SCENARIOS

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Executive Summary

The SCENARIOS project has produced an external reference scenario for European transport in 2020. Using a forecasting methodology, and a range of projection tools, medium and long term trends were identified and analysed for the key scenario variables: external factors, determinants of demand and supply and the transport policy environment. In addition a review of strategic transport modelling was undertaken to provide recommendations for further research. The complexity of European and national decision levels is also discussed for the definition of a policy scenario.

Methodology
A scenario can be defined as the description of a future situation (or final image) of the external transport environment and transport system. Scenarios can be produced to give a number of contrasting images of a future situation (involving the development of different hypotheses), or may develop only one horizon project for a trend situation, which is the case of a reference scenario.

Construction of a reference scenario requires a detailed analysis of the entire transport system, including both quantitative and qualitative elements. The first task is to present a complete and coherent picture of the present situation, the variables, their functions and interrelations, as well as the dynamic policy and institutional context. To reveal the underlying dynamics of the system it is then necessary to refer to past trends, for a clearer perspective of the structure and workings of the system and to avoid periodical blips.

A future reference scenario can then be deduced from the trends of key variables in a given institutional context, with the trends then projected to the desired time horizon. Following this scenario phase, there may be a strategic phase in which the scenario results are applied to the decision-making sphere, in order to assess policy changes, and corresponding development strategies.

External Reference Scenario
Using a trend extrapolation technique, projections of **economy, population and employment** were produced as a baseline for an external 2020 reference scenario. A further study on regional clustering enabled the SCENARIOS system dynamics model to be tested for functional EU regions at NUTS 2 level. The comparison between the results of the different approaches did not reveal significant divergences in results. For population, the number of EU inhabitants is predicted to increase until 2010-2014, after which it will decrease slightly until 2020.With a lag of time of about 10 years, the number of employees is forecast to decrease slowly after 2020. Due to the improvement of productivity, GDP will probably not follow this trend, but will continue to increase steadily. However, at national level, there will be variations between the member states, for example population will increase by 2020 in a number of countries such as Netherlands, France, Ireland and Portugal, but will decline in Germany, Italy and Austria.

Differences between European regions were considered as part of the assessment of **spatial dynamics**, highlighting the importance of different demographic, economic and land planning trends, between different regions at European level and differences in development between regions of the same country. For example the regional distribution of inhabitants varies greatly with the EU, and there continue to be significant disparities in regional economic wealth. In terms of territorial structure, the European population has become increasingly urban, and the growth of cities is predicted to continue although more at the periphery than in the centre for large cities. In rural areas there are strong differences in development between regions, with some in decline and others growing. Problems due to declines in agricultural subsidies will not be homogenous; in densely populated areas a reduction in agricultural jobs can be offset by other services and industries, but in areas with declining or ageing populations the potential for diversification is more limited.

Since it was impossible to consider every European region individually, the SCENARIOS approach was based on functional regions, and hence required a first analysis of regional clustering. The classification takes into account socio-economic indicators (e.g. population density, sectoral GVA) and accessibility characteristics. An aggregated clustering technique was used to classify European regions focussing on the relationship between accessibility and socio-economic indicators. This produced an index of road accessibility for European regions considering average speed and population.

For further projection of socio-economic variables at regional level, the clustering approach was used to give four main region types: service dominated regions, industrial core regions, relatively rich rural & peripheral regions and finally the low developed regions. After this classification a **potential development analysis** was applied to determine the over and under average performing regions, depending on the level of public endowment and attractable factors such as private capital. Given the region type and the over or under average performance, specific bundles of policy measures are proposed to improve the performance of the particular region types.

Determinants of Transport Demand and Supply

The most significant determinants of demand for passenger and freight transport and their trends, were identified. **For passenger transport demand**, a wide range of factors were identified as: socio-demographic, economic, lifestyle, spatial factors, dynamic and saturation effects, demand/supply determinants and feed-back effects of demand on supply.

For short distance trips, which represent the largest share of all trips the primary influence on demand for travel and mode choice is income. Major long-term determinants are land-use patterns and public transport policies. Journey lengths are increasing, partly due to the ability to travel further and partly due to urban sprawl. Population trends are also a key, as Europe faces an ageing population, but with a higher proportion of car drivers than in past cohorts, who are expected to maintain their car use into old age. Life-styles too are changing, with greater participation in the workforce, smaller households, etc., and these effects added to income effects tend to reinforce the dependency on the car. In order to break the link between car ownership and income and car use and income, a change in attitudes will be required. While concern over congestion and the environmental impacts of transport can be seen, this is not translated into behavioural shifts.

Income is one of the most important determinants of long distance trips, although it is necessary to distinguish between business trips, short stay personal trips and international holiday travel. While the general economic situation and globalisation trends will influence the level of business trips, factors such as disposable income, lifestyles and the amount of free time will be more significant for leisure trips.

A study on international tourism has shown that the European tourist market has increased dramatically, due to changes in behaviour patterns, as Europeans travel more often for shorter periods. The result is an increase in road, rail and air traffic, a decrease in the number of nights in accommodation, and greater concentrations of flows in tourist areas.

For the study of household car ownership behaviour, a longitudinal analysis was performed using cohort data from Household Budget Surveys in five EC countries, the USA and Japan. A demographic model was applied to measure the relative importance of the stage in life cycle, of the replacement of generations, and of variables linked to the general economic environment. The demographic approach provides a powerful tool for making long term forecasts of the household car ownership and car fleet, since it avoids fixing saturation thresholds, it conciliates the effects of economic and demographic factors, and it relies on stable population projections. Estimates were made at the national level, as well as for two contrasted wide regions in Italy and for homogeneous zones with respect to population density in France. A comparative analysis of the results enlightened the role of the history of car ownership development, of population density and of economic development.

Concerning **freight transport demand**, the external determinants were defined by identifying four main trends, which seem most relevant for long term changes in freight flows. These trends are outside the transport sphere, but exert influence on all the constituent markets of the transport system. In no particular order they are:

- Globalisation, which refers to the increasing independence between regional economies,
- Networking concerns the ongoing rationalisation of business processes, for the optimisation of efficiency of entire chains of products.
- Information and communication technology which make it possible to radically improve the efficiency of economies.
- Greening of business involves growing awareness of environmental change.

Globalisation will chiefly affect the volume and geographical patterns of freight flows, whereas the networking trend will determine the type and thus the logistical characteristics of goods that are moved. Information and communications technology will primarily increase the efficiency of movements, thus allowing distances to become larger and transport to become more reliable. Finally, it may bring substitution effects in terms of eliminating the need for transport for certain relations and certain types of goods. The greening of business is expected to raise the costs of transport as a result of concrete steps towards the internalisation of the external costs of freight transport.

Most external trends point to an increase of freight transport, especially intercontinental (high-value) and international (intra-EU: diversification). Beside overall economic growth, this is the result of changes in the way that production, trade, distribution and transport systems are organised.

The key changes in transport determinants that will have a positive effect on freight flows are the geographic concentration of production, flexible production/internal control systems, economic concentration, division of production and assembly, higher customer service, and decreasing stock levels. Electronic commerce and the greening of business are developments that may on the long term slightly dampen overall growth although they may increase the efficiency of production and trade.

Scenarios for 2020 relating to **transport supply**, considered the possible dissemination of a number of new technologies and operational innovations: telematics, information technologies, intermodality, alternative urban systems and magnetic levitation. Each technology or innovation was assessed according to its potential at a technological, operational and socio-economic level. This selection assumes that new technologies must have sufficient potential at engineering level to enter the market as operational technologies, where they are expected to yield benefit to users and operators. If they are successful then they will interact with the collectivity and society, which produces regulations and policies that stimulate or restrain their socio-economic influence.

Using this approach, the study concluded that telematics and intelligent transport systems (ITS) will have the most significant impact on the transport supply in the 2020 perspective. Telematics will spread widely, especially as a commercial means of information using the infrastructure and services of the main mobile telecommunication operators. Institutional use for safety and traffic regulation will depend on European-wide agreement on standards and financing schemes.

The influence of intermodality on the transport system will depend on the degree of implementation of political measures, but intermodality requires improved organisation rather than technological development. Information technologies (teleservices) are expected to play a key role in society as a whole, but not so much in the transport system. Indeed, teleservices such as telework and videoconferencing may become a substitute to some business traffic, but they also foster traffic generation by making more time available.

Autonomous urban systems are expected to spread from 2010 onwards. They will follow the standardisation of telematic systems, especially automatic debiting systems, on which they heavily rely for operation. Magnetic levitation technologies are difficult to finance and environmental concerns can lead to the development of underground solutions. Maglev technologies will not notably influence transport supply in Europe by 2020.

European and National Policy Environment

For transport scenarios some main themes of the policy environment of the member states and the EU can be highlighted: the problems of sustainability, of safeguarding the environment, and of improvement in safety. Equally important is regional economic and social cohesion, although there is not as yet full agreement as regards these aspects. Yet the differences existing between national policies on these issues are not, in most cases, irresolvable in nature, but are essentially due to different starting conditions, such as a different geographic position, different population density or different levels of economic development.

It is clear that individual policy measures must be seen in the context of the global CTP approach: initiatives concerning road improvement, the design of vehicles, demand management, transport infrastructure, control and management of traffic, and measures to improve safety and protect the environment are all interrelated within the context of the European transport systems and increasing interdependence between states. It can be concluded that the measures that seem most likely to be implemented are those involving demand regulation and pricing to alter the modal distribution of demand, in favour of the safest and most environment-friendly modes. The implementation of policies aiming to improve public transport infrastructure appears less likely, in the present economic situation.

Furthermore, a **European trend policy scenario** was defined, which took into consideration the key policy directions of liberalisation and harmonisation, in order to estimate the implications for the economy and spatial environment in 2020. This policy scenario was applied in the Pilot Strategic Environmental Assessment (SEA) project of the Trans-European Transport Network, for calculation of traffic flows and emissions.

It is expected that greater liberalisation will increase economic efficiency for all modes, but that without changes in environmental standards, a greater exploitation of the natural environment may result. The harmonisation policy aims to ensure that increased competition does not result in the deterioration of social, safety or environmental conditions, and will thus lead to some improvement in environmental terms, but a relatively smaller increase in economic benefits. The principles of harmonisation and the internalisation of external costs have been agreed and therefore must be taken into account in a trend policy scenario, even though implementation measures have not yet been taken.

The effects of liberalisation and harmonisation policies were also considered for passenger and freight market segments, in order to give some indications of changes in costs per mode. In summary, the policy trend scenario shows a decline in road freight costs under the liberalisation policy, then a small increase under the harmonisation policy. In contrast for rail freight, costs are expected to increase due to the requirement of budgetary equilibrium, and will remain stable under a harmonisation policy scenario. Overall there will be no change in equilibrium in favour of non-road modes or intermodal alternatives. For passenger transport, under the liberalisation scenario costs will remain stable for road, increase for rail and fall for air transport. However road transport will be more affected than other modes under the harmonisation scenario where an increase in fuel taxes and more stringent pollution norms will result in higher costs.

Recommendations for Strategic Transport Modelling

Finally, some key recommendations for strategic transport modelling were made, concerning three areas of model design. First it is recommended that certain new elements be integrated into strategic modelling to consider aspects of the transportation system and its environment which have so far not been described sufficiently well to comply to existing requirements. Secondly, problems relating to the choice of scale were highlighted. When studying transport problems at the European and strategic level different problems occur with choosing the level of aggregation at which to describe elements in the transport system due to statistical data inadequacy, conflicts in representation at different levels of detail and the complexity of models. Finally concerning the actual modelling process, recommendations were made with respect to the practice of model design, with a view to a quick diffusion of modelling research experiences.

Introduction

The SCENARIOS project aims to support decision making on policy and planning issues of medium and long term, far reaching implications for society including new transport networks and technologies as well as structural changes of location and trade patterns. The project research activity was organised into 4 Work Areas as follows:

Work Area 10 Scenarios on external developments affecting European Transport.
This Work Area investigated the external environment of transport focussing on key variables such as population, economy and trade, and integrating a system dynamics approach. Secondly the key descriptors and determinants of demand for passenger and freight transport markets were considered. The final task looked at transport supply, and the significance of technological and operational changes for transport scenarios.

Work Area 11 Modelling and Methodology for Analysis of the Interrelationships between External Developments and European Transport
Since the SCENARIOS project did not aim to develop a European transport model, the objective of this Work Area was to create terms of reference on the state of the art in passenger and freight transport modelling. The main output was a review of the 4th Framework Programme models, with recommendations for further research.

Work Area 12 Reference Scenarios
A typology of scenarios for long-term projections was produced, with a methodological structure for an external reference scenario. A European trend policy scenario, was also developed.

Work Area 13 Policy Environment
In relation with the POSSUM project, which investigated building policy scenarios, this Work Area studied the past and present European and national transport policy environment.

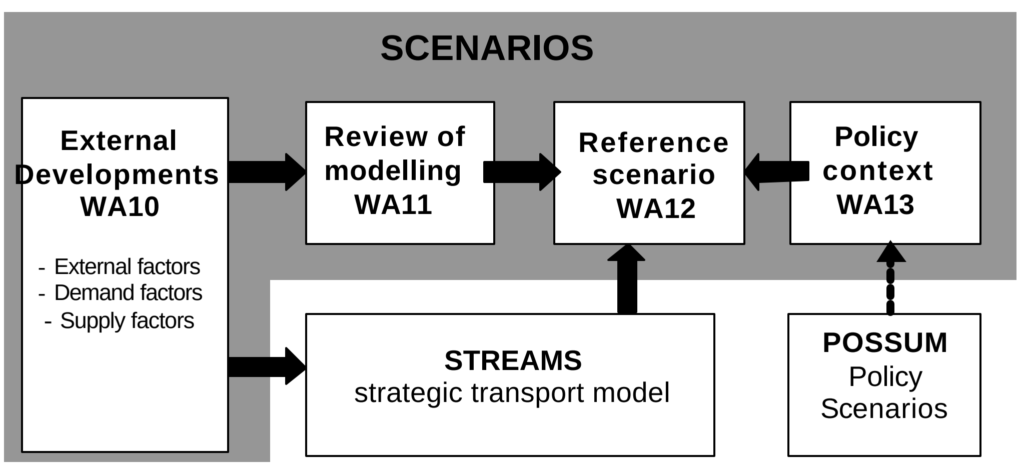


Figure 1: SCENARIOS project interactions

In the SCENARIOS project, the focus was on development of an external reference scenario, rather than on projections of traffic for the selected time horizon (this task was carried out by the STREAMS model). In SCENARIOS, a range of different modelling tools was used for specific projection purposes, including system dynamics modelling for functional regions and an age-cohort-period model for motorization).

The Pilot SEA project undertaken by the Commission, for assessment of the whole Trans-European Transport Network, brought together the SCENARIOS, STREAMS, COMMUTE and MEET projects to produce a full image of the transport system in the 2010. The external socio-economic environment and trend policy scenarios developed in SCENARIOS were used to define a number of different scenarios (Reference, CTP, TEN-T) which were then tested using the STREAMS model to produce projections of O/D traffic flows in Europe, region to region at the 2010 horizon for passengers and freight. The final stage was completed by the COMMUTE and MEET projects, which calculated emissions and transport safety. The full results of this project are given in the Pilot SEA final report.

Results from SCENARIOS (notably for the socio-economic external environment and trend policy scenario) have also been used in other research projects of the 4th Framework Programme (including SOFTICE, EUFRANET and CODE-TEN).

In the perspective of an enlarged European Union, the SCENARIOS project made a first step towards inclusion of Central and Eastern European Countries in its research. Two institutes, from Poland and Hungary were members of the project consortium. In the following SCENES project, the geographical scope of research is further extended, to consider socio-economic scenarios and transport projections for an enlarged Europe.

The main deliverables of the project, were reorganised into 6 “C” reports, a list of which can be found at then end of this report.

This final report presents the main result of the project deliverables, concerning construction of an external reference scenario (chapters 1-4), drivers of transport demand (chapters 5 & 6), innovations in transport supply (chapter 7), and a policy trend scenario (chapter 8). Results of the review of strategic transport models can be found in the Annex.

1 CONSTRUCTION OF AN EXTERNAL REFERENCE SCENARIO

This section considers the baseline methodology for definition of a global reference scenario. It looks at the merits of the scenario approach, and the different types of scenario construction, describing the main stages of system analysis for definition of a reference scenario.

A more detailed description of this work can be found in the SCENARIOS Report C5: *Global Reference Scenarios.*

1.1 Introduction to Scenarios

Scenarios are increasingly used in many different spheres of activity, by governments for policy making but also in the commercial sector by private firms. Scenarios provide an innovative approach to the long-term decision making process, and permit the exploration of alternative hypotheses in relation to expected or desirable changes. Their results, setting out the expected trends of key variables can therefore be an important input to strategic policy making.

Scenarios can provide a complementary approach to more classical forecasting techniques which rely on sets of formalised mathematical equations to describe the way in which variables of a given system interact. Such econometric tools or models thus depend upon reliable quantified data (excluding qualitative factors) with the principle of the model being the continuity of past trends, in order to produce projections at a single linear point. This makes modelling techniques more suitable for certain sectoral and short-medium term trend projections, than global long-term analyses of a dynamic and evolving context.

The scenario approach, may be able to complement modelling techniques by producing a wider analysis, to include qualitative as well as quantitative data, and integrating the dynamic external context, including the role, influence and interrelations between relevant actors.

A scenario can be defined as: *the description of a future situation (or final image) of the external transport environment and transport system.*

The aim of a scenario is therefore to describe the given "system" of variables and to provide a forecast for a future horizon. Unlike econometric tools and models, scenarios are not necessarily in a mathematical form, and can be represented graphically by flow diagrams, showing the interactive elements of the system.

1.2 Types of Scenarios

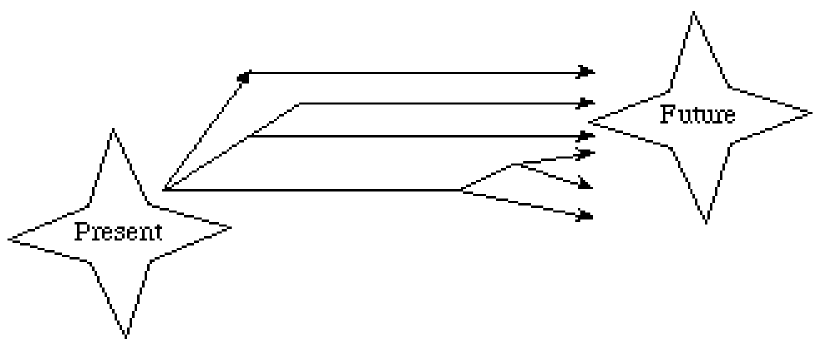
The main approaches to scenario construction can be divided into two principal categories, in relation to their relatively more or less "voluntarist" approach to the construction of possible futures.

First, **forecasting** is an exploratory, forward looking approach which constructs alternative scenarios for a desired time horizon from the present situation with evidence of different trend hypotheses and expected developments

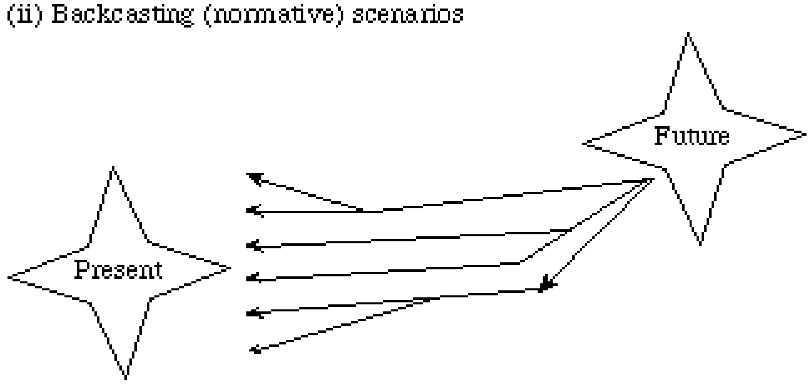
In contrast, **backcasting** adopts a retrospective, normative approach, which defines the desirable future, and then traces backward to the present to examine the feasibility and necessary conditions to achieve it.

Figure 2: Types of scenario

(i) Forecasting (exploratory) scenarios



(ii) Backcasting (normative) scenarios



The SCENARIOS project adopts the former strategy for scenario construction, whilst the POSSUM research project takes a backcasting approach[1], detailing a desirable future in terms of policy goals and then constructing a number of "policy paths" which would enable the desirable future to be reached.

The two methods have quite distinct merits and applications. For example the backcasting method is characterised by clearly defined objectives, the existence of desirable norms and is directed towards action to prepare the future. The forecasting method however is essentially conservative, based upon the transposition of the past and is free from value judgements.

The different methods are also suited to different time frames, with exploratory (forecasting) processes being more sensitive in the short term and normative backcasting scenarios directed towards the long term, to take account of important breaks in trends.

A further distinction may be made for forward-looking scenarios, between *contrasting scenarios* (involving the development of a number of different future hypotheses) and *reference scenarios* (the subject of this chapter).

[1] POSSUM (1997), Deliverable 1

Contrasting scenarios are based on a range of hypotheses developed from chosen variables, which give a projection of the system studied at a base and horizon year. They can include an unlimited number of variables and develop different trend and policy hypotheses to produce contrasting images of possible futures.

Contrasting scenarios are constructed by analysing elements of uncertainty identified in the system, and out of the many potential future images that can be produced, those images with some probability of being realised can be selected.

In relation to traditional high/low growth forecasts, such contrasting scenarios offer the advantage of investigating in depth specific anticipated changes and the conditions in which they could be realised. Examples could include changes in technology, the impact of a downturn in the global economy, fluctuations in input prices or a major change in institutional structures. Such events may have a weak probability but if realised would have a potentially strong impact.

A Reference Scenario on the other hand, develops only one horizon projection.

The continuation of past trends and behaviour is taken as the hypothesis, with maintenance of the decision structures for actors. In this way the reference scenario can provide a standard against which other contrasting hypotheses can be compared. However this does not imply that the reference scenario is the most probable future position.

Within the SCENARIOS project the socio-economic scenarios presented here will follow only observed trends excluding the possibility of any major technical, social or environmental changes.

A break in trends can be integrated into the scenario if the past and present situation indicate that there is a strong probability of such a change in the system. Examples could include a "threshold effect" where the market appears close to saturation, new innovations, changing habits, or important changes in policy. The SCENES project, which follows up the work of SCENARIOS and STREAMS, will integrate this aspect of breaks in trends into scenario construction[2].

1.3 Methodology for a Reference Scenario

Construction of a reference scenario requires a detailed analysis of the entire system to be studied, including both quantitative and qualitative elements. The first task is to present a complete and coherent picture of the present situation, the variables, their functions and interrelations, as well as the dynamic policy and institutional context. To reveal the underlying dynamics of the system it is then necessary to consider past trends, for a clearer perspective of the structure and workings of the system and to avoid periodical blips.

Future reference scenarios can then be deduced from the trends of key variables in a dynamic institutional context, with the trends simply projected to the desired time horizon. As mentioned above, in the SCENARIOS project the reference scenario does not consider any possible breaks in trends.

Following this scenario phase, there may be a strategic phase in which the scenario results are applied to the decision-making sphere, in order to define anticipated changes, and corresponding development strategies.

[2] SCENES, (2000) Deliverable D3

The construction of a transport scenario can be broken down into 4 key phases:

1 identification and clustering of key variables
2 analysis of interrelationships between the variables
3 review of main past trends and interrelations
4 consideration of the transport policy context and actors

The first two stages consider the transport variables and the general external environment to discover the internal structure of the system. Then it is necessary to examine the past trends of the selected variables. Finally the examination of the policy context and interrelations between the different actors will help to put the scenario in the wider external and dynamic context.

