figure clearly shows the very high growth rate of Train tonne-km resulting from the Intervention Scenario of over 4% per year, although even in this Scenario, Truck tonne-km still grows at more than 1% per annum. For the other tests, the growth rate for Truck tonne-km is more than 2% per annum and more than 2.5% for the Base Forecasts Scenario. The overall growth in tonne-km for each of the four Scenarios lies between 2.28% per annum and 2.56% per annum.

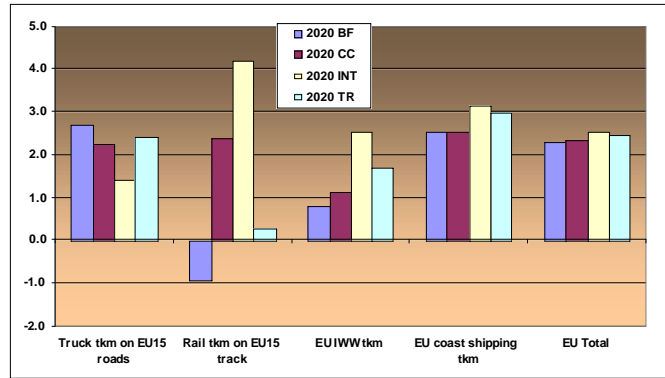


Figure 8.14 Change in Tonne-km on EU territory, 1995-2020, by mode (% per annum)

The forecasts of tonne-km moved are now presented at the country level, by mode. Firstly, figures for Truck are shown in absolute terms for the national territory level in Figure 8.15 together with the implied percent per annum changes.

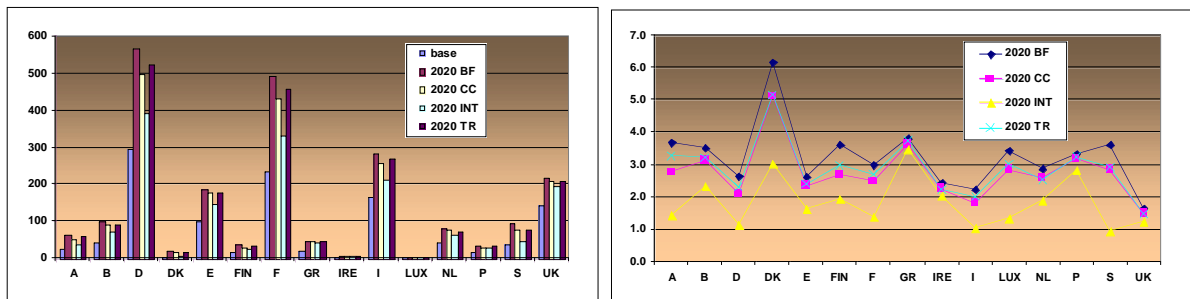


Figure 8.15 Tonne-km travelled within EU countries, Truck (tonne-km *10⁹ / annum)

Figure 8.15 clearly shows how Germany, France, Italy and the UK dominate in terms of the absolute volumes of tonne-km moved by truck on EU road networks in 1995. The growing internationalisation of freight traffic in 2020 means that Germany, France and Italy outstrip the UK for Truck tonne-km in 2020. Almost without exception, all countries encounter increases in Truck tonne-km in all the 2020 Scenarios. The general trend is seen in most countries, the Base Forecast has the highest growth in Truck tonne-km, and the Intervention Scenario has the least. In between, the Constant Cost and Trend Scenarios see more similar growth rates. There is however a wide range of growth rates between countries, with the UK in general seeing the smallest growth, and Denmark, Belgium and Portugal seeing the largest growth rates. The same figures for forecasts of Train tonne-km by country are now shown in **Figure 8.16** below.

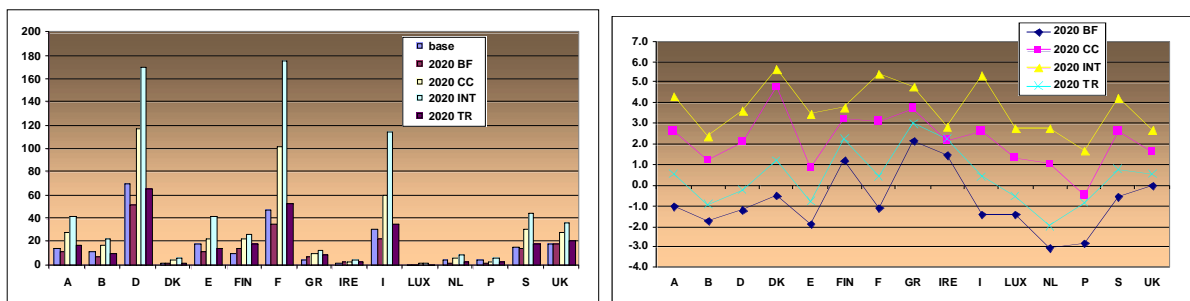


Figure 8.16 Tonne-km travelled within EU countries, Train (tonne-km *10⁹ / annum)

The country level figures show that Germany, France and Italy have by far the largest amounts of tonne-km within their borders for the Intervention and Constant Cost Scenarios. The Intervention Scenario in particular produces very large volumes of rail tonne-km in France. The caveat here is that there are no rail capacity restrictions represented on the networks, so this result is pure demand. Figure 8.16 shows the equivalent growth rates in rail tonne-km at the national level.

There is a very regular pattern here, with the growth in rail tonne-km increasing in virtually all countries as the tests go from Base Forecasts to Trend to Constant Cost and finally Intervention. The Base Forecast Scenario sees a decline in rail freight in all countries except Finland, Ireland and the UK whilst the Trend Scenario has a more even spread between countries increasing and decreasing rail tonne-km.

8.4 Combined 2020 Model Network Flows

The 1995 modelled road network flows were presented previously, at the EU and country level. Here, the Passenger and Freight 2020 Scenarios are combined and presented together with the 1995 results. In this way, an indication of the likely future traffic levels on the European road network can be established.

The Scenarios are combined as follows:

- Passenger "Constant Cost" and Freight "Constant Cost" [CC],
- Passenger "Radical" and Freight "Intervention" [Rad-Int],
- Passenger "Long Term Trend" and Freight "Trend" [TR], and
- Passenger "Income Tracking" with Freight "Base Forecast" [IT-BF].

The last combination of Scenarios is clearly the least satisfactory of the four, the first three being more internally consistent, but is included in any case for illustrative purposes. The aggregate results are shown in Table 8.17 below. This table shows the percentage of road network kilometres in the EU which carry each range of traffic, e.g., in the Constant Cost combined Scenario (CC), 14.5% of the road network carries between 20,000 and 30,000 pcu / day. Note that the intra-zonal links are not included in these calculations.

Table 8.17 Proportion of network km by transport flow, combined 2-way flow, 1995 & 2020

	'000 pcu / day							Grand Total
	<10	10-20	20-30	30-50	50-70	70-100	100+	
Base	38.1	21.9	12.9	14.5	5.4	4.1	3.2	135,580.5
CC	27.5	18.0	14.5	16.9	9.0	6.7	7.3	142,134.9
TR	25.8	16.9	13.7	18.1	10.2	6.9	8.4	142,134.9
Radical / Intervention	31.9	19.8	12.6	16.6	8.2	5.0	5.9	142,134.9
IT_BF	24.2	16.9	14.2	18.9	10.9	7.0	7.9	142,134.9

This Table illustrates the very significant increase in road traffic associated with the growth in travel forecast in all of the Forecast Scenarios. It also shows the increase in the network from 1995 to 2020 associated with new road construction and upgrading. Looking at the flows, from the 30,000 to 50,000 pcu / day range onwards, all Scenarios see an increase in the percentage of network-km found in these traffic volume ranges. The combined "Trend" Scenario leads to the largest kilometrage of road with flows of greater than 70,000 pcu / day. Conversely, the combined "Radical-Intervention" Scenario sees the fewest network kilometres experiencing this level of traffic – but even in this Scenario, there is a significant increase from the base year.

Figure 8.17 overleaf shows the EU figures as in Table 8.17 above, but differentiated for each of the four road types: toll motorway, motorway, dual carriageway and other road.

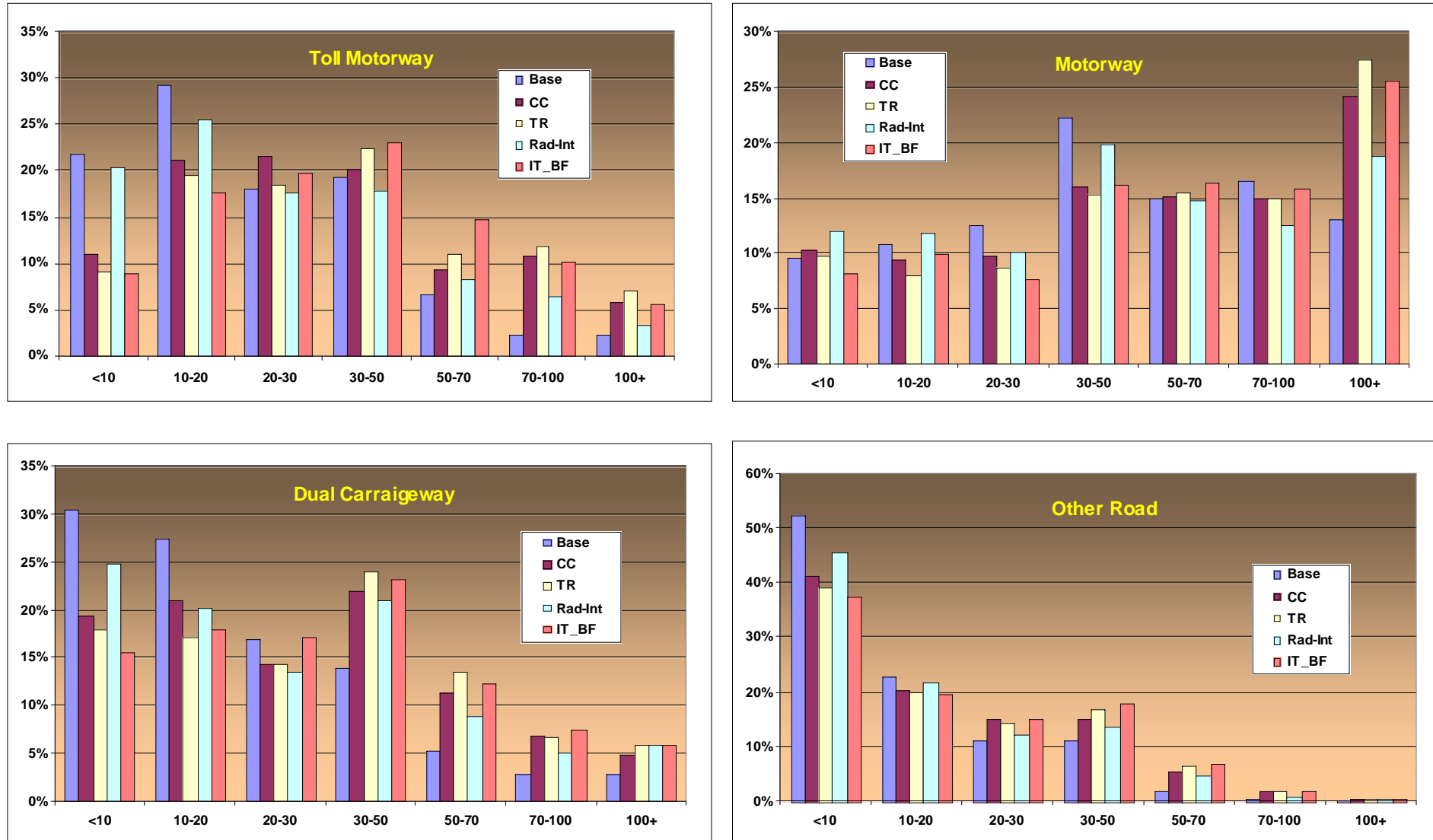


Figure 8.17 Percentage of EU road network km by traffic volume, 1995 and 2020, by Road Type

Work Area 12

9 INTRODUCTION TO WA 12

WA 12 explores specific scenarios and uses a set of modelling tools, the so-called "modules" in the project definition, in order to show how alternative hypotheses might influence the transport system in the future.

It builds on the work realised in WA 10 on the collection of information and on the drivers of transport demand, and on the work in WA 11 on the development of a European-wide model. Based on a set of contrasting scenarios the WA 12 focuses on structural changes and spatial development patterns to explore how these affect the different components of the transport system. In that sense WA 12 provides a complementary approach to that in WA 11. In WA 11 different forecasts of transport are produced around a single reference situation. These transport scenarios estimate how the future transport patterns would vary as a result of differences in input policy variables, mainly the transport cost inputs. In WA 12 in contrast the emphasis is to estimate the importance of structural changes and of their impact on traffic growth for different modes.

The approach used here is inspired by the work in the Deliverable C5 "Global Reference Scenarios" developed in the earlier SCENARIOS project to provide a clear methodology for scenario construction. A variety of scenarios have been built up by exploring a series of different dimensions in separate work streams. Then the results of these have been drawn together in a coherent fashion.

A **scenario** can be defined as

the description of a future situation (or final image) of the external socio-economic environment and the associated transport system.

Scenarios can be produced to give a number of contrasting images of a future situation through the development of different hypotheses. Two major dimensions of the construction of scenarios have been distinguished in this study

The external (socio-economic) dimension: this comprises the range of external factors (economic, institutional, social, behavioural, technological, geographical) that will influence the future pattern of transport. To a large extent the evolution of these factors is outside the control of the transport policy maker, though they may be influenced by policy decisions outside the field of transport.

The transport policy dimension: this comprises the range of policy initiatives within the field of transport, e.g. pricing, regulation, investment, etc. that the transport policy maker may wish to explore.

Within the external dimension the two main aspects that have been investigated are:

- the **spatial** dimension of Europe and the regional spatial dynamics of an extended Europe. For this dimension two main spatial development scenarios were developed: one which is termed the "Euroland" scenario is a radial development scheme in which the industrialised core of the EU is the centre, the contrasting alternative scenario is a "multi-polar" scheme based on the revival of regional links within an enlarged European space
- the dimension of **structural changes in behaviour:** this includes both the behaviour of passengers through changes in car ownership and attitudes to car use, and the behaviour of companies through changes in their forms of organisation and logistics. For this dimension, two main behavioural

scenarios were developed: one is termed the "Unrestricted", the alternative is the "Quality of Life" scenario.

These two dimensions are described in detail in the SCENES Deliverables 5a and 5b respectively, which present the results of scenario investigations into spatial and structural change in Europe through to the year 2020. The objectives are to produce contrasting external scenarios on European spatial development, focusing on regional developments; and to analyse and test the implications of behavioural and structural change for passenger and freight transport in Europe.

In the construction of internally consistent scenarios reference is made to two major trends that are relevant to, but uncertain for the future. These trends provide a common framework for the various scenarios and have impacts on many behavioural changes:

- **Globalisation:** this corresponds broadly to the "Radial Development – Core of EU" spatial scenario and to the "Unrestricted" behavioural scenario
- **Regional integration:** this corresponds broadly to the "Multi-Polar Development" spatial scenario and to the "Quality of Life" behavioural scenario.

The trends are based on contrasting globalisation and liberalisation on the one side with local sustainability and protection of the environment on the other side.

The investigations within the transport policy dimension placed particular emphasis on two major topics discussed in the Commission's recent White Paper (2001) on European Transport Policy for 2010, namely:

- infrastructure charging policy and the consequences on modal equilibrium
- the harmonisation of national policies and the consequences on modal equilibrium.

The Alpine Crossings and the TINA network have been taken as case studies in order to show the relevance of the approach. The extension of East-West corridors from EU countries and major cities through to Eastern countries have also been chosen as application case studies in order to illustrate the spatial dimension for projections up to 20 or 30 years from now, and to show that a link can be made in the long run between a European vision of the future and concrete localised projects. The two corridors that were studied are

- Paris – Brussels – Berlin – Warsaw – Moscow
- Marseilles – Milan – Venice – Ljubljana – Budapest

These case studies and the associated transport policy scenarios are described in detail in the SCENES Deliverable D8.

In the chapters below the main tasks carried out in the WA 12 are summarised in turn. The development of the set of contrasting external scenarios is presented in the Chapter 10, then the set of transport policy scenarios and the associated case studies are presented in the Chapter 11. The Chapter 0 then draws together the various themes of the earlier work.

10 EXTERNAL SCENARIOS DEVELOPMENT

The external scenarios have been constructed by analysing the different dimensions of the scenarios individually and then integrating these dimensions together for a time horizon of 2020. The different strands in this process are outlined in turn below.

10.1 Implications of Behavioural Changes on the Definition of “Global” Scenarios

Research on implications of behavioural changes relevant for passenger and freight transport has shown that these behavioural changes have a considerable impact on the demand for transport services and on mobility patterns. Therefore it is essential to take behavioural changes into account when defining the "global" scenarios in use in SCENES. This section outlines the methodology used to implement the behavioural changes in the "global" scenario. Since the "global" (example for different kinds of parentheses) scenario cannot consider all of the behavioural changes that have been identified, the main intention below is to develop an appropriate approach for packaging these behavioural trends.

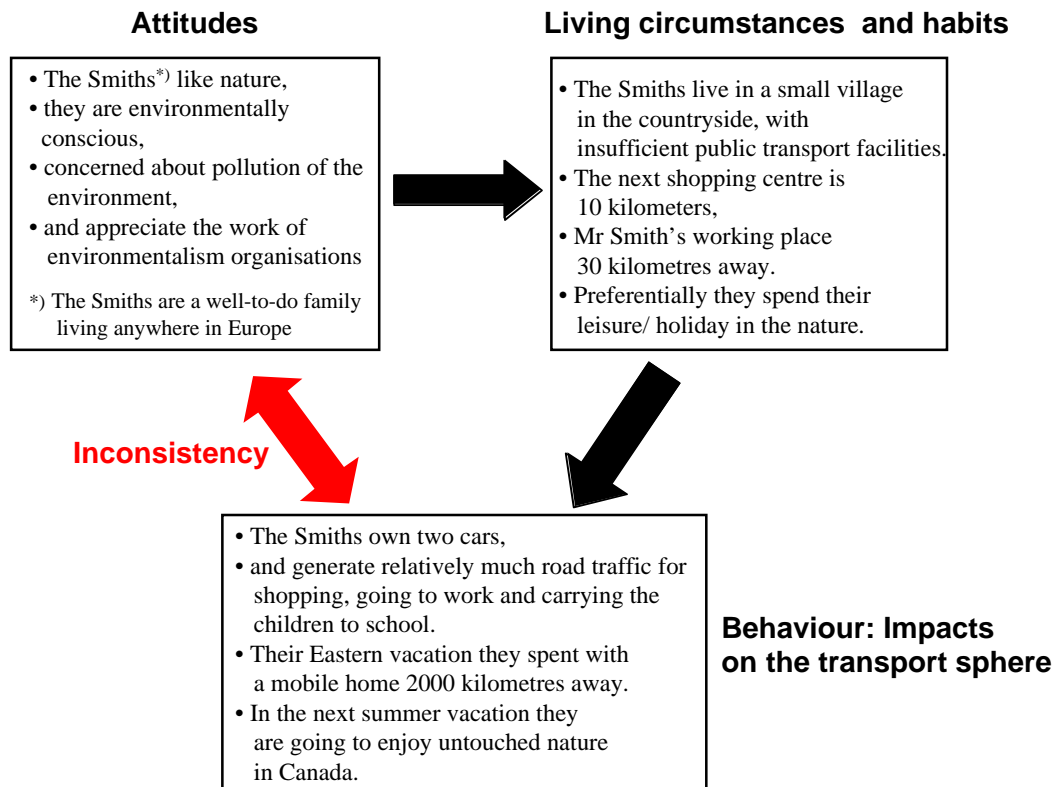


Figure 10.1 Possible inconsistency between behaviour and attitude - example for transport

Source: SCENES Workshop on behavioural trends. Karlsruhe 2000 (IWW, Eckhard Szimba).

Behaviour in relation to passenger transport depends on mobility behaviour of *individuals*, while behaviour in relation to freight transport depends mainly on behavioural patterns of *organisations*

(companies). Therefore the approach follows the distinction between the behaviour of individuals and of organisations made in consumer behaviour theory⁹.

Behaviour can be defined as "a consumer's actions or intentions with regard to an attitude object" (Solomon, 1996). In the case of passenger transport, behaviour implies every kind of mobility pattern, e.g. selection of destinations, modes, routes, tariffs, and so on. However, the concepts "behaviour" and "attitude" must be distinguished. "Attitude", which can be defined as "a lasting, general evaluation of people, object or issues" (Solomon, 1996), influences behaviour, but can also differ significantly from actual behaviour. An example, which refers to the transport sphere, is illustrated in Figure 10.1.

10.1.1 Behavioural changes identified for passenger transport

For passenger transport a number of important trends have been identified within the SCENES workshop at Karlsruhe as listed in the Table 10.1. The implications of these have been explored within into modules discussed later in the current chapter.

When scrutinising these behavioural trends the driving forces behind them can be differentiated. A trend like "Increasing environmental concern and responsibility" hints at changes in individuals' attitudes and refers rather directly to behavioural issues, while a trend like "Migration within Europe" is a more exogenous trend less closely related to behaviour. Therefore exogenous and endogenous trends can be differentiated.