1.3.1 Identification and clustering of the variables

For a reference scenario a comprehensive list of all possible variables of the transport system, both internal (describing the transport system itself) and external (concerning the general environment) should be made. These variables may cover many different areas such as the economy, social factors, technical changes and the spatial situation. The policy and institutional context must also be considered, although in a reference scenario there will be no change in policy orientation.

For example, for a transport reference scenario key external factors will certainly include socio-economic indicators (for example, population, GDP, households disposable income, industrial production and trade) and spatial patterns (covering urban and regional development, migration, location of economic activity).

Spatial or geographical variables are often discarded or underestimated in transport scenarios, because of the difficulty encountered with trying to integrate spatial elements into economic theories and transport models. However the physical dimension of transport cannot be disregarded, particularly considering the growing attention which is paid to regional development, spatial cohesion and the environmental impact of policies.

Internal variables, describing the transport system itself, can consider factors such as the level of competition and regulation, technological improvements/perspectives, the motorization rate and fuel costs.

In SCENARIOS a simple clustering of these 3 main groups of variables was adopted: socio-economic variables, spatial variables and transport variables. Changes in behaviour and values, the introduction of new technology and "breaks in trends" will be considered in the following SCENES project.

It is then necessary to further define the variables in relation to their role in the transport system and their explicit and implicit interrelations.

1.3.2 Interrelations between the variables

To identify the functioning of the transport system it is necessary to isolate the nature and role of each variable, and the level of its influence/dependence on the system. Particularly important are certain key variables, which exercise a strong influence on the evolution of the system. Identification of these principal determinants is essential to understand the functioning of the transport system and to predict future trends.

Variables can be internal or external to the transport system. In practice though, a transport scenario will only concern those variables that have some connection with the transport system and so the internal/external distinction may not always be easy to make. However in SCENARIOS, "internal" variables can be considered as transport supply and demand and "external" variables cover socio-economic and spatial aspects.

The nature of the causal relationships, which unite different variables, must also be identified in this system analysis. Some factors may be invariable, whilst others are particularly sensitive to changes in the system. Determination of the influence or dependence of the variable on the system will deepen understanding of the dynamics of the transport system.

Factors may be explanatory or autonomous, with differing rates of movement, and both direct and indirect effects of the external variables on the internal ones should be considered.

Structural analysis techniques can be used in practice to isolate determining and dependent variables and to assess the intensity of interrelationships. One method, involving cross impacts is based on the construction of a Boolean matrix (consisting of 0 and 1) with the different variables represented in both lines and columns. A variable is given the number 1 in relation to its impact on another variable if there is a causal relationship, and a 0 if there is no relationship.

A grid of interrelationships is thus produced, providing guidance for scenario construction and modelling on the intensity and possible coefficient, which can be used to define interrelationships.

Econometric modelling tools may be useful at this stage for synthesising certain types of relations and are used in some cases for simulation (e.g. for spatial analysis of transport flows) considering both explicit and implicit relationships between variables. Any difficulties encountered in analysis of these relations (such as lack of data, or the "reducing effect" of some econometric equations) must be noted and accounted for in the scenario.

1.3.3 Review of main past trends and interrelations

Investigation of past trends constitutes an indispensable part of the construction of a reference scenario. A retrospective study is necessary to discover the evolution of the transport system, its main variables and actors, and to avoid placing too much importance on the present situation, which could be influenced by temporary conditions.

For a reference scenario of the transport system, a review of past trends will therefore need to assess the impact of external variables on the main variables of the transport system, principally in relation to market regulation (competition conditions, measures concerning norms, (total weight of the vehicle, length etc.) or simplification procedures) and price and tariffs (including user charges and internalisation of external cost principles).

Technology variables are also becoming increasingly significant due to the strong interrelation of information technologies and transport operating systems. The change over time of a transport supply variable (such as price or time) is one means of taking into account the impact of technological progress in a transport scenario. Lastly the impact of external variables on investment in infrastructure should be considered. Investments may concern the equipment of companies or households (motorization) and are often related to revenues and demographic structural changes.

Some of the major trends of European socio-economic and spatial variables to be highlighted are the following:

?? There has traditionally been a strong link between industrial production and freight transport although there are wide differences between European countries.

?? Sectorial disaggregation reveals that the link between TK and industrial production is weaker for certain important growth areas, particularly high value goods

?? Trips are increasing in length for both passengers and freight

?? Passenger trips are less related to general economic activity, and more closely closely linked to urban spatial patterns (daily trips of quit short distances)

?? Vacation trips are increasing but the number of days of each trip is decreasing

?? Short distance trans-border traffic is increasing fast for goods and passengers

?? A multi-motorization analysis for households is necessary to consider the range of hypotheses concerning lifestyle changes and urban structure, which are related to household structure in terms of size, age and class.

?? Transport elasticities in relation to macro-economic aggregates vary greatly between countries even at comparable levels of development

?? International traffic is expected to increase to at least 30-50% of global traffic on inter-regional networks in most countries for freight transport.

?? Urban sprawl and suburban developments favour growth of private transport

?? For the regional transport level there is a concentration of activities at the national and European scale

1.3.4 Actors in the transport policy context

A final part of scenario construction involves analysis of the policy context and main actors on the variables of the transport system. These additional elements help to put the scenario in the wider external and dynamic context, acknowledging the significant influence of policy and the interrelations between actors.

Although the purpose of a reference or trend scenario is not to analyse the potential impacts of alternative policies , a minimum level of past and present policy measures must be integrated. Previous policy decisions, taken before the base year, form part of the reference policy context on which the scenario is built, and in the same way, present policy objectives and directions will help to shape the construction of future transport scenarios.

Within the European transport context, there are many bodies which act together to decide and implement transport policy. Both the European Union and national governments have to co-operate together to ensure the success of projects, such as the road liberalisation programme. In addition the contributions of local authorities, city authorities and private investors may also be influential in the policy making process.

There may well be differences between the approaches of national governments in implementation of these policies and measures, according to their particular objectives and strategies. Equally the management of local transport systems will depend upon the organisation and policy priorities at local level. The role of each organisation in this multi-layered institutional structure must thus be clearly understood for construction of a European reference policy scenario.

In the transport policy context there is an increasing number of relevant actors to take into account due to greater political decentralisation, the increasing involvement of the private sector in infrastructure projects and the growth of NGOs and citizen associations.

Such actors may exist at the international, national, regional or local level, and can be distinguished by their role and influence on the system. Three different although not exclusive characteristics can be noted :

?? actors who intervene as an information source
?? influential actors who influence the decision process at different levels or who could refuse a public decision when it is not considered in their interest
?? dependent actors who have to adapt their behaviour to decisions taken by authorities.

These criteria enable us to assess the influence and role of key actors (individuals, groups or organisations) in the system and to identify their objectives, strategies and means of action. Interrelationships between the main actors strongly influence the policy context, which will be determined by their respective strengths and weaknesses, conflicts and co-operation.

One means of defining the relationships between them is through cross impact analysis as described above for variables. The weight attached to the role of actors will depend on the scenario approach adopted. For example in the POSSUM project the importance of good co-ordination between the actors in the decision process for policy implementation was explored for a sustainable development policy scenario.

In SCENARIOS we identified the different levels of actors at international, national, regional and local level, although focusing primarily on the European and national transport policy context.

At *international level* three types of actors are observed:
?? International public authorities (EU, UN, OECD) as well as those bodies which prepare multinational agreements between states, EFTA, OPEC. These kind of actors represent a political and economic power, which must be taken into account and they may also be an important source of macro-economic political influence.
?? Multinational companies : have a real economic and sometimes political power
?? Populations and individuals who define social acceptability

At *national level* the increasing power of the media has led to changes in policy making strategies due to the increasing number of interested actors.
?? Governments and ministries which may have contradictory objectives.
?? Trade unions, different economic sectors and industrial lobbies.
?? Citizens as potential voters.

At *regional and local level*, decentralisation and application of the subsidiarity principle means that more account must be taken of local authorities, public opinion and the wishes of local inhabitants. These factors help to explain increasing concerns about ecological and quality of life issues.
?? regional or federal authorities
?? municipal authorities
?? large private companies, as important regional employers
?? local lobbies

As already mentioned, European transport policy does not result from an unique decision centre: European policy is implemented by national governments with regional and local effects. Moreover, the financing of many transport networks, such as the TEN requires the participation of other external organisations, including private contractors or companies. The implementation and the impact of a decision will therefore depend upon the consensus developed between all these actors.

At national level, transport infrastructure policy has always been very well developed, and for example most TEN projects are in fact national projects. The reorganisation of former national transport companies is also largely left to the initiative of national states, especially as concerns the "non-discriminatory" measures to be taken. Regional development measures and public services policy also tend to fall within the domain of national administrations.

At a local level, transport management and organisation occurs in close collaboration with the communities involved. This remains very important since most transport is for short distances, and because local strategies are required for densely populated areas, which experience high levels of pollution. Congestion and pollution in these areas may be relieved by the closer integration of local and interregional/international networks.

From an international perspective directed by market regulations, to a local level more oriented towards transport organisation, the European and national authorities hold a key intermediate position, with influence and authority to determine policy directions and maintain a good consensus between the different actors and institutions.

2 SOCIO-ECONOMIC ENVIRONMENT

In Work Area 10 of the SCENARIOS project 'External Developments' of scenarios were considered, focusing in particular on social and economic external factors. The aim of this task was to describe the external factors and the data availability for a base year, and also to produce projections of population, economy and trade in Europe for the year 2020. This was done using a combination of official forecasts and trend extrapolation.

The report of this research work is *C1: Socio-economic external developments, spatial dynamics and their relations to transport*.

This section will consider the main socio-economic projections produced for this Work Area, (see appendix to the C1 report), the main results of which were also included in the C5 report, *Global Reference Scenarios*.

2.1 Methodology

For the SCENARIOS (External Factors) database, 1994 was chosen as the base year. Trend forecasting (one scenario with several variants) of population, economy and trade started from this base line and has been prepared on a country level for 2020 projections. The time horizon of most of the published studies normally extends to 2005 sometimes to 2010, but there are hardly any projections or trends available, except population, for 2020. Hence the available projections are given for up to 2005, then a trend scenario with several variants for economic indicators and trade is presented for 2020.

There are three main methods which are used to come to projections on a very highly aggregated spatial level:

?? (analytical and/or graphical) trend extrapolation,

?? (multiple) regression analysis,

?? system dynamic modelling

2.1.1 Trend Extrapolation

A forecast can be generated by observing a change through time in the character of something and projecting or extrapolating that change into the future. In making such a forecast, the focus is on the long-term trend, so short-term fluctuations are disregarded. Trend extrapolation requires the forecaster to have an understanding of the factors which contributed to change in the past, and to possess confidence in the notion that these factors will continue to influence developments in a similar fashion in the future (Schwarz, Svedin, Wittrock, 1982).

One commonly employed approach to trend extrapolation involves the use of growth curves (Cornish, 1977). Growth curves are loosely based upon the notion that the growth of a socio-economic indicator can be charted in the same way organic growth can be charted. For example, the growth in height (and weight) of an individual can be charted, and will commonly display a pattern which indicates a levelling off around early adulthood. It is believed that the growth pattern of a socio-economic indicator (e.g. increasing share of employment in the tertiary sector according to the sector hypothesis; Hoover, 1948) can also be plotted and charted in a similar fashion.

The level of detail and spatial disaggregation required for the external factors depends on the type of model being used. In general terms an aggregate transport demand model makes fewer requirements than a disaggregated one. Projections on a regional level always have to be embedded in national forecasts to prevent mistakes which occur due to isolated thinking at a regional level. The preparation of regional projections therefore must consider development tendencies in other regions, which are part of the whole study area.

The apparently simplest option in dealing with external factors is to use official forecasts. Of course, these forecasts are seldom at a sufficient level of spatial disaggregation to be directly usable in a detailed model. However, they do reduce the amount of work needed to generate the required values for the external factors at regional level. To some extent the problem with using official forecasts is that they sometimes reflect the expected effect of economic and regional policies whose success may actually depend on other uncontrollable factors like international trade and co-operation.

Based on literature research and analysis of long-term projections, with comparison of assumptions estimations are given for average annual growth rates up to 2020 (concerning productivity, employment and GDP per capita). The sources for these trend forecasts are national statistics offices of several European countries, consultants (e.g. PROGNOS) and other institutions (e.g. OECD). Projections of population are also given, with data taken from EUROSTAT and from other studies (e.g. Prinz / Lutz). Central and Eastern Countries are also included in these socio-economic projections, and the main sources for data were the World Bank and OECD, Eurostat, UN, International Monetary Fund and PROGNOS AG.

2.1.2 Regression Analysis

Depending on the investigation regression techniques use time series or cross-section data. The aims of multiple regression techniques are basically similar to bivariate regression. These include defining trends, enabling projection, and identifying deviations from trends. It can also be used to order the importance of the independent variables Xi (e.g. GDP, cost index motorized private transport, price list or tariff of public road transport and railways, population; all country level) used in estimating the dependent variable Y (e.g. cross-border motorized private transport in passenger kilometres on a country level).

The line is fitted by minimising a sum of squared deviations. For this reason regression analysis is a least squares method. Multiple linear regression is an extension of two variable linear regression. One variable is designated as the dependent variable (Y) and the others are all independent variables (Xi). The linear regression model is:

$$Y = b0 + b1X1 + b2X2 + ... + bnXn + e$$

where

b0 is the general coefficient,

b1 to bn are the coefficients for the independent variables (Xi) and

e is the error constant.

All of the b values are the partial regression coefficients. These give the rate of change in the dependent variable (Y) for a unit change in the independent variable (X) when all of the other variables are held constant. The aim of multiple regression is to estimate these partial regression coefficients. In the end the procedure will quantify how the mean of the dependent variable, e.g. cross-border motorized private transport in passenger kilometres, changes as the other variables change. Calculating projections in general assumes constant regression coefficients and requires projections for independent variables.

Within the approach for the C1 report, two regression analyses have been made. One focuses on the southern part of Germany only and includes 6 independent variables: Agglomeration, Infrastructure, Accessibility, Education, Nature, Industrial settlement area. The dependent variable was the sectoral (agriculture, industry, services) regional GVA. The second regression analysis, which took the results of the detailed work for southern Germany into account, focused on the NUTS 2 regions of the EU15. Due to limited data availability only three independent variables have been considered: Agglomeration, Infrastructure and Education. As the dependent variable the GDP per capita has been chosen (for more details see Chapter 3).

2.1.3 System Dynamics Modelling

System Dynamics Models are able to simulate dynamic processes and take into account interactive processes. A more detailed explanation of System Dynamics Modelling is presented in Chapter 4.

For the C1 report, the results of the regression analysis were used for the system dynamic modelling. For technical reasons the system dynamic model shows growth rates for functional regions, although major trends for the EU15 members can be identified. When compared with the regression analysis some trends appeared to be different, and so assumptions for the trend scenarios were reviewed.

2.2 Demography

Demography is supposed to be one of the most predictable factors in scenario definition. For transport scenarios the age structure has an important influence on the motorization rate, especially as the present "generation effect" (greater mobility for ageing persons) is changing mobility patterns.

According to UN data, the trend of falling birth rates is set to continue into the first quarter of the next century. In this context, migration will be a key determinant of the level of demographic growth. Migration is currently responsible for almost 75% of demographic growth in Europe, which represents an average growth of 0.3 % per year in a context of a generally low demographic growth rates, at below 0.5 % per year. Migration has the largest impact in large urban areas.

Despite differences between data sources on the absolute figures for population projections, a common conclusion is the change of the age structure. In 1995 the European Commission stated in its “Report on the demographic situation in the European Union” that, without unusual developments, the number of people over 60 years old, will rise from 76.3 million in 1995 to 113.5 million in 2025. This section of the European population will increase strongly especially from 2006 onwards. In contrast the number of younger people under 20 years will fall by 11 per cent.

This change in the age structure will obviously have many consequences for all members of the European Union concerning social, cultural and economic life, and considerable implications for the labour market. While the younger section (under 30) of the working population will drop in relative terms by around 17 per cent, the number of people nearing the end of their working life will increase by around 6.5 million.

In particular the change in the structure of the population will influence the motorisation rate. At present the highest motorization rates are observed for 40 to 50 year olds. But the phenomenon of a “generation effect” means for a given age the ratio of motorization is increasing with each generation. This phenomenon is particularly conspicuous for the older age groups (60 - 80 year olds)[3].

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[3] See Chapter 5.2.3

Table 1: Long term population projections

	1995	2010	2020	% change 1995-2010	% change 2010-2020	% change 1995-2010
Austria	8 050 000	8 040 000	7 930 000	-0.1%	-1.4%	-1.5%
Belgium	10 140 000	10 100 000	10 280 000	-0.4%	1.8%	1.4%
Germany	81 660 000	81 540 000	78 450 000	-0.1%	-3.8%	-3.9%
Denmark	5 230 000	5 280 000	5 350 000	1.0%	1.3%	2.3%
Spain	39 210 000	39 150 000	39 330 000	-0.2%	0.5%	0.3%
Finland	5 110 000	5 110 000	5 360 000	0.0%	4.9%	4.9%
France	58 140 000	57 780 000	63 450 000	-0.6%	9.8%	9.1%
Greece	10 460 000	10 410 000	10 860 000	-0.5%	4.3%	3.8%
Ireland	3 580 000	3 830 000	3 950 000	7.0%	3.1%	10.3%
Italy	57 300 000	57 140 000	55 940 000	-0.3%	-2.1%	-2.4%
Luxembourg	410 000	460 000	490 000	12.2%	6.5%	19.5%
Netherlands	15 460 000	15 690 000	16 780 000	1.5%	6.9%	8.5%
Portugal	9 920 000	9 870 000	11 570 000	-0.5%	17.2%	16.6%
Sweden	8 830 000	8 820 000	9 220 000	-0.1%	4.5%	4.4%
UK	58 590 000	58 610 000	61 080 000	0.0%	4.2%	4.2%
Switzerland	7 270 000	7 440 000	7 550 000	2.3%	1.5%	3.9%
Norway	4 360 000	4 660 000	4 830 000	6.9%	3.6%	10.8%
Poland	38 450 000	-	43 500 000	-	-	13.1%
Czech Rep.	10 300 000	-	10 530 000	-	-	2.2%
Hungary	10 210 000	9 940 000	9 640 000	-2.6%	-3.0%	-5.6%

Source : IWW 1998 in SCENARIOS C5

In SCENARIOS, the central hypothesis of EUROSTAT projections was taken as reference with mention of a minimum and maximum hypothesis. It must also be kept in mind that demographic factors should be considered at regional level to more fully appreciate the effects of the structural demographic changes on transport. The trend analyses show that the demographic factors are not at all similar throughout Europe; the structure per age varies greatly from one country to another, but also from one region to another within the same country.

The table above, produced from a number of population projections[4] and using a system dynamics approach, gives population projections for 2020. As can be seen, there are wide differences in the projected populations for the EU Member States with some countries (Germany, Austria and Italy) expected to witness declining populations, others significant increases (France, Ireland, Luxembourg, Netherlands and Portugal). For the remaining Member States moderate increases can be expected.

Like the EU Member States, diverging trends in population growth figures can also be found in the Central and East European countries considered by SCENARIOS. For example, Hungary's population is predicted to decline over the 25 year period, whilst in Poland the population is expected to increase by around 13%. In contrast the Czech Republic is expected to see a small increase.

[4] PROGNOS World Report (1996), UN (1992), EUROSTAT (1991), Prinz, C.; Lutz, W. (1993)

2.3 General Economic Prospects

The SCENARIOS research aimed to produce projections of economic growth, for a number of different horizons, also considering productivity, employment and trade. It is clear that economic growth directly influences transport, although it is difficult to give an elasticity between GDP and traffic growth for goods and for passengers as many structural effects intervene between transport and economic growth. Here some of the main results are presented for economic trend scenarios in Europe.

2.3.1 Medium-term Projections

Concerning medium-term outlooks (around 2005), many factors will influence developments. Political willingness towards low inflation seems a main objective of European policy. With regard to monetary union, the efforts to keep public sectors deficits small will continue as well. This is combined with many tariff agreements in Europe, that show moderate wage increases although unfortunately the effects on the labour market will stay at a low level for the next few years.

Concerning the annual growth rates, Ireland, Finland, Norway, Portugal and Spain are likely to enjoy faster growth rates than the strongest European economies. For Portugal and Spain accessibility is expected to improve constantly, so that high growth rates for ex- and import, in particular between these two countries, are assumed. Ireland started, as Portugal, at a relatively low level. For this reason momentary efforts of improving infrastructure (transport and telecommunication) and accessibility, will probably result in higher growth rates in the coming years. Low taxes for foreign investors will support this development.

Finland's economy was affected by both the European-wide recession and also a drastic reduction in Finno-Soviet trade following the break-up of the Soviet Union. Now economic development of the Baltic states looks quite favourable and they are expected to become strong trading partners for Finland. Trade growth rates are already increasing and Finland's economy is likely to recover rapidly. The high potential of natural resources (e.g. oil and gas) will support Norway's upswing.

Because of constant technological development combined with rather small increases of population the GDP per capita is rising in Europe. Switzerland, Luxembourg and the Scandinavian countries are the most affected by this. Starting from lower levels Greece and especially Portugal no longer seem satisfied with only moderate productivity and may show high annual growth rates in 2005. Portugal's upswing is not only a result of the general favourable climate, but it is also an effect of its strong links with the buoyant Brazilian economy.

The number of civil employed persons is likely to increase by more than 1% only in the United Kingdom. Employment in other European countries will not rise significantly, but data concerning labour market have to be taken with care, because statistical effects can be rather high.

2.3.2 Long-term Projections

Statistics concerning long-term economic trends (after 2010) are extremely rare. According to the PROGNOS world report, most data are available only up to 2005. In fact almost all scenarios or trends for 2010 and 2020 are limited to demographic data.

The tables below present the estimated GDP and annual percentage growth rate at national level (IWW trend modelling) for EU countries and some CEEC countries. Two hypotheses have been made at the horizon 2020 concerning productivity, which surrounded a central hypothesis, taken as reference for 2040 extrapolation.