Exogenous and endogenous trends

Mobility behaviour can be described as the result of an interactive, complex decision process being determined by exogenous factors and endogenous factors. Seen from an external point of view mobility behaviour is closely linked to the following spheres:

- Policy (land use policy, transport policy, environmental policy)
- Economy (economic growth, GDP per capita, employment, economic cohesion etc)
- Society (importance of societal values, like environmental awareness, freedom, social responsibility, unlimited mobility etc.)
- Transport supply parameters (tariffs, availability and quality of infrastructure, comfort, travel time, reliability of modes etc.)

Policy, economy variables and variables describing societal values as well as transport supply parameters, can all be considered as exogenous factors, since these factors have indirect impacts on the behaviour of individuals. It is rather obvious that mobility behaviour is indirectly determined to a considerable extent by such exogenous factors: the time available for mobility is dependent on the working hours, the budget available for mobility depends on the general economic situation, income and taxes. Also policy issues, like transport policy and land use policy, have a relevant impact on mobility behaviour. Furthermore, ethical and societal values prevailing in a society influence individuals' mobility behaviour. Finally, transport supply parameters, such as travel costs, travel time, punctuality, comfort, reliability of modes as well as the availability and quality of transport infrastructure have an impact on the mobility behaviour of individuals.

Apart from these exogenous factors there are endogenous factors, which refer to the individuals' point of view. Seen from the individuals' point of view (mobility) behaviour is influenced by at least following endogenous items:¹⁰

⁹ See e.g. Williams, K. C.: Behavioural Aspects of Marketing. Butterworth Heinemann, Oxford, 1992; Solomon, M. R.: Consumer Behavior. Prentice Hall International, New Jersey, 1996; Bänisch, A.: Käuferverhalten. Oldenbourg Verlag München Wien, 1993.

- Social status
- Affiliation to a social class
- Culture
- Affiliation to groups
- Position in the family life cycle
- Life style, which implies
 - Activities, like work, hobbies, social events, vacation, shopping
 - Interests, like family, home, job, community, fashion
 - Opinions concerning social issues, politics, economics, education, future, mobility issues
 - Demographics, like age, income, education, occupation, family size, dwelling, city size, stage in life cycle.

The most relevant exogenous and endogenous factors and their interrelations are pictured in Figure 10.2.

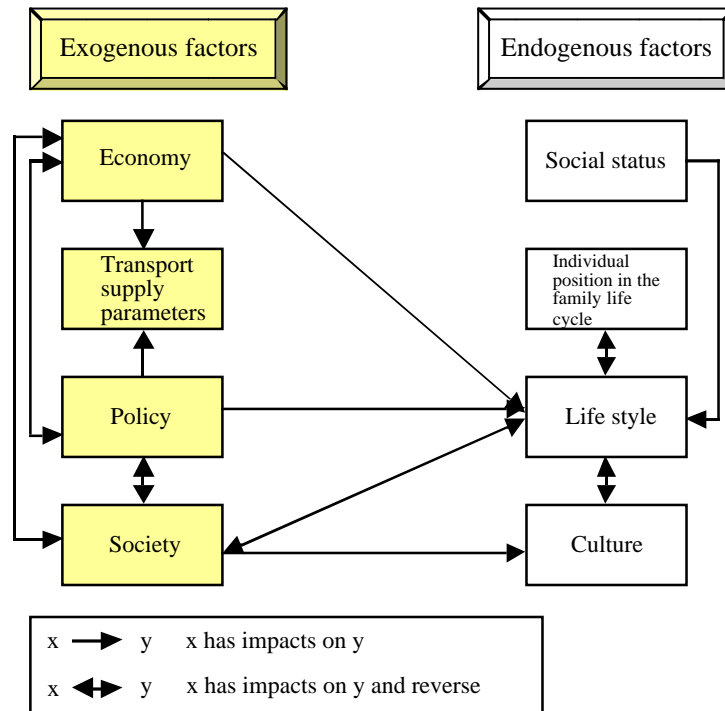


Figure 10.2 Exogenous and endogenous factors influencing mobility behaviour

Assignment of behavioural trends to exogenous and endogenous factors

Now the behavioural trends are assigned to the exogenous and endogenous factors described in the previous section. The Table 10.1 gives an illustration of which behavioural trends are caused by which exogenous/ endogenous factors.

¹⁰ See also Williams, K. C.: Behavioural Aspects of Marketing. Butterworth Heinemann, Oxford, 1992.

Generally speaking, the exogenous factors have more influence on the behavioural trends than do the endogenous factors. In order to be able to represent in the "global scenario" the behavioural trends that have been identified, assumptions are necessary about economy (GDP growth, employment, economic cohesion), policy (transport, land-use, environmental policy) and transport supply parameters (tariffs, level of service, infrastructure). Assumptions about societal values are relevant, but less important. As far as exogenous factors are concerned, assumptions about (changes in) life style are required in order to represent the behavioural trends identified, while the consideration of changes in social status, culture and the position in the family life cycle seems to be less important.

Table 10.1 Passenger exogenous/endogenous factors, implications on behavioural trends

	<i>Behavioural trend is caused by which factor(s)</i>	Exogenous factors				Endogenous factors			
		Economy	Policy	Society	Transport supply parameters	Social status	Culture	Position in the family life cycle	Life style
Behavioural trends	Urban sprawl		xx		x				xx
	Increasing environmental concern and responsibility			x			x		xx
	Increasing average number of trips per day	x		x	x				xx
	Increasing number of cars per household	xx	x	x	x	x	x	x	x
	Increasing importance of P&R facilities		x		xx				x
	More flexibility and diversification of activities	x			x				xx
	Immigration surplus	xx	xx						
	Migration within Europe	xx	x	x					
	Car sharing and car pooling			x	x				xx
	Decreasing population			x					
	More business trips	xx							
	Shopping malls	xx	x	x	x				xx
	Diversification of firm location by sector	xx	x		x				
	Development of ICT in the area of traffic management	xx	xx		x				
	Increasing production and incomes	xx	x						
+ implication exists		++ strong implication exists							

10.1.2 Behavioural changes identified for freight transport

For freight transport important trends have also been identified within the SCENES workshop at Karlsruhe. These are listed in the Table 10.1.

For the most part freight transport is generated by companies; thus in contrast to behavioural trends in the passenger transport market the behaviour of an *organisation* will be subject to discussion here. As for passenger transport, the exogenous and endogenous factors underlying behavioural changes can also be distinguished for freight transport. The most important exogenous factors are

- Economy (economic growth, trade, global economic situation etc)

- Competitive pressure
- Policy (transport/ land-use/ environmental policy, (de-)regulation)
- Culture
- Society
- Transport supply parameters (tariffs, availability and quality of infrastructure, transport time, reliability of modes, etc)

The endogenous trends refer to the behaviour of companies. The most important endogenous behavioural patterns are

- Increase in a company's size
- Diversification into new areas of business
- Changes in the background, training and occupation of employees
- Production technology, distribution and procurement policy

The trend "technological innovation" can be seen either as endogenous factor (in case the innovation is generated by the company in question itself) or as exogenous factor (in case innovation comes from outside). The Figure 10.2 illustrates the (inter-)relations between the two sets of factors.

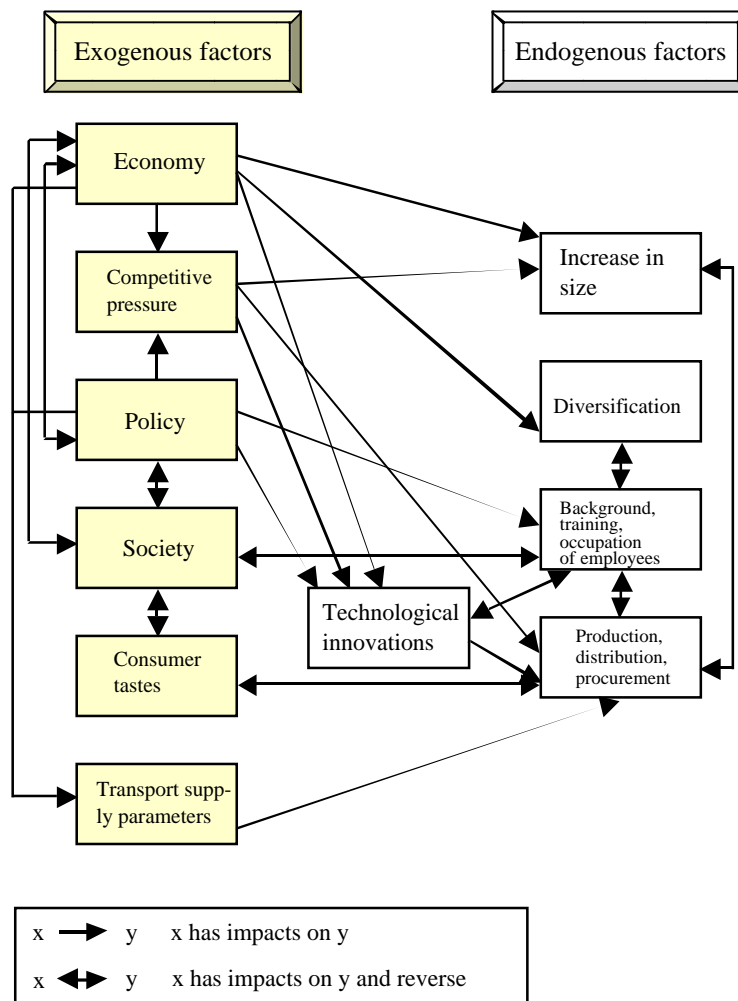


Figure 10.3 Exogenous and endogenous factors influencing behaviour of freight transport

Assignment of behavioural trends to exogenous and endogenous factors

The implications of the exogenous and endogenous factors described in the previous paragraph on the selected behavioural trends are summarised in the Table 10.2 which contains an allocation of exogenous/ endogenous factors to behavioural trends.

Table 10.2 Freight exogenous/endogenous factors, their implications on behavioural trends

Behavioural trends	Behavioural trend is caused by which factor(s)	Exogenous factors						Exo./Endo.	Endogenous factors			
		Economy	Competitive pressure	Policy	Society	Consumer tastes	Transport supply parameters		Increase in company size	Diversification	Background, training, occupation of employees	Production, distribution, procurement
	Global sourcing	xx	xx				xx	x	x			xx
	Single sourcing	xx	xx							xx		xx
	Global production and geographic specialisation	xx	xx	x			xx	x	x			xx
	Specialisation of production, economies of scale	x	x									xx
	Higher product values, dematerialization			x	xx	xx		xx			x	
	Shorter product life cycles				x	x						
	Production on order		x			x	x	x				xx
	Industry settles in less dense populated areas			x			x					x
	Centralised stocks		x	x			x					x
	Outsourcing of transport and distribution		xx									xx
	JIT		xx				xx	xx		xx		xx
	Reverse logistics		x					xx				xx
	Combined distribution centres	x		x			xx					x
	New distribution centres						x					x
	Standardisation of load units and packing		x	xx								
	Growing degree of containerisation			x			xx		X			x
	Distribution by night		x				x					xx
	24 hour economies		xx	x	x	xx		x				x
	Shorter order times		xx			x		x				xx
	Increasing share of large retailers		x				x		X			xx
	+ implication exists ++ strong implication exists											

The results show that from the set of exogenous factors, the most important ones in terms of representing the behavioural trends in freight transport are: economy, competitive pressure, policy and transport supply parameters. Competitive pressure has a strong impact on the selected behavioural trends. For the most part, competitive pressure is accelerated by European integration and by the process of globalisation. An enlargement of the EU and further globalisation will most probably induce a strong push towards increase in competitive pressure.

Turning to endogenous factors, the most relevant drivers are production technology as well as the distribution and procurement policy of companies. Also technical innovations, which can be considered as both exogenous and endogenous factor, are responsible for several behavioural trends.

10.1.3 The definition of Global Scenarios

The implementation of behavioural changes within different modules, as discussed in the Section 10.3 has shown that the assumed behavioural trends do have relevant impacts on the transport sphere (in terms of changes in the average number of trips, average trip length, transport distance, transport volume, transport performance). Thus there is a need to cover these various trends within the "global" scenarios that are defined.

The approach applied when packaging together the great variety of behavioural changes leads to the following recommendations:

- Many behavioural trends for passenger and freight transport can be covered by detailed sets of assumptions concerning exogenous trends, these are:
 - Economy: economic growth, expansion of employment, growth of GDP/ income per capita
 - Policy: assumptions concerning land-use, transport and environmental policy; assumptions in respect of regulative measures or measures aiming at deregulation
 - Transport policy supply parameters: assumptions about the evolution of costs, travel times, level of service, availability and quality of infrastructure
- Mainly in respect of freight transport, but also of some relevance to passenger transport, assumptions about the future pace of globalisation are necessary. Within the set of exogenous factors the factor "competitive pressure" is mainly driven by globalisation. Globalisation/ European integration has been identified to be of the main driver of the increase in demand for freight transport.¹¹
- As far as endogenous trends are concerned the factor "life style" has proved to be an important factor in terms of covering behavioural trends in the passenger transport market. With regard to freight transport the most important endogenous trends are the companies' production technology as well as distribution and procurement policy.

To enable them to be implemented in the modules the behavioural trends identified in passenger and freight transport have been packaged together by the generation of two types of scenarios: "Unrestricted mobility/ non-constraint scenario" versus "quality of life/ sustainable development" scenario. The main assumptions of the unrestricted mobility and non-constraint scenario as well as of the quality of life and sustainable development scenario are comparable.

When implementing the behavioural changes in two contrasting "global" scenarios, it might be appropriate to develop two contrasting scenarios, which focus on a factor, which has impacts on many behavioural trends: globalisation. Thus a "globalisation" scenario could be generated, which contrasts

¹¹ See SCENES Deliverable D3a: Drivers of Transport Demand -Western European Countries-", Karlsruhe, 2000.

with a scenario on "regional integration"¹². The assumptions of the globalisation scenario could describe a development with high economic growth rates, unrestricted land-use, deregulation in the transport sector, globally oriented distribution and procurement policy of companies, which is enabled by intense use of new information and communication technologies, as well as a globally oriented life style of individuals (which has impacts on travel behaviour). Assumptions for this scenario are very similar to those of the "unrestricted mobility" scenario.

On the other side a scenario on "regional integration" could be defined, in which the acceleration of regional production compounds the regionally oriented procurement and distribution policy of companies. This scenario would also assume responsible/ restrictive land use and environmental policies, as well as a regionally oriented life style of individuals (home and work locations being adjacent, regionally oriented leisure and holiday behaviour, environmental awareness).

Accordingly to provide a framework for the scenario development, two decisive external trends were selected, in order to construct internally consistent scenarios. The main aim was to identify contrasting trends which were both relevant and uncertain in the future, and which are therefore of particular interest to policy makers.

The two contrasting trends selected have been entitled "globalisation" and "local sustainability". Each trend corresponds to a set of values, such as unrestricted individual freedom, or local quality of life, and is associated to a specific set of transport policy measures. The elaboration of these external trends was inspired by the Questa project, undertaken by the Dutch Ministry of Transport¹³

The Figure 10.4 illustrates these two major trends which are explained in more detail below.

10.1.4 Globalisation Trend:

"Globalisation is a term which aims to express a widening of activity patterns from local, regional or national origins towards a world-wide action radius."¹⁴ The trend also refers to the development of a new kind of "global management", which means that decision processes are increasingly dependant on each other. Strategic decisions, taken at an international level, would aim to increase free trade and mobility, thus accelerating cross-border flows of trade, investment and financial capital.

For the spatial and behavioural scenarios studied in this report, a scenario inspired and guided by this globalisation trend was defined. The behavioural scenario on globalisation, which is entitled the "**Unrestricted**" scenario, aims to analyse and test the effects of globalisation for passenger, freight and local transport.

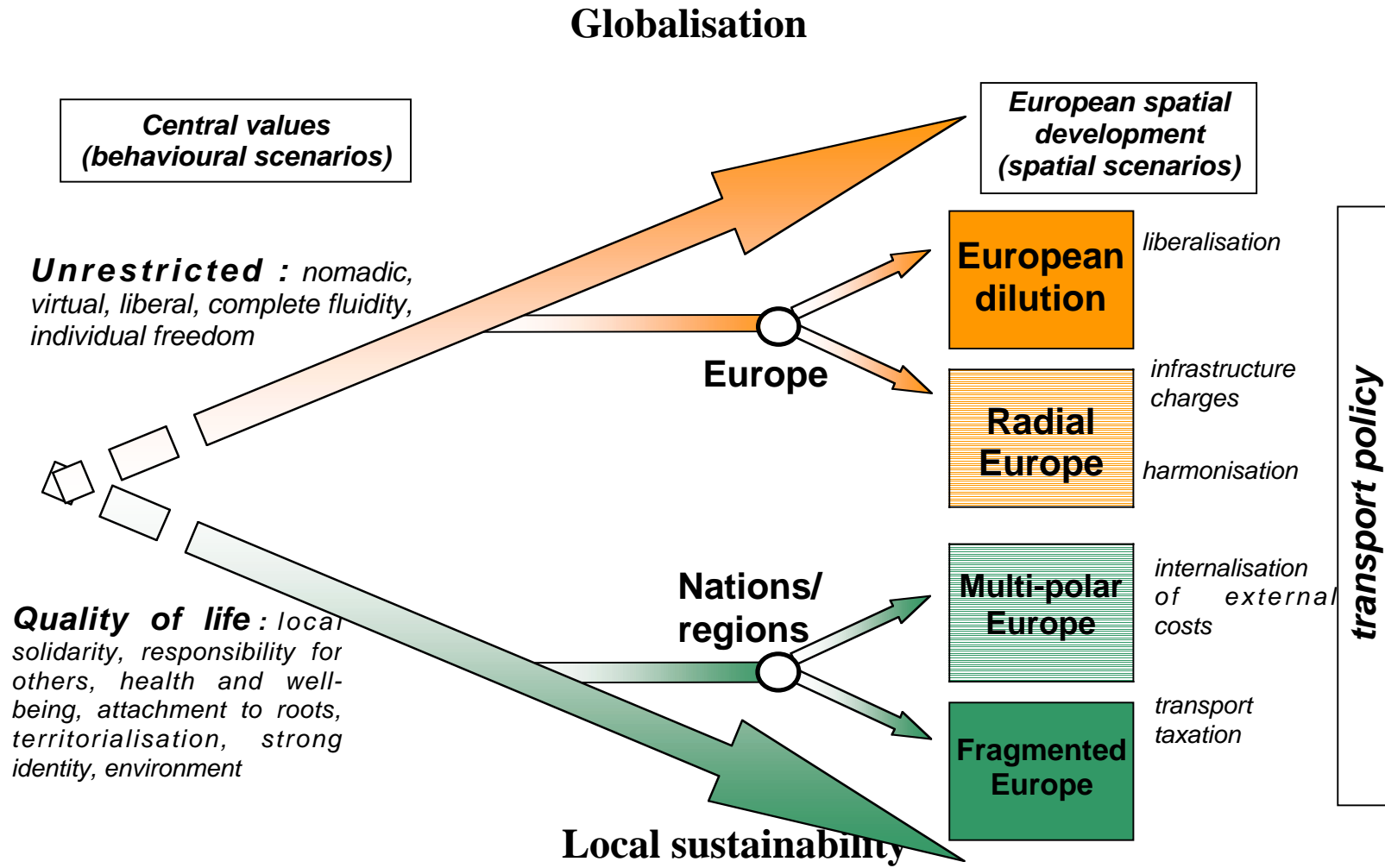
The research into the spatial and behavioural scenarios was greatly influenced by the work of the Questa project, which presented a detailed overall scenario of the possible results and changes brought about by globalisation, as given in the example below:

¹² See conclusions of research on "Changes in trends" in SCENES Deliverable D3a: Drivers of Transport Demand -Western European Countries-", Karlsruhe, 2000.

¹³ Ministry of Transport and Water Management (1998) Project Questa : Movement in the Future (in Dutch). This Questa project describes four scenarios for the Netherlands and translates each scenarios into mobility forecasts for the Netherlands up to 2030

¹⁴ P.Nijkamp,H.Van Delft, H.Geerlings, D.Van Veen-Groot, (2000), "Transportation between Globalization and Localization"; *Innovation*, vol.13, n°1.

Figure 10.4 The defining trends for the spatial and behavioral scenarios



transport policy

“Europe would be able to take optimal advantage of international trade and technological progress. Individual freedom of choice for citizens then becomes of prime importance. In parallel economic freedom and the liberalisation of world trade would help the economy to boom with everyone sharing in work and money.

Demand and supply would determine developments, and the supply of labour would diminish because of shorter working weeks and a decrease in the number of labour years. The growing economy resulting in a tighter labour market would solve its shortage of labour by attracting foreign employees.

In terms of transport, a globalisation scenario would see volumes of raw materials and semi-finished goods increase considerably because of the distribution of chain activities all over the world. The transport of finished goods would also increase since goods are increasingly produced and assembled at a greater distance. Road transport would dominate in Europe, and intercontinental traffic air transport would increase its share. Passenger mobility would also increase, especially for social and recreational purposes. Individual transport (car) dominates and choices are based on economic motives.”

10.1.5 Local Sustainability Trend

This trend envisages a strengthening of local and regional diversity and culture, in contrast to the above globalisation phenomenon. It is also associated with aspirations for a different quality of life with more emphasis on ecological issues. In contrast to the Globalisation trend, the Local Sustainability trend is characterised by policy decision-making at a regional level, rather than an international level.

However, in this scenario trend, there is the risk that free trade would be hampered by regional protectionism, which would restrict the integration of production. The efficiency and effectiveness of the transport system could also be impeded by regional standards and policies that restrict the development of international transport networks.

The behavioural scenarios, entitled "**Quality of Life**", aim to analyse and test the effects of locally orientated transport policies and behavioural trends that aim to minimise the environmental impact of transport.

Again, an example from the Questa project, gives an idea of the effects of the Local Sustainability trend in terms of values, economic, social and spatial impacts.

“Environment and health: these are the central values in life. Citizens and companies are aware of the fact that their actions have a direct impact on the environmental and social well-being of the world and therefore on their own well-being. Immaterial values have a higher priority than material success. Success is therefore not related to income and possession, but to health and social behaviour. Sustainable development is a condition for personal well-being and that of fellow citizens.

Economic differences between nations and continents are reduced; the economy develops world-wide at a stable pace, world trade is flourishing and there is good international co-operation with focus on sustainability. Population grows above average as a result of confidence in a sustainable future and a higher life expectancy, this is due to healthier lifestyles and improvements in medical science; migration increases. Shorter working weeks and increased tele-working lead to an increase in recreation and visits and there is a decrease in holiday trips to remote destinations. At the same time there is a decrease in distance between locations for living and working with the development of housing and economic activities in urban areas and along major corridors.

For freight, the world-wide transport of luxury goods decreases considerably. Production and consumption grow because of the increase in wealth and population, but the number of movements per product decreases. The reason for this is that the transport distance per product decreases and that better load factors are realised in transport. For passengers, there is an increase in the use of collective transport systems for passengers, especially in urban areas, which results in less car traffic. Cars are cleaner and road infrastructure is utilised better because of automatic vehicle guidance. Transport of passengers over longer distances is mainly performed by high speed trains.”

10.2 European Spatial Development Scenarios

The objective here is to explore the spatial aspects of European development for a set of geographically defined zones. The analysis of the potential for the further integration of or for the opening up of Europe is then used to identify the resulting impacts on the transport system.

As part of this development of these external scenarios **5 regional zones** were defined in order to explore the spatial aspects in more depth across Europe:

- the Industrialised Core of Europe
- Baltic Sea Area
- Balkans and East Mediterranean
- Western Mediterranean
- Central and East European Countries.

For each of these regional zones the SCENES partners have reported detailed scenarios, based on their knowledge of national and regional prospects. These scenarios outline within a harmonised framework the evolving characteristics of these regional zones in terms of their demography, economic growth and concentration of activity, foreign trade, tourism, transport supply and infrastructure, patterns of freight distribution and logistics, inter-modal transport chains and finally transport policy.

This information has been used to elaborate **Spatial scenarios** for two radically different patterns of European spatial development as shown in the Figure 10.4.

- The **Radial Development Scenario** focuses on the integration and opening of Europe and is built up around the first of the above regional zones, the Industrialised Core of Europe
- The **Multi-Polar Scenarios** focus on a regional re-orientation of trade patterns and cover the other four regional zones.
- These spatial scenarios underline the heterogeneous nature of the European economic space, by taking into account the different regional trade patterns, distribution of economic growth, transport networks and regional policies, as well as the different objectives and constraints of different regions within the EU.

For the elaboration of the SCENES regional scenarios, the European Commission report, “Scenarios Europe 2010 (Five Possible Future for Europe)” (Bertrand et al, 1999), on possible paths for European integration, was used as a foundation document.

10.2.1 Integration of Europe: Euroland - the Radial Development Scenario

The Radial Development Scenario is closely linked to the globalisation trend and explores the implications of a radial development of Europe from the central “Industrialised Core” of the EU,

outwards in concentric circles, particularly through the influence of monetary union in increasing the competitiveness of regional economies across the EU.

Traditionally, the bulk of both heavy industries and other manufacturing in the European Union is concentrated in the industrialised core: the wide area that includes the main metropolitan areas in the UK, the North East of France, Belgium, the Netherlands, Denmark and the former Federal Republic of Germany down to Northern Italy passing through Austria and Switzerland. Both services and agricultural production are well represented in most industrialised regions. Some 200.000 million people inhabit this area, which exhibits a strong concentration of production and quite specific clusters of regional specialisation in industry, services and agriculture.

In the Radial Development Scenario as a result of the longer term success of European Monetary Union (EMU), the peripheral regions and the less industrialised regions, of the EU are assumed to become more productive/attractive to investors, allowing them to develop faster. This results in a more even spread of interregional trade and to a lessening of economic inequalities between the regions across the EU.

The general model in which economic growth spreads from the core to the periphery of the Union within a “divergence toward convergence” pattern can be explained in more detail by assuming that growth in production and employment may further consolidate around existing clusters in those industrial sectors that need qualified labour, specialised sub-contractors and services. Where factors that make clusters competitive are combined with proper conditions in terms of quality of life (housing, education as well as good infrastructures) they can also become an attractive location for high tech firms, the sector in which Europe is trying hard to reduce the present gap with the US.

Also an exploration on the potential for different industries to become/remain global, European, national or just regional can be linked to or derived from past trends. For transport intensive manufacturing, the process of internationalisation is close to completion in capital intensive industries, such as automotive and petrochemical. In the presence of a steady decline in the value of production in heavy industries (most of which have already moved their main production to less developed, lower wages regions) the leading role of Europe in engineering can be expected to further consolidate. As retailing becomes National/European or even global, the ability of European companies to serve a huge variety of local markets should not be under-estimated starting from those where local tastes matter more. This may be the case for a substantial proportion in the production of food and beverages for which local customers seem prepared to pay higher prices for high quality local products. In combination with reforms of the Common Agricultural Policy, growing concerns over healthy, biological food may further encourage local specialisation in both farming and food processing in an enlarged Union.

Transport Intensity, Regional Integration and Infrastructure Development

This Radial Scenario for the new European economy is a rather transport intensive scenario. The degree to which adequate transport chains can be expected to be in place in the years to come will be highly critical in determining the volumes and patterns of inter-regional trade, especially that between the regional markets at the centre and those at the periphery of the European Union.

As the liberalisation of transport services exposed to international/global competition has demonstrated (e.g. road haulage, civil aviation and maritime transport) the transport industries have had and continue to play a key role in providing to European firms and customers better services at decreasing prices. As the EMU can be expected to put the less industrialised/peripheral regions in a better position to compete in sectors where industrial production is concentrated in Europe, the availability of good, cheap transport services is likely to become an even more important factor in terms of improving their competitive position.

Even in the absence of a mass transfer of traffic from road to rail, reserving an adequate supply of the existing rail capacity for use by efficient freight undertakings may be a strategic necessity in order to

connect distant markets without increasing road congestion on the main international corridors. As both public ownership and subsidies are no longer the key option in transport industries, additional resources will need to become available for investment on both local networks (where most of traffic is performed) and for strategic transport investment at the pan European scale.

Given present constraints on public spending and the difficulties in increasing general taxation (that may depress economic growth), workable solutions to raise additional finance for strategic transport infrastructure may be limited to two basic options: either to rely more on *road transport taxation* or on *infrastructure charges*. Both of these transport policy scenarios could be implemented as consistent (second best) options in the on-going revision of guidelines for TEN investment and in the principles set in Commission policies for fair and efficient pricing.

The two alternative strategies that may emerge from an early decision on how to fund major investment in Europe can be optimised by means of designing two transport policy scenarios that couple an internally consistent set of options in three distinct areas.

- criteria to prioritise infrastructure investment in the TEN and Helsinki programmes;
- the degree to which the single market for transport services can be expected to be completed in the years to come
- specific institutional and regulatory requirements.

Due to more direct governmental control over revenue and its re-investment, the transport taxation scenario may be more likely to provide transport investments that promote development in the weaker regions. The infrastructure charges scenario on the other hand, can be expected to prioritise investment as a function of traffic levels and their associated revenue flows, and so it is more likely to support regional development and trade within/between the most dynamic regions.

In either case, the impacts of decisions that European, national and regional governments have to take "now" on how to fund the improvements envisaged for transport infrastructure will have to be assessed in strategic terms. That is, by understanding how conditions and priorities to improve transport connections at the continental scale are likely to influence the competitiveness of both European business and regional economies.

10.2.2 Opening of Europe: the Multi-Polar Development Scenarios

The four Multi-Polar Development Scenarios are closely linked to the Local Sustainability trend. They consider the implications of closer regional co-operation and development within each of the four regional zones: Baltic Sea Area, Balkans and East Mediterranean, Western Mediterranean, Central and East European Countries.

These scenarios analyse the implications of increased regional links and a renewal of regional identity. They show how trade flows and spatial links with the rest of Europe might be reshaped according to the dynamic characteristics of each geographical area.

In the Multi-Polar Scenarios, trade and commerce are more focused on regional rather than on EU trading partners and there is strong competition between the different regions to attract investment. Transport policy and infrastructure projects are only realised at a regional scale, and as a result there is a slower rate of European integration, with no extension of the Euro zone. Specific regional uncertainties (for example relations with Russia, Turkey, and Maghreb countries) must also be taken into account.

"Baltic Renaissance" (Baltic Sea Area)

Important growth factors for the Baltic Sea Area are a successful European integration, open borders for trade and commerce, improved legislation and investment security in the Baltic States. The main

dividing line is the division between the established market economies and the emerging market economies in the former centrally planned regions. The different characteristics separating older and newer market economies could be the source for economic growth in the short-run. The involvement and integration of St Petersburg and Leningrad Region into a common economic market will have a crucial impact on continuing growth in the Baltic Sea Area.

The integration and specialisation patterns have changed enormously since the beginning of the 1990's. Despite rapidly growing trade and movement of people between the areas around the Baltic Sea; there is still extensive dissimilarity in the local cultures, administrative practices and business environments and these may act as serious impediments to future integration. Removing boundaries through EU enlargement and through high level political decisions to increase the free movement of people and goods between Russia and the EU will have a crucial influence on future co-operation in the Baltic Sea Area.

The main features assumed for this scenario are as follows.

- The Stockholm region will evolve into the major distribution and regional headquarters centre of the Baltic Sea Area, due to its large regional and national market and traditional business gateway status and qualifications.
- The role of St Petersburg in the Baltic Sea Area will mainly relate to raw materials and semi-finished products and to cargo handling.
- Riga and Tallinn and their hinterlands will become to a great extent the basis of raw material and labour for Swedish and Finnish owned industries, manufacturing for the Baltic and EU markets.
- For the residents of Stockholm and Helsinki, both the Riga and Tallinn regions will remain important tourism and holidaymaking locations, due to their lower labour costs in the provision of services.

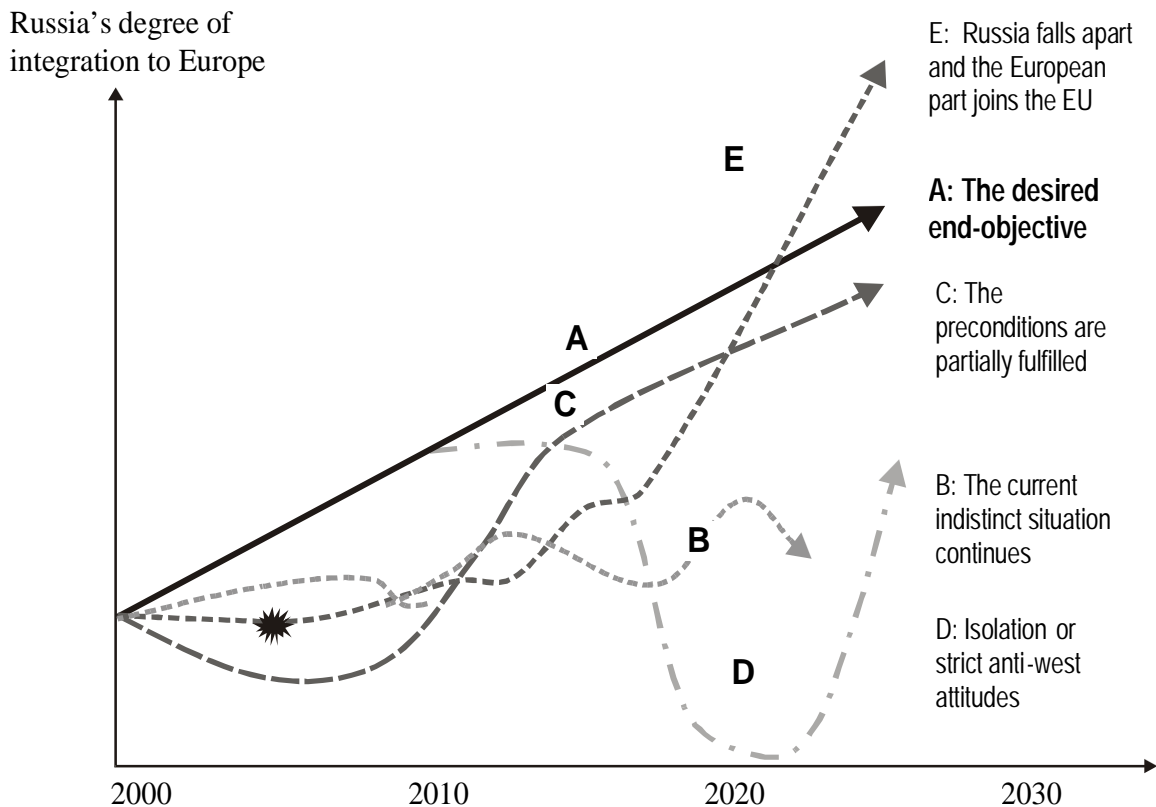


Figure 10.5 Baltic Scenario: example of alternatives for Russian integration to Europe

The **Figure 10.5** provides an example of the influence of the periphery on a European region through a graphical illustration of a range of different scenarios for the degree of integration of Russia to Europe. The key uncertainty in this scenario is the nature and the rate of economic, social and political development in Russia, since due to its size Russia has the potential to act as a major force for good or for ill on all of its neighbouring Baltic States. The involvement and integration of the St Petersburg region into a common economic market has a crucial impact on the growth potential in the Baltic Sea Area.

The transport requirements for this region contain a number of special features. The Baltic Sea forms an important connecting link between various parts of the area. Russia is to a large extent dependent on sea transport for its exports of oil, some of which go via Baltic ports. In the case of Finland, 80% of its exports and imports are transported across the Baltic Sea.

An example of the special characteristics of transportation in northern Europe is the so-called modular trucks. These safeguard the economy of road transport in an economically justifiable way in both Finland and Sweden. Both countries are sparsely populated and have long transport distances. The new regulations concerning length and weight in connection with modular trucks take these factors into consideration. In connection with the approval of these large vehicle combinations, the dimensions of the vehicles were also adjusted. In other words, modular trucks give carriers in the other EU countries the same opportunities to use larger vehicles when operating in Finland and Sweden.

The Baltic Sea region is located well outside central Europe. For that reason the linking of the area to the heartland of the EU as well as to the Asian and American markets is of crucial importance for the economic development of the area. Because the distances to major cities outside the Baltic Sea region - as well as between the cities in the area - are long, the availability of cost-effective air passenger services is important.

The largest problem concerning transport infrastructure in the Baltic Sea Area is the need for major reconstruction of the road (particularly the local roads) and railway networks to the east of the Baltic Sea. The problems are acute and the main focus of the transport sector for years to come will need to be on improving these physical structures. Only in the more distant future will other more detailed policy instruments have more attention.

"Integrating Two Worlds" (Balkans and East Mediterranean Countries)

Based on the regional diversity in this area, four main groups of countries can be identified:

- Greece
- Bulgaria, Romania, Slovenia, Cyprus and Turkey
- Albania and the other former Yugoslavian Republics (Yugoslavia, Croatia, FYROM, Bosnia)
- And other Eastern Mediterranean countries (Syria, Lebanon, Israel, Palestinian Authority, Egypt, Libya).

Greece is the only member of the EU in the region. Following a period of stagnation in the early nineties, the rate of development has been better in the last five years. The economic stability and the achievement of the criteria of the Treaty of Maastricht have recently allowed the official integration of Greece into the Monetary Union.

The second group includes candidate countries for accession to the EU. They exhibit different growth rates and other policy characteristics, but they are already applying some basic rules of the market economy, despite the relative uncertainty of some of their national economic environments.

The third group consists of Albania and the other former Yugoslavian Republics. These have all suffered the economic or physical impacts of the recent conflicts. All of these countries present high geopolitical and social uncertainty.

The fourth group consists of countries with their own policies and plans, and they do not seek to integrate them with those of the EU. Needless to say that there are some EU initiatives, like the MEDA programme, which tries to promote a co-operation between EU and Mediterranean countries. However no formal agreements exist that are the equivalent of those for the Accession Countries to the EU. In addition the peace process in the region is uncertain, and consequently severe obstacles exist for bilateral trade and movements of people between several of these countries, which impedes the growth of regional trade. Consequently the short to medium term prospects of this group of countries have not been analysed, since their influence on intra-regional flows will be limited for the time being.

The main focus has been placed on the non-EU Balkan countries in the groups 2 and 3 above. These countries present considerable uncertainty because their pattern of economic and political development will affect the future inter-relationships in the area. Greece is not analysed in detail since it is assumed to follow the more predictable economic prospects of the other EU countries, especially after its anticipated entry to the Euro zone. The identification of trends and opportunities for the non EU Balkan countries is used as a basis for future transport scenarios.

After the break-up of COMECON in 1990, there has been considerable re-orientation of trade from Bulgaria and Romania towards the European Union. As a result after a few years, these countries of the former COMECON now depend on EU for 60 % of their foreign trade, which is a percentage comparable to that observed in EU countries themselves. For almost ten years, the exchanges between the two sides of Europe have boomed, achieving annual increases of 15 % more recently. In contrast the succession of disputes in the Former Yugoslav Republics have precluded them from experiencing similar rates of economic growth over this period.

Road transport is the dominant mode of freight distribution in the Balkans, in terms of tonne-km. However, in terms of tonnage, rail transport carries a greater volume (approximately 43 million tonnes, excluding Greece) than road transport. However, the general pattern of rail and road freight traffic differs significantly. Nearly 43% of road freight is between the EU and the Balkan countries (excluding Greece). Only 19% of rail freight traffic relates to the EU. Approximately 70% of rail traffic is between Russia, the CEEC countries and the Balkans. This compares to only 10% of the road freight traffic. The traffic between Greece and the other EU countries uses the Short Sea services of the Adriatic corridor. Since the conflicts in Yugoslavia, this route, being the main alternative to the north-south Yugoslavian inland corridor, carries almost all the trade between the southern Balkans and the EU.

In the years to come, exports from the Balkans should also stimulate the strengthening of regional trade. Significant potential appears for a re-birth of exchanges between the Balkans and the CIS (the former Soviet Republics). Furthermore, regional trade can also create new "transit" flows, in addition to the existing flows in Central and Eastern Europe. Slovenia constitutes a representative example where significant changes are expected to occur in the field of freight transit. Given recent more positive developments in Serbia, the prospects for the re-construction of the transport infrastructure destroyed during the hostilities have improved, so that the traditional transit routes through the former Yugoslavia should gradually come into operation again. This will result in a rapid increase of north-south transit flows in the area. In turn this may lessen the volume of the transit flows between Turkey and Bulgaria and the EU countries that currently passes through the north of Greece.

One decisive point is their integration into the EU, which is dependent on the speed of their structural changes, differing very much from one country to another. Tight monetary policy, fiscal prudence and a significant acceleration in structural reform, including privatisation are the key parts of the agreed policy framework. The restructuring and development of export sectors boosts the growth of investment, thus improving the current balance. Global capital will help to finance the reforms. The

increase of regional trade within the Balkans could also enforce co-operation in the region, helped by the development of a dense and integrated transport network that would facilitate and further stimulate the regional cohesion and integration.

The tourist potential of this region is large, but with the exceptions of Greece, Turkey and Cyprus, the remaining countries have under performed in the last decade for a variety of reasons. In fact an interesting recent pattern is emerging: Greece and Cyprus are receiving tourists (as a result of the improving economies) from the Balkan countries. So instead of being importers of tourism, the Balkan countries are becoming exporters of tourism.

As far as national transport policy is concerned, the framework and policy targets are not yet well developed in the Balkan countries. National policies do not converge. In recent years, Greece has elaborated a national transport Master Plan, which has been integrated in the 2nd and 3rd Community Framework Support. Furthermore, in alignment with European Legislation, Greece is implementing a rigorous programme of deregulation of the transport market, affecting road, rail, sea and air transport.

In the other Balkan countries (except Slovenia), such reforms have not yet progressed very far. As an example, the Black Sea countries (Romania and Bulgaria) have indicated the intention to introduce some degree of private sector involvement in their national ports industry. In general, despite some small-scale privatisation of transport entities, the bigger state-owned transport bodies remained almost untouched by the privatisation process.