Table 2: GDP/billions $US according to the constant hypothesis (1992 prices)

	1994	*2000*	*2005*	*2020*	*2040*
Austria	171	197	221	328	485
Belgium	201	230	258	387	578
Denmark	140	162	182	280	440
Finland	124	148	167	259	414
France	1241	1431	1606	2414	3694
Germany	1830	2161	2438	3258	4083
Greece	70	79	89	134	196
Ireland	54	67	76	127	254
Italy	1133	1301	1458	2114	2929
Luxembourg	11	13	15	24	40
Netherlands	302	347	390	579	857
Norway	119	141	160	246	391
Portugal	69	82	95	171	308
Spain	511	601	690	1072	1828
Sweden	223	254	282	409	584
Switzerland	226	253	280	402	558
UK	1014	1180	1326	1988	2985
Total	**7439**	**8647**	**9733**	**14192**	**20625**
	1993				
Poland	71			250	485
Czech Rep.	25			115	197
Hungary	30			175	271

Source: IWW 1997 in SCENARIOS C5

Table 3: Percentage annual growth rates of GDP

(according to the constant hypothesis - 1992 prices)

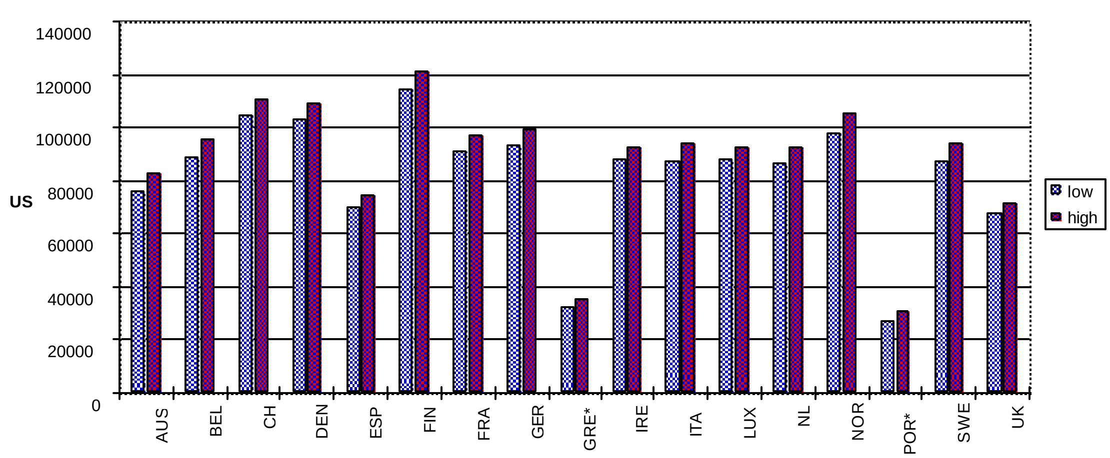
	1994-2000	2000-2005	2005-2020	2020-2040
Austria	2.39	2.33	2.67	1.97
Belgium	2.27	2.32	2.74	2.03
Denmark	2.46	2.36	2.91	2.29
Finland	2.99	2.45	2.97	2.37
France	2.40	2.33	2.75	2.15
Germany	2.81	2.44	1.95	1.13
Greece	2.04	2.41	2.77	1.92
Ireland	3.66	2.55	3.48	3.53
Italy	2.33	2.30	2.51	1.64
Luxembourg	2.82	2.90	3.18	2.59
Norway	2.87	2.56	2.91	2.34
Portugal	2.92	2.99	4.00	2.99
Spain	2.74	2.80	2.98	2.70
Sweden	2.19	2.11	2.51	1.80
Switzerland	1.90	2.05	2.44	1.65
Netherlands	2.34	2.36	2.67	1.98
UK	2.56	2.36	2.74	2.05
Total	**2.54**	**2.39**	**2.55**	**1.89**

	1994-2020	2020-2040
Poland	4.79	3.37
Czech Rep.	5.78	2.73
Hungary	6.76	2.21

2.3.3 Productivity and Employment

The projected GDP for 2020 should be handled carefully, but the situation concerning to the labour market is even more difficult. Many uncertainties and unknown factors make projections for labour force data more difficult than trends for population or GDP. However some trends for civilian employment can be made.

Figure 3: Labour productivity in 2020 at 1990 prices (low and high performance variant)



Besides the change of the population structure, productivity (GDP per employed person) has been taken into consideration. Its annual growth rates from 1984 to 1994 and the expected rates for 1994 to 2000 respectively for 2000 to 2005 has been compared with the growth rates of GDP per capita. According to this information two average growth rates for 2005 to 2020 have been projected. They are related to the business as usual variant for GDP per Capita up to 2020. It is hardly possible to choose one probable rate, so that a low and a high performance variant for productivity have been provided.

Due to the definition of labour productivity (GDP per employed person) it is possible to deduce the figures for national employment in 2020. Based on the 'business as usual - GDP' for 2020 a corridor for the civilian employment can be developed. With regard to the different uncertainties, the results have been compared with a forecasted number of employees, that results from an assumed constant average growth rate for EU members, given by PROGNOS up to 2005, and for advanced industries, presented by the OECD up to 2020. Only twice the number has not been found in the following corridor. Both times (Denmark and Norway) the corridor has been extended slightly. The number of employed persons are given in thousands.

Table 4: Civil employment by country

	1994	2010	2020
Austria	3 698 000	3 362 000	3 413 000
Belgium	3 748 000	3 917 000	3 976 000
Denmark	2 537 000	2 566 000	2 605 000
Finland	2 046 000	2 095 000	2 127 000
France	21 720 000	22 785 000	23 129 000
Germany	35 840 000	33 675 000	34 184 000
Greece	3 786 000	4 221 000	4 284 000
Ireland	1 207 000	1 280 000	1 230 000
Italy	20 024 000	21 885 000	22 216 000
Luxembourg	165 000	165 000	167 000
Netherlands	6 706 000	6 852 000	6 955 000
Portugal	4 440 000	5 107 000	5 184 000
Spain	11 728 000	13 715 000	13 922 000
Sweden	3 926 000	4 156 000	4 219 000
UK	25 657 000	26 857 000	27 263 000
EU	**147 228 000**	**151 485 000**	**153 773 000**
Switzerland	3 776 000	3 859 000	3 917 000
Norway	2 002 000	2 225 000	2 259 000
Czech Republic	4 729 000	4 890 000	4 964 000
Hungary	2 505 000	2 531 800	2 570 000
Poland	13 446 000	13 699 000	13 906 000

Source: IWW 1998 in SCENARIOS C5

2.3.4 Trade

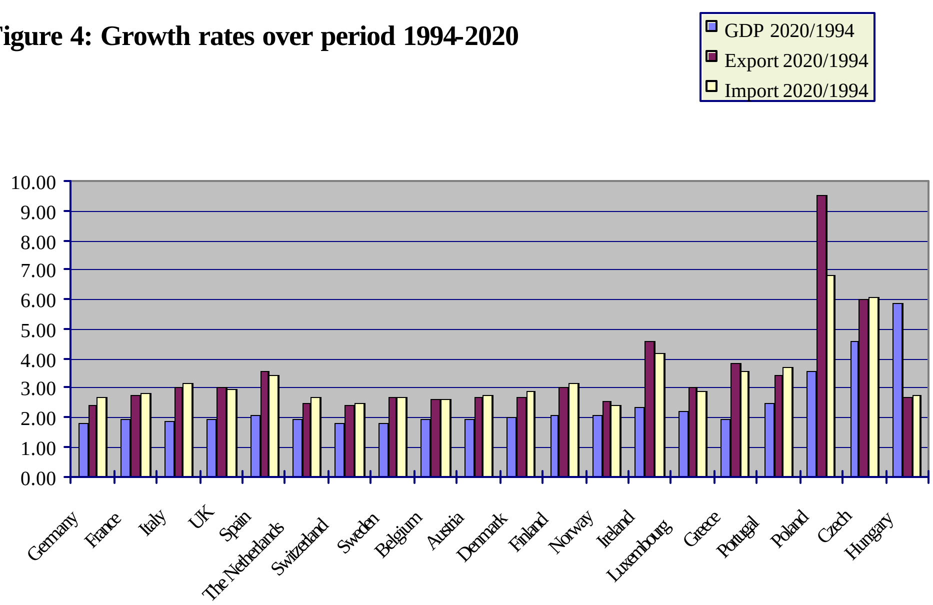
In order to improve the connection between economic growth and traffic growth for goods, more details are needed concerning the structure of production, per country as well as the trend of the national foreign trade.

The general trend is well known but can be clarified: a falling share of primary goods and bulk products, a decreasing share of intermediate goods, but on the contrary a rapidly increasing share of the high value goods. In this latter case the average value of one ton transported increases and the volume (measured in cubic meters) becomes a more relevant unit of transport than the tonnage. In parallel, we observe a decrease in the shipment size and the development of associated logistic services.

Foreign trade is a very important socio-economic variable for transport. International traffic flows are growing at a much faster rate than national traffic, in parallel with international trade which is rising more quickly than national trade. On trunk networks international traffic is taking a growing share which may often reach between one third and one half of the total traffic of many links within the next 20 years. The evolution of traffic in the hinterland of the large ports provides just one example of this phenomenon. Further research on the consequences of international trade was carried out for the SCENARIOS study of freight transport determinants (see chapter 6.2.1).

The distinction between intra- and extra-European international trade was highlighted as an interesting topic for future research, particularly for a definition of alternative scenario hypotheses, for example, a "globalisation" hypothesis (world scale market) or an "integration" hypothesis (EU policy).

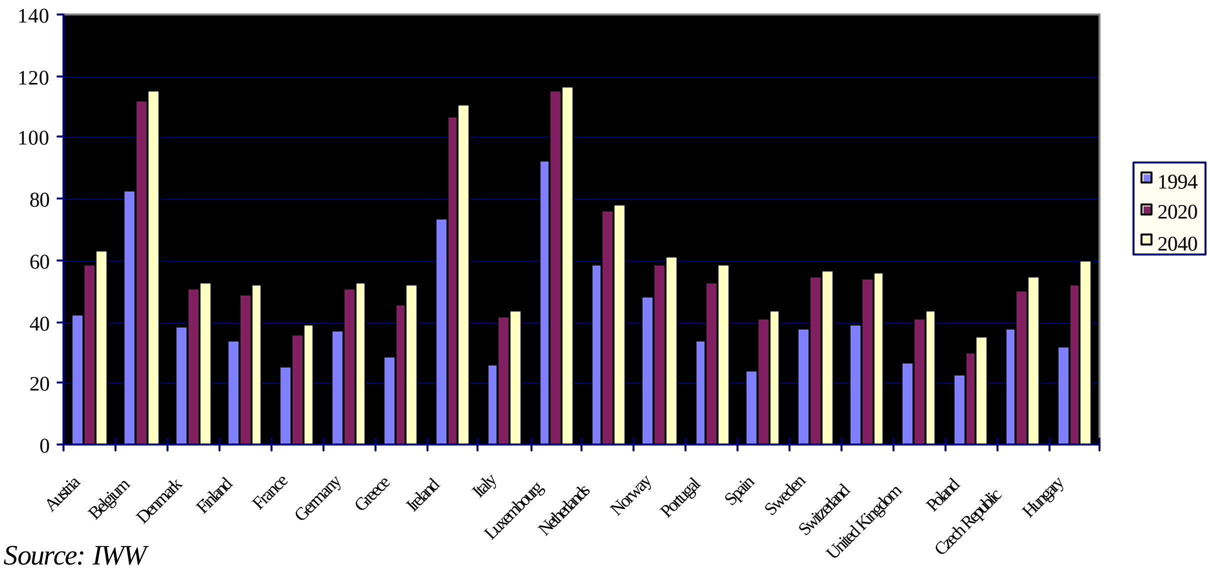
Figure 4: Growth rates over period 1994-2020



Source: IWW

The SCENARIOS C5 report presents hypotheses of import and export levels, deduced from trend analysis of the opening of national economies (import and export rates, in relation to GDP). Several analyses are available (OECD 2020, for example) which are compatible with the GDP growth taken as reference; their results can be used to take different growth hypothesis for intercontinental and European trade, and to stress the importance of the traffic growth in the hinterland of the main ports.

Figure 5: Quotas of Exports (% of GDP, 1990 prices)



Source: IWW

It is noted that foreign trade growth continues to be higher than GDP growth; the opening of national economies will thus go on with increasing intra-branches exchanges and the development of logistics patterns at European scale (European Logistics Centres). For some countries and in particular some well developed small countries, the opening rate (imports or exports divided by GDP) will be higher than 1.

2.3.5 Projections of fuel prices

For the fuel costs, taxes range from 65% to 80% for unleaded petrol to 60% to 72% for diesel in the different European countries. The objective of the CTP is harmonisation and an increase of these taxes.

After a sharp decrease in the price of fuel at the beginning of the eighties, the price has been growing again slowly since 1985, in parallel with an increase in fuel taxes. The difference between petrol and diesel remains around 20% on average.

The structural composition of the stock of private vehicles in Europe must also be taken into account: in 1980, the percentage of diesel cars was 7% although by 1995 it was 22%, with a sharp increase in France, Austria and Belgium (more than 40% of the sale of new cars in these three countries), but not in Germany or Italy where this percentage fell in the eighties and has now stabilised.

The difference in rates of consumption between diesel and petrol cars is around 1 litre per 100 km. The automobile industry thinks it can reduce significantly the unit consumption of diesel engines in the years to come by 25% for private cars, although this will not be possible for truck engines whose unit consumption is already optimised. This improvement however appears to be more difficult for private cars run on petrol.

Petrol prices have decreased since the beginning of the eighties and on this basis three future hypotheses can be considered[5]:

[5] As selected by the French Ministry of Industry in 1997

- the low scenario considers a stability of the price until the 2010 horizon with a moderate increase of petrol demand, higher taxation on the final consumption and an improvement of energy efficiency.

- the high scenario forecasts an increase of the price until 2010 and a stability afterwards, in spite of an increasing demand for transport.

- the medium scenario forecasts a stability of the price of petrol after 2005.

Estimates of fuel prices for 2010 do however vary greatly depending on which scenario is chosen. Whilst the low scenario estimates fuel prices in 2010 at between $16 and $17/barrel, the high scenario forecasts a price of between $29 and $33 per barrel. A more moderate estimate of $24/barrel is proposed by the medium scenario. For the final user, fuel prices are the combined result of the petrol price, taxation policy, as well as distribution costs.

In the SCENARIOS trend policy scenario (chapter 8.3) it was assumed that oil prices would remain stable at around $25/barrel. The main impact on petrol or diesel prices was assumed to come from transport policy which determines changes in fuel taxes (since taxes represent around 80% of the price of petrol). Any large change in oil prices (for example due to more efficient vehicles and lower demand) would have wide geopolitical consequences, which go beyond the scope of the fairly simple trend policy scenario.

In the SOFTICE project[6] an overview of long distance haulage truck operation costs was presented, which showed that as a percentage of operating costs, vehicle taxes (based on gross vehicle weight and number and type of axles) vary greatly between European countries. For example in France and Denmark they represent 0.5% of costs, whilst in the UK the share is higher at 4% of total costs.

Efforts remain to be made for full implementation of the Directive 93/89 concerning the harmonisation of taxes on goods vehicles (over 12 tonnes), as well as tolls and payment for use of certain infrastructure. Again considering the SOFTICE study, it can be seen that drivers' wages, (together with fuel) take the largest share of long distance haulage operating costs in all countries of the EU. This makes the question of harmonisation of social legislation and working conditions a particularly sensitive subject, all the more so given the increased competition with central European countries.

The structure of the stock of trucks between light and heavy vehicles is also important in the definition of scenarios since it reflects their respective use for long and short haulage. The importance of the items differs, for example drivers wages take up to 40 or 50% of light vehicle operating costs.

[6] SOFTICE (1998) Deliverable 1

3 SPATIAL DYNAMICS

Spatial dynamics are another important aspect of the SCENARIOS work on External Developments, which were considered in the C1 Report: *Socio-economic external developments, spatial dynamics and their relations to transport*.

Most transport problems cannot be analysed without explicit reference to the location where they develop, for example, a specific region or zone for congestion, the urban or suburban environment for pollution, a transit corridor for long distance transport, a well identified missing link for interconnection, or a capillary network services for transborder relations.

Therefore the hypotheses relating to such problems, such as scenarios about the average increase of transport time because of congestion, an average toll charge to finance infrastructure, or an average mobility rate, do not have any real significance unless they are put in their proper geographical context. Local and long distance transport do not obey the same socio-economic logic and do not follow the same trends.

The socio-economic projections at national level in the previous chapter, have therefore been developed further for functional European regions. National trends remain important for reference scenarios, but in the long run regional developments are likely to increasingly influence external factors.

This chapter will consider first of all the demographic, economic and territorial trends of European regional development which then provide the basis for a clustering of European regions and analysis of their accessibility characteristics and regional development potential.

3.1 Regional Development

3.1.1 Population

The regional distribution of inhabitants varies greatly within the EU from the very small to the very large in some of the biggest capital cities. The size of regions in the EU is also very different, varying from city regions in the centre (Brussels 161 km²) to vast areas (Pohjois-Suomi in Finland 136,000 km²).

The average density therefore shows great variations from the desert like periphery (e.g. Övre Norrland and Mellersta Norrland in Sweden with 3 and 6 inhabitants per km² respectively) to the urban regions in the centre (Brussels in Belgium 5,900 inhabitants per km²)

Regions tend to be more densely populated but with a general decline in birth rates particularly in southern Europe. A geographical analysis shows a sharp division between zones in which the population is increasing and zones with diminishing population densities. Furthermore, the phenomenon of "heliotropism" has resulted in the southern regions of states (for example in Germany, France and Spain) becoming denser and growing faster than northern ones.

In the centre of the continent, densification tends to be located along axis and corridors. For example along the Rhine in Germany, Rhone and Loire in France and the Po in Italy. But in other countries the corridors are less homogenous and continuous.

In many states depopulation is an important trend, being more significant in the centre of big cities than rural areas, and particularly obvious in former industrial areas. Depopulation in rural areas, is not a present trend in general terms, but is important in areas with low accessibility, such as Italy, Portugal, Spain, Germany (Eastern Länder) and France.

Future prospects : Some northern Member States are likely to see negative rates of population growth, whilst some peripheral regions (S. Spain, S. Italy, Ireland, Northern Ireland) are likely to see increases even though birth rates are expected to decline. Internal migration within the EU is likely to remain low despite persistent differences between regions, although short distance migrations from rural areas to medium sized cities will be the norm in most of Southern Europe. The reactivation of immigrants from outside the EU is expected to continue.

With the ageing population, there are expected to be differences in the regional distribution in 2020. The over 65s will represent on average 20% of the population for the whole of the EU, with variations between 15- 25% across regions.

3.1.2 Economic activity

There continue to be significant disparities in regional economic wealth, with the GDP per capita 4.5 times greater in the ten richest than the ten poorest regions, with even greater disparity between regions in relation to unemployment rates. There are also much lower levels of transport and general infrastructure in poorer regions (usually peripheral e.g. Ireland, Greece, Portugal, Spain).

The decline in the importance of manufacturing has reduced the relevance of traditional location factors such as the proximity of raw materials and energy. At the same time, progress in transport and communication technology and emergence of new methods of production organisation have greatly increased the mobility of a large part of the industry and services.

For example in the 1970s Southern France and Eastern Spain joined Southern Germany and Northern Italy in attracting hi-tech industries, increasing the GDP in these regions much more rapidly than in other areas of traditional industrial activity, and this evolution seems likely to accelerate.

For the service sector, those services linked to population (distribution, health) are likely to follow the pattern of population (especially distribution and retail). Services closely linked to companies will concentrate more in cities, in spite of opportunities offered by new communications technologies. Financial services seem to become ever more concentrated, with London and Frankfurt at the forefront of activity.

3.1.3 Territorial structure and land planning

The European population has become increasingly urban since the end of the Second World War (although there may be wide differences between large and small "cities") Cities themselves are growing, and this growth is predicted to continue although more at the periphery than in the centre for large cities (for a number of reasons, including growth of the service sector and decline of manufacturing).

Rural areas show strong regional differences in development, with some regions in decline, and others growing. In the future agriculture is likely to be centred on the Mediterranean regions. However problems due to declines in agricultural subsidies will not be homogenous: in densely populated areas a reduction in agricultural jobs can be offset by other services and industries, but in areas with declining or ageing populations (e.g. mountainous areas of France, parts of Ireland, Western Scotland, northern Spain) the potential for diversification is more limited.

Some regions may experience specific problems, for example the decline in fishing and related industries has seriously affected some coastal regions. Border areas are likely to benefit from the disappearance of national boundaries for trade, with increased commercial exchanges, although administrative differences may remain.

3.2 Regional Clustering

Since it was not possible to consider every region individually, the SCENARIOS approach was based on functional regions, and hence required a first analysis of regional clustering. The classification takes into account socio-economic indicators considered above (e.g. population density, sectoral GVA) and accessibility characteristics.

3.2.1 The influence of accessibility

An aggregated clustering, based on a cluster analysis technique as well as on a factor analysis of all the variables, was used to classify European regions. It focuses on the relationship between accessibility and socio-economics, but also considers additional values such as education. The analysis includes the 203 NUTS-2-regions and the neighbouring countries (Switzerland, Poland, Czech Republic and Norway).

Although this aggregated clustering is a very rough simplification of the regional differentiation characteristics in Europe, it was decided to use this system in order to test the functioning of the SCENARIOS System Dynamics Model (see chapter 4) and create the platform for subsequent extensions. Furthermore, two accessibility indicators were applied, which for reasons of data availability are restricted to the road network.

For the clustering study of the C1 report, four main regional types are defined, as follows:

(1) Service dominated regions: A relatively high level of service and a relatively low level of industrial GVA percentage are characteristic features of service dominated regions. Many of the richest regions in the EU and densely populated regions are part of this group. However, a high level of GDP per capita is not necessarily characteristic for this group.

(2) Industrial core: This cluster contains regions with a high level of industrial GVA percentage. Many regions in the centre of Europe, regions in the United Kingdom and regions around Stockholm, Paris, Helsinki and Barcelona are members of this group. The majority of these regions show a high level of GVA per capita.

(3) Relatively rich and rural or peripheral regions: This group consists of relatively rich and rural or relatively rich and peripheral regions. Many of these regions form the periphery of powerful economies in the EU (France, Italy, United Kingdom and Scandinavian countries). The GDP per capita of the regions belonging to this cluster is in most cases significantly higher than GDP per capita of other rural or peripheral regions. Regions that benefit from tourism can also be found in this cluster.

(4) Low developed regions High rates of unemployment, low level of educational attainment and relative high share of agriculture are characteristic features of low developed regions. The status of accessibility is low.

Figure 6: Classification of European Regions

3.2.2 Regional Development Potential

After the classification a potential development analysis is applied for the regions of the considered cluster. In dependence on their public endowment the potential regional product is calculated and compared with the momentary 'real' regional GDP. Thus, on the one hand, the bottlenecks are identified and, on the other hand, the members of each cluster are classified into over- and under-average performing regions.

The regional development level is normally measured in terms of income, productivity and employment. Besides attractable factors, such as private capital, resources characterised by high degree of public provision are the main determinants of the regional product levels. These resources not only influence the current regional income; they also determine the potential income of the considered region.

Since future development is dependent on the potential input of a region, and not automatically on the momentary status, the potential regional income seems to be of considerable interest for the SCENARIOS and the following SCENES project - maybe of even higher interest than actual regional product.

The potential analysis is an important approach to derive regional policy instruments. The idea is to make out the weaknesses and the strengths of each region and to simulate the use of appropriate policy instruments.

According to many development potential approaches public resources are identified by the following characteristics (e.g. Biehl, 1991):

- Indivisibility: Resources with high degrees of indivisibility have large capacities that normally are utilised in different intensities. There is no benefit from a resource, if only parts of the resource are available. (E.g. a bridge can not be used if it is not finished, neither by one nor thousands of cars)
- Non-substitutability: Resources that can hardly be replaced by other resources, in particular by attractable factors.
- Immobility: Resources that can not or can hardly be moved.
- Polyvalence: Resources that can be used as input for a large number of production processes.

In literature various potential factors can be found. All are based on these characteristics, but as most of the factors do not fit all characteristics exactly, different authors may, or may not, identify the public character of the considered resource. While e.g. infrastructure and agglomeration is taken into consideration as potential input in almost all approaches, employment or sectoral structure are evaluated differently. After the selection of the potential inputs, the problem of collinearity must be carefully addressed. That means it has to be proved that a potential factor does not explain another of the selected potential factors (e.g. potential employment could be explained by potential population and vice versa).

3.3 Methodological remarks for a NUTS 3 level analysis

This section explains the methodology used for a preliminary SCENARIOS pilot study of the NUTS 3 region of Baden Wuerttemberg in Germany. The results of this study can be found in the C1 report. The following potential inputs were used for this analysis. Some are oriented on the inputs suggested by Blum and Biehl (Blum, 1982; Biehl, 1975):

- Agglomeration (**D**)
- Infrastructure (**I**)
- Accessibility (**A**)
- Education (**E**)
- Nature (**N**)
- Industrial settlement area (**S**)

Density (**D**) is used as an agglomeration indicator. The number of employees is strongly related to population and to the age structure, that determines the employment capacity. Hence no further employment indicator is taken into account.