The co-operation between the Balkan countries (excluding Greece) and the EU countries is based on bi-lateral agreements and the gradual abolition of trade barriers and duties. However, the expected growth of regional trade and the generalisation of the dominant trends should push liberalisation and the restructuring of the transport sector in these countries. The validation of the Multi-polar Development Scenario in Europe is strongly related to the liberalisation and harmonisation of institutional frameworks within the region.

Finally, transport scenarios derive from larger socio-economic policies. Future transport development in the region will differ considerably, depending on external factors, such as the national strategies of Eastern Black Sea countries, particularly Russia and Ukraine, and of the other Eastern Mediterranean countries. A clear strategic role for the Black Sea ports of Russia and Ukraine would significantly affect policy orientations in the Balkan countries. A catalyst for future developments could be the eventual full normalisation of relations between Greece and Turkey.

But a number of particular characteristics of the Balkans and of the greater Eastern Mediterranean area hold certain important risks for regional cohesion. These are mainly related to the ethnic and cultural diversity of the population, political divergence and possibly the influence of larger geopolitical interests.

"The Mediterranean Divide" (Western Mediterranean)

In spite of revealing many consistent geographical elements and having constituted a single region from classical times up unto well into the Middle Ages, the North and South of the Western Mediterranean basin is currently divided into two separate parts that to a certain extent could be considered opposites.

The population changes that have taken place in the Western Mediterranean (European) countries have brought about an accelerated ageing as a result of the extremely low birth rate (Spain in fact has reached the lowest rate of all countries with reliable statistics). In contrast, the birth rate in the Mahgreb countries maintains levels whereby young people account for virtually half of the population. The postwar migratory flows from European Mediterranean countries towards Central Europe have been transformed into a marked flow from the Mahgreb to Southern Europe. Countries that formerly recorded a heavy imbalance in export of labour (Italy, Spain and Portugal) are now net receivers from further south.

As is the case with the demographics, there is also a fundamental difference in the structure of the economy between the countries in the North and the South of the Western Mediterranean. The success of the Cohesion policy within the EU has lessened the economic differences within the EU countries, but extended the gap between the North and the South. The economies in the South are not only different from those in the North but also vary quite substantially amongst each other (predominance of hydrocarbons in Algeria, important tourism development in Tunisia, solid agriculture in Morocco).

In unit of weight, trade flows between the two shores are disproportionately large in the South-North direction, whereas in terms of value, flows are much greater in the opposite direction. This is due to the differing nature of the exchange of goods involved - basically hydrocarbons, unprocessed food and mineral products from the South to the North, while in the opposite direction the main exchanges involve higher unit value processed goods.

Tourism is a highly important activity on the Mediterranean coasts of all the countries in the Western Mediterranean, especially the EU. Tourism is of up-and-coming importance in the Maghreb countries - it is already well developed in Tunisia, but it continues to encounter serious problems in Algeria due to its political situation. The enormous development of seaside tourism in Spain and France means that visitors outweigh residents several times over in coastal regions, giving rise to highly pronounced seasonal flows and associated temporary transport congestion problems.

Thanks to major investment programmes the transport infrastructure in Southern European countries has made substantial strides over the past twenty years. As a result their level of quality on road and on the major rail lines has come reasonably close to that of the other EU members. Ports and airports in the Western Mediterranean constitute sufficiently well developed interchange hubs in all EU member states except for certain isolated capacity gaps in specific cases, which planned investment is in fact in the course of solving.

One of the main targets of the European Commission is to develop short sea shipping. This will improve sea haulage amongst Western Mediterranean countries which, to date, is largely carried out overland. The growth of certain shipping lines in direct competition with road transport between Spain and Italy attests to this statement. This will involve the development of specific ports and of intermodal exchange centres in port areas. It will also have a substantial effect on trade relations amongst Western Mediterranean countries and will also influence relations between Western Mediterranean states and the Maghreb countries.

In the Maghreb the density levels in the interior are typical of desert regions and make rail transport economically unviable. Except for a few cases where mining products create substantial volumes of transport, rail transport plays a marginal role. This is why, except for the gas pipeline, the other transport needs are covered by road services. Quality standards are relatively poor in many places and some the areas surrounding large cities suffer from substantial levels of congestion. Management problems are of major importance and can represent a powerful curb on development owing to the stalling effect they impose on logistical cycles and company costs (excessive customs delays, little automation of document management, etc.).

Developing transport infrastructure in the Maghreb calls for heavy investment, especially in ports and airports, to encourage trade relations. As a result of the weaknesses in the economies of these countries, investment of this kind has to be made relying on aid from international organisations and EU agreements. One example of this type of situation is the substantial aid the EU has already provided to develop the Port of Tangiers.

A trend based scenario would point to a strengthening of integration amongst the countries on the European continent but where many of the development difficulties in the Maghreb countries might continue. An extrapolation of this trend would lead to the persistence and even accentuation of the differences between the North and the South. This would signify a widening of the gap existing

between the North and the South and an accentuation of the dangers of economic and political tensions between countries that are geographically close to each other. The main threats stem from two specific and inter-related aspects:

- the relations between the countries in the area
- the pressure from emigrants from the South to the North.

There is the danger that the trend that has come to be known as "Fortress Europe" would consolidate. In such a scenario, the EU would represent a bloc extending more or less eastwards but with a strong tendency to become hermetic as regards the exterior. This would limit trade expansion possibilities amongst the Maghreb countries and in a North-South direction and consequently would curb the economic growth potential of the Maghreb.

This general scenario assumes a moderate rapprochement between the EU and the Maghreb. The size of the gap existing between the North and the South diminishes somewhat and the economic and political tensions between the Maghreb countries also diminish.

"The Visegrad Revival" (Central and Eastern European Countries)

In the present context, the CEEC region comprises of an area of Europe, which has traditionally had strong internal connections. Since the beginning of the Transition, the development rate of the different regions has been uneven, for example, the eastern parts of Hungary and Slovakia are far behind the western regions. This uneven regional development pattern was also present in the earlier accession countries: Spain, Portugal and Greece. There is a mutual interest both for the applicants and the present EU member countries to reduce these regional differences. Therefore projects with extra improvement results in these eastern regions should be assigned a higher priority.

In contrast to the Maghreb, this region exhibits low population growth or actual declines in many areas, and has an aging population profile.

In the first phase of the transition development of the CEE countries the main investments were concentrated in the areas which were already developed, or had good accessibility, communication and skilled manpower. After the saturation of these areas the other regions of the countries will also become interesting. This spreading of development is also being promoted by governmental programs, which try to improve the potential of these areas through better accessibility and special advantages for new investors. This means that although the difference between the economic levels of the regions will not disappear, it will be diminished. The eastern regions of Slovakia, Poland and Hungary will be bridgeheads to the Ukrainian and Russian market in both directions.

After the economic revolution in 1990 the CEEC economies turned their trade away from the former COMECON countries towards the developed countries, mainly to the EU. The CEEC wanted to bind their economy tighter to the EU because they want to enter the EU, and also the acceleration of their economic growth was expected to be led by the investments from the developed countries. In this context it is certain that the trade connections with the former COMECON countries were limited to the necessary minimum level.

From the CEEC's point of view, the integration into the EU is a major step. Economic advantages are expected but at the same time risk factors exist, which can reduce the positive effects. Almost all the risk factors are connected to the stability of the economy, the safety of the investments, and the ability to foresee the social and economic consequences.

There are considerable motorway/expressway network development plans in these countries. The new motorway sections are to be built mostly in the main European corridors and are scheduled according to the estimated growth in the traffic load. The improvement to the road infrastructure will provide good support for the higher traffic volumes of foreign trade originating from the rapidly developing areas of this region. The expected accession to the EU (Czech Republic, Hungary, Poland and

Slovenia at first, Slovakia, Romania later) will heavily increase the East-West traffic demand, and the related network investments will amplify this trend.

The low car ownership levels of the past created a large demand for public transport services both in the local and the long-distance passenger traffic. However, since 1990 the state subsidy for these services has reduced and the demand for them has also decreased, so the service level is becoming worse than in the past (e.g. less frequency, overcrowded vehicles, etc.). This both encourages, and is exacerbated by, a greater use of private cars, which causes more traffic jams and higher air pollution in the city centres and on the access roads.

In the case of the railway network there are few capacity problems because of the continuing decline in its modal share. New rail developments are mainly confined to the improvement of the existing tracks, which are in much worse condition than in Western Europe. The extension of the High-Speed Rail network to the CEEC capitals or further into this region is a question of an EU-level political decision. In the CEE countries there is currently no source of finance, and no solvent demand for such services at this moment or in the near future.

The importance of the Danube harbours has increased since the integrated Danube-Main-Rhein waterway has been operation. The Danube crosses six countries and approaches another one (Czech Republic), and so connects this region to their main Western and Central-European partners, to Germany and to Austria. Therefore the main harbours on the Danube can play an important role in the freight transportation and distribution of this region. To increase their potential the harbour infrastructures will have to be upgraded, in some cases significantly, and the overall quality of service on the inland waterway mode would need to be improved.

In some of the CEE countries the condition of the environment is rather bad. The situation is less bad in those likely to join to the EU in the first turn. But in this aspect they are not independent of their neighbouring countries. It does not mean only the pollution from traffic but also, and above all from industry, which is a heavy polluter, and in some cases a potential ecological bomb (e.g. the cyanide poisoning of the river Tisza in Hungary by a gold mine in Romania).

These countries are trying to meet the environment protection rules - they have ratified most of them. Nevertheless it is a serious question as to whether they can actually fulfil these strict requirements. This would need large investments, which are impossible for many reasons. On the one hand there are no resources earmarked for such purposes. On the other hand investments like these would make production more expensive, reducing further the competitiveness, which is low anyway. This could result in higher unemployment, further harming the condition of the economy. The ecological difficulties can cause not only direct damages and losses but also drawbacks in tourism or in some other fields.

Some of the above factors have no direct connection to transportation itself. However the task of transportation policies should be to provide circumstances that achieve social, economic goals, and take into consideration the ecological aspects without exceeding the level of sustainable development of the region.

10.3 Behavioural and Structural Change Scenarios

This section studies the impacts of behavioural and structural changes on the future evolution of the patterns of passenger and freight transport.

By investigating the different components of the socio-economic environment and transport policy, it is possible to have a more precise appraisal of future mobility trends and to assess their impact on spatial organisation as well as on the environment. The focus in this section is on behavioural changes, which are not induced by transport policy but which rather are being caused by external factors.

The Dutch Questa scenarios provide a suitable environment, which has the advantage that the scenarios are internally consistent. The two selected contrasting scenarios are the Unrestricted and the Quality of Life scenarios that have already been introduced in the Section 0. The main difference between the two scenarios is that Quality of Life is mainly aimed at sustainability in both the environmental and social sense, while Unrestricted shows a focus on individual development and economic prosperity.

The method of analysis of the behavioural scenarios involved the following steps:

- Listing and qualification of behavioural and technological trends in transport
- Building of, and assigning trends to scenarios
- Preparing and running the model
- Interpretation of model runs

The five models below were each applied independently, giving different interpretations of elements of these scenarios. Each model highlights different specific aspects of the transport system:

- changes in logistics strategies: SMILE
- dynamics of travellers behaviour: ScenarioExplorer
- transport/land use interaction: Mentor
- interaction between the local, regional and national level: Telescopage
- long term car ownership trends: Demographic approach model

Although the European-wide SCENES model that has been presented previously in the chapters on WA 11 covers all of the above topics to some extent, it cannot by virtue of its wide-ranging nature treat them at the same level of detail as the five more specialised models that are discussed in this section. All models involve compromises in the levels of detail of the components within them so that there is always a need to consider the underlying aims for which a model was developed as a guide to which models are most relevant for which purposes.

10.3.1 SMILE¹⁵

SMILE is a scenario model for freight transport that calculates the consequences of world-wide economic and logistics developments for flows, within and throughout the Netherlands, as well as the effects on regional employment and the environment.

SMILE was built on the philosophy that the logistic choice behaviour of various parties in the logistic chain, is the main driver of changes in goods flows.

The conceptual model consists of two main building blocks, concerned with economics and transport. The economic blocks calculate the long-term development of regional production and consumption patterns. The transport block calculates the associated transport demand and the resulting freight flows through distribution sales channels and infrastructure networks.

¹⁵ The Strategic Model for Integrative Logistics and Evaluations (SMILE) has been developed by TNO Inro, NEI and QQQ Delft for the Transport Research Centre of the Dutch Ministry of Transport, Public Works and Water Management.

The results of the two scenarios: the Unrestricted (Unr), and the extended Quality of Life (Qol) scenarios are compared and from these conclusions were drawn. The conclusions are focused on trade tons, transport tons and ton kilometres, modal split, logistics cost and distribution centre throughput.

The differences in the growth of trade tons in the Figure 10.6 show the differences in the two economic scenarios. As expected, the Unr has a higher growth of trade tons than the Qol scenario. Especially from 2020 the growth of the total tons and of the domestic tons in the Netherlands in Unr is much higher. The growth of domestic trade tons does not differ much before 2015 between the two scenarios.

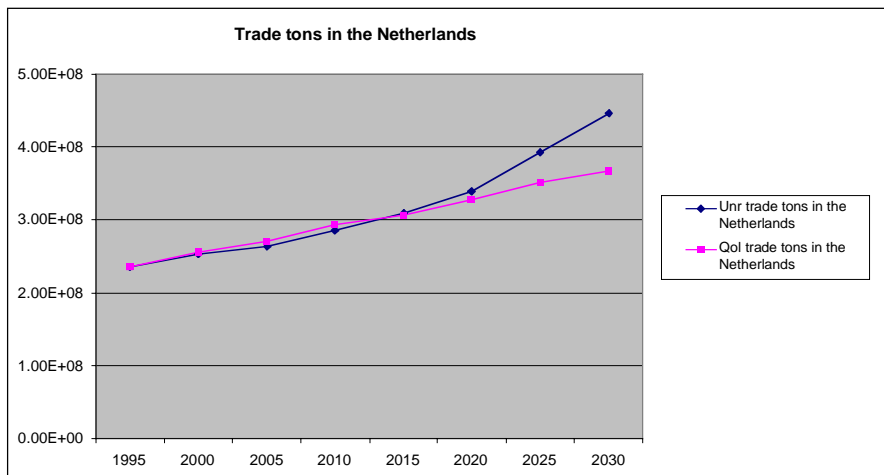


Figure 10.6 Trade tons lifted, domestic, Unr V Qol

In units of ton-kms transported this difference is even higher, as illustrated in the Figure 10.7, due mainly to a lower growth in ton-kms in the Qol scenario as compared to the growth of tons transported. The average length of haul grows more slowly.

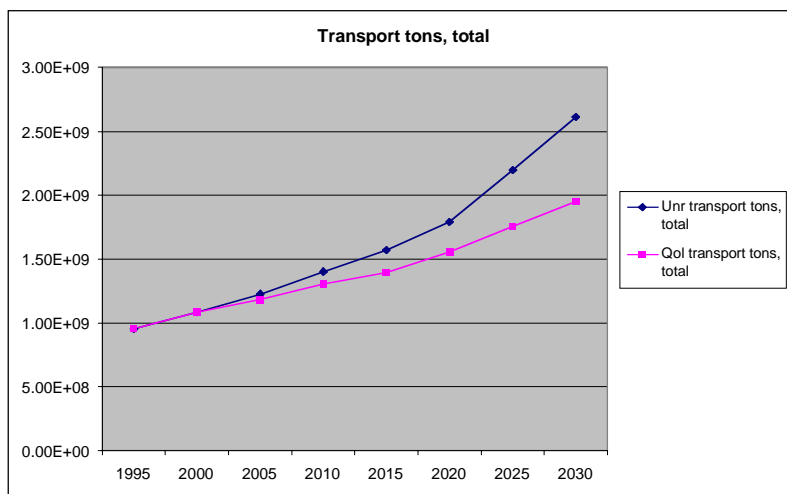


Figure 10.7 Transport tons moved, Unr V Qol

The tons moved through distribution centres also show a difference between the two scenarios as illustrated in the Figure 10.8. In this figure the percentage increase in the throughput through distribution centres from 1995 to 2030 is plotted for each of a large number of logistics families (a

logistics family is a group of commodities that have similar logistical requirements). The horizontal axis shows the %age increase in Unr, the vertical axis in Qol. The slope of the trend-line on the graph shows that the rate of increase for Unr is about twice that for Qol. The highest increase in both scenarios is for industrial products, while the lowest is for bulk products such as sands, coal and oil.

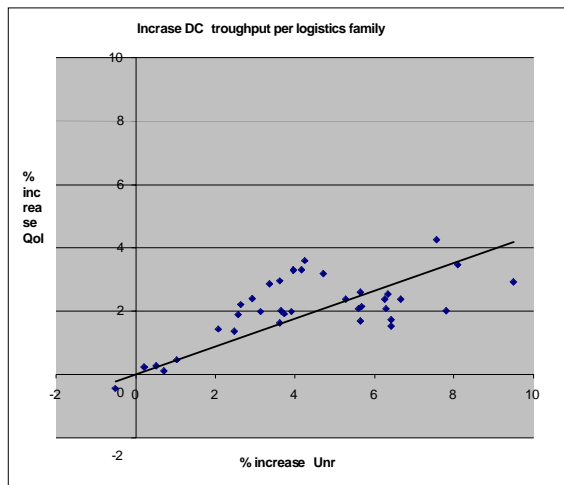


Figure 10.8 Percentage increase in distribution center throughput per logistics family, Unr V Qol

10.3.2 SCENARIOEXPLORER¹⁶

The ScenarioExplorer is a model that assesses the effects of behavioural trends on transport demand with a time horizon of 15 to 60 years into the future.

The purpose of the analysis is to discover the boundaries of future developments under contrasting conditions; and to show the dynamics of impacts on transport demand from changes in behaviour that can result from changes in the environment in which transport takes place.

The analysis of implications of behavioural change on passenger transport demand starts out with the identification of behavioural trends that are considered important for the development of transport demand. The procedure adopted for this identification was as follows:

- Overviews of behavioural trends have been prepared by both the Institut für Wirtschaftspolitik und Wirtschaftsforschung of the University of Karlsruhe (IWW) and TNO Inro. The lists are based on earlier research and expert opinions within the institutes;
- At a workshop held at IWW in Karlsruhe, experts have first been asked for additional behavioural trends to complete the lists;
- Next, these experts have been asked to identify the three most important behavioural trends for the scenario analysis. The two main criteria for the selection are the importance of the trends for transport demand and the uncertainty with regard to their development. Certain trends are less interesting for a scenario analysis, since they do not lead to uncertainty with regard to policy (see Figure 10.9);

¹⁶ The ScenarioExplorere has been developed by TNO Inro for the Dutch Ministry of Transport, Public Works and Water Management.

- Finally, a list has been made of behavioural trends in order of their relevance for the scenario analysis. It was decided to include all trends in the subsequent analysis that were chosen by more than 20 percent of all experts in the meeting.

The procedure resulted in 16 relevant trends (after some overlaps were removed) that were treated in the analysis. (see Table 10.3).

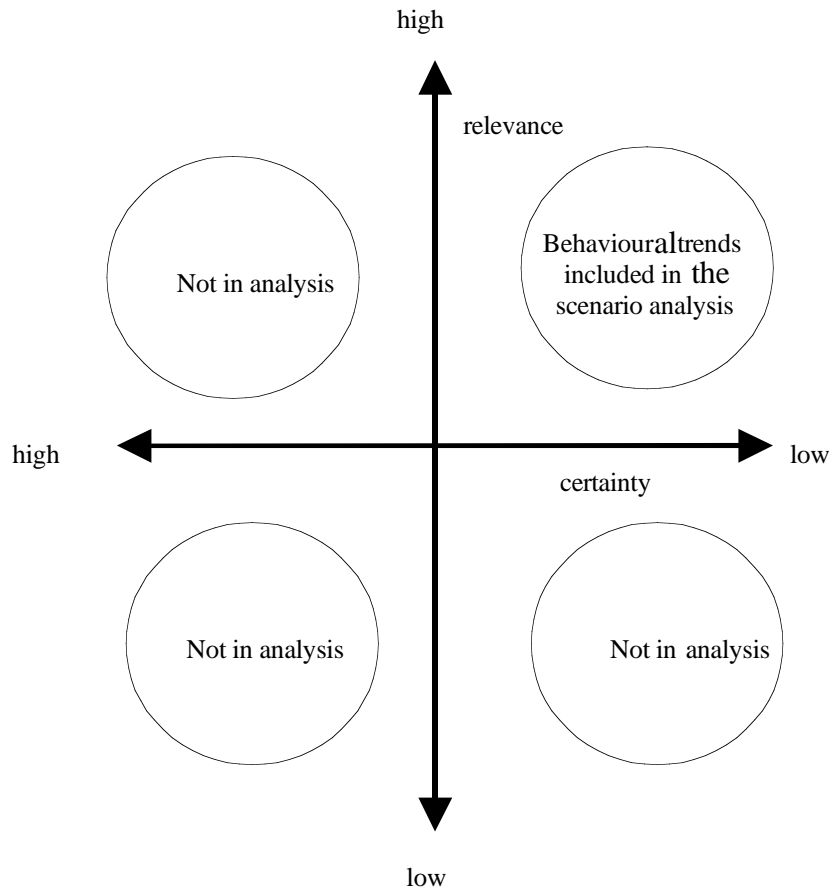


Figure 10.9 Classification of behavioural trends by relevance and certainty

Having identified the most important behavioural trends for passenger transport, these trends are then embedded in the 2 scenarios presented above that describe the development of society. Then the calculations are done with the ScenarioExplorer using System Dynamic techniques.

The core of the ScenarioExplorer is the transport demand model. Starting with a base situation, changes in the number of trips are calculated for each year and for each travel purpose, transport mode and type of traveller (an incremental multiple model).

The output of the transport demand model is an equilibrium outcome that results from feedback on demand and supply. Four groups of output can be distinguished: transport volume (trips, kilometres and average trip distance), car ownership (fleet size and saturation), time and expenditure on transport, accessibility (travel speed, travel times).

However it is inappropriate to take the outputs of such a model, which has been applied to only one country, as a direct quantitative measure of more global EU projections. Instead the order of magnitude of the resulting dynamics between complex phenomenon are more appropriately presented with qualitative symbols as in the Table 10.3 which gives the effects of the Unrestricted compared to the Quality of Life scenario for 16 trends.

Table 10.3 Effect of the Unrestricted compared to the Quality of Life scenario for 16 trends

	<i>Trend</i>	<i># of trips</i>	<i># km's</i>	<i>Trips p.p.</i>	<i>Km's p.p.</i>	<i>Car ownership</i>	<i>Travel times</i>	<i>Modal split / Use of PT</i>
1	Moving to suburbs (urban sprawl)	+	++	+	++	+	+	--
2	Increasing environmental concern and responsibility	+	+	+	+	+	+/-	-
3	Development of ICT (teleworking, teleshopping)	--	-	--	-	0	+/-	+
4	Increasing daily travel	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	2 or 3 cars per household	+	+	+	0	++	+/-	--
6	Park and Ride	+	+/-	+	+/-	+	-	--
7	More flexibility and diversification of activities	+	++	+	++	+	+	-
8	Immigration surplus	-	-	+	+	+/-	+/-	-
9	Migration and urban sprawl in Europe	+	++	+	++	+	+	--
10	Car sharing and car pooling	+	+	0	0	+	+	+/-
11	Decreasing population	-	-	0	0	-	-	0
12	More business trips	+	++	+	++	+	+	-
13	Shopping malls	+	++	+	++	+	+	-
14	Diversification of firm location by sector	+	++	+	++	+	+	-
15	Development of ICT (traffic management etc.)	-	-	-	-	0	+	-
16	Increasing production and incomes	+	+	+	+	+	+	-
	<i>Summary: Total effect</i>	+	+	+	+	+	+	-

10.3.3 The MENCAM land use and transport model of Cambridge¹⁷

The behavioural and structural changes scenarios, Quality of life and Unrestricted, are addressed from the point of view of land use and their relationships with transport and transport policies, using the case study of an integrated land use/transport model of the Cambridge sub-region of the UK. MENTOR is used as the land-use software package, together with the transport model of the same area implemented within the MEPLAN package. The model is run to 2016 and comprised assumptions for each scenario regarding the level of transport infrastructure provision and the potential location of new development. In the modelling system, the transport conditions have an effect on the location of growth in employment and of households, and vice versa.

¹⁷ The MENCAM model has been developed by ME&P.

The land-use model results for each scenario are considered in terms of the location of employment, households, different socio-economic groups, and dwelling occupancy within the study area for the forecast year. The effect of intensive investment in the public transport corridor option ("Quality of Life") on all these factors is clearly illustrated in the results, set against the "Unrestricted" scenario, where the planned growth is much more evenly spread in a dispersed pattern through the region.

The transport model results also reflect these different patterns of growth through modal share and volume of travel. The Unrestricted scenario sees a much higher growth in car use, for the modelled AM peak period, than the Quality of Life scenario. Other effects are seen in terms of average journey distance and speed. Clear modal shift effects are seen when looking at individual corridor results.

The Unrestricted scenario shows a significant increase in car use in the Figure 10.10. The improved capacity of the trunk road network allows traffic growth on these roads without worsening congestion. Those living outside of the city centre gain increased mobility, but those in urban areas suffer greater congestion, forcing them to use slow modes increasingly.

Public transport is largely unaffected, remaining at a low level of use, though rising in line with the overall increase in travel. The prosperity of the area means that high levels of car ownership and use are maintained.

In the Quality of Life scenario the improved provision of public transport decreases car use significantly as a proportion of trips, with increases in bus and train use. It is helped by the closer proximity of residents to areas served by public transport, and the siting of employment nearer to houses also reduces car dependency. The relative lack of highway investment means that the existing congestion prevents significant increases in traffic, and reduces the attractiveness of car use.

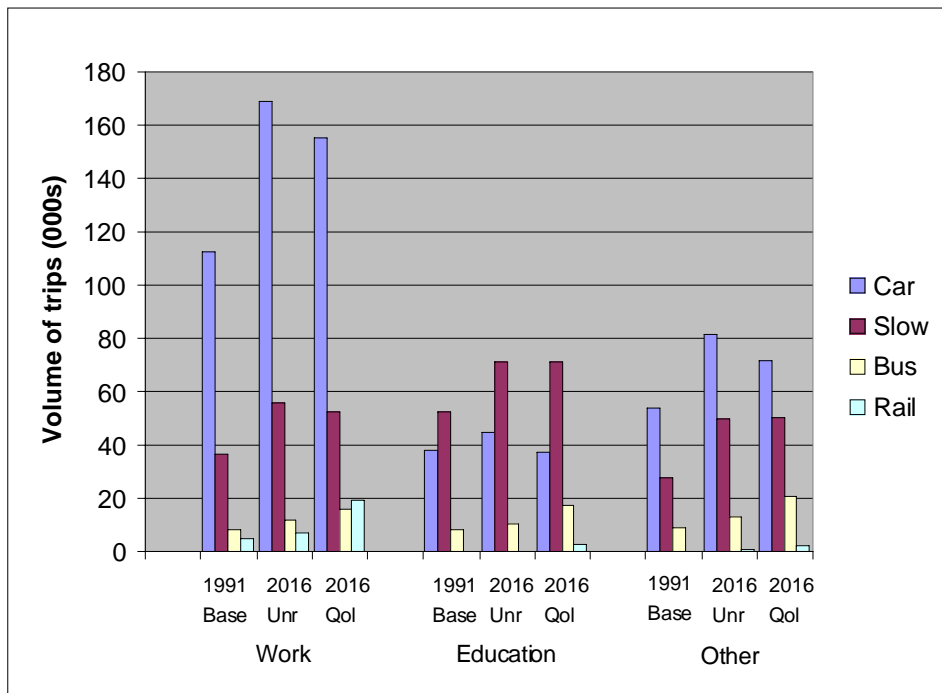


Figure 10.10 Trip volume by scenario, mode and purpose

The most dramatic change in journey length in Figure 10.11 is the increase for Qol in the number of shorter journeys by rail, for Education and particularly for Work trips. The large decrease in average journey length is due to improved local "shuttle" services, which encourage the use of rail for short distances. The average distance travelled by other modes remains largely unaffected, though there is a

small decrease in education car journey length. The average distance for slow mode trips increases in the Unr case, due to the increased road congestion in urban areas, which make short journeys by car or bus less attractive.

Road speeds in urban areas are generally improved in Qol relative to the Unr scenario, though congestion remains on extra-urban roads.

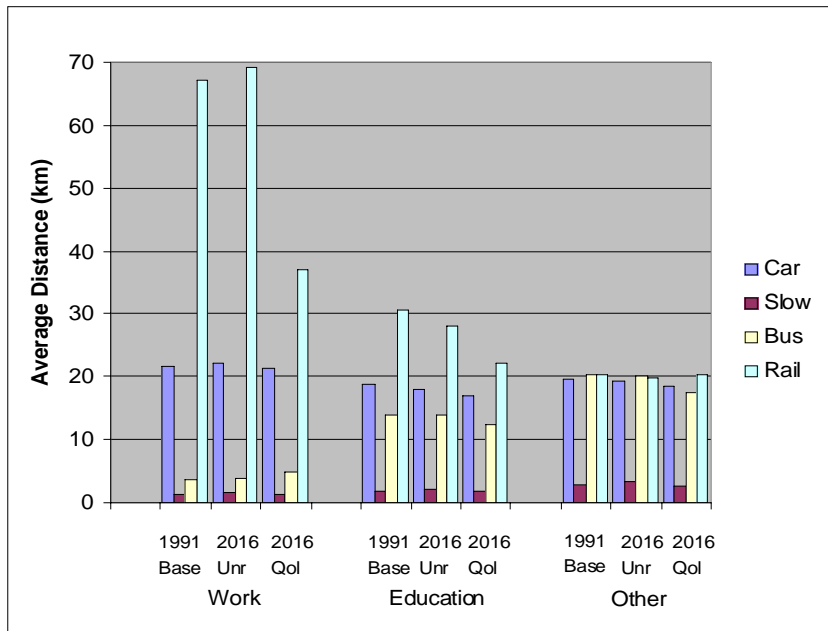


Figure 10.11 Average Journey Length by scenario, mode and purpose

This element of the work concerning the development of External Scenarios demonstrates the methodological approach of using integrated land-use/transport models. The effects of transport policy on the location of development, and vice versa, are analysed in one comprehensive framework. The results of the case study also illustrate the scale and scope of the effects that may occur as the result of different transport and planning policies.

10.3.4 TELESCOPAGE¹⁸

The traffic problems around a great city arise from several interacting sources: local traffic related to the urban area exchanging with the external and transit traffic. Such phenomena can be illustrated through two reciprocal impacts: that of local traffic on long distance traffic (transit and non transit), and that of long distance traffic on the local transport system, these impacts are illustrated in Figure 10.12.

The urban region around Lyon constitutes a relevant study area because of its economic dynamism and its role as a transport centre. Local traffic, already significant, is forecast to increase with the expansion of urban development, spreading further and further from the city centre. The region is also an important economic and population centre because of its industries, employment and the consumption in the conurbation. The major exchange of goods with the world outside, from primary products to finished products, generates considerable traffic.

¹⁸ Telescopage has been developed jointly by ISIS, LET (Laboratoire d’Economie de Transport) of University Lyon 2 and CETE (Centre d’Etudes Techniques de l’Equipement) of the French Ministry of Transport

Also, it is an area of transit traffic due to its position on major European corridors, where development will increase with the development of the European economy.

The Telescopage model deals with the transport phenomena through integrating different components which take place on different spatial scales: conurbation, region, and country. These spatial interfaces, can be distinguished in terms of the interface within the network and the interactions between transport and land use. The model operates over the long term with a horizon of around 20 years.

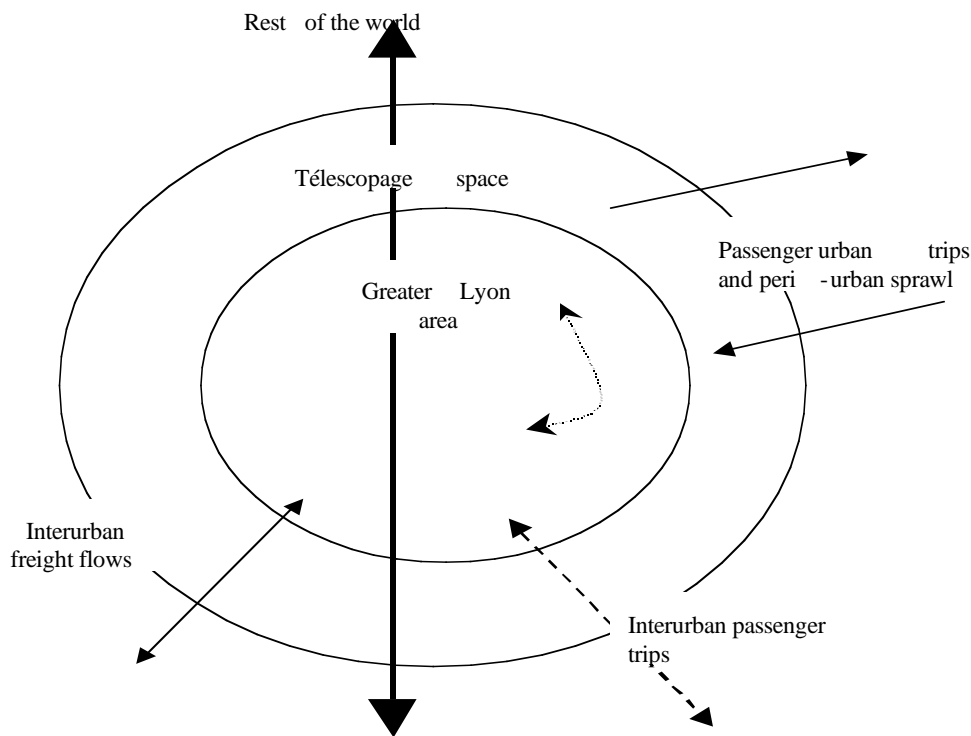


Figure 10.12 · Different types of traffic, and objectives

The long term simulation of Telescopage between different types of traffic (local, exchange and transit) covers an urban and suburban space defined around the centre of the urban region of Lyon. This study area extends to a radius of 45km around the city. This area has been chosen because it minimises the reverse commuting with the outside.

The Telescopage model can be considered as a tool to help in the definition of transport policies and planning orientation. It allows testing of the impacts of transport policies at different spatial scales: urban area or interurban area. By distinguishing the local, exchange and transit traffic; it identifies the most discriminating set of policy levers on the functioning of the transport system.

The Table 10.4 illustrates how much the traffic flow patterns can be affected by structural changes in external environment, when referring to the three possible scenarios for the development of Lyon and its regional environment. The "Business as Usual" scenario is quite close in nature to the "unrestricted" scenario so that the transport results are not very different between them. As in the other study areas that were analysed in previous sections, the Unrestricted scenario is associated with less growth within the urban centre and with a continuation in the future of increasing car usage.

In contrast the measures taken in the QoI scenario have significant effects on the evolution of the modal pattern of trips. The use of the private car is on the increase (+36%), but what is more interesting is the increase in walking/cycling which account for a rise of 13% and especially public transport which has seen an increase of 21%.

Should the situation continue at the same rate as indicated in the extrapolation for 2020 the measurement of the sustained development (QoI) scenario reveals an equivalent increase in walking and cycling and public transport (an increase in the region of 39% over 25 years which relates to 1.35% of the average annual growth rate). The journeys made on private transport decrease by 13% compared to the business as usual scenario.

Table 10.4 Spatial structure of the journeys in 1995 and for each scenario in 2020

	<i>1995</i>	<i>Business as usual</i>	<i>Quality of Life</i>	<i>Unrestricted</i>
<i>Urban</i>	59%	41%	46%	40%
<i>Périurban</i>	17%	27%	27%	28%
<i>Urban-périurban</i>	14%	17%	14%	19%
<i>Great exchange</i>	8%	14%	12%	12%
<i>Transit</i>	1%	1%	1%	1%
	100%	100%	100%	100%

10.3.5 Long Term Projections Of Car Fleets: A Demographic Approach

A comparative analysis across European and non-European countries showed the major contribution of the car to personal mobility, its growing importance and the probable continuity of this evolution in the future (Scenarios D5, 1997). A thorough understanding of the factors influencing car ownership is essential for making long term projections of the car fleet, thus providing inputs for a reference scenario of mobility and traffic.

Based on this earlier analysis, forecasts were made of the car fleets in four EU countries, and for comparison Japan and USA by means of a demographic approach for a horizon as far as 2010 or 2020. Using population projections by age class (either for the number of households or for the number of individuals), the estimated effects of age, generation of birth and economic factors were used to produce long term projections of the car fleet for each country.

Nowadays, the individual motorisation rate (i.e. the average number of cars per adult) continues to rise almost linearly in most industrialised countries. Such a tendency questions the relevance of using *a priori* the saturation thresholds typical of many past models. Saturation thresholds fixed *a priori* in car ownership forecasting models have successively been exceeded (particularly in USA), due to the rise of multi-equipment (urban cars, vans, etc.) and to complex individual attitudes characterised by some inertia. Indeed, even in a period of collapse of the market for new cars, the lengthening lifetime of the cars already owned may minimise, and perhaps offset, the impact of recession on car ownership.

The profound structural changes which have accompanied the rapid growth of individual mobility in developed countries underline the necessity of studying the transportation demand not in a context of equilibrium, but in a context of historical evolution (Goodwin *et al.*, 1987). Only a longitudinal analysis of behaviour, centred on the temporal follow-up of individuals or cohorts, permits the identification of the factors determining this evolution. The longitudinal approach highlights the complex impact of age, which in a dated temporal context consists of the combination of three linked dimensions:

- the *stage in the life cycle*, which indicates the importance of age in car ownership decisions;

- the *generation* (or cohort), which identifies the behaviour of individuals born during the same period, and therefore sharing a common life experience; and
- the *period*, which indicates the impact of the global socio-economic context.

The evaluation of the effect of the stage in life cycle gives a characteristic curve indicating the evolution of the motorisation rates related to age, which corresponds to a definite pattern. The introduction of the generation effects constitutes a first amendment to the vision of equilibrium, and places this profile in a historical perspective. In the case of the acquisition of durable goods, this approach is relevant since it shows the importance of effects of diffusion linked, for example, to the evolution of the life styles, institutional constraints, needs of the consumers, or characteristics of supply. Finally, taking into account the period effects permits the measurement of short term or medium term factors of disequilibrium, which simultaneously affect all the individuals or households.

The long term projection model thus comprises two parts:

- first, a projection of the age structure of the population of driving age, which takes into account purely demographic phenomena, in relation, for example, to aging which is foreseeable in most industrialised societies; and
- second, and fundamental to the model, the estimation of a standard profile of the life cycle and its evolution through time.

The long term projections carried out show a continuous growth, though at a decreasing rate, in the car fleets in all of the countries analysed. The growth rates differ from one country to another. The estimation procedure showed that France and the UK are more sensitive to changes in income than to changes in car prices, but that the reverse is the case for Italy as shown in the Table 10.5.

Table 10.5 Effects on household car ownership of income growth and car purchase prices

	Adjusted R ²	Income or Total expenditure			Purchase prices		
		Coeff.	Std error	Elasticity [conf. interval]	Coeff.	Std error	Elasticity [conf. interval]
NUMBER OF CARS PER HOUSEHOLD							
France	0.948	0.462	0.055	0.42 [0.32 ; 0.52]	-0.185	0.046	-0.17 [-0.25 ; -0.09]
Italy	0.976	0.464	0.076	0.42 [0.28 ; 0.55]	-0.552	0.073	-0.50 [-0.62 ; -0.37]
UK	0.934	0.562	0.075	0.58 [0.43 ; 0.73]	-0.125	0.054	-0.13 [-0.24 ; -0.02]
Japan	0.979	0.280	0.104	0.26 [0.07 ; 0.45]			
USA	0.826	0.187	0.194	0.15 [\leq 0.53]	(**)		
NUMBER OF CARS PER ADULT							
France	0.954	0.229	0.027	0.40 [0.31 ; 0.49]	-0.083	0.022	-0.15 [-0.22 ; -0.07]
Italy	0.974	0.086	0.033	0.18 [0.04 ; 0.31]	-0.348	0.032	-0.71 [-0.84 ; -0.59]
UK	0.916	0.376	0.037	0.71 [0.57 ; 0.85]	-0.073	0.027	-0.14 [-0.24 ; -0.04]
USA	0.630	0.154	0.096	0.23 [0.04 ; 0.42]	(**)		

Sources: Data from Family Expenditure Surveys for Italy (1985-94, 1996), UK (1977-94) and Japan (1979, 1984, 1989 and 1994); INSEE Household Conjuncture Surveys for France (1977-94); Consumer Expenditure Survey for USA (first quarter in 1980, 1981, 1984, 1985, 1987, 1988 and 1989).

Two main factors explained the differences between countries and zones:

- **the history of car ownership development:** the US, where the diffusion of the automobile started before World War II, is closer to saturation than the West European countries and Japan. Indeed, there are now smaller differences between generations in the USA than elsewhere. Moreover, income elasticities are lower than in Europe and Japan.

- ***population density***: saturation thresholds are likely to be lower in more densely populated areas (city centres or metropolitan areas) or countries (e.g. Japan and the Netherlands). During the life cycle, maximum levels of motorisation seem to be observed later in dense countries than in the other countries.

11 TRANSPORT POLICY SCENARIOS DEVELOPMENT

The previous chapter explored a range of external scenarios. These relate primarily to factors that are outside the control of the transport policy maker. In contrast this current chapter explores a range of *transport policy scenarios*. These focus on policy measures and their impact on the transport system.

This approach is illustrated through the development of transport policy scenarios concerning two major areas of EU policy: the enlargement of Europe towards CEEC countries, and the Transalpine case study.

- For the enlargement to the East, the policy scenario is a combined infrastructure and pricing scenario for the TINA (Transport Infrastructure Needs Assessment) corridors.
- For the Transalpine corridors, the policy scenario investigates harmonisation of national policies as well as initiatives to achieve an increase in rail modal share in order to reach a 50/50 road/rail balance for Transalpine freight crossings.