Due to the data availability the infrastructure variable focuses on the regional road network. In accordance to Biehl (Biehl, 1975) the infrastructure indicator may be defined in the following way:

Road infrastructure (I): $0{,}5 * \left(\frac{population}{roadnetwork\_w.} + \frac{roadnetwork\_w.}{area} \right)$

The roads are subdivided into four groups. Motorways, national, interurban and urban roads are taken into consideration with different weights (highest weights for motorways and lowest for urban roads). Much more information, such as rail km, waterway km, communication networks etc. would be interesting, but data are not available at regional level within the SCENARIOS database yet.

The third factor is accessibility. At first it seems to be similar to infrastructure, but it is not. While infrastructure describes the internal regional road network, accessibility focuses on the exogenous (road) links of a region. The indicator is generated by the number of persons travelling from the considered region i to any region j multiplied with the travel time. The result is divided with the total number of travelling persons.

Accessibility: $\frac{? \; x_{ij} * t_{ij}}{? \; x_{ij}}$

x_{ij}: number of persons travelling from i to j

t_{ij}: travel time from i to j

i: considered region

j: 1, ..., i-1, i+1, ..., n

Contrary to all other indicators the smaller and not the higher values are the 'better' ones. Therefore the reciprocal value is used for the analysis.

Concerning education obviously two alternative directions can be followed. First the indicator could focus on school education. The alternative is to build an indicator with the help of qualification. For this approach the indicator is defined as follows:

Education: $\frac{employees\_with\_university\_degree}{total\_employment}$

The fifth indicator is connected with the natural environment. Natural areas play an important role if soft factors, that have become more and more important in recent years, are taken into account. Beside recreation areas considered in this approach, cultural activities would be an interesting indicator.

Nature: $\frac{recreation\_area \, ? \, forrests \, ? \, waters}{total\_area}$

Blum (Blum, 1982) suggests integrating industrial settlement (measured by sqkm). Actually the availability of industrial area has been a bottleneck in the late eighties and early nineties. It is not clear if it can still be seen as bottleneck factor. On one hand big parts of industrial estates remain unoccupied and many office buildings are not in use in Germany, but on the other hand new industrial plants are established in emerging regions. In this approach the availability of industrial area[7] is taken into account as necessary input which can be seen as complementary factor to the public resources listed above. Nevertheless, the risk of collinearity is rather small, because industrial land use is not included in any of the other inputs.

Sectoral structure (GVA by sectors) and employment by sectors are not defined as inputs, because in this analysis they are -similar to the regional product- seen as endogenous variables, which will be explained by the exogenous potential factors.

While creating a production function based on the regional input potentials, it is assumed, that the already mentioned attractable factors are combined with input potentials in fixed proportions (Kowalski, 1985).

First of all, the regional product (RDP) is analysed. Hence the general form of the production function is as follows:

RDP = f (D, I, A, E, N, S)

Based on the well-known Cobb-Douglas production function, a quasi-production function is created. It is called quasi-production function, because it is based on public immobile resources and not on private capital. The specific form is:

$$\mathbf{Y = c} * \mathbf{D}^{?} ?* \mathbf{I}^{?} * \mathbf{A}^{?} * \mathbf{E}^{?} * \mathbf{N}^{?} * \mathbf{S}^{?} ?$$

A Cobb-Douglas function is characterized by a total sum of the elasticities of one. The applied quasi-production function, however, is in the proper meaning not a production function. Therefore, the sum of elasticities can be different from one.

3.4 Results at NUTS 2 level

Following the preliminary pilot study for the NUTS 3 region of Baden-Wuerttemberg, results were then calculated at a NUTS 2 level for selected regions in Europe. In this less detailed study it was planned to focus on agglomeration, infrastructure and education, still bearing in mind the earlier results at NUTS 3 level.

With regard to the clarity of the System Dynamics Model one endogenous variable has to be chosen. These variables have been selected as the total and sectoral GVA and employment respectively. If the analysis is focused on only one variable, an alternative is the GDP per capita. Hence the production function is given by the equation:

$\mathbf{Y = c} * \mathbf{D}^{?} ?* \mathbf{I}^{?} * \mathbf{E}^{?}$ with **Y**: GDP per capita, **D**: Density/Agglomeration, **I**: Infrastructure, **E**: Education

Based on the NUTS 3 regions of Baden-Wuerttemberg the regression analysis results in the following elasticities:

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[7] Industrial area does mean that kind of area, which is available within a short period of time for industrial use (incl. infrastructure, accessibility, etc).

Table 5: Elasticities of German regions belonging to the industrial core

Endogenous variable	Elastic ities		
	Agglomeration	Infrastructure	Education
Y	? ?	? ?	??
GDP per capita	0,14	0,15	0,13

Since the quasi production function is based on the Cobb-Douglas production function, the sum of elasticities is of special interest:

?

? ?????????????????

?

That means that agglomeration, infrastructure and education per capita influence 42% of the GDP. 58% is determined by other mobile and immobile inputs, which are not explained in the quasi production function.

Although the 'Industrial core' covers each NUTS 2 (and hence NUTS 3) region of Baden-Wuerttemberg, the elasticities will not be taken unchanged for the new 'Industrial core elasticities'. Austrian, French, Italian and Swedish regions belong to the same cluster and may influence the results. In particular detailed data about road infrastructure is only rarely available for European NUTS 2 level (normally only two categories: motorways and other roads). Hence the motorization M (cars per 1000 inhabitants) is taken into consideration. The authors are aware that this indicator is not an adequate substitute for an infrastructure indicator suggested by Biehl (Biehl, 1975), but it seems to be a sufficient indicator for this approach.

In accordance with EUROSTAT[8], the indicator concerning education is based on the percentage of the highest educational attainment.

The production function for the selected European regions is given by the equation:

$\mathbf{Y} = \mathbf{c} * \mathbf{D}^{?}?* \mathbf{M}^{?} * \mathbf{E}^{?}$ with **Y**: GDP per capita.

The table below shows the elasticities dependent on the regional type.

Table 6: Region-type specific elasticities

Region-type	Endogenous Variable	Elasticities		
		Agglomeration	Motorization (Infrastructure)	Education
	Y	? ?	? ?? ? ? ? ??	? ?
Service dominated regions	GDP / capita	0,17	0,14 (0,09)	0,17
Industrial core	GDP / capita	0,12	0,23 (0,15)	0,1
Relatively rich and rural or peripheral	GDP / capita	0,01	0,43 (0,28)	0,13
Low developed	GDP / capita	-0,02	0,39 (0,25)	-0,08

The elasticities do not say anything about the total values. They can be seen as an indicator of relative importance for the regional GDP per capita. Regarding 'Service dominated regions' high

[8] EUROSTAT (1997), see SCENARIOS (1998) Deliverable C1, Appendix

density and high levels of educational attainment are more important for the future development of GDP per capita than 'motorization'[9]. Minor importance of private car ownership can be interpreted as an indicator for the availability and necessity of high quality of public transport.

On the contrary, the development of GDP per capita of the other regions is much more correlated to the development of 'motorization'. In particular, the economic situation of the 'Relatively rich and rural or peripheral regions' depends on improved accessibility and infrastructure, which are expressed by 'motorization'. If ? (0,23) of the European 'Industrial core' is compared with ? (0,15) of the Industrial core based on Baden-Wuerttemberg, it becomes clear, that ? is probably too high as an indicator of infrastructure and accessibility. But if this share is taken into consideration, plausible results (in brackets) for the relevance of road infrastructure and accessibility can be given. Since the richer peripheral areas often show high shares of services, the relevance of educational attainment is, for future development, higher than for members of the 'Industrial core'.

The elasticities are the result of a linear regression analysis. Obviously the 'real' elasticities concerning over- and under-average performing regions differ quite considerably. But since the regional equilibrium is considered as a main issue of regional politics, under as well as over-average performing regions are expected to reach approximately the average elasticities in the coming years. As already mentioned, slight changes of the average elasticities will be anticipated. The main assumption is that GDP per capita will be increasingly determined by educational level. On the other side, infrastructure effects are expected to decrease, at least where infrastructure covers nothing but road and rail infrastructure.

[9] We are aware that a growing motorization is probably the result of growing GDP per capita and not vice versa, but in this context the regional motorization is treated as an indicator for accessibility and/ or infrastructure.

3.4.1 Policy conclusions

Several policy conclusions can be drawn from the regional potential analysis. The elasticities are average values of all considered regions in one cluster. The next step is to compare the potential regional product based on the average elasticities with the real actual regional product. After the comparison the regions can be subdivided into three groups:

i. Over-average performing regions (Real regional product > Potential regional product)
ii. Under-average performing regions (Real regional product < Potential regional product)
iii. Average performing regions (Real regional product = Potential regional product)

Over-average performing regions, which are characterised by relative over-utilisation of their development potential, are relatively better equipped with mobile or private capital than with public resources. This implies that the costs of attracting and using private capital are in high performing regions lower than in low performing ones. In this case public investments should be focused on public inputs mentioned above. A better endowment with public resources will result in higher growth rates of the regional product. However, these regions run the risk of growing beyond their optimal degree of agglomeration and of increasing their benefits at the cost of pollution and time loss.

Under-average performing regions lack adequate quantities and qualities of private capital and labour. First of all, policy makers should concentrate their efforts on attracting private capital. In the short run it may be helpful to subsidise private investors. Due to the already existing under-utilisation of public inputs it would not be helpful to increase expenditures for resources characterised by a high degree of public capital. If there is a sufficient endowment of public resources, this strategy will succeed. But as long as the costs of attracting private capital are high because of a low potential productivity (as a result of low resource endowment), this strategy will fail in the long term. In this case, as long term strategy, public resources have to be improved. Long and short-term strategies can be considered as complementary policies, which have to be done simultaneously.

The public endowment of over- and under-average performing regions can not be automatically considered as high or low, but in fact, most over-utilised regions are characterised by a high level of public inputs, as well as many under-utilised regions show modest levels.

The third group is more or less a theoretical one. However, it may be possible that some regions may produce (generate) a real regional product that is near the potential product. As a long-term strategy these regions should improve their public resource endowment, while attracting mobile factors simultaneously.

Figure 7: Classification of European Regions into eight clusters

The following table gives an overview of the derivation of regional policy conclusions for over- and under-average performing regions.

Table 7: Derivation of regional policy conclusions

Performance of the region	**Comparison:** Real Regional Product versus Potential Regional Product	**Equipment with mobile/ private capital**	**Equipment with public capital**	**Regional policy conclusions**
Over-average performing	Real Regional Product > Potential Regional Product	Relatively high	Relatively low	Improving the equipment with public capital
Under-average performing	Real Regional Product < Potential Regional Product	Relatively low	Relatively high	Improving the equipment with private and public capital

Though over- or under-average performance results from the public resource endowment, different over-average performing regions may show the same degree of over-utilisation with a totally different structure of potential inputs. Due to this fact it is not surprising, that different bottlenecks could be identified for different over- or under-utilising regions. One possible way of identification is to calculate the regional Marginal Rate of Substitution (MRS) and to compare it with the average MRS. As the MRS shows the approximate increase of a potential input, which is necessary to compensate for a unit decrease of another input potential, the MRS is suitable to identify regional bottlenecks (Blum, Kowalski, 1985).

Obviously the calculation of the MRS would be beyond the scope of the SCENARIOS project. Hence the suggested policy tools will be the same for different over-average performing regions of the same cluster, even if different bottlenecks could be assumed. On the other hand the policy instruments will not be applied in isolation, but as a bundle, such that the orientation on a specific bottleneck will hardly correspond to regional policies.

It is obvious that the policy mix for over-average performing regions is different from the policy mix for under-average performing ones. Therefore, by taking into account the performance of the regions, the process of clustering is to be extended: European regions grouped in four clusters are subdivided into over- and under-average performing regions, such that the final clustering consists of eight region-types.

3.4.2 Policy measures and their suitability

The short and long-term strategies can be realised by using selected measures. Various instruments are offered and the most interesting and obviously the most difficult job is to choose the most appropriate policy mix for the considered region at the considered moment. Due to the regional type, the political willingness and the over- or under-average performance mentioned above, a specified bundle of measures will be applied. It is not possible to list all instruments known and applied in European regional policy. Seven popular policy instruments are briefly introduced here:

1. SME-programs: A popular measure to strengthen the regional economy is to subsidise small and medium sized enterprises.

2. High-Tech programs: This measure is often used to support young (and therefore small) enterprises. It is part of most of the programs for establishment of new companies (setting up premium programs) and can be seen as motivation instrument for innovative entrepreneurs.
3. Tourism and culture: Tourism became more and more important in the late eighties and early nineties. It is now one of the most important sectors (GVA and employment) in Europe. Especially peripheries profit by this trend.
4. Industrial Construction: Programs for support of new non-residential, in particular industrial, construction are popular, because of their relatively high flow-on effects on the labour market.
5. Accessibility and infrastructure programs: If the main object is to improve the public resource endowment, infrastructure programs have been the favourite instruments in recent years.
6. Education: There is no doubt, that human capital has become more and more important in Europe in recent years, and that this trend will be intensified in the future.
7. Nature: Environmental protection is not policy of a minority anymore. The issue of environmental pollution is often mentioned in polls as one of the most important problems, that has to be solved by politics in the coming years. Intact nature is part of the standard of living in particular in highly developed regions.

As already mentioned, policy measures not only depend on the region-type, but also on the performance of the region. Table 8 gives an overview of a bundle of three regional policy instruments and their suitability for the different region-types subdivided into over- and under-average performing regions.

Table 8: Appropriate policy bundles

Performance	Over-average performance			Under-average performance		
Policy measure Cluster	SME and high-tech	Accessibility, infrastructure	Education	SME and high-tech	Accessibility, infrastructure	Education
Service dominated regions	policymix_1			Policymix_2		
	+	o	++	++	o	+
Industrial core	policymix_3			Policymix_4		
	+	++	++	++	+	+
Relatively rich rural	policymix_5			Policymix_6		
or peripheral regions	+	++	+	++	++	+
Low developed regions	policymix_7			Policymix_8		
	++	++	+	++	+	+
++: very appropriate measure, +: appropriate measure, o: neither positive nor negative effects are expected						

Following this further classification, each of the four region types described earlier can then be subdivided into over-average performing regions and under-average performing ones, to produce eight different clusters, as shown on Figure 7.

4 INVESTIGATION OF SYSTEM DYNAMICS MODELLING

An important objective of the Work Area 10, and of the C1 report involved the development of a System Dynamics Model for projections of changes in regional variables (population, employment, GDP). This model, developed by IWW in Karlsruhe, has been tested using the "functional region" analysis presented in the previous chapter, comparing its results with those generated by conventional trend forecasting.

4.1 General Aspects of System Dynamics Modelling

System Dynamics Models pay tribute to complex systems whose elements are subject to steady and rapid change. Indeed, the most important quality of System Dynamics Models is their ability to simulate dynamic processes.

The theory of System Dynamics Modelling is based on the work of J.W. Forrester (Forrester, 1961). The Club of Rome first applied the technique of System Dynamics Modelling in order to develop the famous "World Model"[10] which was designed to simulate the interaction of four domains (population, economy, environment and energy resources) over a long period of time. This application of a System Dynamics approach enabled scientists to make long-term forecasts by taking into account various relations and interconnections between the different sectors.

The system described by a System Dynamics Model consists of state and flow variables, which are interconnected by dynamic relationships. The behaviour of a system mainly depends on its structure. For this reason system analysis focuses more on the interrelations between the elements of a system than on details of the input and output data. By focusing on interrelations, system analysis tries to explain the time-dependent changes of the elements of a system.

The modelling can thus take account of interactive processes (such as the interconnections between macro-economic conditions and regional outcomes, or the effects of regional policy on macro-economic and regional conditions). The model itself is made up of 3 interrelated sectors: the Macro-economic Sector, the Regional Sector and the Transport Sector. The System Dynamics model can also take into account elements which are subject to steadily increasing or rapid changes such as migration, changing mobility patterns or the effects of technological changes.

Important elements of System Dynamics Modelling, therefore relate to the model's feedback loops, which can be subdivided into two classes (Bossel, 1994):

?? *Negative feedback* processes tend to counteract any disturbance and lead systems towards a steady state. An example of a negative feedback loop is the regulation of temperature in a room by a thermostat: If the actual temperature differs from optimal temperature, the system modifies the actual temperature until the difference between the actual and optimal temperature is zero.

?? *Positive feedback* processes imply self-strengthening effects. Changes of elements provoke changes in other elements, which strengthen the original process. In contrast to negative feedback processes, the positive ones imply a process of growth or shrinking. An example for positive feedback is the dependency between prices and wages: Increasing wages may lead to higher inflation. Higher rates of inflation again result in claims for higher wages.

The System Dynamics approach therefore provides improved understanding of systems and deeper insight into causal connections between different elements, for forecasting the behaviour of systems.

[10] Meadows et al, (1972), Mesarovic et al, (1972)

Especially for the generation of long-term forecasts, analysts may take advantage of the interactive and dynamic approach of System Dynamics Modelling.

4.2 Comparison: System Dynamics Modelling versus Macroeconomic Modelling

There are a number of important differences in the aims, design and application of System Dynamics Modelling and the conventional and more common macroeconomic approach.

?? The purpose of System Dynamics Modelling is to improve the intuitive understanding of behaviour of dynamic and complex systems. Macroeconomic models aim at forecasting direct effects of economic decisions without taking into account the complexity of economic decisions.
?? System Dynamics Models are designed to enable medium- or long-term forecasts, while macroeconomic models are more suited to short- or medium-term forecasts.
?? System Dynamics Modelling is based on know-how and intuition. The required amount of data set is rather moderate. Within macroeconomic models theory construction and data pattern design plays an important role.
?? In contrast to macroeconomic models, System Dynamics Models do not need any time series data. Furthermore, System Dynamics Models are able to process qualitative variables.
?? Non-linearity of parameters and variables can more easily be included in System Dynamics Models than in macroeconomics ones.
?? Feedback mechanisms are inherent components of System Dynamics Modelling. By applying macroeconomic models one may receive feedback as result, but feedback mechanisms are not considered as inputs.

Following Kuchenbecker (Kuchenbecker/ Rothengatter, 1998), Table 9 demonstrates some important differences between System Dynamics and macroeconomic models.

Table 9: Comparison of System Dynamics and Macroeconomic Models

	System Dynamics Models	**Macroeconomic Models**
Kind of policy simulation	Policy-change	Decision-change
Variation of	Model structure	Parameter values
Analysis of	Long-term trends	Short-term changes
Effects on	Behaviour modes (qualitative)	Endogenous goal variables (quantitative)
Demand on accuracy of database	Refers to time profile and is moderate	Refers to point of time and is high

4.3 Structure of the Applied System Dynamics Model

The System Dynamics Model applied for SCENARIOS is based on the IWW Master Model (Kuchenbecker/Rothengatter, 1998), which has been developed to forecast aspects of economy, transportation and environment in Germany. For the application in SCENARIOS, many elements of the IWW Master Model have undergone changes.
The System Dynamics Model applied for SCENARIOS consists of the Macroeconomic Sector, the Regional Sector and the Transport Sector. These three main sectors again can be subdivided into smaller entities as follows:

The *Macroeconomic Sector* consists of

- the National Demand Sector
- and the National Income Sector.

The *Regional Sector* includes

- the Regional Employment Sector,
- the Population Sector
- and the Spatial Sector.

The *Transport Sector* finally is composed of

- the Road Vehicle Sector
- and the Infrastructure Sector (which includes both rail and road infrastructure).

Environment is not regarded in the applied model, because the emphasis of this study lies in the field of regional politics. Effects on the environment would be able to be examined if the applied System Dynamics Model contained an environment sector.

4.3.1 Data input

As explained above, European NUTS 2 regions are divided into four groups or clusters (service-dominated regions, industrial core, relatively rich rural or peripheral regions, low developed rural regions). Each group again is subdivided according to two features (over- and under-average regions). Therefore, eight different types of regions are to be considered by the System Dynamics Model. As the model needs both macroeconomic and region-type specific data, representative data for each region-type has had to be identified.

For this reason region-type specific average values have been calculated. In order to get the region-type specific average values, data of Austria, Denmark, France, Germany, Greece, Italy, Luxembourg, Portugal, Spain and Sweden have been considered. Since System Dynamics Models do not need any time series data as input, data of the year 1994 have been used as input values.

Within the ***Macroeconomic Sector*** data of government spending, investments, private consumption, foreign trade and private and public capital has been inserted. In order to get these macroeconomic figures, data of EU-countries (NUTS 0 level) have been aggregated. Thus, the 15 countries of the EU are regarded as 'Macro-Region'.

The ***Regional Sector*** needs region-type specific data input as follows: data of population distinguished between different age classes (under 15, 15 to 50, 50 to 65, over 65) the numbers of sectoral and regional employees, and information about wages. The input data of the number of employees not only distinguishes between region-types, but also between the three different sectors regarded in SCENARIOS (agriculture, industry and service). The input of data for wages only distinguishes between sectors.

The data input in the ***Transportation Sector*** is the number of trucks as well as data of transport infrastructure (road and rail). Concerning transport infrastructure, two kinds of links are regarded:

- Interurban links
- Interregional links.

Interurban links imply important transport axes between big cities (rail: high-speed links, IC-/EC-links; road: motorway, national roads). Interregional links are connections between different (rural) regions or between bigger cities and regional districts (rail: German Inter-Regional lines, express train links; road: regional, local, municipal roads.) As for the Regional Sector, the data input in the Transportation Sector is region-type specific.

In the ***Spatial Sector*** region-type specific data of car ownership have been inserted.

4.3.2 Calibration of the applied System Dynamics Model

As mentioned above, the applied model is based on the IWW System Dynamics Master Model which has been calibrated for the period of time between 1986 and 1994. For SCENARIOS some of the calibration parameters of the IWW Master Model have been adopted. Other parameters had to be calibrated again (base year 1994) in order to apply the model to European regions. Due to various feedback processes within the model and its high complexity, the procedure of calibration is quite difficult.

As region-type specific data of regional and sectoral GVA is not given to the model (the regional and sectoral GVA is calculated by the model itself regarding the average number of employees and productivity), the model has had to be calibrated. Table 10 shows a comparison of the values of real GVA in 1994 (average values of all considered regions belonging to the referring region-type) distinguished by sectors and the values for 1994 calculated by the model. The differences between the real values and those calculated by the model are rather low and within an acceptable range.