For both of these case studies specific transport models have been used: the VACLAV¹⁹ model for the TINA corridors, and the TRANSALP²⁰ model which has been specifically built within the SCENES project.

These two policy case studies are complemented by detailed East-West corridor case studies which illustrate how detailed results on network sections can be obtained using the different tools available. These simulations are done for a reference scenario and two contrasted socio-economic scenarios depending upon the rate of economic growth and the level of regulation and environmental concern. The innovative element of these case studies is that the corridors are extended across EU and CEEC countries from Paris to Moscow through Berlin and Warsaw in the first case, from Marseilles to L'viv in Ukraine, through Minalo, Venezia, Ljubljana, Budapest in the second case. In both cases traffic projections and route assignment along the corridors, take into account major transport investment projects.

11.1 A Combined Infrastructure/pricing Scenario Applied to the TINA Corridors

This study deals with two (closely connected) spheres of transport policy: infrastructure building, and charging for the use of infrastructure. A combined infrastructure/pricing scenario is developed for the TINA network, with the underlying assumption that the majority of the infrastructure costs have to be paid by the users of the infrastructure.

11.1.1 Construction of a policy scenario

Within this study a transport development scenario has been built up, which considers the restrictions on public budgets. Recent developments have shown that several investment projects for transport infrastructure have not been realised, because governments have been not able (or willing) to pay for them. Even the funding of TEN projects (e.g. corridor Berlin-Verona) has become problematic.

This is the reason why a policy scenario is defined, which takes into account the limited financing capacity of public budgets. Thus the scenario defined is one which is not necessarily desired by policy makers, but it is realistic because its assumptions take into consideration the financial bottlenecks in public budgets. Moreover, it is an innovative scenario, since many of the scenarios implemented in

¹⁹ The VACLAV model has been developed by IWW, University of Karlsruhe

²⁰ The TRANSALP model has been developed by EPFL LEM, Lausanne.

models for EU projects assume high investments in the railway network without considering these financial bottlenecks.

The rail and road infrastructure, which is assumed to be built in the Reference Scenario is the so-called TINA "backbone network".

The Policy Scenario combines infrastructure and pricing policy. It is assumed, that only such infrastructure will be built, which can be financed for the most part by the users of the infrastructure. So a rather realistic policy scenario (in terms of budget restrictions in many European countries) is designed, which could be called a "self-financing scenario". The Policy Scenario aims to distinguish those parts of the network on which the expected traffic demand is not sufficient to justify the investments. The most important assumption underlying the methodology for defining the Policy Scenario is the following: 90% of the rail infrastructure costs and 95% of the road infrastructure costs have to be paid by the users of the infrastructure.

In order to define the Policy Scenario, a series of runs of the VACLAV model were carried out. In the first step the costs for each section of the TINA network are assigned to the users, based on the demand on each section as expected in the Reference Scenario. Since the assignment of additional costs to the users results in changes in modes and routes, in the next step an iterative procedure is applied, which finally results in a quasi-equilibrium state. The demand level in this equilibrium state is used to estimate the revenues to be expected from the infrastructure charging. Finally the expected revenues are compared with the infrastructure costs. Having considered the balance between revenues and infrastructure costs and having implemented further plausibility checks, the assumptions for infrastructure building in the Policy Scenario were derived.

As a result of this procedure in the Policy Scenario a few branches of the TINA road network and several rail connections are assumed not to be constructed and upgraded, respectively. Exceptions are relatively expensive sections and/or connections that have comparatively low levels of traffic demand. These are illustrated in the maps in **Figure 11.1** and **Figure 11.2**, which also display the population density²¹.

For the rail network the following infrastructure sections were assumed **not** to be built:

- Complete Corridor I.
- The Lithuanian sections of Corridor IX.
- The Katowice-Zilina sections of Corridor VI.
- The south-western part of Corridor V on the territory of Slovenia and the section Bratislava-Zilina-Uzgorod.
- Parts of Corridor IV (Arad-Craiova-Romanian/ Bulgarian border and the section south of Sofia).

Most parts of the road infrastructure of the TINA network were assumed to be built. Those sections which were assumed **not** to be built are as follows:

- Corridor I: section between Sovetsk-Siauliai-Jehlgava-Riga and the section between Riga and the Latvian/ Russian border.
- The Zilina-Uzgorod section of Corridor V.
- A part of Corridor IX in the eastern area of Romania.
- The Arad-Craiova-Sofia section of Corridor IV.

²¹ The data stem from the SCENES Internet Database (SCENES Deliverable D6)

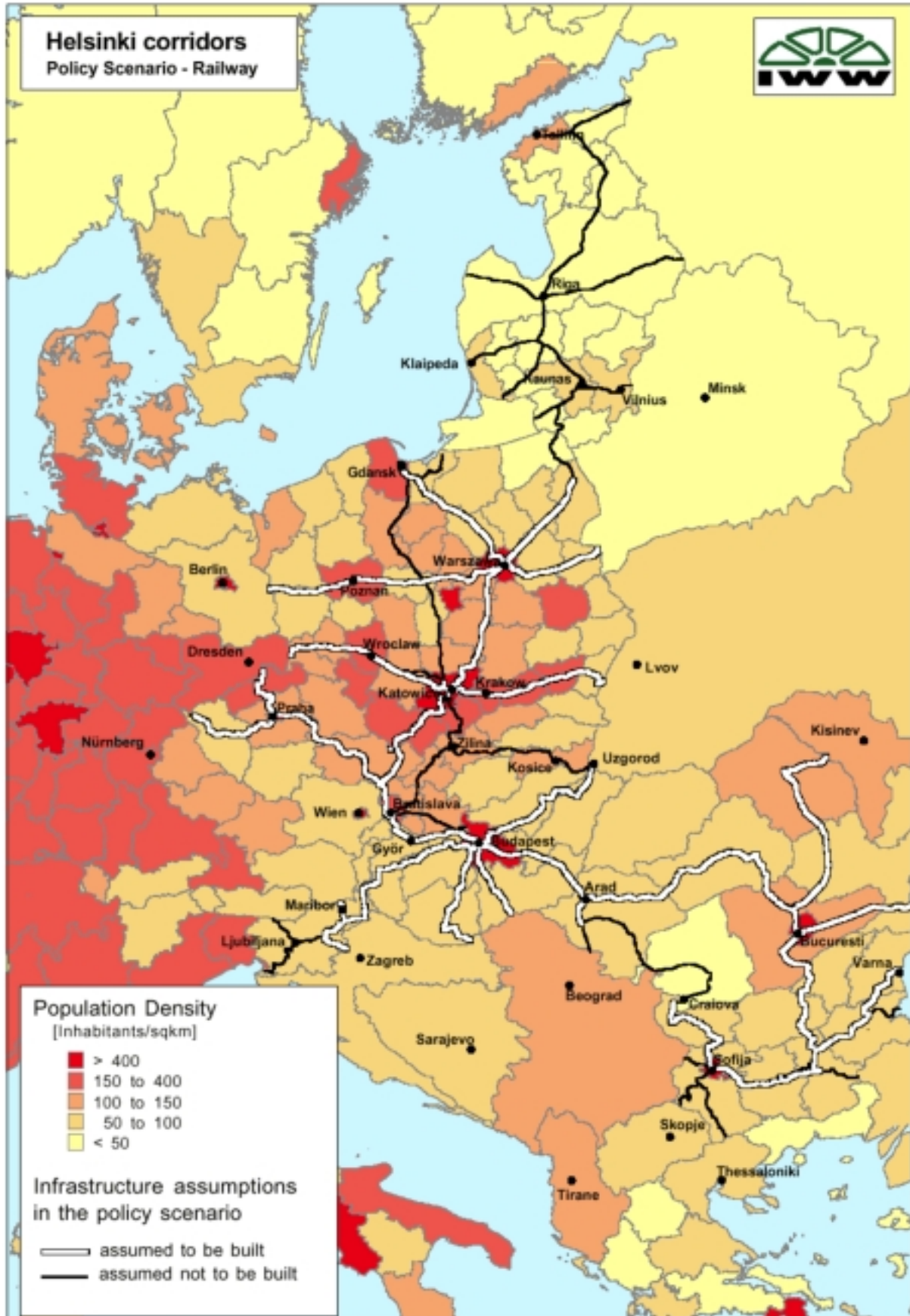


Figure 11.1 Assumptions on rail infrastructure construction in the Policy Scenario

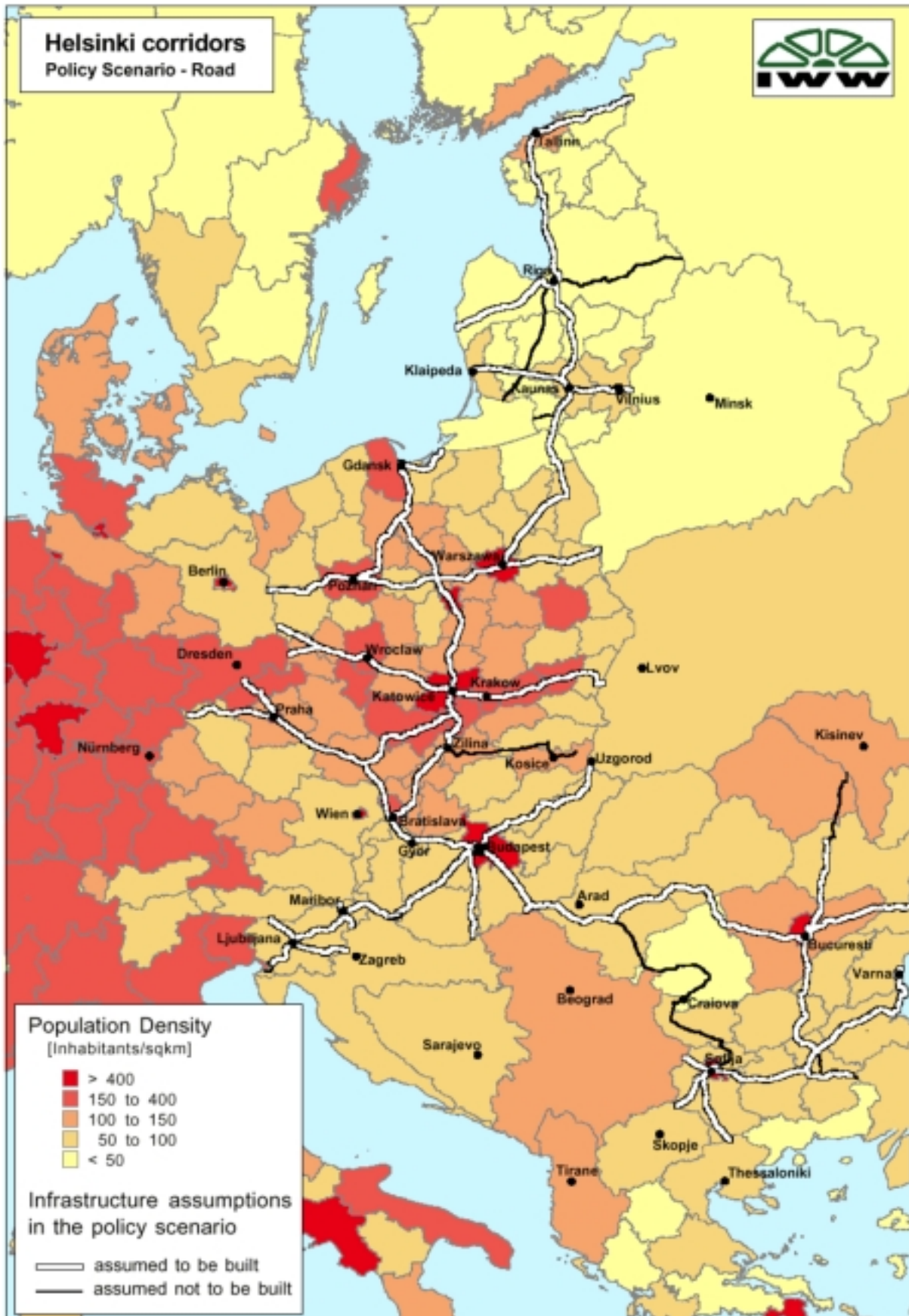


Figure 11.2 Assumptions on road infrastructure construction in the Policy Scenario

After the implementation of the Policy Scenario within the VACLAV passenger model the outcomes were compared with the outcomes of the Reference Scenario. This has shown that the assumptions made in the Policy Scenario are clearly in favour of the modes private car, coach and air, and stacked against the mode rail. The market segment of international passenger traffic is more sensitive to the assumptions of the Policy Scenario than is the national passenger transport. While the changes (Policy Scenario versus Reference Scenario) in the number of trips of national traffic are moderate (rail: -2.6%, private car: +0.4%, coach: +0.5%), the reactions in the number of international trips are stronger (rail: -6.1%, private car: +0.7%, coach: +1.1%, air: +1.4%). The unequal reaction patterns are due to the fact that the TINA network carries a major part of the international traffic, which therefore is more affected by the assumptions of the Policy Scenario than is the national traffic, which is dispersed throughout the entire network of the area.

Changes in the total number of trips generated in the Policy Scenario in comparison with the Reference Scenario are wholly negligible. This result is reasonable, since the assumptions underlying the Policy Scenario do not influence the generation of trips, but rather the modal choice and the assignment of trips.

Apart from the changes in the modal split there are - as far as the road mode is concerned - significant changes in the route choice. Transport demand is shifted significantly (up to 10 percent) from charged TINA corridors to uncharged bypasses. This effect will cause additional social costs, e.g. by overstraining minor roads, which are not designed for so much traffic or by an increase in congestion on these bypass routes. This effect shows that it is counter-productive to charge only *some* main roads. Instead of charging only a sub-set of the main roads it seems to be more reasonable to charge all major roads in order to avoid such undesired bypass effects.

11.1.2 Main findings

The exercise has shown that most parts of the road and rail infrastructure of the TINA core networks could be financed by charges on the users. However, when comparing the share of rail infrastructure assumed not to be built with the share of road infrastructure assumed not to be built, the approach that was applied of internalising the infrastructure costs, results in a higher share of rail infrastructure being shown to not be financially viable, than is the case for road infrastructure.

Summarising these results leads to the conclusion that the assumptions made in the Policy Scenario are ill-adapted to encourage the sustainable development of transport. Quite contrary to the goal of achieving more sustainability in transport, the assumptions of infrastructure building in the Policy Scenario encourage higher market shares for the modes: private car and air but a decline in the rail share.

The second important finding from this study is that it has proved more difficult for the rail mode to finance its infrastructure from its users than is the case for the road mode. This is due to rail's higher infrastructure building costs and relatively high maintenance costs. However, this problem could be solved by an increase in the attractiveness of the rail mode. This would result in an increase in the demand for rail transport, which would imply an allocation of the infrastructure costs to more users, so that the additional costs for each user would become lower. Furthermore, the railway system will need more public funding – eventually through increasing the ISPA fund - to be able to contribute to aiding the achievement of sustainability goals.

11.2 Policy Scenario for the Transalpine Freight Transport System

This section presents the results of the Transalpine freight study that was undertaken. It analyses how the modal pattern and Transalpine crossing volumes in 2020 would be influenced by transport policies.

The objective here is to forecast the impact of new policies or to estimate the effects of trends. Growth has been deliberately assumed as a projection of past figures and hence it follows a uniform

rate, in contrast to the linkage of growth to socio-economic forecasts that has been adopted in the development of the SCENES model in WA 11. In addition to delivering a case study, this part of the WA 12 has built a new transport model "TRANSALP", dedicated to Transalpine freight forecast.

TRANSALP is based on an extensive set of observed freight traffic data for the year 1994 (transport mode, Alpine crossing, commodity group for movements between origin-destination pairs). The most significant origin-destination pairs have been selected from the 1994 database, and then updated with more recent – although more aggregate - figures and economic data. Demand is then estimated by means of cost functions, which indicate shippers' modal choice and crossing selection through a logit allocation procedure.

An important feature of the model is that it has been designed as a set of interdependent modules and it is fully compatible with standard spreadsheets to facilitate the development of new interfaces. This allows the possibility of further integration with new modules concerning air pollution and other sustainability issues.

11.2.1 Transalpine freight analysis

The present analysis relies upon the 1994 Cross Alpine Freight Transport (CAFT) database. CAFT is the most detailed survey of origin-destination, modal split and itineraries of freight transport over the entire Alpine crossings. Analysis of the CAFT database, together with more recent annual counts²² suggests the following traffic pattern:

Traffic flows: North-South traffic flows prevail, with 60% of the volume transported.

Traffic split between O/D: 4 relations gather half of all Transalpine traffic (Germany-Italy, France-Italy, Italy-Germany, Austria-Italy) and 13 relations cover 75% of the total volume (8 bi-directional relations).

Traffic split by itinerary: 48% through Austria, 34% through France and 18% through Switzerland.

Transit traffic: Switzerland is particularly exposed to transit traffic since 71% of the Transalpine transport volume using Swiss passes is on transit (29% internal traffic, versus 47% for Austria and 42% for France).

Traffic generators: Italy is the largest Transalpine transit traffic generator, with 30% of the entire volume. Austria follows with 20%, Germany 16% and France 12%. These 4 countries represent 78% of the Transalpine volume.

Transalpine freight not only depends upon the Alpine economy, it also has long-distance connections.

Domestic traffic (first level): Transalpine crossings serve national domestic traffic to a minor degree (around 15% of the global Transalpine traffic (ton km) is domestic traffic: Austrian -26%- and Swiss crossings -12%-).

Import-export traffic (second level): The import-export between Alpine countries and Italy plus Germany is the most significant (29% of the total). Import-export with Italy represents 55% of the volume for France, 17% for Austria and 14% for Switzerland.

Dominant relation (third level): the most important relation links Italy to Germany and represents 28% of the entire tonnage (39% of the Swiss traffic, 5% in France and 39% in Austria).

²² Number of vehicles on the road axes. An interpolation made by the Swiss Department of Transport allows an estimation of freight volume by mode and corridor. No information about goods categories is given.

Long distance traffic (fourth level): Long distance traffic amounts for 18.5% of the global Transalpine volume. It involves the following regions: Benelux, Spain / Portugal, Scandinavia and Great Britain / Ireland. The volume is split between Switzerland (25%), France (36%) and Austria (40%).

Synthesis: The four traffic levels described above stand for 90% of the total volume, 96% of French traffic, 93% of Swiss traffic and 86% of Austrian traffic.

Basic principles can then be deduced. They are:

Distance and modal choice: the common idea that rail share does increase as a function of distance is true only for flows using Swiss crossings and exclusively for the North-South traffic. Conversely, for transport registered in France and Austria, road dominates to such an extent that similar trends could not be identified.

Shortest way principle (average distance): this principle is verified on the relation between Germany and the three North-Italian regions (Piemont, Lombardia, Venetia - 25% of the Transalpine volume-). Indeed, going from West to East, the share of France goes successively from 28% to 5% then 1%, for Switzerland from 48%, 59% then 3% and finally, for Austria, from 24% to 36% then 96%. This principle is less significant for long distance.

Modal choice and origin countries: rail share represents 38% of the total Transalpine volume. However, four origin country groups generate a less than 20% rail share (Great Britain / Ireland, Spain / Portugal, Russia and Balkans). Rail share is above 70% for five origin countries (Scandinavia, Poland, Hungary, the Czech and the Slovak Republics).

Modal captivity: more than 80% of 10 goods categories are transported by road. The main part of these flows is connected with French and Austrian passes. Petrol (internal to Austria and between Austria and Slovenia / Croatia), animals (France – Italy), foodstuffs, textiles and concrete are the goods most captive to road.

Goods value and modal choice: the 1994 survey confirms the principle that most valuable goods are those most likely to be transported by road.

11.2.2 Scenarios for Transalpine freight

Three scenarios have been defined in order to investigate the future pattern of Transalpine freight, in accordance with national transport policies and rail productivity changes.

Two scenarios are based on a projection forward of the present trends. Since both, even though positive to rail, indicate that road would keep a larger market share than rail, a third scenario has been created. The third scenario, entitled "fifty-fifty" relies upon the back-casting principle: a target of equal transport volume for both modes has been set for the year 2020 and the results indicate a series of paths that would facilitate reaching this goal.

Reference scenario : Trend and implementation of current transport policies

The Reference Scenario explores the effect of the current transport policy of each European country on Transalpine freight. All information concerning: the future evolution of the transport policy of each country, i.e. the new infrastructure investments, the development of the modal networks, the introduction of new heavy vehicle tax, collaboration for a better management of the flows of vehicles, are taken into account.

This Reference Scenario assumes a 1 hour time saving at the Brenner crossing, as well as over all Swiss crossings. It assumes that the project Lyon-Torino will have some delay due to the opening of the Mont-Blanc tunnel and so will not be in service before 2020. The average rail speed is 45 km/h.

Improve-Rail scenario: A strong will to improve the rail share of Transalpine freight

This scenario explores the effect of an extended European collaboration in terms of transport policy implementation that has the explicit objective of favouring modal shift to rail.