Table 10: Calibration of region-type specific GVA by sectors

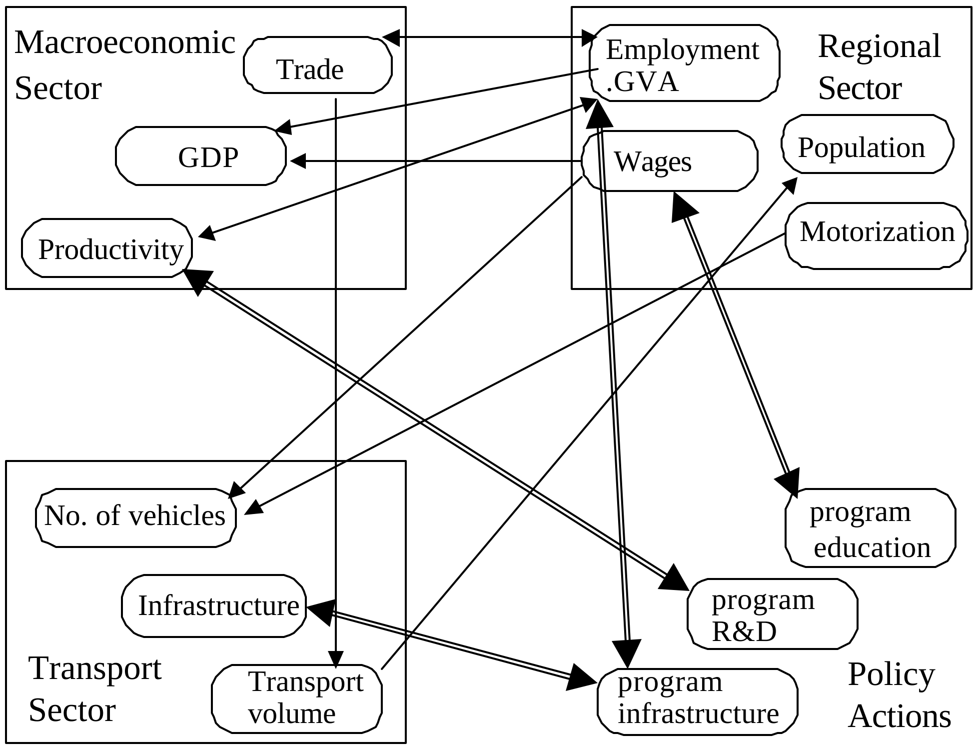
Region-Type	**GVA by sector: Agriculture (in Billion DM)**			**GVA by sector: Industry (in Billion DM)**			**GVA by sector: Service (in Billion DM)**		
	Real GVA	Model calculation	Difference	Real GVA	Model calculation	Difference	Real GVA	Model calculation	Difference
Service Dominated Regions (over-average)	1,1	1,1	0,0%	36,37	36,52	0,41%	101,82	101,92	0,10%
Service Dominated Regions (under-average)	1,57	1,55	-1,3%	19,18	18,98	-1,04%	58,01	57,71	-0,52%
Industrial Core (over-average)	1,33	1,33	0,0%	31,23	31,75	1,67%	49,77	50,28	1,02%
Industrial Core (under-average)	1,91	1,91	0,0%	36,01	35,79	-0,61%	57,76	57,28	-0,83%
Relatively Rich and Rural or Peripheral Regions (over-average)	2,41	2,38	-1,2%	16,37	16,2	-1,04%	36,95	36,75	-0,54%
Relatively Rich and Rural or Peripheral Regions (under-average)	1,6	1,62	1,3%	11,87	11,71	-1,35%	26,97	26,83	-0,52%
Low Developed Regions (over-average)	2,5	2,47	-1,2%	11,45	11,43	-0,17%	29,11	29,26	0,52%
Low Developed Regions (under-average)	1,34	1,31	-2,2%	4,36	4,48	2,75%	9,88	9,77	-1,11%

4.3.3 Regional policy as part of a System Dynamics Model

Figure 8 shows some interconnections between the three sectors regarded in the applied model, and between policy actions (which may themselves be linked to each other) and the three sectors. Concerning the intention of the applied model, first experiences have to be collected in order to get information about the effects of policy actions on dynamic systems.

As illustrated in Figure 8, the program of education mainly has a bearing on wages, while the R&D-program improves productivity. The infrastructure-program is interconnected with industrial employment and, of course, with the transport sector. This figure focuses on the influence of policy on the sectors and the links between the sectors. It does not however consider the possible links between policy actions.

Figure 8: Interrelations between the three regarded sectors and policy actions



4.3.4 Critical review

First of all, it should be stressed that the System Dynamic Model is not a magic tool. It takes dynamics into account, and, if the functions and the correlations are elaborated well, projections may reach a higher standard of reliability. Nevertheless, it should not be considered as a prophetic eye.

The regional clustering is done at a rather aggregate level. Only four groups being subdivided into under- and over-average performing ones can hardly represent the variety of European regions. With regard to the linear regression, it would be necessary to form groups with at least 20 regions (if possible, even more than 40).

With regard to increasing average growth rates of national economies, it could be a good strategy to support especially rich over-average performing regions. On the other hand, it could be argued that, with regard to social equity, differences between regions, concerning their GDP per capita should be minimised. Then the appropriate strategy is to strive toward regional equilibrium.

4.4 Definition of the Applied Scenarios

The following scenarios have been applied for the model:

- Business as usual Scenario (bau_lit)
- System Dynamics Reference Scenario (sys_dyn_ref)
- System Dynamics Policy Scenario (sys_dyn_pol)

Their different inputs are shown in the figure below:

Figure 9: Basic inputs of the applied scenarios

BUSINESS AS USUAL SCENARIO (bau_lit)
Based on studies by PROGNOS, OECD, UN, etc.
Projections have originally been made on national level (NUTS 0 level)
Additional projections delivered by SCENARIOS partners
Taking into account expert knowledge

SYSTEM DYNAMICS REFERENCE SCENARIO (sys_dyn_ref)
Integration of dynamics
Integration of regional characteristics
Regional data for 1994 delivered by SCENARIOS partners
Long term experience with the model for Germany
Taking into account expert knowledge

SYSTEM DYNAMICS POLICY SCENARIO (sys_dyn_pol)
Based on the System Dynamics Reference Scenario
Additional assumptions about regional politics
Taking into account expert knowledge

The forecasts of the ***Business as usual Scenario*** are based on figures found in literature and are in accordance with the previous projections (SCENARIOS, 1997). These forecasts have been generated on NUTS 0 level. In order to get business as usual forecasts for NUTS 2 level, region specific growth rates have been assumed with the help of expert knowledge. The Business as usual Scenario includes neither interactive dynamic processes of society, economy and transport, nor detailed regional characteristics.

The ***System Dynamics Reference Scenario*** could also be called a "business as usual scenario". However, in contrast to the Business as usual Scenario the System Dynamics Model has been applied. Regional data (NUTS 2 level) and data for the Macro-region EU have been used as input for the System Dynamics Model.

For the ***System Dynamics Policy Scenario*** the System Dynamics Model has again been applied. Furthermore, this scenario implies the assumption of regional policy measures. A bundle of three policy measures has been assumed for the System Dynamics Policy Scenario:

- A mixture of SME- and high-tech programs
- An infrastructure program.
- An education program

Since it is only a kind of prototype, the System Dynamics Model considers only three kinds of regional policy actions.

The measures of the SME-/ high-tech program will have only little influence on employment, but will accelerate technological development and, as a consequence, productivity. Depending on the regional type and the performance the measures of the infrastructure program will have (very) minor up to medium influence on industrial employment. The education program will not result immediately in higher employment, but in the long run the share of qualified people in the service sector will increase and hence the salaries in the tertiary sector will increase faster than the industrial wages.

Selected results of the three scenarios are presented in Figure 10, for the EU macro-region. More specific results for regional or region-type specific forecasts are given in the C1 report. The monetary values are based on prices of 1991. The exchange rate has been 1USD= 1.7 DEM. Since the System Dynamics Policy scenario is oriented on a regional equilibrium, major differences concerning the forecasts for the EU Macro-Region are not expected. However, the economic climate is assumed to be more favourable, such that employment, GDP and even population (migration) may increase slightly.

4.5 Comparison of the Forecasts

Regarding the development of population, the forecasts follow more or less the same direction. After having reached the highest number of inhabitants in 2010 (bau_lit scenario) respectively 2014 (sys_dyn_pol and sys_dyn_ref scenario), population will decrease within the period of time between 2014 and 2020. With a lag of time of about ten years the number of employees is forecasted to decrease slowly after 2020. Due to the improvement of productivity the GDP will probably not follow this trend. GDP is forecasted to increase steadily. Due to the financial crisis, especially in Asia, which was not expected in 1994 literature forecasts, but which has been taken into account for the projections generated by the System Dynamics Model, GDP values differ significantly. However, after 2010 values of GDP forecasted by the System Dynamics Model slowly catch up business as usual values.

Figure 10: Development of population, number of employees and GDP in EU countries

5 PASSENGER DEMAND FACTORS

The SCENARIOS work on transport demand factors was subdivided into passenger and freight demand sections. The main objective of the study on passenger demand was to analyse the development of mobility and mobility patterns and their relationship to influencing factors, in order to better understand the long term development of transport demand. Within the SCENARIOS project, this research serves to identify the elements of the transport system and the relations with the socio-economic environment, which are relevant for design of a trend scenario.

5.1 Descriptors of Passenger Transport

Mobility is a rather complex concept. Following Salomon, Bovy and Orfeuil (1993) mobility is the revealed travel behaviour of individuals, which is carried out in response to a set of needs and desires related to work, maintenance and leisure activities. Mobility can be described by a quantification of the actual movements such as the (average) number of trips, the length or duration of trips, or the mean distance travelled by trip purpose or by mode.

According to the modelling phases of transport demand as generally practised in transportation planning, that is trip generation, distribution, modal split and assignment, basic descriptors of revealed demand for transport services have been defined as the trip generation rate, trip duration and distance travelled, by mode used, distance category (short and long distance trips) and trip purpose. In addition, the degree of motorization and car ownership are used as indices of mobility that are based on transport supply.

There are many sources of data describing mobility available, they are, however, typically not comparable (because of different definitions, for instance). Scarcity of comparable data is thus a prevailing problem in Europe. This is the prime reason that the development and structure of European mobility can be described only on the basis of some European countries.

The overall trip generation rate of Europeans varies significantly; the average rates are lowest in Poland with about 400 and in Germany with 700 respectively and highest in Switzerland with 1900 trips (movements from the origin to the destination) per person per year. Extrapolating from the data available it may be concluded that people in Northern Europe make on average 1200 - 1400 trips per year, people in the large West European countries 700 - 1100 trips, while people in the Central European states follow to a smaller degree out of home activities, their trip generation rate being around 400 to 600 trips per person and year.

Despite the great differences in trip generation, the personal mobility rate has grown only moderately over time in most European countries; the annual growth rate was in general below 1 % and was fairly constant in these countries. It is in the Central European countries, as the Polish example demonstrates, where comparably low mobility rates will probably grow faster and approach levels observed in Western European countries.

For out-of-home activities people spent on average 300 to 400 hours on travelling, or about one hour a day. The time spent in travelling did not vary much over time and between countries in Europe. In contrast, the average distance travelled grew between 1.0 and 1.7 % annually and was between 11,000 and 14,000 kms per person per year in the early nineties. Except in France and in Germany where trips have on average a distance of 15 and 16 kms respectively, in the other European countries trips are shorter and have a length of 8 to 11 kms. The fact that trip distances have grown faster than trip durations indicates an increase in the average speed of transport modes caused by higher speed of the same mode and/or a modal shift to faster modes.

People in Western European countries travel first of all for non-business and non-work related purposes, the biggest travel segment are leisure trips. In Poland, however, leisure trips have a share of only 3 %, while commuting accounts for 55 % of all trips. The trip purpose structure has only gradually changed during the last decade, the share of business and shopping trips has slightly increased while the portion of commuting trips has decreased.

More than nine out of ten trips are ***short distance trips***, they are realised and repeated within the daily activity pattern of people, in contrast to long distance trips, which occur within a weekly, seasonal or annual activity pattern, like holiday trips, which are typically undertaken in the summer and/or winter season and repeated within an annual schedule of activities.

The definition of short distance trips covers all local trips (less than 10km) and some medium distance trips, between 10km and 100km. However the precise definition varies between countries in Europe, for example in France short distance trips cover those trips of a "crow-fly" distance of 80km, but elsewhere in Europe the cut-off between long distance and short distance trips varies between 50km and 100km.

Long distance travel accounts for only a small segment of total trip making, however, the demand for interregional travel has grown faster than for short distance travel. Since country statistics use different minimum distances for describing long distance travel descriptors of this segment are not comparable between countries.

Comparing short and long distance trips one can see that in both segments, the total person kilometres have increased. This fact can be explained for short distance trips by increases of trip lengths, whereas for long distance trips it is caused first of all by the growth in number of trips. One hypothesis is that the increase in trip length of short distance trips is caused by decentralising trends, e.g. urban sprawl.

One important and "European" travel segment is holiday travel, which has been analysed in detail on the basis of data from France, Germany, the Netherlands and UK. Descriptors like travel intensity (the percentage of the population going on holiday) and travel frequency (the number of holidays per holiday maker) were used besides the trip generation rate to show mobility characteristics of the population in this segment.

Travel intensity for holiday trips varies widely between Northern (around 80 %) and Southern Europe (as low as 30 %). Holiday making has become very important in the Northern societies. The number of holiday journeys made per person has grown in all countries surveyed; the generation rate was between 1 and 1.2 journeys per person per year in 1995. In 1970 this figure was between 0.6 and 0.8 journeys.

An important feature of cross-border travel in Europe is the so called "boundary effect": travel flows between two similar regions vary strongly depending on the existence or non-existence of a national boundary between these regions. Although no data exist that give proof of this phenomenon analyses of holiday and long distance business trips indicate that boundary effects exist between European countries and have not been reduced significantly in the past. With data of business travel, model estimates have yielded boundary effects between European countries in the order of four, indicating a resistance to border crossing business travel of being four times as high as on a similar domestic origin-destination relation.

The dominant mode used in both short and long distance travel is the private car. For most trip purposes the car share has increased in the past. In recent years, however, it has decreased somewhat for holiday travel, while the air share has grown strongly.

As the analysis of car fleets and motorization rates has shown, both these mobility indicators continue to rise almost linearly in most industrialised countries. Three different indicators of motorization rates have been established and analysed over time and between countries; they are the number of private cars per household, per adult and per 1000 inhabitants. All three indicators show differences in the development within and between countries. While the number of cars per inhabitant and per household is stable or decreasing in some countries (and growing in other countries) the motorization rate expressed as the number of cars per adult is still increasing in all countries surveyed. This poses the question of the relevance of a saturation threshold.

5.2 Determinants of Passenger Transport

As transport is a derived demand it is influenced by a wide range of factors which vary for each trip and trip maker. Not knowing all these factors in every case an attempt has been made to aggregate and categorise them to a relatively small group of so called determinants.

Determinants stand for a group of similar factors influencing a specific type of travel, for instance business travel. Whereas demand descriptors may be regarded as output terms of the modelling process, determinants can be seen as the input and are applied - if feasible - as variables in demand modelling.

Determinants may be subdivided into two main groups which are the endogenous and exogenous factors. There is a third group which contains the factors “behind determinants”; societal values and their changes belong to this group. These factors can be described only in a fairly general qualitative way, quite in contrast to the others.

The **exogenous determinants** are also called demand factors and belong to five subgroups which are:

?? Socio-demographic factors (e.g. population by age)
?? Economic factors (e.g. disposable income)
?? Lifestyle (e.g. preferences)
?? Spatial factors (e.g. modal accessibility)
?? Dynamic and saturation effects (e.g. inherited wealth)

The transport **endogenous** or **supply related factors** are:

?? “Demand/Supply”-determinants (i.e. car availability)
?? Feed-back effects (of supply on demand)

5.2.1 Short Distance Trips

Definitions of short distance trips vary in Europe, but however defined, most trips fall into this category. In France short distance trips cover those trips of less than 80 km direct, while in other countries the cut off point varies between 50km - 100km. To assess the proportion of all trips which are below a threshold of 160km, use is made of tables published in Clark (1998) which present trip distances from United Kingdom National Travel Survey data, disaggregated by mode and purpose, first for all trips and then for trips less than 160km in length.

As would be expected, the short and medium trips form a very high proportion of all trips, over 99%, but this dominance is much weaker when measuring trip distances. Thus if the descriptor is passenger trips then total passenger trips are a reasonable estimate of short and medium passenger trips. If, however, passenger kilometres are taken as the descriptor then short and medium trips within the United Kingdom are only around 80% of total passenger kilometres. Similarly, in France for 1982, 99.5% of the trips were of less than 80km in length but this percentage had decreased slightly to 98.5% in 1994 (Madre et al 1997). Given the longer distance “cut-off” for the United Kingdom data, the statistics from these two nations appear consistent.

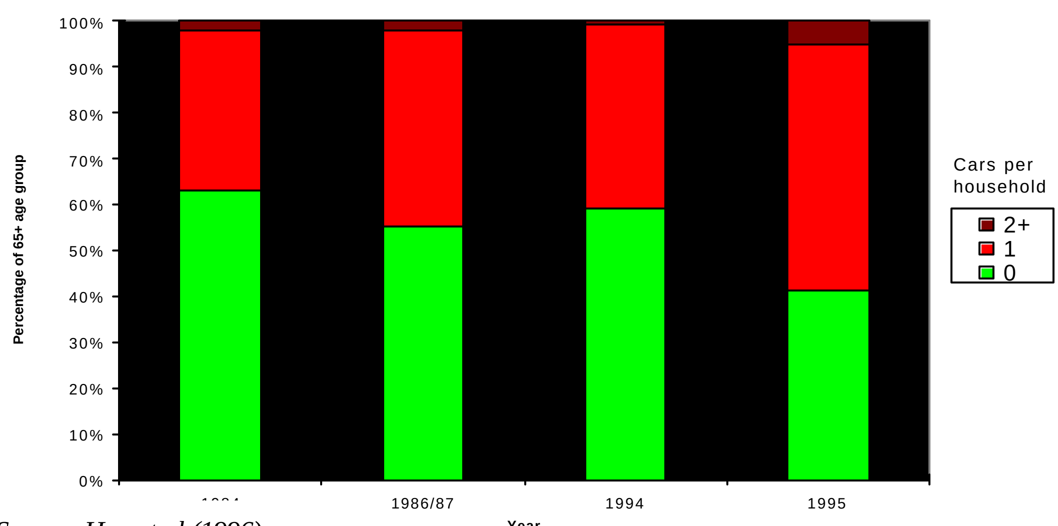
5.2.1.1 Socio-economic and demographic factors

Driving Behaviour and Licence Holding

A simple approach to model the growth in licence holding is to use a sigmoid growth curve, the main driving force of which is a time trend (DETR, 1989). This modelling process will also yield an estimate of the saturation level of licence holding. There is a “natural” saturation level for such a quantity which is 100% of the driving age population. It is unlikely that such a level will be reached since not all adults will want to or be able to drive, although technological developments may enable those who are currently unable to drive to be given the capability (Mogridge, 1989).

Household age compositions may also have an effect when considering car ownership. The tendency of middle aged individuals to continue their use of the car for transport as they age, rather than adopting the habits of the current elderly population will also have an impact. Household data from Stockholm (Han et al., 1996) reproduced below, shows that over time, the car owning characteristics of the 65+ age group have modified, with a tendency towards greater ownership rates among this age group. This effect is particularly strong for 1995. The Han paper also presents discrete choice models of the generation effect for car ownership which shows that a significant reduction in the propensity to own a car exists for those born before 1920 and a moderate reduction for those born between 1920 and 1945, relative to those born after 1945.

Figure 11: Car Ownership in 65+ age group Households in Stockholm



Source: Han et al (1996)

5.2.1.2 Economic factors

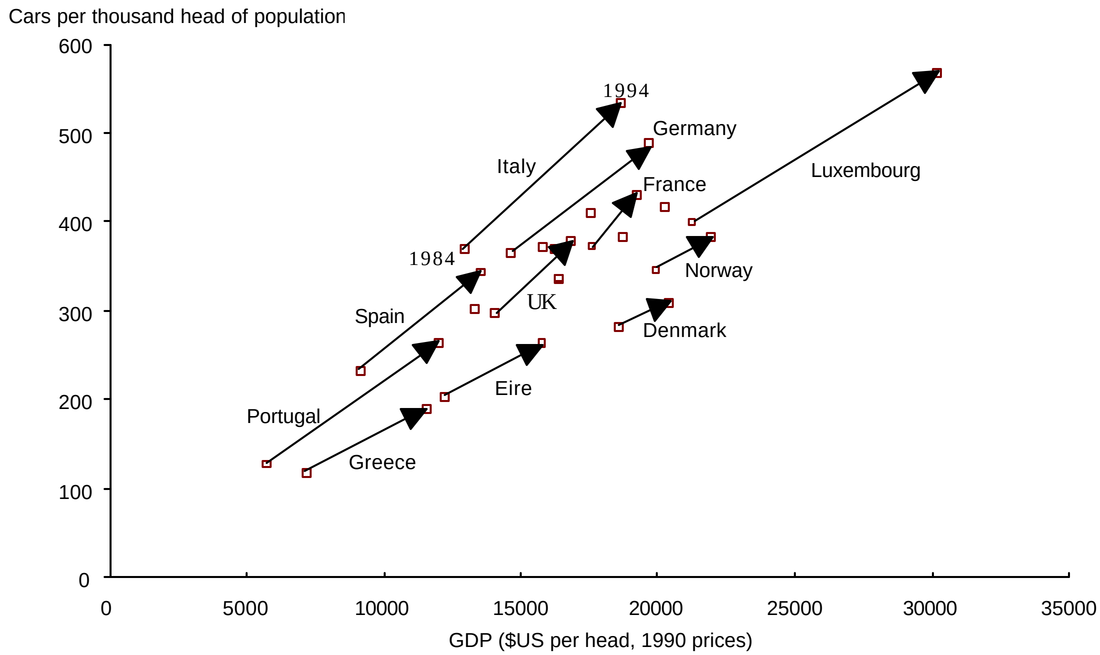
Car Ownership

Car ownership can increase as a result of a number of factors. Some are “hard” measures such as income whilst others are “soft” such as the status attached to car ownership. Increasing incomes tends to increase car ownership.

This trend for increases in wealth to be associated with increases in car ownership can also be illustrated by looking at the change in position for various countries over the ten year span, 1984 to 1994. Figure 12 shows how all nations have demonstrated an increase in GDP at PPP and an increase in car ownership.

Car use is undoubtedly related to the same factors as car ownership, although the magnitude of the impacts will differ. Once again, the availability of income to maintain and operate a car will be an important factor.

Figure 12: Trends in Changes of Income and Car Ownership



Source: National Road Traffic Forecasts (Great Britain). Working Paper 1.

Public Transport

The United Kingdom National Road Traffic Forecasts for 1997 include separate forecasts of local bus use and (long-distance) coach use. The significant determinants listed for local bus use are service level; fares; availability; quality of service; competition from other modes and national and local government policy. The suggested strongest influences are income and car ownership.

5.2.1.3 Spatial Factors

Planning undoubtedly interacts with transportation. The concentration of many facilities such as shops, schools and colleges and medical facilities has necessitated the need for new transport infrastructure. In turn, the provision of transport has encouraged this concentration process. Since there is little available free space in dense urban centres much of this development has taken place "out-of-town", an area traditionally served badly by public modes of transport.

5.2.1.4 Social attitudes

Ultimately, if policies are to work successfully they need to be adopted by the population. Stokes et al. (1995) report findings from the British Social Attitudes Survey of over 2,200 individuals. The first finding is that there are high levels of concern about congestion and the environmental aspects of transport, but these concerns tend not to be shared by the same groups in society. To gain an insight into these concerns, the acceptability of a tough policy option of higher car taxation (indications are given that these taxes are geared towards car use rather than ownership) and a soft policy option of bus priority techniques are measured. The acceptability of these options were disaggregated by various categories such as age, gender, income, education, travel behaviour, social class and social attitudes.

Those with a degree and higher incomes tend to support higher taxes, a reflection of the ability to pay the increased taxes whilst gaining benefits from those who are unable to pay and thus must sacrifice the car as a mode of transport. The higher taxation policy option was not well received by the daily car users and those with no interest in politics. The softer option was more generally well received, although some categories of individuals failed to show a majority in favour of such measures. Taylor and Brook (1998) reporting the most recent survey, find an increase in concern for the environment and over the growth in congestion, but still a variable response to policy options with no clear trend. Those most likely to support demand management measures being those with a high level of education, exhibiting “enlightened self interest” and those without a car.

The problem with social attitudes is that they are potentially the least transferable or universal evidence across Europe. “Typical” individuals in some nations may adopt a more green attitude than those reported in the United Kingdom, whilst other nations may be more pro-private transport and the perceived personal and economic benefits it brings.

5.2.1.5 Conclusions

The main conclusions are summarised in Table 11 overleaf. As transport is a derived demand it is influenced by a wide range of factors. These factors influence the decision as to whether to travel, when to travel and how to travel. National statistics show that short distance trips dominate over all other types of trips when considering travel trips, but less so when considering travel distances.