Improve-Rail implies better organisation and logistical improvement of rail, together with no effort to improve road infrastructure. It makes the following assumptions:

- all European countries improve railway logistics as much as possible, which boils down to a yearly 1% reduction of global costs
- the improvement in the rail infrastructure, Lötschberg & Gothard tunnels, Brenner, and Lyon-Torino are all in operation by the year 2020
- time at customs posts is reduced which leads to a 50% time reduction at borders, and average rail speed is assumed to increase up to 55 km/h
- Austria, Germany, Italy and France maintain their present road transport policy. The Mont-Blanc tunnel is open. Switzerland introduces the Alpine tax at the maximum rate allowed.

Fifty-Fifty scenario: back casting towards equal modal split

The Fifty-Fifty scenario highlights the conditions that are necessary for achieving a 50/50 ratio on the global Alpine crossings. Equal rail share more imply more efforts than Reference and Improve-Rail scenarios, which already suggests that all European countries have to co-operate closely and harmonize their national policies.

Fifty-Fifty scenario is a back-casting exercise: the rail-road modal split in 2020 has been set equal and the main issue of the study is the investigation of the paths that may lead to this objective.

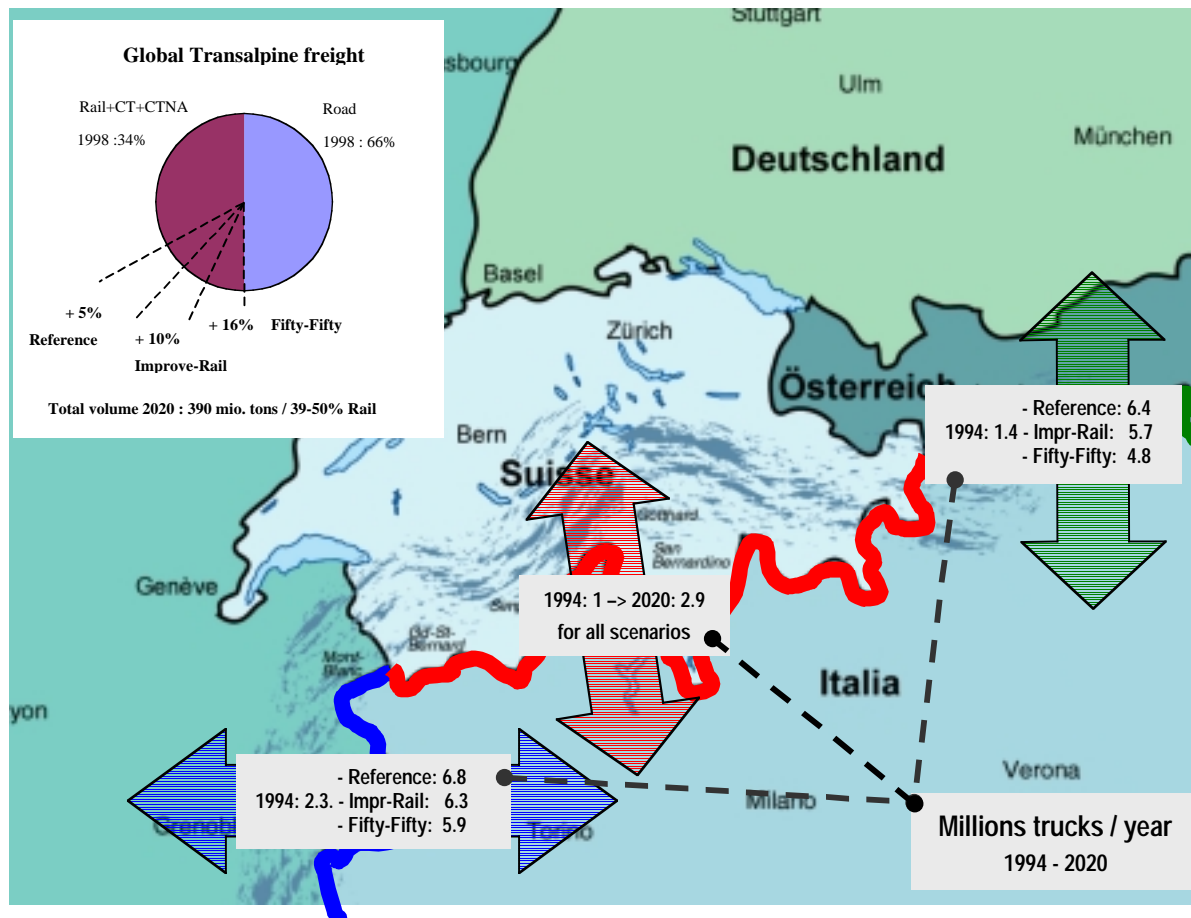


Figure 11.3 Transalpine freight in 2020: Reference, Improve-Rail and Fifty-Fifty scenarios

11.2.3 Results

The results based on 3 scenarios show in the Figure 11.3 how road and rail infrastructure will be used along the Alps between now and 2020, depending upon changes in transport policies as well as economic development. In the EU Member states and in Switzerland: more and more stringent measures are introduced in order to increase rail freight modal share from 39 % (Reference scenario) to 44 % (Improve-Rail scenario), up to 50 % by 2020 (the Fifty-Fifty Scenario).

All countries play an important role, but it appears that the most significant changes would happen in Austria, with a shift in rail share from 37% in 1998 to 53% in 2020 for the Fifty-Fifty Scenario. Modal split remains nearly unchanged around 70% rail in Switzerland²³, whereas rail share in France decreases by 4% to 17% to 2020 in the Reference Scenario and increases only to 23% in the Fifty-Fifty Scenario. Italy is the only State concerned with all projects. Therefore, it acts as a catalyst for all Transalpine actions.

Setting sustainable objectives

Rail currently carries some 34% of the total Transalpine freight; the study confirms that a 50% share is conceivable in the future. This is of particular importance in the ecologically sensitive Alpine regions, where road traffic is likely to cause a significant impact on the environment and on local populations.

More stringent measures are needed

The case study highlights that even a thorough implementation of present measures would not increase the Transalpine rail share by more than 5% by 2020. Further improvements are needed; these have to be elaborated as global and trans-modal package measures. For instance, 20% faster trains, with a yearly 1% cost reduction, partly financed through road taxes such as the heavy vehicle fee, could improve rail share by 10% by 2020, which still would lie below equality across modes.

Institutional harmonisation

Hence, if equal market share between road and rail is ever to be achieved in the Alps in 2020 (i.e. still allowing for inertia such as more road freight in France & Austria, whilst more rail in Switzerland), there is a need for extremely strong actions, co-ordinated at the European level. The first and most straightforward measure should be a complete removal of administrative barriers.

Efficiency through packages of measures

Equal market share requires both rail improvement and road impediment, not only close to the Alps, but also over the entire North-South transport chain. Co-ordinated measures could reach this objective if they enabled the attainment of a range of speed-productivity enhancements, for instance a yearly 2,0-2,5% decrease in rail costs, together with increases in rail average speed up to 60-90 km/h.

Rail infrastructure improvement is no luxury

The study shows that all three large-scale Transalpine rail projects under study or construction in France, Italy, Switzerland and Austria are essential to meet future needs and make freight transport more sustainable. Freight growth is such that the 2020 rail share would reduce without them. Indeed, these projects merely enable a reduction in rail share to be avoided.

11.2.4 Next steps

The most stringent scenario (Fifty-Fifty) considered in this case study had been targeted towards equal partition of Transalpine freight between rail and road. Fifty-Fifty has been chosen as a landmark. However, there is at present only poor knowledge about the stakes of potentially more sustainable transport and about the means to achieve it. This leads to two questions:

a) is equal share sustainable?

²³The reason for this is that the most important enhancements within Switzerland are actually underway, therefore they are already included in the Reference Scenario.

Freight growth is such that the most ambitious option would reduce the number of trucks crossing the Alps in 2020 by less than a fifth²⁴, still leaving more than 13 million trucks on the roads. This is more than the double of 1998 figure.

The problem is that such a trend justifies no measures, since the limits to sustainable Transalpine freight transport are still unknown. This topic should be examined more intensively.

b) to what extent can road and rail modes be tackled separately?

Rail and road fully complement each other in the case of Transalpine freight: versatility -the main advantage road- is almost useless in Alpine regions, where there is almost no reason for fine distribution²⁵. Indeed, the Alps concentrate freight so that it is economically sensible to group it onto trains, which also frees crossing capacities for short distance road distribution.

A global concept for short and long-distance Transalpine freight should be developed.

11.2.5 Recommendations: A Supra-national Transalpine authority

The clearest outcome of this study is that a new, supra-national, authority should be created, with the mission of co-ordinating global Transalpine issues linked with transport and the environment. This authority should lead to a better harmonisation of policy measures, infrastructure planning, realisation and operation amongst the Alpine countries as well as amongst countries influencing Transalpine transport. The main Transalpine freight issues this new authority should tackle are listed below:

Harmonisation of rail performance

Balance (Fifty-Fifty Scenario) is only reached after all barriers to rail freight have been lifted at the borders, allowing average speed up to 60-90 km/h, in concert with yearly cuts in rail costs between 2-2,5%.

This leads to two interrelated measures: first, all new Transalpine projects linking France, Switzerland and Austria to Italy are needed, not merely for the extra capacity, but also to enable high commercial rail speeds to be achieved; secondly, their realisation should be synchronised with the complete removal of institutional obstacles.

-> Political measures have to be created and implemented.

Harmonisation of modal complementarities

Analysis of the Transalpine relations in the database shows that countries far away from the Alps, primarily on the North-South corridor, are important traffic generators. Indeed, Alpine crossings regulate modal choice far upstream, and also the upstream modal choice influences the selection of the crossing point. Accordingly, the main origin and destination regions should participate – to some extent - to modal shift measures and/or to finance infrastructure.

-> A legal structure has to be developed.

Consequently, at the larger scale, national policies have to be harmonised with the objective of influencing traffic flows all along the international logistics chain: road freight should not be heavily charged in the locality of the Alpine regions, while at low cost on the rest of the continent.

-> This harmonisation process has to be launched.

²⁴ 10% compared to Improve-Rail scenario and 18% compared to Reference scenario.

²⁵ Rolling highway is considered as an alternative to road, although it is essentially the continuance of two road segments, thus fosters road industry, still making use of rail infrastructure.

Trans-modal economics

New large-scale projects aimed at achieving globally more efficient and sustainable Transalpine transport should be financed trans-modally, seeking modal solidarity, over one or two generations, whereas traditional (unimodal) long-term return on investment approach should be left to the case of local infrastructures, where modal choice is less appropriate.

-> An official framework should be produced, with a clear definition of the objectives, in terms of sustainability, transport efficiency and finance.

11.3 East West Case Study

This case study relates to a corridor which is to a large extent similar to the Pan-European Corridor II marked out at the second Pan-European Conference in Crete. The Figure 11.4 presents the corridors in Central and Eastern Europe according to the Crete and Helsinki corridor definitions.

The task here is to review existing information and to go one step further by considering the extension of corridors into Western Europe and providing a Pan-European scenario for the entire extended EU-CEEC corridor. It should be stressed that for the aims of this SCENES case study, the extended corridor from Paris to Moscow is analysed, and the analyses take into consideration all the countries, i.e. France, Germany, Poland, Belarus and Russia.



Source: Pan-European network, EU

Figure 11.4 Pan-European transport corridors according to Crete and Helsinki corridors

The case study has been carried out in two general parts, i.e. first part concerns western and central sections of the corridor (France-Germany and Poland), while the second concerns the eastern section of the corridor (Belarus and Russia). Two different approaches have been taken into consideration due to level of availability of the necessary data. Along the western and also the central section of the corridor it has been possible, on the basis of generally available data and previous studies, to analyse given scenarios of transport traffic. However, in eastern sections, traffic passenger and freight data is

not available, so that it has not been possible to execute the study in the same manner. Therefore, it has been decided, that in the eastern part of the corridor, on the base of common scenarios, the analysis was based on:

- in passenger transport – changes of international traffic and their influence on transport volume, modal structure, etc.
- in freight transport – changes of foreign trade and their influence on transport volume, modal structure, etc.

11.3.1 Analysis

In its western section the corridor leads through intensively industrialised areas with a high level of GDP per capita, and in its eastern section it goes through agricultural and forest areas where GDP per capita is low. In future such differences may influence passenger and freight traffic flows within the transport network included in the corridor. Moreover, the differences in question may lead to an increasing imbalance in investment intensity in the modernisation of the Western and Eastern transport networks as a result of the different availability of funds for such investments.

Notwithstanding the differences in the economic and political systems of the countries in which the corridor is located, the **freight transport** volume in the corridor's transport network increased in the 90's which was triggered by a change of foreign trade directions. European Union countries became the dominant direction (approx. 2/3 of turnover) for the countries from the eastern part of the corridor (Poland, CIS).

Passenger transport had less dynamism as a result of continued limitations on the international traffic of CIS citizens and the low level of their personal income.

Road transport development within Corridor II has been more intensive than rail transport development. However, the size of the urban areas located along that corridor and the distances between them creates the possibility of the development of high speed railway passenger transport in the future. However, investments in that respect require accurate identification of future passenger flow volumes.

There are considerable differences with respect to priorities given to transport investments when investment policies of the Corridor II countries are considered. Whereas in Germany and France transport infrastructure investments in the 90's accounted for 1.1-1.2% of GDP, in Poland and CIS it was less than 0.5%. Changes occurring in economic policies of Central and Eastern European countries have not given a "green light" to investments in transport infrastructure. Many transport networks development plans and programmes in those countries remain on paper only (e.g. the motorway building programme in Poland). Without a long term transport infrastructure modernisation strategy and without ensuring 1.5-2.0% of GDP for that purpose it will not be possible to implement the Corridor II vision.

Investment policy with respect to transport in Europe still mainly has a national dimension. The involvement of UE budget and structural, cohesive and aid funds accounts for only several percent of general investment needs in respect of the member countries' transport. It hardly seems possible that investment policy programmes constructed according to the European corridors scheme could be created in the nearest future. However, arrangements made between the governments of France, Germany, Poland, Belarus and Russia in that respect could help specify the scope of available funds from national and international sources and determine the number of tasks that have no financial cover.

11.3.2 The Scenarios

Despite the regional separation the same two scenarios are defined for each part of the corridor. The main goal of the case study is to define the scenarios and according to the scenarios to project the

development of the transport flows for the extended Corridor II. The scenarios are based on contrasting political strategies.

The first scenario (Scenario A) takes into account the growing awareness of the environment among the European population. The main goal of this scenario is the ecological and economical sustainability. In order to anticipate or to correct market failures a stronger regulation is foreseen. Since the regulations shall be similar for all the regions considered, harmonisation is more important than liberalisation in this case. However, it is well known, that ecological awareness is strictly related to favourable economic outlooks. As soon as the rate of unemployment rises and private incomes start to drop (or stop to increase) environmental awareness vanishes rapidly.

Therefore a second scenario (Scenario B) has been elaborated. It follows the idea of the free (transport) market (liberalisation) and neither national nor European interventions are expected. However, harmonisation does not automatically exclude liberalisation and vice versa. The baseline for the scenarios is the situation of 1997. The forecast year is 2020.

A variety of results for passenger and freight transport have been generated for the reference scenario (Ref. Scenario), the sustainability and regulation scenario (Scenario A) and the liberalisation scenario (Scenario B). Bus and rail transport is strongest for the sustainability scenario, although the current rail and bus shares will still decline. Car ownership will grow for any scenario, so that the importance of the private car will increase anyway. Certainly Scenario B will speed up this trend. While travellers from Paris, Brussels or Cologne already prefer the plane to the train, bus or car (and will continue to do so), domestic air traffic will not be of high importance along this corridor.

Synthesis and conclusions

12 THE ROLES AND INTERRELATIONSHIPS OF THE TOOLS DEVELOPED

The output from each of the three Work Areas has already been presented in some detail in this report. The WA 10 lays a sound foundation for the other two WAs through providing socio-economic data and a detailed analysis of the main factors that will influence future travel demands of passengers and freight. Because the primary purpose of the models and the scenarios that have been used in this study is to understand the future and to understand how it can be improved through the adoption of suitable policies, it is critical that there is a strong behavioural basis underlying these models and scenarios. The analysis carried out in the WA 10 provides such a basis.

Then WA 11 and WA 12 have built on this foundation in separate, but complementary, ways as now outlined.

The SCENES model of WA 11 has taken a pan-European perspective that includes within it all of the passenger travel and all of the freight transport for all of Europe. In this way the future scenarios that have been developed by this SCENES model for 2020 provide a comprehensive and consistent picture of the future evolution of transport at the European scale. However, this type of comprehensive, all encompassing view is only feasible in practice through simplifying and aggregating many of the relationships that are modelled. It provides the functionality of an 'umbrella' model - a high level model which gives a strategic point of comparison or a backdrop for the results of other models.

In WA 12 a contrasting but complementary approach has been taken in which a range of more specific topics have been analysed as separate case studies and modelling exercises. The ambition of WA 12 to focus on structural changes makes it impossible to build a unique model for WA 12, which would be able to reflect all the required variety of aspects (geographical, behavioural, organisational, political breaks in trends, etc.) all at the same time. Instead, many models are used. Each specific model, or so-called "module", is adopted solely to point out the importance of a given structural change or variation in one component or part of the transport system.

All models involve compromises in the levels of spatial and behavioural detail, as well as in the comprehensiveness of coverage of the components within them so that there is always a need to consider the underlying aims for which a model was developed as a guide to which models are most relevant for which purposes. This topic is now addressed in more detail in subsequent sections.

12.1 The Role of the SCENES European Model

The European-wide SCENES model, to some extent, covers all of the same topics that are modelled individually within the separate models of WA 12. However, by virtue of its wide-ranging nature it is not necessarily designed to treat specific individual topics at the same level of detail as in one of these more specialised or localised models.

The SCENES model adopts a comprehensive modelling framework that is validated at the national level for all of Europe. The aims when developing this SCENES model were that the model should achieve:

- **Spatial comprehensiveness:** it should cover for all European countries all transport movements at all spatial scales (the only current exception is that the freight transport wholly internal to the CEEC countries is not modelled).

- **Modal comprehensiveness:** it should cover all freight and all passenger transport modes in order to ensure that the full range of reactions to future transport developments is included. It is for this reason that modes such as walk/cycle and fuel pipelines are included, and not just the conventional road and rail modes.
- **Behavioural comprehensiveness:** it should represent transport as a derived demand in which changes in economic structures, in demographic structures and in location patterns can influence the patterns of transport demand. It should not be restricted solely to the conventional supply based influences from changes in the transport cost, time, capacity and quality of service by mode.
- **Behavioural segmentation:** It should maintain a substantial degree of segmentation in the categories of passenger types, travel purposes, commodity types and freight loading types in order to take account of the differences in the transport requirements and the rates of responsiveness between the different segments in each such category.
- **Full responsiveness:** In response to transport supply changes it should represent the lengthening and redistribution of trips, and not solely changes in mode and route. The model excludes time of day choice, which is an important response, but one which is difficult to implement at the European scale, and excludes elastic passenger trip generation, as this is believed to be a relatively minor response in practice.

The above ambitious set of aims has been fully met as has been illustrated by the model results that have been presented in the earlier chapters. Two aspects of the SCENES model that would benefit from further development in the future are: the level of spatial detail in the assignment model, and the underlying data used to calibrate the model.

The SCENES model operates at the NUTS II zoning level (244 zones) across Europe, but in order to refine the local spatial detail a special procedure was devised to enable the road assignment to be carried out using a NUTS III zoning level. More recently, an alternative procedure has been developed by ME&P²⁶ that enables efficient assignments to be carried out for models with large numbers of zones. This uses differential sampling of zone pairs to avoid bias while increasing computational efficiency. The implementation of this approach within the SCENES model would have the potential to substantially improve the reliability of the estimates of road congestion.

Because of its comprehensiveness the creation of the SCENES model has required an extensive range of detailed data inputs across the whole of Europe. However, when developing models at the pan-European scale it rapidly becomes clear that there are not at present comprehensive, consistent, harmonised datasets available for the whole of the EU, and still less so for non-EU countries. In reality some northern European countries do indeed have good transport data. But even for these, the categories, data definitions and years for which such data are available in one country are not harmonised with those for other countries.

Despite the hard work on data assembly and harmonisation that has been carried out at: Eurostat, in the proceeding STREAMS project, and within the WA 10 of SCENES, the database on which the SCENES model has been constructed is not ideal for some countries and for some transport characteristics²⁷. The ATOM (2002) FPV study for the Commission has highlighted the need for improved coverage and harmonisation of passenger and freight data across the EU. The SCENES model would be a major beneficiary when such improvements have been completed.

12.1.1 Policy testing with the SCENES model

The discussion above has explained the reasons why the SCENES model is at its strongest when operating to represent strategic issues at the European-wide level, but currently is less suited to analyse

²⁶ This approach has been successfully implemented on PC for a 10,000 zone road assignment model as part of the National Passenger Model for Great Britain.

²⁷ See Annex C of the SCENES Deliverable D4 for examples.

specific small-scale initiatives in a particular locality. For example, the model might need some further improved input data and local calibration as a prior step to being used to study policy initiatives within some specific European corridor. It might also be advisable in such a case to increase the level of zoning detail within such a corridor, to enable the more localised supply and demand characteristics to be represented in a more refined fashion.