A primary influence on demand for travel and mode choice is income. The link between income levels and car ownership persists. Journey lengths are increasing, this seems to be partly due to the ability to travel further and partly a function of urban sprawl. Population trends are also a key, as Europe faces an ageing population, but with a higher proportion of car drivers than in past cohorts, who are expected to maintain their car use into old age.

Life-styles too are changing, with greater participation in the workforce, smaller households, etc., and these effects added to income effects tend to reinforce the dependency on the car. In order to break the link between car ownership and income and car use and income, a change in attitudes will be required. While concern over congestion and the environmental impacts of transport can be seen, this is not translated into behavioural shifts.

Table 11: Effects of Determinants

Category	Descriptor	Evidence
Demographics	Population Volume Population Density	Static population in European nations. Higher population densities correlate with higher public transport provision and hence use. Trend towards increase in sub-urbanisation for residential and commercial purposes
	Population Structure	Equalisation of license holding between genders. Increased desire to hold a driving license by the young. Greater car use amongst elderly, who "inherit" their earlier travel habits. Growth in number of households greater than rise in population.
	Household Structure	Smaller household size, less capacity to "share" vehicles. Growth in single adult households with greater travel aspirations and freedoms.
Economy	Incomes	Growth in car ownership faster than income growth. Growth in car use slower than growth in income.
	Working Status	Unemployment reduces need for travel by about a 50% proportionate change. Reduction greatest in commuting journeys.
	Employment Patterns	Longer distance commutes, difficult to serve by public transport. Disproportionate rise in number of part-time (same travel for less work) and temporary (more flexible commute patterns) jobs.
	Regulation	State regulation of economy tends to favour use of public transport but this may be due to a reduced income effect rather than regulation of economy. Privatisation may need regulation if it is to succeed.
Environment	Government Awareness	Most European nations aware of the issues with regard to transport and the environment. Very top down approach with government trying to educate their populace.
	Individual Awareness	Scope for non-party organisations (green movements and pro-road lobbies) can have an influence on individuals. Recognition by individuals of health issues such as asthma and carcinogenic particulates.
Land Use	Residential, Commercial and Industrial Development	Urban sprawl evident. Public modes dominant where employment concentrated in urban centres, weak where concentrated in satellite centres.
Infrastructure	Public Transport Provision	Increase in use less proportionate than increase in provision of public transport. Innovative schemes can be effective.
	Road Building	New roads tend to encourage car use rather than car ownership.
Cost	Capital Cost	Income dominant effect for car purchase.
	Running Cost	Increases in running costs reduces car use but by a less proportionate amount. Cost increases encourage more fuel efficient vehicles as well as less use.
	Fare Structure	Long-distance rail use more sensitive to increases in fares than other public transport use. Positive effects on public transport use if a pre-paid / discounted ticketing is in operation.

5.2.2 Long distance trips

Long distance trips are influenced by several determinants. Income is one of the most important determinants, because of the relatively high elasticity with respect to generating trips and multiple correlations with other determinants.

5.2.2.1 Socio-economic and generation factors

It can be noted that women travel less than men, for example in France and Norway, it seems that women make 3 trips per year less than men, which corresponds to roughly 25-50% of the average annual trip making per person. Concerning age, it can be noticed that as the age increases, both the number of long distance trips undertaken and the travel intensity increase until the age category of 35-45 years. Beyond this peak the number of trips and travel intensity decline. The travel intensity for long distance trips will also vary in relation to the socio-professional status of the traveller, for example, the higher the status, the greater number of trips per person.

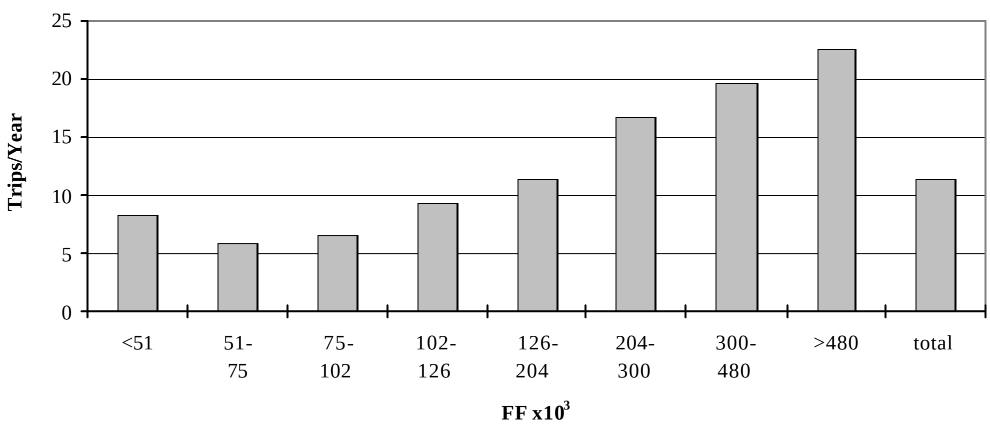
5.2.2.2 Economic Factors

Income is related - with a more or less strong effect - to age, (gender), education, socio-professional status, professional position of employees, life cycle group, household size and structure and life-style.

Income has not only an influence on the number of trips but also on the modal usage. German data indicate that with increasing income on the one hand the share of car usage increases strongly and on the other hand the share of train usage decreases. In the lowest income groups rail transport has a share of about 40 % and road transport a share of about 15 %. Road transport counts for about 65 % and rail transport for only 11 % in the highest income groups. (Hamacher et al., 1988)

The introduction of the TGV in France has shown that people with higher income use the high speed services relatively more often than people with lower income.

Figure 13: Number of Person Trips(>100kms) by Household Income per year in France 1994



Source: INSEE, 1994

5.2.2.3 Spatial factors

The main modes for long distance trips are the private car, train and air. The reasons for choosing one mode over another will depend on both subjective and objective reasons, which will consider factors including the modal accessibility, the price and travel time. Finally, the number of trips per person increases with the size of the conurbation. For example, the trip generation rate of residents of rural areas of France is almost half that of residents of Paris, the capital city.

5.2.2.4 Business Trips

Socio-demographic factors have a rather low influence on business trip making. One main determinant will be the economic situation, which can be expressed in terms of GDP. The economic welfare of a company can be shown by its activities in investments, productivity etc. being accompanied by contacts, negotiations, selling and purchasing and therefore by business trips. This welfare is reflected in the growth of GDP in a country.

The relationship between economy and business trips can be analysed by studying time series for business trips and GDP, which in Germany are available from 1979 till 1987. The data for the year 1991, are untypical because of the unification of Germany in 1990; therefore they are not taken into consideration. The GDP in Germany (in prices of 1991) grew by 9.4%. During the same period the number of business trips increased by 5.8%. The number of employed persons grew as well by 1.8%. Thus one can conclude that there is a strong linear relation between economic growth and the number of business trips generated.

Another important determinant is globalisation. The trading world is moving closer. Big companies all over the world are creating joint ventures; companies are purchasing companies on other continents; firms have trading contracts with firms in foreign countries. In air transportation former national airlines have founded and gained strategic alliances with a number of airlines in order to compete in global networks. With increasing globalisation the number of business trips will grow, especially the number of business flights, and trip distances will therefore increase.

5.2.2.5 Trips for private purposes

Due to the fact that trips for private purposes have a share of over 70% of all long distance trips in Europe, and that short stay personal trips make up for about 90% of all leisure trips it can be concluded that the determinants influencing all long distance trips are similar to those influencing short stay personal trips. So the development of the economic situation of people, which can be expressed in income will mainly influence short stay personal trip making. In addition, one can assume that free time to spend will have a positive influence on trip generation. With increasing time which can be spent in attending leisure activities the number of leisure trips will increase, too.

Socio-demographic and economic determinants have a major impact on holiday travel. Income and age are the strongest determinants in this segment as they have an impact on nearly all holiday descriptors. In particular, younger people travel more than older people, although travel intensity for the over 65s also seems to be increasing more than the average (NBT, Netherlands holiday trips, 1996). Lifestyle influences more the choice of destination than travel volume. The choice of destination is mainly determined by travel motive e.g. the preferred countries for a "sun and beach holiday" are Spain, Turkey or Greece. Lifestyle only plays a minor role in travel volume.

5.2.3 Feedback effects of transport supply on demand

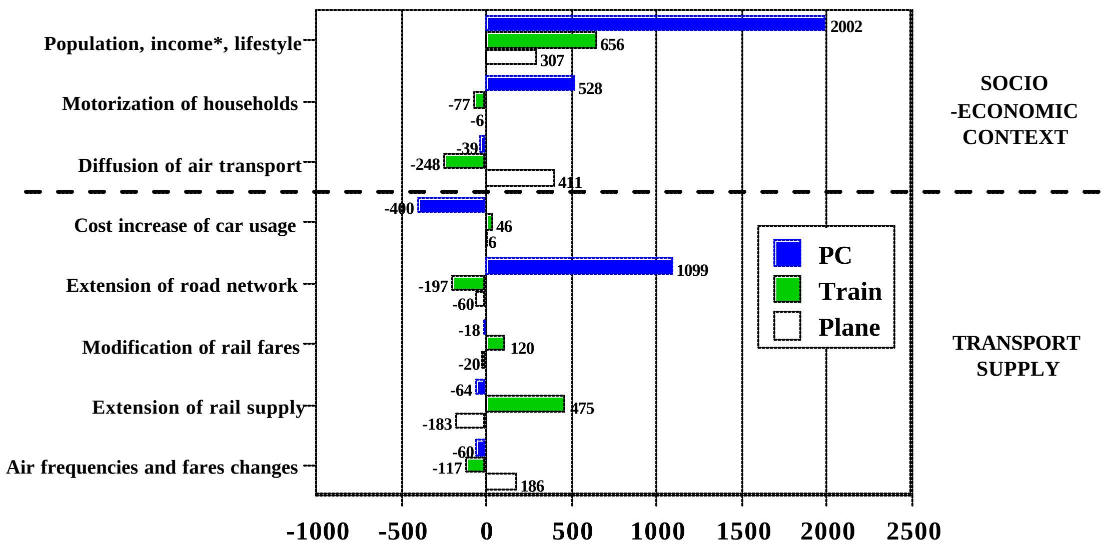
Supply factors also influence the possibility to travel. For example, the modal choice for long distance trips by trip purpose is influenced by the transport system and land use factors as well as by personal and household factors.

Contributions of different supply characteristics

The effects of transport supply improvements for each modal transport network concerning long distance traffic in France is described in a paper by INRETS (Calzada et al, 1997). The annual contribution of the development of different supply characteristics on the additional passenger kilometres travelled from 1975 to 1996 was assessed using the M.A.T.I.S.S.E. model. The different contributions of supply factors to traffic growth were estimated by comparing the results given by M.A.T.I.S.S.E. in two situations :

?? The real situation for a given year;
?? The same situation for the same year, without the change observed during the period for a particular supply factor.

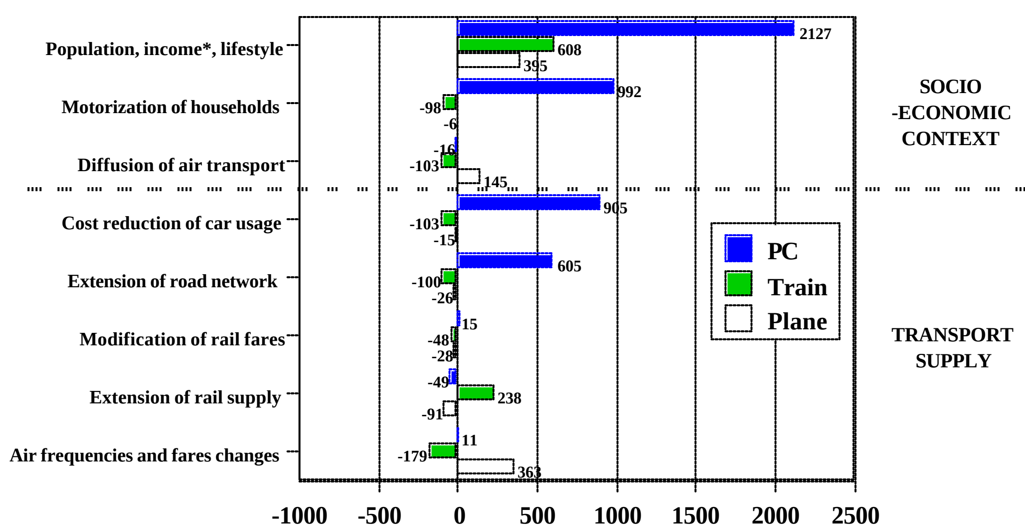
Figure 14: Contribution of socio-economic and supply characteristics to traffic growth (1975-1984) - million passenger kilometres (French long distance domestic traffic)



* without effect on motorization of households

Source : Calzada et al, 1997

Figure 15: Contribution of socio-economic and supply characteristics to traffic growth (1984-1996) – million passenger kilometres (French long distance domestic traffic)



* without effect on motorization of households

Source: Calzada et al, 1997

Figures 14 and 15 give the results for 1975-1984 and 1984-1996 periods. For all means of transport combined or considering only private car (PC), the main supply factor influencing traffic growth is the extension of road network (mainly tolled motorways : + 270 km/year in France during this period).

When considering the train, the main element responsible for rail traffic growth is the improvement of railway network in France during this period, mainly with HST lines.

For air travel, the change in frequencies (+ 5% per year in the number of domestic flights) and fares structure is the main element, but it is almost cancelled out by the negative contribution of the extension of HST lines.

The main difference between the first period and the second one is the change in car usage cost (+ 1.5% increase per year for fuel price during 1975-1984, vs 1.3 % decrease per year during 1984-1996).

Contribution of transport supply characteristics compared to overall socio-economic context

Using the same methodology, M.A.T.I.S.S.E. was applied to estimate the global contributions of socio-economic context (including changes in population, income, lifestyle, motorization of households) and transport supply to traffic evolution for the same periods.

This exercise showed that the changes in transport supply during 1975-1984 were responsible for 22% of the increase in French domestic long distance traffic, and for 25% during 1984-1996.

The overall changes in transport supply and the socio-economic context between 1975 and 1996 led to a significant increase of the share of car passenger kilometres from 66% to 70%. The share of train passenger kilometres decreased heavily, from 1975 to 1996, in spite of the new high speed lines completed during this period (mainly TGV South-East, Atlantic and North).

5.2.4 Changes in societal values

A number of important societal values, were examined to assess their influence on the development of mobility:

?? materialism
?? value of leisure time
?? individualism
?? education
?? "escape into the green"
?? ecological values

It can be concluded that in the long run most of the values are developing in the direction of an increase of demand for mobility. The interdependency of the different values even increases this development. This trend is only likely to be stopped if ecological sensitivity becomes so important that a change of behaviour follows.

The following table gives some indications of how values may have influenced mobility over a time span of about 12 years. If it would be possible to have a look at the same indicators over a longer time-interval then these developments would be even more pronounced.

Table 12: Development of Local Mobility between 1981 and 1993

Changes in	work trips	shopping trips	visiting friends and relatives	leisure trips
number of trips	2 %	13 %	33 %	22 %
average distance of trips	25 % 8.6 to 10.7 km	25 % 5.4 to 6.8 km	3 % 11.3 to 11.6 km	26 % 9.1 to 11.4 km
person- kms	28 %	37 %	41 %	53 %

Data provided by INRETS.

The growing value of leisure time can be seen by the fact that trips for the purpose of visiting friends and relatives and leisure trips have by far the greatest increase

The fact that there is also a growing number of shopping trips can be seen as a result of the value of materialism. That the number of trips for getting to work is still growing although the general time spent at work is decreasing can be a result of the growing importance of education including post-graduate education. It may be also a result of a growing share of the working population within the total population.

The fact that, in general, the average distance per trip has grown so rapidly is in the first place the result of the value "escape into the green" and of the still ongoing urbanisation and urban sprawl. The continuing decentralisation can be seen in the fact that the average growth is more or less the same for trips for work, shopping or leisure.

5.2.5 International Tourism

International tourist arrivals world wide totalled 60 million in 1960, 286 million in 1980 and 592 million in 1996, according to World Tourism Organization (WTO) estimates. Europe, the leading world market for international tourism, accounted for 60 per cent of all arrivals.

Tourism has become an economic force in Europe. Its market has grown substantially, its targets have diversified and its products have been aimed at satisfying the expectations of new publics, or "creating" new demand, through innovation. In some regions of Europe, the standard of amenities and service that tourism requires has made it a powerful factor in the location decisions of business and new industry.

This dramatic increase in tourist flows is based on changes in behaviour patterns: Europeans are travelling more often, for shorter periods. Instead of a month-long vacation in the same place, they are taking shorter breaks in different places throughout the year. The consequences of these changes in tourism patterns have been multiple: a drop in number of nights in accommodation, but also an increase in road, air and rail traffic, and greater concentrations of flows in tourist areas.

In Europe, earnings related to international travel (transport and accommodation) accounted for an estimated 1.9 per cent of GDP, and as much as 4per cent in Spain and Greece, 5 per cent in Portugal and 7 per cent in Austria. They also accounted for 15 to 25 per cent of foreign exchange earnings in Spain, Portugal, Greece and Austria, (OECD, 1994). Lastly, they generate a lot of jobs, an estimated 10 per cent of jobs in Europe, according to the World Travel and Tourism Council (WTTC) and the International Labour Office (ILO). The importance of tourism for the economy and for building a European identity and the problems that it poses for transport networks call for an in-depth understanding of tourism demand patterns and associated mobility.

International tourism, as defined by the WTO[11]: comprises a visit to a country outside the country of residence for less than one year for a main purpose other than the exercise of an activity remunerated from within the place visited, involving a stay of at least one night. It should be noted that tourism is not just confined to vacation trips: it also includes business travel (business, working meetings, fairs, exhibitions, conferences and incentive trips), visits to friends and relatives (VFR) and for leisure and cultural purposes (more typical of tourist travel in the ordinary sense of the term). The latter are further divided into short breaks (1 to 3 nights away from home) and vacations (at least 4 consecutive nights away from home).

According to European Travel Monitor (ETM) estimates, international trips by EU and EFTA residents totalled 206 million (or almost 2 billion nights spent abroad) in 1995, representing a total spending (transport, accommodation) of ECU 150 billion. This spending total may seem low, compared with the number of nights, but the explanation is quite simple: visits to friends and relatives account for a substantial number of international trips, as do camping holidays (tents and caravans), and only the direct costs of motoring are included. A characteristic of tourism is that, in the vast majority of cases, it is "self-reliant", avoiding the commercial accommodation and transport sectors.

Europe has the highest demand for international tourism in the world, currently 60 per cent of world tourism demand (in terms of trips) and some 65 per cent of revenues generated by tourism. There are numerous reasons (historic, socio-economic, cultural and geographical) why its leading position has so far gone unchallenged, a state of affairs that is likely to continue according to WTO forecasts[12].

Tourist flows have not grown to the same extent in all market sectors. Growth is based on radical changes in tourist mobility behaviour patterns; over the last 10 years the most dramatic increase has been in the number of short breaks: short breaks are rising at a faster rate than "long holidays". This change in the market is easily explained by the fact that, in most of Europe, longer paid holidays enable people to take more long-weekend breaks. In the area of business travel too, the growth in fairs, exhibitions and congresses has stimulated short international trips. This trend is obviously being accelerated by the development of high-speed transport (motorways, aircraft and trains) which cut travel time and often prices (as for air transport).

The destinations of European flows are also changing in line with underlying economic developments. International tourism, in particular, is very sensitive to fluctuating exchange rates. After devaluation, Spain and Italy are once again destinations competing strongly with France. In turn, however, their relative market shares will be challenged by Turkey, and more distant destinations such as Asia, in the next few years.

As well as being sensitive to economic developments, which are often gradual, the tourist industry is highly sensitive to socio-political events, both negative and positive. For example, the economic recession in the early 1980s, the Gulf War, and the Paris bombings of 1986 and 1995 caused a sudden slump in international flows. On the contrary events such as the Olympic Games, the universal exhibition in Portugal and the World Cup in France, substantially boosted tourism in Europe (the Jubilee in Rome will no doubt have a similar effect).

Even more than other types of travel, international tourism is also subject to short cycles that can be influenced by fashion. This makes any attempt at predicting or forecasting in this industry somewhat difficult.

[11] Definition accepted by the UN

[12] For 2010, WTO estimates that international flows in Europe will total 1 billion, or 52% of all flows.

5.2.5.1 Socio-economic determinants

One of the fundamental factors in the development of tourism has been that the majority of consumers no longer consider vacation trips a luxury. Leisure and tourism have become signs of success. Many surveys show that, when finances are tight, travel will be sacrificed much less readily than the purchase of consumer goods such as washing machines, televisions or even cars.

Shorter working hours and more time off, or free time, during the week, the year or a lifetime have been fundamental to changes in leisure and tourism patterns. In forty years, total working hours have been cut by 40 per cent.

An added consideration is that while working hours are decreasing, people are living longer. There is a dichotomy in the way the employment relationship is evolving, resulting either in longer holidays overall, reflecting a more relaxed approach to life in the firm, or in the need to take frequent short breaks from work, which -- in a fair number of highly interactive professions, particularly in the services sector -- also reflects the fact that greater competition at work precludes taking longer breaks.

Early retirement, longer life expectancies and more affluent pensioners are boosting the departure rates of people in the 55-75 age bracket, which had been particularly low. Carriers and hoteliers are targeting this age group, which is free to utilise tourist capacity in the off-season, with hundreds of special offers. At the other end of the age scale, single adults and couples with no children -- a steadily larger share of the population -- are also target markets that have already been widely studied and nurtured by carriers.

The train, the main mode of transport for tourists since the 19th century, was overtaken by the car in the 1960s. Since then, the spectacular increase in private car ownership has brought unlimited opportunities for easy breaks. The development of motorway and high-speed rail networks, and the elimination of natural barriers by major feats of engineering that have enabled the operation of services such as Eurostar, have now reduced travel time.

Reservation systems are becoming more flexible and provide increasing choice. Now that they are easier to use, they are used more widely. These systems set people dreaming and make it possible to take last minute holiday decisions on impulse. Initiatives at European Union level tend to standardise legislation in the Member States and eliminate "frontier effects" in the region. In addition, deregulation of air transport along with access to new regional and international destinations, and the availability of more intra-European flights at attractive fares, are bringing in new clients and more frequent travel.

5.2.5.2 The tourist population

Findings on international tourism by Europeans are consistent with those on holidays and mobility in general. On the basis of the average number of stays abroad, they demonstrate that high-income, educated households in the upper socio-economic categories (managerial, professions) residing in large European cities are over-represented.

In addition to the classic economic determinants, other socio-economic variables also influence the international travel behaviour of Europeans. For example, the number of trips abroad taken by Europeans generally increases with age, up to 60 years old.

By and large, those who travel most often abroad are managers, the under 35s, people living in cities, single people and childless couples. Those who travel least often abroad are the retired, the unemployed, the elderly, people on low incomes, people living in rural areas, Europeans with young children and women from southern Europe.

Demography and lifestyles can play a role at many different levels: large numbers of young children (Ireland), short holidays and a still sizeable agricultural population (Ireland, Greece) can act as a brake on travel, while in countries of emigration (Portugal, Ireland) or immigration (France) the need to maintain family contacts can encourage travel. Analysis of the statistics for Europe suggests that while these factors are no doubt very significant for the individuals concerned, they do not explain a great deal at aggregate level which shows little significant variation in these factors across Europe.

The economy must play a major role, through at least three factors: a country's wealth (for example per capita GDP) which is a determinant of both business and leisure travel, the degree of openness of the economy (for example the ratio of imports/exports to GDP) which is probably related to the amount of business travel, and differences in income, standard of living and prices between a given country and its neighbours, which can influence the propensity to spend leisure time in one's home country or in a country where salaries are lower.

Lastly, geography dictates how easy or difficult it is to travel, and the location of the country relative to high attraction areas is significant, as are natural barriers (Ireland and the United Kingdom, despite the Channel Tunnel), a country's size (it is difficult to avoid leaving Luxembourg, for example, which obviously raises a definition problem), its distance from the Mediterranean or, conversely, the fact that it is located in the Mediterranean area.

5.2.6 Demographic modelling of car ownership

A comparative analysis across European and non-European countries has enabled us to show the leading contribution of the car to personal mobility, its growing importance and the probable continuity of this evolution in the future[13]. A thorough analysis 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.

We apply a demographic modelling, namely the Age-Cohort-Period model, for the analysis of car ownership behaviour in four EC countries (France, Germany (West), Italy, The Netherlands and UK) and, for the sake of comparison, in Japan and USA. Using data from series of Family Budget surveys, cohorts are constructed according to the generation of household head; this is also done for two wide regions in Italy and for homogeneous zones with respect to population density in France. Estimates are made for age and generation effects, along with income and price effects reflecting the general economic context faced by households during the period considered.

5.2.6.1 Car ownership patterns

The car fleets continue to grow almost linearly in all the countries studied[14]. Making long term forecasts of these fleets raises the question about the suitable kind of data to use. Scrutiny of the evolution of the number of cars per household in three countries, as shown by the survey data for the defined cohorts, reveals interesting features[15].

Thus, from the US data, the number of cars owned by a household increases until the head is around 50 years old and then it decreases. On the other hand, the comparison of the average numbers of cars

[13] See SCENARIOS (1998) Working paper D5
[14] See CCFA (1994) and IRF (1984, 1991 & 1997)
[15] See Deliverable C2 for an extensive version of this work.

per household of two or three successive cohorts interviewed at a given date shows the differences in motorization at the same age, thus reflecting the generation effect. Hence, the use of aggregate time-series is not relevant, since they do not take into account the heterogeneity across indiv-iduals. Nor is the use of only one cross-section of individual data, since the heterogeneity of behaviours over time is not accounted for (Pendyala et al, 1995). This enforces the necessity of a longitudinal analysis.

A comparison across countries shows different patterns in terms of motorization levels, life cycle profiles and discrepancies between generations, reflecting the diversity of economic and socio-cultural contexts and of the historical developments of car ownership across countries.

5.2.6.2 An Age-Cohort-Period Model

Why a demographic approach to car ownership?

Nowadays, the individual motorization rate (i.e. the average number of cars per adult) continues to rise almost linearly in most industrialised countries[16]. Such a tendency questions the relevance of a priori saturation thresholds. 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 of new cars, the lengthening lifetime of owned cars minimises, and perhaps offsets, the recession impact on car ownership[17]. Not only the threshold estimates rely heavily on the set of observations considered, but they may also differ significantly according to the error structure assumed (Brooks et al, 1978).

The profound structural changes which have accompanied the rapid growth of the 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 us to identify 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 **moment 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 indic ates the impact of the global socio-economic context.

The evaluation of the effect of the stage in life cycle gives us a characteristic curve indicating the evolution of the motorization 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 permits us to place this profile in a historical perspective. In the case of the acquisition of durable goods, this approach is quite 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 us to measure short term or medium term factors of disequilibrium which simultaneously affect all the individuals or households.

[16] See SCENARIOS (1998) Working paper D5
[17] In France, the mean duration of car keeping decreased from 3.82 years in 1985 to 3.72 in 1990 and then grew to 4.08 years in 1994. *See L'Industrie Automobile en France 1994*, CCFA, p.64.

5.2.6.3 A comparative analysis

In what follows, we analyse the results obtained for one motorization rate[18]: the number of cars per household[19].

On the example of the generation 1936-40, the number of cars per household is higher in the US than in the other countries. The lowest motorization levels are observed in Japan for young households and in The Netherlands for old ones. France and the UK show quite the same pattern. In all cases, the average number of cars increases at the beginning of the life cycle until it reaches its maximum and declines thereafter. The maximum is reached when the head of household is around 50 years old in France and in the UK, about 55, about 55 in Italy and The Netherlands, and about 60 in Japan. In USA, this occurs earlier (at the age of 45 to 49). This maximum is around 1.7 cars per household, 1.3 in UK and in Japan, 1.2 in France, and 1.1 in The Netherlands. At old age (for instance, 70-74 years), the average number of cars per household is about the same in France, Japan and the UK (0.8).

As noted in the examples of Paris and Montreal (Bussière et al, 1994), there seems to be a generation with maximum motorization rates in almost all the countries under review: at the same age, those born after 1950 have significantly fewer cars in the UK and in France, while in Italy (respectively in Japan), there is almost no difference between generations born after 1950 (respectively 1955). Compared to this most motorized generation, the cohort born during the second half of the 60's has 0.15 less cars in France and 0.1 in the UK. As one could expect, the most motorized generation in USA was born earlier (in the 1930's). The gap between the most motorized generation and the generations born at the beginning of the century is more significant than the gap between new cohorts (notably less in the US where car ownership developed 20 years earlier than in Western Europe).

Concerning period effects, the total expenditure elasticity is significantly lower for USA (0.15) and Japan (0.26) than for France and Italy (0.42) or UK (0.58). Price elasticities are higher (in absolute value) in Italy than in France and in the UK.

5.2.6.4 Regional disparities

Additional analyses have been carried out on Italian data to account for economic disparities between regions. Thus, the model has been calibrated separately for two contrasted wide regions: northern and central Italy, and southern Italy and the islands (Sicily and Sardinia).

As simulated for the generation 1936-40, the number of cars per household shows the same pattern along the life cycle in the two regions: it grows at the beginning of the life cycle until it reaches its maximum and then decreases. However, at all ages, it is greater in the North and Centre of the country than in the South and the Islands. The difference ranges from 0.2 to 0.3 cars per household, except for old households (75 and over) for which it amounts to 0.1. The differences between successive generations evolve along the same lines in the two regions.

Concerning economic factors, the main difference between the two regions relates to the responsiveness of car ownership to income. The elasticity to total expenditure is lower in the North and Centre region (0.3) than in the South and the Islands (0.5).

[18] A more extensive presentation of the complete results is provided in Deliverable C2, except the results for Italy which are new.

[19] Germany is not represented because we have data on only the percentage of motorized households. It is worth noting that, for this indicator, the simulated life cycle profiles of car ownership and the differences between successive generations are similar in France, Germany and the United Kingdom.

5.2.6.5 *The effect of population density on car ownership*

Other factors than those already mentioned can be analysed by adjusting different models for different categories. High population density is likely to lower car ownership. Indeed, alternative transport modes are more widely available in high population density areas compared to less dense ones. Besides, congestion problems may lead to a restrained use of cars, either by users themselves or by specific political measures. Such an influence could be observed in the cases of Japan and of The Netherlands for which population density levels are the highest among the countries considered.

More specifically, we performed the Age-Cohort-Period model for three homogeneous zones in France, with respect to population density. We considered concentric zones: city-centres, inner suburbs, and outer suburbs and rural areas. The curves representing the average number of cars per adult have the same shape for each zone: it increases rapidly till 35-39, then stays almost constant at a slightly lower level till 70 years old and decreases. Up to the age of 65 to 69, car ownership is higher in outer suburbs and rural areas than in inner suburbs and city-centres. In all zones, there is almost no significant difference between generations born after 1945. For all generations, the number of cars per adult is higher in outer suburbs or rural areas than in inner suburbs and city-centres.

The main contrast between zones is for period effects. Income elasticity is significantly lower in city-centres and inner suburbs than in outer suburbs or rural areas. As for purchase prices, the elasticity is lower in absolute value in outer suburbs and rural areas than in the two other zones. These results reflect the differences, pointed out above, between high population density areas and less dense ones regarding the availability of alternative modes and congestion problems, and their consequences on car ownership and use.

5.2.6.6 *Long term forecasting using the demographic approach*

The demographic approach provides a powerful tool for making long term forecasts of the car fleet, in that it avoids fixing saturation thresholds, it conciliates the effects of economic and demographic factors, and it relies on stable population projections.

The long term projection model thus comprises two parts:

?? first, a projection of the age structure of the population of driving age, which allows us to take into account purely demographic phenomena, in relation, for example, to ageing 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, as described above.

From population projections[20], a general feature in all the countries considered is the decrease of the proportion of the young population (under 40) and the increase of that of the old population (60 and over). Such a tendency would be of great importance as to the future evolution of the car fleet.

5.2.6.7 *Conclusions*

The differences between countries and zones can be explained by two main factors :

?? **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 or Japan. Indeed, there are smaller differences between generations in USA, and new cohorts

[20] Figures for European countries are from EUROSTAT population projections (1995-2050 ; base scenario). For Japan and USA, projections (until 2050) are from the International Data Base of the US Bureau of the Census.

seem less motorized than those born in the 1930's. Moreover, elasticities with respect to total expenditure are lower than in Europe and Japan[21];

?? **population density**: saturation thresholds are likely to be lower in more densely populated areas (city-centres or metropolitan areas) or countries. During the life cycle, maximum levels of motorization seem to be observed later in more densely populated countries (e.g., Japan, The Netherlands).

The analysis also showed the differences in household car ownership behaviour between regions with different economic development levels in the same country.

The demographic modelling allows long term forecasts of the passenger car fleet to be made, which constitute inputs for the reference scenario of mobility and traffic.

[21] However, the phenomenon of saturation in the US could be overestimated, because of the substitution of light trucks and vans for private cars (which are the only type of vehicles covered in this study).

6 FREIGHT DEMAND FACTORS

6.1 Introduction

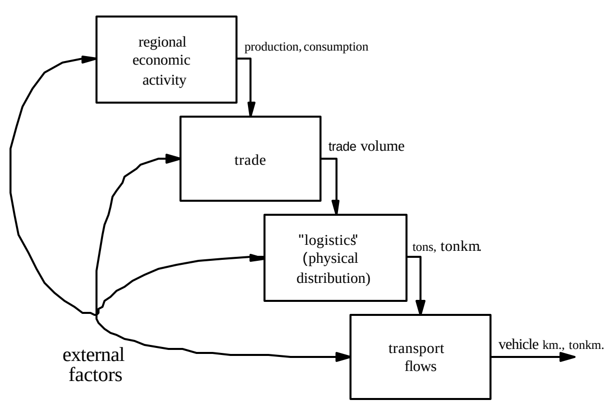
The objective of this chapter is to make the link between external determinants and descriptors, using internal determinants as 'intermediate' variables. We describe these external determinants for transport demand by identifying so-called megatrends, a limited number of key developments which we think are most relevant for long term changes in freight flows.

In the study the market approach is used to describe the impacts of these megatrends upon transport system. We distinguish the following markets:

?? production (or: regional activities),
?? sales and sourcing (or: trade between regions),
?? logistics services (defined here as: physical distribution) and
?? transportation services (including transshipment).

Note that, depending on which markets are distinguished, the facilities and services to describe as well as the descriptor used will differ. Likewise, the attributes of activities (related to their nature and organization) determining transport demand will depend upon the markets considered.

Figure 16: Transport System Markets



This chapter is presents first of all, the descriptors of freight transport and the trends in transport demand, and then considers the external trends and their impacts on transport demand. The final section looks at the effects of the external developments for freight, in terms of the four transport markets identified above.

6.2 Descriptors of Freight Transport and their Trends

Depending on the market of the transport system that is being studied, different descriptors or indicators of demand are required. Note for example that, although the weight of the consignments lifted is one of the most widely used measures, it is not unusual to find transport users defining their requirements in terms of volume, physical units or units of transportation. Due to changes in the structure of production and in the value of goods it is now necessary to describe also the "volumes of business". Finally, the problem of the constant decreasing of the density (greater volume to weight ratio) and the organisation of transport modifies the quantity of vehicles used for transport that determine the flows on the networks and therefore the congestion ("vehicle-km").

From the study we conclude that freight transport demand, if it is to be described systematically and exhaustively, should be characterised by a number of variables. The main descriptors, as touched upon in our analysis are:

- ?? tons
- ?? ton-kilometres
- ?? distance travelled
- ?? type of product
- ?? invoice (volume of business)
- ?? vehicle-km
- ?? speed of transport

Below the main results of an analysis of the available data regarding descriptors of transport demand, on the four levels of activity, are summarised.

6.2.1 Regional Economic Activity

The present phenomena like the production of goods with elevated added value, declining weight and increased importance of packaging, are modifying the relationship between produced tons and gross national product. For example, in the last decades, higher value manufactured products have increased their share in the total trade at the expense of traditional industrial products. As a result, not all trends in trade value imply the same trend in the volume transported.

From the analysis carried out within this project it is also possible to say that, in spite of the lack of data at this stage, a relatively clear relationship has been found between, on the one hand, transport generated and attracted and, on the other, industrial gross value added (regional level) and GDP (country level).

Germany and the Netherlands have the highest volumes of incoming and outgoing shipments, followed by France and Belgium. The factors determining such a structure are mainly the economic weight of Germany and France, as well as the role of the Netherlands and Belgium, which channel vast quantities of freight.

6.2.2 Trade

The proportion of intra-EUR 15 to total international trade has been relatively stable in the last decade. But in absolute terms, the increase is a general feature. The increase for Spain and Portugal is astonishing - the impact of the accession to the EU being the main cause.

Within the Central area of the EU most of the flows are concentrated, while flows in the periphery are much less dense. As a consequence of concentration, in the centre of the EU the concept of corridor is relatively blurred, while in the periphery corridors are better defined.

Nevertheless, changes of any kind in the structure of the transport supply (from infrastructures to legal barriers) may introduce important variations in flows. The recovery of the Eastern European countries might greatly affect the general structure of trade related to Germany and, to a lesser extent, to Austria, albeit the insurmountable difficulties of forecasting.

6.2.3 Physical distribution

The Internal Market has meant a change of concepts in the field of trade, and certainly in logistics. Major companies are planning their distribution operations on a continental basis rather than on a national one. In fact, for many sectors and companies, the driving force behind most of the changes in transportation and logistics is the internationalisation of the markets.

Anecdotal evidence as well as a few studies show that cross border traffics have been increasing at a rate of some four times that of domestic ones. The trend seems well established and some forecasts give hints that cross-border traffic is increasing its average length of trip more sharply than the average.

The developments in logistics in Europe and world-wide have a great impact on the organisation of transport and therefore also on traffic. Among these are a concentration of products and warehousing, increased reliability and flexibility in services, a decrease of stocks, supply chain integration, a decrease of order cycle time and an increase of assortments.

6.2.4 Traffic flows

In addition to the general trend of an increase in transport flows, all developments in modern logistics tend to favour road transport. The growth in international trade and sourcing, as well as the relevance of new business strategies, may make policies aiming to reduce road transport difficult to implement.

As a result of border effects, in the short term a diffusion of flows is expected over the network, followed by a concentration of flows as a result of a polarisation in trade (regional competitive advantages) and distribution structures (centralised warehousing). The first signs of such changes in flows are already visible on domestic as well as cross-border relations.

The very different nature of products and markets, even within a single large firm, makes it necessary to keep a range of transport suppliers, each adapted to a certain need. It still remains to be seen whether the concentration of production and warehousing will open up new opportunities for the rail transport and inland shipping sectors.

6.3 Determinants of Freight Transport

The objective of the study on the identification of determinants of freight transport demand is to explain further how and why observed changes in transport demand take place through time. The point of departure will be drivers for change in freight transport demand in the areas of organisation and management (public and private), technological innovation and logistics (including the entire supply chain).

The research has identified four key external trends, called “megatrends”, that are outside the transport sphere but exert influence on all the constituent markets of the transport system. In no particular order, these are:

?? globalisation
?? networking
?? communications
?? greening of business

In the following sections an explanation will be given of the main drivers behind changes in transport demand, starting from these megatrends.

6.3.1 Globalisation

Globalisation is a general term for the increasing interdependence between economies, but in particular for the rapidly growing specialisation and the resulting intra-firm trade of, principally, intermediate products. Globalisation is accelerated not only by foreign direct investment in search of factors of production, but also by joint ventures, outsourcing and other forms of cross-frontier networking. The term has also come to encompass phenomena such as financial globalisation, the increasing importance of the emerging economies and the widening areas for international competition into fields formally reserved for national monopolies or otherwise protected (telecommunications, transport, banking, etc.).

6.3.1.1 World Trade Growth

International trade has been growing at a startling pace and the ratio exports/GDP is still increasing. Analogously, the volume of international traffic substantially increases. In recent years, a process of definition of new political frontiers has motivated the appearance of newly industrialised countries. The creation of new political frontiers is an important obstacle for the interchange, but this process has had less influence on the growing amount of exchange, than the increased balance of size of the different economies in the world. In spite of the usual assertion, the increased competition from low-wage developing countries has not destroyed jobs and pushed down wages in today's rich economies.

6.3.1.2 Trade Liberalisation

Trade liberalisation within the framework of the GATT (General Agreement on Tariffs and Trade) has cut the average tariff on manufactured goods from 40% in 1947 to less than 10% by the mid-1970s. Since then the average tariff has fallen even further, to roughly 5%. Between 1950 and 1975 the volume of trade expanded by as much as 500%, against an increase in global output of 200%.

6.3.1.3 Geographical Concentration

One of the principal characteristics of international trade is its concentration in geographical areas. The consolidation of the EU market is the biggest success in this respect, which needs no explanation. NAFTA (North American Free Trade Agreement) signed in august 1992 between Mexico, Canada and USA, is the biggest free trade area in the world in terms of population.

An overview of the trade behaviour of the world leading exporters reveals that economic blocks show important internal links (Intra-EU, Intra-NAFTA, etc.). National economies are undoubtedly becoming steadily more integrated as cross-border flows of trade, investment and financial capital increase. Forty years of development policy in the industrial countries have succeeded in transforming a growing number of "third world" countries into newly industrialised countries, which are now able to participate in the world economy.

6.3.1.4 Developing Countries

Real GDP in Eastern and Central Europe and in the former Soviet Union rose by 1,4 % in 1997, but despite Asia's problems world output grew by 3%, the best rate in eight years.
It is expected that by 2020, developing countries will have doubled their share of global GDP, according to the World Bank in its annual report, to account for nearly a third of global output. The big five developing countries, China, India, Brazil, Indonesia and Russia, will grab an export market, rising from 9% in 1992 to 22% in 2020. In East Asia the Bank forecast real GDP growth slowing to 7,6 % in 1987-1997. Thailand, meanwhile, issued its own forecast of 4,9 % annual growth over the next five years. If these forecasts were to become reality, the impacts for Europe's external orientation would be considerable.

Globalisation is accelerated not only by foreign direct investment in search of factors of production, but also by joint ventures, outsourcing and other forms of cross-frontier networking. The importance of globalisation for this networking phenomenon, visible in e.g. the rapidly growing specialisation and the resulting intra-firm trade of principally, intermediate products, is treated in the following section.

6.3.1.5 Consequences for transport demand

Global networks have increased their importance at a startling pace in the last years, due to several reasons –among them the very transportation possibilities and its accelerated improvements. But, in turn, this trend will greatly influence European transportation, both in terms of intra-EU transport as well as international transport with origin or destination in the EU.

Liberalisation of trade seems to be a well-established and irreversible trend, with a clear prospect of continuous improvements. In fact, in recent years it is impossible to mention a single relevant reversal of the liberalisation trend. It may be noted, however, that the removal of actual trade barriers may be replaced by new barriers using different motives, e.g. environmental ones.

Those activities that are 1) relatively sensitive to small improvements in local circumstances and 2) have a low inertia in terms of moving production facilities (“foot-loose” companies) will look for a better plant location and move. As trade tariffs are being lowered for consumer products, firms have the opportunity to move production locations and warehousing locations. Depending on the type of activity this movement will be directed downstream (assembly near customer) or upstream (consolidation of distribution channels).

The EU will be affected in two different ways – in terms of its internal market and in terms of its relationship with other countries and/or blocks. The first one will be more related to the intra-EU trade. It is expected that the EU economic integration will be further increased by the Monetary Union, and that this integration will have an important impact on intra-EU transport. All changes aiming at freeing internal trade will have some kind of impact. And, although it can be taken for granted that most of the general changes will be due to the Monetary Union, in specific sectors there is still some additional room for the improvement.

At the firm level we expect a functional specialisation (emergence of “focused factories”) of firms. At the macro level, international transport may grow considerably as a result of the expected specialisation of the world economies. A sector which may experience changes at both scales is Agriculture, with a relatively high degree of intervention (recently, it was reported that EU countries trade four times more foodstuff than other countries with identical production and consumption levels). Most other sectors have been open to some degree of market testing for some time and, therefore, their impact will be much more mitigated.

When it comes to trade with other countries and/or blocks, it is also a rule of thumb that the more protected a sector until recently, the greater the impact it will experience as a result of the liberalisation. Some sectors such as textiles, agriculture, steel or the automotive industry will experience big impacts.

Transportation will be directly affected by changes in the pattern of demand, with reallocation of the origins and destinations. Present domestic traffic will be diverted towards intra-EU flows, and what is now intra-EU traffic will become inter-blocks. The net impact seems to be a clear upward trend in the volume of transport and, above all, in an increase in the average distance of transport. The observed past trend of steady increase of the amount of ton-km, will be reinforced in the future.

6.3.2 Networking

Through an ongoing rationalisation of production, logistics and transport processes, entire chains of products are being optimised in terms of their efficiency. This general trend is leading to a reorganisation of industrial, trade and distribution networks.

6.3.2.1 Inter vs. Intra Industry trade

At the beginning of the 1980s, most trade within the European Community could be classified inter-industry corresponding to specialisation based on comparative advantages (around 45% of total manufacturing trade), but this started to decline in the mid-1980s. The preparation phase of the single market was accompanied by a decrease in the share of inter-industrial trade in Europe and a rise in intra-industrial trade.

The rise in intra-industry trade has predominantly been in products differentiated by prices and quality (from less than 35% of total manufacturing trade in 1985 to more than 42% in 1994), whilst intra-industry trade in similar products remained rather stable (around 20% of total intra-EU manufacturing trade).

6.3.2.2 Global Partnerships

Today firms are increasingly reliant on informal partnerships. Instead of playing off numerous suppliers against each other, they are reducing the number of suppliers they use and forming closer relationships with the ones who survive (in a space of three years, Ford reduced the number of its suppliers by 45%, 3M by 64% and Motorola by 70%).

Partnerships are also spreading to the retailing and services sectors. This is leading to a vast process of non-localisation of the production. An increasing number of partners are participating in different stages of the added value chains and those stages are completed in those countries that represent better conditions. As a result, international trade is shifting and increasing; also the value added incorporated at different stages is a decreasing part of the total value added.

The production process is changing into networking chains in which the companies settle in the countries that give them better economics conditions. The best example of such a process is Nike, an American sports-shoe and clothing firm, which has created a vast but closely knit network of subcontractors in China, South Korea, Taiwan, and Thailand. Each develops its own products.

6.3.2.3 The Distribution Revolution

Shippers are confronted with steadily rising demand from more international markets, and with increasing competition. Under these circumstances, the shippers have reduced decision-making power, and it is the customers who increasingly determine production. This is called the change from a 'sellers market' to a 'buyers market'. In response to increasing competition, customers will demand products that fit more closely with their own needs and habits.

With consumer goods the product variety in particular will increase. It is also likely that goods will be sold to a wider market. At the same time total stocks will have to decrease. More product variety will result in more overall production and this will result in more freight transport. Because of the customer's demand for increased product variety, the time period over which a product will be competitive with other products will decrease.

In many countries retailing was-and remains-the largest single industry, employing between 7% and 12% of the work force in rich parts of the world. At the heart of this retailing revolution lie two things. One is the rise in disposable incomes since the Second World War, first in the industrialised countries and more recently in parts of Asia and Latin America. The second is more recent, and arises from changes in the way goods and services reach the consumer. The distribution chain used to be controlled by manufacturers and wholesalers. But both individual shops and retail companies have become much bigger and more efficient.