The issue here is not that the general structure of the SCENES model would need to be changed, it would not. It is rather that the underlying data in use in SCENES, and in consequence the quality of the local calibration, is not of a uniform standard across the whole set of countries of Europe. Moreover, even with the acquisition of better and more harmonised data, significant further resources would still be required to enable the quality of the calibration in *all* European corridors in the SCENES model to be enhanced to the level achievable when developing a specialised model for just a single European corridor.

The usage of the SCENES model for transport policy scenario testing reported in Chapter 8 has focused largely on exploring the effects of future changes in the levels of transport costs for different passenger and freight modes within a single external scenario. The objective was to demonstrate how the model could be used to provide comprehensive information on the impacts of specific transport policy initiatives. In the future, other alternative external scenarios could be developed based on different assumptions regarding the evolution, for example, of GDP and car ownership growth and of the sectoral patterns of future trade. Likewise, a wide range of other transport policy scenarios (e.g. major infrastructure investment, regulation of road vehicle speeds, fuel taxation, etc., applied differentially to some or all regions or parts of the modal networks) could be tested within the model. The Pilot Strategic Environmental Analysis of the TEN network that was carried out using the previous STREAMS model is a good example of such a study.

Another important topic in which the SCENES model could be of future value is through use of its comprehensive reporting capability to provide a future transport baseline as a foundation for European transport projections. These projections of future numbers of trips, vehicle-kms, tonne-kms, etc. by area and type, would play a role similar to that played by demographic or energy consumption projections at present (ATOM, 2002). The potential role of European transport projections is as an agreed background input to studies in related topics, such as energy usage, pollution emissions, accessibility and social exclusion. In the absence of agreed European transport projections such studies are forced currently to make their own projections (often of poor quality), with the resulting disadvantage that they rarely will be common across studies.

12.2 The Roles of the Detailed Models

The "modules" of WA 12 represent a wide range of well-known models used in different European countries. Most of these models have already been widely used and experimented with in the past but have never before been put together within a common framework of analysis. Here their inputs have been defined according to a common general scenario scheme designed to illustrate alternative situations, each having its own internal logic of development. Each model highlights different specific aspects of the transport system.

These models do not seek to produce a comprehensive estimate for the entire transport system, in the manner that the SCENES European model in WA 11 is designed to do. Through taking this partial modelling approach in WA 12, in which only a particular corridor or a sub-set of travel movements is analysed in detail, it is possible to analyse the specific topics of interest in greater depth. In turn some of the insights that are gained through this process could be fed back into a longer-term enhancement programme for the SCENES model.

However, considerable care needs to be taken with models designed for a specific locality or purpose, when extending their results to provide more general insights across Europe. The ever-present danger when adopting and combining results from an array of different models is that their underlying

assumptions and data definitions may differ significantly between the models. This can lead to a proliferation of findings due as much to unintended differences between the models themselves, as to genuine differences in the real transport systems being studied. This is an issue that has been discussed in more detail in the ATOM (2002) FP V study on the future modelling needs of DG TREN, and by the ECMT (2001) in the comparison of results from different models of the Transalpine area.

The key requirement to obtain maximum benefit from the combined use of a range of models is that there are agreed common underlying assumptions for those background aspects of these models that are not the direct object of study. As an example if for overlapping study areas, one model assumes high economic growth while another assumes low economic growth, then the resulting forecasts of transport responses would be difficult to interpret. This highlights the need for clear specifications of agreed baseline assumptions when defining scenarios.

12.2.1 Policy testing with the detailed models

The aim of the usage of models in the WA 12 was to focus primarily on current EU policy concerns, as discussed in the Commission's recent White Paper (2001) on European Transport Policy for 2010.

The first set of objectives, concern the transport policy in an enlarged Europe and the application of "user charge" principle, to accession countries or more precisely to the use and development of TINA network. The second set of objectives concern the Transalpine policy and the question of harmonisation of national policies. In both cases a major objective is the encouragement of public transport modes in order to improve the level of sustainability of future transport.

The Alpine Crossings and the TINA network have been taken as case studies in order to show the relevance of the approach. The extension of East-West corridors from EU countries and major cities through to Eastern countries has also been chosen as application case studies in order to illustrate the spatial dimension for projections up to 20 or 30 years from now, and to show that a link can be made in the long run between a European vision of the future and concrete localised projects.

But beyond these policy case studies there was also the ambition to show that such tools and approaches could be applied across a range of specific projects or measures in a consistent way, based on a more global vision of the European transport system. These case studies have deliberately been chosen to cross the borders of countries. In fact the East-West corridors have been selected to have sections across EU countries, accession countries and even across neighbouring CIS countries further to the east.

To a large extent the role of the testing of policy scenarios with these detailed models is one that is complementary to that of the European SCENES model, rather than an approach that is in direct competition. Many specific infrastructure investment projects, by their very nature have a very pronounced local impact, but one which declines strongly with distance from the project, except for the often limited proportion of long distance traffic that uses the enhanced facility. For such projects, the usefulness of a model that is directly focused in detail on the area surrounding the investment, is likely to be greater than the usefulness of a general European-wide model.

In contrast, when examining either the net result of a whole collection of major infrastructure projects in differing locations, or the impacts of major transport cost changes that operate over the transport system as a whole, then a comprehensive model such as SCENES provides important insights into the interactions within the transport system as a whole, that the more detailed models would struggle to achieve.

13 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations from the range of tasks within the SCENES project have been discussed in earlier sections and are summarised here. They fall into three main groups: those concerning drivers of transport demand, those related to transport policy issues that have been derived through the development of scenarios and the use of analytical procedures, and those related to the analytical procedures themselves developed within the project.

13.1 Drivers of Transport Demand

The socio-economic forecasts generated within the SCENES project suggest that there are significant differences across Europe. The strongest dynamic of economic growth in Europe is expected to emanate from the accession countries and Eastern European countries, which in the long run will result in a higher level of parity of wealth and cohesion in Europe. A similar contrasting development is forecasted for car ownership growth.

Detailed investigation of the drivers of transport demand has shown that the demand for transport is not solely influenced by the factors that are usually included in transport modelling, such as preferences for mobility, sectoral development of production, or transport supply characteristics. In order to explain long term changes in transport patterns it is also necessary to study the demand/supply effects, which occur in second round interactions between *land-use changes and transport development*. Neglecting such effects would lead to failures in transport planning. Furthermore, it has been shown that in transport markets, in which supply parameters (e.g. costs, level of service) are flexibly adjusted to demand structures, like in the air market and increasingly also in the long-distance rail market, a state of total equilibrium between demand and supply will never be achieved. Guiding the demand for transport modes into certain directions does not necessarily require a direct influence on the mode under consideration. Since demand and supply for different modes affect each other, there is also the option to give a small (and maybe cheaper) impulse to one or more of the other modes and to end up with the desired results as well.

The results of research on demand-supply interaction underline the requirement for an integrated transport policy, which is characterised by a consistent approach to handling the long-term interrelations between transport policy measures and land use, and which also pursues an integrated approach when designing policy measures in order to guide modal split in the required directions.

Another area of great influence on the long term development of transport patterns is the type of *regulation* of the different transport sectors. In the EU countries, changes in the regulatory systems and changes of organisation in the transport sector have been stimulated, in particular after 1985, in order to improve allocation efficiency and competitiveness. Different concepts for regulating and organising public passenger transport have emerged across Europe. Several case studies have shown that, in certain countries, regulatory change has gone in parallel with growing demand for public transport. This holds true in particular for the introduction of franchising systems rather than outright deregulation. However, in most cases the regulatory changes within public transport have not led to a substantial increase of patronage, but rather to faster rationalisation and more cost efficiency on the supply side. Without direct initiatives towards the harmonisation of transport markets it is unrealistic to expect substantial shifts from individual motorised transport to public transport.

On the contrary, due to the liberalisation process in the road freight and the airline sector in the European Union, further strong impulses have been given towards those sectors, despite all concerns expressed in Green and White Papers on the environmental consequences of such developments. Looking at the railway sector in some detail one can – after studying the performance of different regulation activities in individual Member States – draw the conclusion that these activities had little

effect on changing the trends of traffic development. In the case of long distance transport, the reasons for this are that market conditions have not yet been harmonised, and that strong national barriers still exist which hamper the development of international railway operations.

Regulatory changes in CEE countries have been most effective for the mode road. The types of changes that have occurred related to the road mode can be summarised by demonopolisation (intercity passenger transport by coach operators), decentralisation (urban public transport) and deregulation (freight market). Generally speaking, deregulation in freight transport has been achieved quicker and on a wider basis than regulatory changes in the passenger market.

It is very difficult to estimate the implications of regulatory changes on transport demand – particularly in CEE countries where the whole economy and society had been transformed, and where transport demand has been driven by many different determinants. Nevertheless, regulatory changes can be shown to be closely connected to changes on transport markets. The most obvious example is the deregulation of the road freight transport market: this market segment has profited most strongly from the transition process – a development, which is underlined by the enormous increase in market shares of road freight transport.

In particular the development of freight transport is heavily dependent on *trends in the spatial organisation of production*. This leads to particular requirements for logistics with respect to supply chains and inventory holding which in the past have not been integrated within the usual top-down modelling approaches of freight transport. However, an innovative approach to this has been tested within the appended module of the SCENES European model. Especially (1) European integration and globalisation, (2) changes in the commodity structure, (3) changes in the operational behaviour of companies and (4) application of innovative information and communication technologies have had a substantial influence on the development of demand for freight transport and the evolution of modal split:

Also for passenger transport the economic development, European integration, globalisation and the evolution of international relationships have widely influenced the pattern of business, holiday and leisure traffic. Upcoming new technologies in the communication sector have contributed more to increasing physical travel demand rather than substituting travelling by Internet surfing.

Large external changes, like the transition process taking place in CEE countries, have been able to provoke changes in trends in transport demand patterns, whereas other less striking external disturbances have only resulted in a temporary discontinuation of prevailing trends. Thus the analyses of changes in trends suggest the conclusion that: whenever policy-makers intend either to achieve permanent changes from the current trends in transport demand growth, or to achieve decoupling of certain transport demand indicators from economic development, then major and extensive efforts will certainly be required.

The *institutional framework* within which transport markets are embedded has proved of great relevance to the development of transport. The institutional framework provides the guidelines for how externalities are dealt with and for how incentive mechanisms are set. It also tackles the problems associated with transaction costs. Thus institutional aspects determine not only the allocation of costs to certain modes, but also the way transport is organised and operated. Thus it has decisive impacts on reliability, quality, efficiency and security of transport services and thereby on transport demand patterns and the relative competitiveness of modes. Although it is rather complex to demonstrate their effects on transport demand indicators, institutional aspects are an important driving factor of transport demand.

Analyses have shown that transport demand patterns have been driven by various developments, which are partly internal and partly external to the transport sphere. Both the external developments (e.g. progress of deregulation, changes in demand structures) and the internal developments (e.g. application of innovative information and communication technologies) have acted in favour of the

modes road and air but have been stacked against the mode rail. This is problematic since, in the opinion of many policy-makers, rail is the mode that most needs to increase if sustainable transport systems are to be achieved. The studies have shown that only radical changes in circumstances can provoke changes in the prevailing trends in transport demand patterns. Therefore in order to push certain modes, on the one hand comprehensive and integrated policy measures are required, on the other hand a high level of innovation is required on the transport operators' side.

13.2 External and Policy Scenarios

The key feature that becomes apparent from the diverse issues that are analysed in the external scenarios is the need for *flexibility* in the transport policies that may be developed. It is clear that however good the forecasting procedures that are available may be, there are still major political and social forces (particularly in the countries outside but bordering on the EU) that could radically alter the future travel demand pattern. Accordingly, transport policies should be such that, if and when major breaks in trend occur, the policy can be adjusted such as to still retain its original coherence.

Yes it is important to use good analytical tools to forecast the potential impacts of transport policy measures. However, it is also important that these policy measures do not rely unduly for their success on an ability to accurately forecast future external social and political events across Europe. Policy measures need to be robust to a range of possible future external scenarios.

The other main finding from the analysis of external scenarios is the importance of behavioural and structural change factors for households and firms in determining future transport patterns. Strategic transport studies should not be too narrowly focused simply on the transport system itself if they are to succeed in understanding transport developments. They need to also look at a wider range of behavioural and attitudinal issues from outside the transport system that may have a major future impact on transport itself. Models that enable many of these issues to be explored have been utilised to explore external scenarios in the course of the study.

The main policy conclusions are drawn from the two transport policy scenario case studies that have been carried out. These show the relative importance of policy variables in influencing how future transport patterns may evolve.

The combined infrastructure and pricing scenario applied to the TINA corridors

The combined infrastructure and pricing scenario has shown that most parts of the road and rail infrastructure of the TINA core networks could be financed by charges on the users. However, when comparing the share of rail infrastructure assumed not to be built with the share of road infrastructure assumed not to be built, the approach that was applied of internalising the infrastructure costs, results in a higher share of rail infrastructure being shown to not be financially viable, than is the case for road infrastructure.

Summarising these results leads to the conclusion that the assumptions made in this policy scenario are ill-adapted to encourage the sustainable development of transport. Quite contrary to the goal of achieving more sustainability in transport, the assumptions of infrastructure building in this policy scenario encourage higher market shares for the modes: private car and air but a decline in the rail share.

The second important finding from this study is that it has proved more difficult for the rail mode to finance its infrastructure from its users than is the case for the road mode. This is due to rail's higher infrastructure building costs and relatively high maintenance costs.

Policy scenarios for Transalpine freight

The clearest outcome of this study is that a new, supra-national, authority should be created, with the mission of co-ordinating global Transalpine issues linked with transport and the environment. This authority should lead to a better harmonisation of policy measures, infrastructure planning, realisation and operation amongst the Alpine countries as well as amongst countries influencing Transalpine transport. The main Transalpine freight issues this new authority should tackle are listed below.

Two interrelated measures would be needed to achieve a proportion of rail freight equal to that on road: first, all new Transalpine rail investment projects linking France, Switzerland and Austria to Italy are needed, not merely for the extra capacity, but also to enable high commercial rail speeds to be achieved; secondly, their realisation should be synchronised with the complete removal of institutional obstacles.

Analysis of the Transalpine relations in the database shows that countries far away from the Alps, primarily on the North-South corridor, are important traffic generators. Indeed, Alpine crossings regulate modal choice far upstream, and also the upstream modal choice influences the selection of the crossing point. Accordingly, the main origin and destination regions should participate – to some extent - to modal shift measures and/or to finance infrastructure. A legal structure has to be developed to enable this to occur.

Consequently, at the larger scale, national policies have to be harmonised with the objective of influencing traffic flows all along the international logistics chain: road freight should not be heavily charged in the locality of the Alpine regions, while at low cost on the rest of the continent.

New large-scale projects aimed at achieving globally more efficient and sustainable Transalpine transport should be financed trans-modally, seeking modal solidarity, over one or two generations, whereas the traditional (unimodal) long-term return on investment approach should be left to the case of local infrastructures, where modal choice is less appropriate. An official framework should be produced, with a clear definition of the objectives, in terms of sustainability, transport efficiency and finance.

13.3 Methodological developments

Perhaps the most important methodological outcome is the demonstration that a comprehensive transport model for Europe can be created, which validates well at the national level. Many innovative research features have been developed in the creation of this model.

The usefulness of this SCENES European model has been illustrated through:

- running the model to produce a reference case for 2020 that can provide a baseline set of future transport results across Europe for use as input to other studies
- testing a range of policy scenarios for 2020 on the future evolution of transport costs by mode, both for passengers and freight.

The main aspects in which this model would benefit from future improvements are:

- modifying the assignment procedure to adopt differential sampling of zone pairs in order to increase the level of spatial detail, especially on the road network
- provided that improved coverage and harmonisation of passenger and freight data across the EU can be achieved, the quality of the local calibration in the SCENES model could be improved through the use of this improved data.

This SCENES model is at its strongest when operating to represent strategic issues at the European-wide level, but currently is less suited to analyse specific small-scale initiatives in a particular locality.

In this study the SCENES model focused on policy testing within a single external scenario. In the future, other alternative external scenarios could be developed based on different assumptions regarding the evolution, for example, of GDP and car ownership growth and of the sectoral patterns of future trade. Likewise, a wide range of other transport policy scenarios (e.g. major infrastructure investment, regulation of road vehicle speeds, fuel taxation, etc., applied differentially to some or all regions or parts of the modal networks) could be tested across Europe using this model.

Another important topic in which the SCENES model could be of future value is through use of its comprehensive reporting capability to provide a future transport baseline as a foundation for European transport projections. These projections of future numbers of trips, vehicle-kms, tonne-kms, etc. by area and type, would play a role similar to that played by demographic or energy consumption projections at present (ATOM, 2002). The potential role of European transport projections is as an agreed background input to studies in related topics, such as energy usage, pollution emissions, accessibility and social exclusion. In the absence of agreed European transport projections such studies are forced currently to make their own projections (often of poor quality), with the resulting disadvantage that they rarely will be common across studies.

It is however clear that a single pan-European model is not sufficient to meet all policy testing and scenario development needs.

Accordingly, a range of well-known models from different European countries has been put together within a common framework of analysis to explore behavioural and structural change issues. Each model highlights different specific aspects of the transport system. These models do not seek to produce a comprehensive estimate for the entire transport system, in the manner that the SCENES European model is designed to do. Through taking this partial modelling approach, in which only a particular corridor or a sub-set of travel movements is analysed in detail, it is possible to analyse the specific topics of interest in greater depth. In turn some of the insights that are gained through this process could be fed back into a longer-term enhancement programme for the SCENES model.

However, considerable care needs to be taken with models designed for a specific locality or purpose, when extending their results to provide more general insights across Europe. The ever-present danger when adopting and combining results from an array of different models is that their underlying assumptions and data definitions may differ significantly between the models.

This highlights the need for clear specifications of agreed baseline assumptions when defining scenarios. There is an important role to be played by DG TREN in the future in the development of an agreed baseline set of transport projections and assumptions for use both for studies within DG TREN and elsewhere.

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Appendix 1 Project Deliverables

The SCENES Deliverables can be downloaded from the SCENES Internet site at IWW, the University of Karlsruhe:

<http://www.iww.uni-karlsruhe.de/SCENES/>

The complete set of Deliverables produced in the course of the project is as follows

Deliverable	Title	Main Authors
D1 – 1999	CEEC Data and Method	UG, NOBE, KTI
D2 – 1999	SCENES European Transport Forecasting Model Specification	ME&P, MECSA, LT, TNO, TRT
D3a – 2000	Drivers of Transport Demand - Western European Countries-	IWW, ITS, DLR, CSST, EPFL, INRETS, ISIS, NEA, TIS.PT, TNO, UPM
D3b – 2000	Drivers of Transport Demand - Central and Eastern European Countries (CEEC)-	NOBE, UG, KTI, IWW
D4 – 2000	SCENES European Transport Forecasting Model and Appended Module: Technical Description	ME&P, MECSA, LT, TNO, TRT
D5a – 2001	External Scenarios Development – European Spatial Development Scenarios	INRETS, KTI, LT, NTUA, TRT, UPM
D5b – 2001	External Scenarios Development – Testing Behavioural and Structural Change Scenarios	INRETS, IWW, ME&P, TNO
D6 – 1999	An Information System for Regional Socio-Economic and Transport Demand-Influencing Factors: The SCENES Internet Database	IWW
D7 – 2001	SCENES Transport Forecasting Model: Calibration and Forecast Scenario Results	ME&P, LT, TRT
D8 – 2001	Case Studies on Scenario Development	INRETS, IWW, EPFL
D9 – 2001	European Scenarios: Description of Process and Quantitative Results	INRETS

Appendix 2 List of abbreviations

AADT	Annual Average Daily Traffic, i.e., Annual traffic / 365
ATC	Air Traffic Control
CE	Central European Countries
CEEC	Central Eastern European Countries
CIS	Commonwealth of Independent States – the former Soviet Republics: Azerbaijan Republic, Republic of Armenia, Republic of Belarus, Georgia, Republic of Kazakhstan, Kyrgyz Republic, Republic of Moldova, Russian Federation, Republic of Tajikistan, Republic of Turkmenistan, Republic of Uzbekistan and Ukraine
CTP	Common Transport Policy
DTLR	UK Department for Transport, Local Government and the Regions
EBRD	European Bank for Reconstruction and Development
ECMT	European Conference of Ministers of Transport
EFTA	European Free Trade Association
EIB	European Investment Bank
EU	European Union
FP IV, V	4 th (5 th) Framework Transport Research Programme of the European Commission
GDP	Gross Domestic Product
GVA	Gross Value Added
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle
MoT	Ministry of Transport
NUTS	Nomenclature des Unités Territoriales Statistiques (Nomenclature of territorial units for statistics)
OD	Origin Destination zone pair
pcu	Passenger Car equivalent Units
OPRAF	Office of Passenger Rail Franchising
ORR	Office of the Rail Regulator
PPP	Public-Private Partnership
RFF	Résau Ferré des France (French rail network)
ROSCO	Rolling stock company
R&D	Research and Development
SDM	System Dynamics Model
TACIS	Technical Assistance to the Commonwealth of Independent States
TEN	Trans European Network
TINA	common Transport Infrastructure Needs Assessment – refers to the transport networks of the CEEC countries
TOC	Train Operating Company