6.3.2.4 Consequences for transport demand

The EU will be one of the areas in the world with the highest impact of the externalization trend. Nowadays, the nation-oriented company is the norm. Only a fistful of EU companies are truly multinationals or have real global orientation – Royal Dutch/Shell, Philips, ABB, etc. The fall of some of the last barriers to conform a vast “domestic” market will pave the way to the consolidation of important European multinationals and/or networks. And that will mean a deep rationalisation of present transport EU networks -- the consideration of the whole Continent as a single logistic unit.

This will not only imply changes in physical infrastructure, but also innovations in the management of Europe-level logistic systems, by means of e.g. virtual warehouse systems (where stock levels are kept decentrally with rapidly varying and possibly overlapping catchment areas depending upon actual demand levels).

One important tendency under the chapter of externalization is the change of power from sellers to buyers. Under these circumstances, the shippers have reduced decision-making power, and it is the customers who increasingly determine production. Manufacturing industry has to pay much more attention to product quality, variety and novelty, and to tailoring its products to the demands of the customers.

These increasing demands (from a social point of view) regarding product variety and high value products, diminishing lifetime cycles together with higher requirements regarding flexibility and quality have direct consequences for production methods. Most producers strive towards a production process in which it is possible to change very rapidly from one (small) series of products to another. The introduction of Flexible Manufacturing Systems enables producers to meet this requirement for flexible production. These systems make it economically possible to produce small batches of different products through which demand and supply of products can be tuned better.

6.3.3 Communications Technology

6.3.3.1 Efficiency Impacts

The collapse in the cost of communications will probably be the single most important economic force shaping society in the first half of the next century. It will alter decisions about where people live and work, concepts of national borders, patterns of international trade. Relentless technological changes are driving down many of the elements in the cost of a telephone call.

Carrying a call from London to New York costs virtually the same as carrying it from one house to the next. As new technologies reduce the cost of entry, competition is spreading, and governments have begun to accept that competition offers the best way to ensure that changing technology is fully translated into lower tariffs.

Similarly, new technologies and strong competition has led to an astonishing reduction of the cost of computing. No other product or market can show prices divided by 10 000 within 25 years. The powerful combination of communications and computing has led to Internet, which has already connected 50m-60m of the world’s population through a seamless digital network.

Information and communication technologies (ICT) are producing dramatic changes in the EU economy, by moving it from a situation in which manufacturing activities have dominated to a situation where most growth and value added is fostered by the development of services. It is particularly true in activities concerned with the creation, processing and transmission of information.

6.3.3.2 Organisational Impacts

ICT is also introducing changes to the organisation of enterprises, the way of working, and upward and downward relationships between sectors. The rapid diffusion of ICT is explained by substantial productivity increases that occur to user industries as well as by the declining cost of such technologies and their continuous improvement. Over the period 1988-96 the market of Western European information technologies grew at the average annual rate of 6,5%.

In manufacturing, ICT no longer means simply the "automation" of production. Most sectors are at the present much more influenced by innovations which do not relate directly to new production technologies but to the organisation of the design, production, marketing and administration functions via the use of information network systems.

For example, in sectors subject to rapidly changing demand patterns (e.g. clothing, footwear, automobiles), the adoption of computer integrated flexible manufacturing systems and computer based quick response strategies have allowed a shortening of the production and innovation cycle, and the life cycle of products; possible rapid design changes in accordance with changing consumer preferences, and a reduced delivery time.

6.3.3.3 Consequences for transport demand

Freight costs take a considerable share of the overall costs of trade. This has motivated an ever more efficient relationship between the economy and the transport system in two ways. First, the world economy has become far less transport-intensive than it once was. Second, the transportation industry has changed in remarkable ways, making it far cheaper to ship goods around the world.

Expectations for the future cannot be but a deepening of the tendency. It does not matter how each sector develops its solution in terms of company structure (conglomerate, networking, etc.). Managers will have to rely more on transport than before. In some cases the web of relationships will be relatively reduced, but in many of them will reach a truly global scale. Cost-efficient, reliable communications are one necessary condition for that – no company can allow their vital inflows or outflows to be carelessly unmonitored. In markets with fierce competition, the more spread the network of customers and providers, the more necessary to have real time information of the shipments.

This trend will mean also the organisation of all long distance transport according to strategic lines defined in the headquarters. The power of the customers of the transport companies is going to increase sharply. Bargaining power of transport companies will be reduced and centred on cost cutting. Unless a transport operator can prove some specific differentiation, the competition will be based on prices – what will end up in a reduction of margins even in the most sophisticated sub-sectors.

Technological changes have occurred at dramatic speed in recent years. Although every sector can claim some kind of technological revolution ("Green revolution" in agriculture, Genetics and Biotechnology in Medicine, etc.), the one with the highest impact in the transport sector is that of the Information and Communication Technologies (ICT). Companies are investing heavily in ICT in order to reduce costs. And that cost reduction is due in many cases to an optimum planning of transport and inventory management.

Cheap and efficient communications networks allow firms to locate different parts of their production process in different countries while remaining in close contact. Two consequences can be detected as a result. The first one is that the new freight transport service has to include ICT within its packages of products. The second one is that, in order to be able to follow this technological pace, transport companies also have to invest heavily -- what leads to market concentration in order to reap economies of scale.

In the next future, no alternative can be seen. ICT will follow their innovative trend (witness Internet) and transportation will have to be integrated within sophisticated packages, where ICT will play a competitive advantage. ICT will influence producing firms, logistic service providers and carriers directly by

- ?? improving their ability to communicate internally and externally and thus raising the efficiency of operations
- ?? facilitating more structural efficiency improvements by e.g. a further standardization of operational working procedures.

Although ICT in itself it does not affect either transport volume or average distance, the indirect impacts will be substantial. This technological evolution will mean a facilitation of a number of strategic trends (internationalisation, networking etc.) which, depending on the sector observed

- ?? due to improved efficiency , will diminish the volumes transported ("e-limination"),
- ?? increase demand for flexible, high frequency transport of consumer products ("e-combustion"),
- ?? increase transport distances due to the cost-lowering effect of ICT in general
- ?? decrease transport distances for those products to which consumers will demand direct access.

Transport operators have to connect themselves to their customers' ICT systems in order to guarantee an adequate information exchange. Not only has ICT diminished its unit cost by a huge amount, but also it has changed the nature of its products. This has had important consequences, such as the change of philosophy in terms of inventory management. Just in time techniques, reputed as the last industrial revolution, are heavily dependent on smooth flows of information in real time, what requires high quality communications and important computing power. Also, the spectacular growth of trade is a consequence of important technological progress in telecommunications, transports and computer science, thus making it fall rapidly the natural barriers of time and space that separate national markets.

6.3.4 Greening of Business

6.3.4.1 World Energy Demand

The shape and size of world energy demand is increasingly being determined not by rich countries but by the fast growing developing countries of Latin America and Asia. By 2010 the share of total energy consumption accounted for by the rich countries will have fallen below 50% for the first time of the industrial era. Eastern Europe and the former Soviet Union will consume a sixth.

The share of developing countries will have climbed from 27% now to 40%, and be rushing upwards faster than ever. The growth in energy consumption in developing countries between 2000 and 2010 will be greater than today's consumption in Western Europe. By 2010 their emissions of carbon dioxide, the main contributor to global warming, will be almost as big as those of the whole world in 1970. Developing countries will produce more than half of world emissions of CO2 by 2010. In the IEA´s scenarios, India and China will produce a bigger increase in emissions from 1990 to 2010 than the entire OECD. Between them they will emit as much as a quarter of the world's total by 2010.

The World Energy Council (WEC) has suggested that by 2020, in a high-growth case, annual world energy demand could double by today's level. More than 90m barrels per day (b/d) of oil will be consumed. Coal output will almost double, approaching 7 billion tonnes, more than twice Britain's known reserves. Gas demand will more than double, reaching 4 trillion cubic meters, almost as much as America's current gas reserve. More electrical generating capability will be built over next 25 years than was built in the previous century.

Economic growth is one of the best routes to increased efficiency use of different kinds of energy. Growth allows the world to break out from using wood, dung and crop residues, which currently supply fully half the world's people with the energy, among 12% of the world total consumption. In addition, it may support efforts directed at increasing the efficiency of energy consumption, and policies directed at mitigating the environmental impacts.

6.3.4.2 Trade liberalisation revisited

The removal of trade obstacles and distortions increases the overall efficiency of the world economic system by allowing countries to specialise in sectors in which they enjoy competitive advantages, including advantages based on environmental conditions. This contributes to alleviating pressures on the environment. However, the environmental impact of trade, depends on a variety of factors:

?? *Transport related effects*: Trade is related to transport, which can put a strain on the environment due to the (negative) effect of using a particular means of transports (e.g. atmospheric emissions from road haulage). On the other hand, liberalisation in the trade sector can result in efficiency gains.

?? *Product and technological effects*: Elimination of export and import controls, improved intellectual property rights systems and other trade liberalising steps could have a positive environmental effect by facilitating the international distribution of environmentally sound technologies, services and goods. However, trade liberalisation could facilitate cross border movements of toxic wastes, hazardous chemicals and endangered species and require enhanced co-operation to mitigate environmental accidents or potential ecosystem degradation.

?? *Structural effects*: Free trade can trigger environmental benefits by its positive structural effect of removing trade-distorting policies. Trade liberalisation should reduce or eliminate many policy interventions that now exacerbate environmental problems through their distortive effects on the location and intensity of production and consumption. Negative structural effects for free trade can occur if trade expands in the presence of market and intervention failures which may, in some cases, worsen the distribution and intensity of economic activities from an environmental point of view.

?? *Scale effects*: By stimulating growth, trade and related efficiency gains can free resources for companies to invest in cleaner technologies and for governments environmental infrastructures, for example sewage treatment. However, growth is associated with greater use of resources and stronger production and consumption emissions. These negative effects might however overcompensate for the positive environmental impact of cleaner technologies, and thus create a net negative impact on environmental quality.

The net effect of trade on environmental quality depends on the relative importance of the various types of effects and on the degree to which market failures and intervention failures occur in the concerned sectors of the trading nations.

6.3.4.3 Public Task or Private Matter?

Developed countries and some developing ones will invest a rising share of their national wealth in protecting themselves from pollution. To that extent, industry can become greener only by growing more slowly. Money invested in reducing air emissions is money not available to spend on building a new plant. Management time put into greenery is time not used to develop new products.

Given the right incentives, industry can also take the initiative for diminishing the quantity of resources used to fulfil human needs. Industry's task is now to find ways to reduce these many forms of pollution. That will not only mean devising new industrial processes that squeeze more output from each unit of input, considering full life cycle costs and imponderable effects.

Society will demand cleaner industrial processes, and then it will want cleaner products. This pressure will change the way companies manage themselves and their relations with suppliers and their customers. Above all though, relations between government and industry will be altered. Government may take a role in setting emission standards, taxing raw materials, and assigning liability for polluting accidents. That will encourage industry and government to see a common interest in a cleaner environment.

Simulation results indicate that a phased in (ad valorem) energy tax rate of up to 25.6 % by 2015 would be necessary to achieve the objective of a 1 % energy consumption reduction per year in Europe. The introduction of this tax would imply only minor macroeconomic effects. Such as is a small loss of real national income of 0.2% against a business as usual (BAU) reference scenario after 25 years.

6.3.4.4 Consequences for transport demand

In the 70's, all fears in the transport sector were easily translated into a single one – energy scarcity. Nowadays, energy sources are not so depleted as foreseen not long ago, and most of the consumption is not due to the developed countries' transport, but to developing countries. Besides, oil prices have been declining in real terms for several years in a row.

The future restriction for the freight transport seems to be centred on the environment. It will be both a limitation of the transport in itself, and a potential reduction of the demand (or, at least, a reduction in its rate of growth).

This impact will not be homogeneous on all transport modes. Road haulage will be strongly affected by limitations in emissions and increases in transport costs. Even customers may have to change their actual preferences in terms of flexibility in exchange for a more environment-friendly transport system.

As far as a reduction of the transport demand is concerned, only heavy restrictions in fuel consumption (by means of taxes, for instance) could have some impact on the actual total demand. Although no study has assessed this effect in detail, it seems that the real reduction in transport volumes would be small. Nevertheless it would not be evenly spread across the economy, with increases and decreases depending on the sector involved.

6.4 Implications of changes in external trends

Most external trends point to an increase of freight transport, especially intercontinental (high-value) and international (intra-EU: diversification). Besides overall economic growth, this is the result of changes in the way that production, trade, distribution and transport systems are organised.

6.4.1 Analysis of Impacts by Transport System Market

6.4.1.1 Regional Activities

The changes influenced by the megatrends described earlier that concern regional activites, can be summarised as follows:

?? *Geographic concentration of production:* This concerns the transfer of production and assembly to low-cost countries, resulting in an increase in distances for intermediate and final products. However due to the decline of labour costs in relation to total costs, this development will be of less importance in the near future. On the other hand, economies of scale will lead to more specialised production units, and the growth of intra-company transport resulting in an increasing demand for transport.

?? *Flexible production / internal control systems:* New flexible manufacturing methods have an impact on purchase and distribution patterns resulting in shifts towards more flexible transport and more frequent and smaller shipments. It is difficult to consolidate these freight flows due to the wide geographical scatter of the buyers and the relatively small size of production batches. Moreover, internal control systems and integration, especially the use of Computer Integrated Manufacturing, enables manufacturers to meet the need to produce to order. The delivery of finished products from shipper to wholesaler or final consumer will therefore need to be faster and more flexible and adapted to smaller units (thus favouring road transport).

6.4.1.2 Trade

The changes influenced by the megatrends described above concerning trade, are summarised below:

?? *Economic concentration*: The concentration of shippers, through partnerships, takeovers or mergers, enables companies to make better use of integrated logistics. In particular, takeovers and mergers have significant consequences for the demand for transport since they result in the reorganisation of the purchasing, production and distribution of products.

?? *Electronic commerce:* Electronic messages help to simplify, accelerate and to some extent eliminate the 'paper stream' which accompanies the physical flow of goods. This leads to, amongst other things, less stock, more information about possible purchase places and more frequent shipments.

?? *First Processing Near Source location:* The trend towards first processing being done in the country of origin is not a general one, and strongly depends on the type of product. The factors behind this are the relatively low import costs of bulk raw material (the greater size of crude oil tankers), and the fact that production often takes place closer to the markets, in cases where manufacturing of a product leads to greater product volumes (e.g. assembly of intermediate and finished products). Finally, costly factories like steel mills are located near to their markets; building new ones near to the geographical sources would require heavy investments. From the point of view of reducing freight demand first processing near the source would be advantageous since it would decrease the raw materials' volume (e.g. of iron ore).

?? *Division of production and assembly:* Shippers will split their production and assembly activities more and more. This could be achieved by concentration of pre-production plants, with final assembly being done in a larger number of smaller units near the markets. This leads to a limited number of movements of large consignments of goods over greater distances to the pre-production plants and more frequent transport of smaller shipments over shorter distances to a larger number of smaller assembly centres.

6.4.1.3 Physical Distribution

Those changes related to physical distribution are highlighted as follows:

?? *Higher Customer Service:* In addition to increasing demands regarding the product, customers also have increasing demands regarding services. So a high level of customer service becomes more and more important. Within the relation between shipper and transporter this means shorter and more reliable delivery lead times, more flexibility, quality and efficiency and more information. These necessitate both better planning and execution of logistical performance and faster corrective action in the event of a problem. As stated earlier, this will lead to increasing demand for transport because of smaller and more frequent shipments.

?? *Decreasing stock levels*: Total stock can be limited by either decreasing the number of stock locations, or by decreasing the size of stock (through the acceleration of the whole transformation process, or by producing, ordering and sending smaller series more frequently). Increasing the demand for transport is mainly caused by the limited number of stock locations, the increasing transport distances and more frequent and smaller shipments. The desirability of holding stock depends on the value of products and the costs of storage: holding a stock of high value products is more expensive than holding a stock of low value products (interest levels and capital tied up) and so has to be avoided. Changes in the locations of stockholding will thus depend on the sector of activity.

?? *Shorter and More Reliable Delivery Lead Times:* Shorter delivery lead times go hand-in-hand with decreasing stock. This requires efficient and effective design, purchase, production and distribution processes as well as proper integration between these processes. Better planning and relevant information will also be necessary.

6.4.1.4 Transport flows

Transport flows themselves will be affected in the following ways by the megatrends outlined above:

?? *JIT Production and JIT Delivery:* Just-in-time production means more than delivering products at the right time: just-in-time production also means extra demands with regard to quality ('zero defects') and services. Especially important are services in relation to transport and the connections with other links: from production to transport, from transport to distribution centre, between different modes and so on.

Higher transport costs are the result of both the higher frequency of delivery and/or higher quality demands concerning delivery. These two factors will lead to more demand for transport. However, there are also factors which will have the reverse effect on the demand for transport:

- because of higher demands in relation to reliability, the number of suppliers will decrease which will lead to more concentrated streams of goods.
- real just-in-time delivery demands that suppliers be relatively close at hand; when limiting the number of suppliers one should take this into account, as it will reduce trip distances.

?? *Standardization of Load Units and Vehicles:* Transport of general goods and other products (grain, fruit) from overseas is a more and more containerized business. In comparison with conventional methods of transport, containerized transport drastically simplifies trans-shipment and facilitates inland transport.

There has been a big rise in the volume of empty containers transported over the last few years. Road transport of empty containers is very costly, which is a good reason for reducing transport by road. Transport by inland waterways can reduce costs. This can be linked to the general problem of the re-positioning of containers. Because of the growing variety of containers (tank containers, bulk containers and so on) they are less interchangeable than formerly.

An important conclusion is that increasing container flow will offer possibilities for transport by rail and inland waterways. This means that road transport will be diminished. Container transport on inland waterways is, however, not profitable for distances of less than about 200 km, since trans-shipment costs are too high in relation to the total transport costs.

The following Table 13 makes the link between determinants and descriptors of transport demand.

6.4.2 Conclusions

Most external trends point to increase of freight transport, esp. intercontinental (high-value) and international (intra-EU: diversification). Beside overall economic growth, this is the result of changes in the way that production, trade, distribution and transport systems are organized.

The key changes in transport determinants that will have a positive effect on freight flows are:

?? Geographic concentration of production
?? Flexible production / internal control systems
?? Economic concentration
?? Division of production and assembly
?? Higher Customer Service
?? Decreasing stock levels

Developments that may on the long term slightly dampen overall growth are the following have in common that they may increase the efficiency of production and trade:

?? Greening of business (through cost increases and reduced or more efficient production)
?? Electronic commerce (through substitution of freight movements)

We can conclude that the analysis presented in this study, which has remained necessarily at a certain distance from the actual disaggregate level of analysis, reveals that highly dynamic and complex mechanisms are at work, which deserve a further detailing through additional research which is more dedicated to specific problem areas identified here, for example, like the economic concentration of activities and the reversal of distribution chains.

Table 13: Synthesis of Interrelations Between Megatrends and Descriptors of Transport Demand

glob	netw	ICT	green		tons	tkm	vkm	dist	prod	speed
+	0	0	0	**Geographic concentration of production**	+	+	+	+	+	+
+	+	+	+	**Flexible production / internal control systems**	-	+	+	0	+	+
0	0	0	+	**Economic concentration**	+	+	+	0	+	0
+	+	+	0	**Electronic commerce**	-	-	0	+	+	0
+	+	0	-	**First processing near source location**	-	-	0	0	0	+
+	+	0	-	**Division of production and assembly**	+	+	+	+	+	+
0	+	+	+	**Higher Customer Service**	0	+	+	+	+	+
0	+	+	0	**Decreasing stock levels**	0	+	+	+	0	+
-	+	+	-	**Shorter and more reliable delivery lead times**	0	0	+	-	0	+
-	+	+	-	**JIT production and JIT delivery**	+	+	+	-	0	+
+	+	+	0	**Standardisation of load units and vehicles**	0	0	+	0	-	+

where:

?? glob : globalisation

?? netw : networking

?? ICT : information and communications technology

?? green : greening of business

?? tons: volume of freight moved

?? tkm: volume of freight lifted times distance of transport

?? vkm: vehicle kilometres travelled

?? dist: weighted average transport distances of transport movements

?? prod: variations in goods types transported

?? speed: time for movement between origins and destinations of transport

7 IMPACT OF NEW TECHNOLOGIES AND OPERATIONAL INNOVATIONS

This Work Area of SCENARIOS examined the issue of how to integrate new technologies and operational innovations in transport scenarios, at a medium and long-term horizon. To study this question a number of contrasting examples were selected:

?? information technologies/telematics
?? intermodal transport (freight and passenger)
?? magnetic levitation
?? automated urban vehicles

More information and case studies on this subject, can be found in the report: *C3 Potentials of New Technologies in Transport Scenarios.*

The dissemination of new technologies depends on many factors ("enabling factors") that have been grouped in 3 different levels: technological, market and socio-economic. It is assumed that the implementation of new technologies passes through these three different levels of interaction:

1 new technological products are continually generated; (technological level)
2 these new products enable changes in operation; (market and operational level)
3 society adopts the new modes of organisation, which in turn stimulates the implementation and the use of new technologies (socio-economic level)

The rationale behind this grouping, is that dissemination is steered by some kind of feedback loop between new technologies and society. Firstly new technologies must have sufficient potential at engineering level to enter the market as operational technologies, where they are expected to yield benefit to users and operators. If they have both these potentials then they are likely to interact with the collectivity and society, which produces regulations and policies that stimulate or restrain their socio-economic influence.

This section attempts to assess how new technologies and operational innovations influence transport supply and what are the conditions for successful development of the most promising technologies. It provides hints for the development of transport supply scenarios in the 2020 perspective.

The study has revealed that the impact of new technologies depends principally on their dissemination. Since the work refers to new technologies, forecasts cannot be based on trends, but have to be established through investigation of the conditions for dissemination.

The discussion about the potential of operational innovations and new technologies for future scenarios is therefore focussed on application and deployment issues: which technology will spread enough to have a significant impact on transport supply? This in turn requires consideration of a number of aspects including the timescale for deployment (short term / long term), the technological feasibility, the economic viability and public/private partnership, planning and synergy in the transport system and finally environmental conservation, quality of life and social acceptance.

Focus is put on the impact of these new technologies on the organisation of transport, rather than on structural changes in the way of life. Indeed, it is expected that some innovations will stimulate transport growth by better use of the infrastructures; other technologies will provide substitution means, whereas some others will make transport more efficient for users and customers.

7.1 Telematics and Information Technologies

In this section, we consider the potential of three types of IT/telematics applications: user information services, teleservices and automated highway systems.

7.1.1 User information services

Under the term "user information services", this study includes all the information provided to road users to enable them to complete their journey in the best possible conditions of comfort and safety. In addition, the efficiency of the road network can be improved with the help of intelligent traffic management technology, which constitutes a sensible complement to the necessary continued expansion of the road network.

In the transport domain, the interest of **public authorities** is strongly linked to their mission in terms of traffic management, network maintenance, safety and information. These new services may help increase the capacity and fluidity of the infrastructure, influence the demand by providing information on alternative routes, and lastly improve the safety with more rapid response in case of accidents.

These new technologies will allow **private service providers** to provide value added services through participation in traffic information systems. With an on-board system deployment, a new market will also be created for telecommunications operators (e.g. broadcasters and GSM operators). Furthermore the addition of services will increase the profitability (return on investment) of their networks.

The range of services is very wide because of the variety of data, communication links, and receivers. On the **supply side**, the potential for new technologies includes automatic data collection (magnetic loops, video, automatic counting), coding information for communication processes, and on-board equipment (e.g. with digital maps, navigation calculation). These new services will allow for better statistics and monitoring and for a higher content of information to be communicated. Given the increased acceptance of such equipment amongst the general public these technologies are likely to spread widely in the next 10-20 years.

In conclusion, transport scenarios must consider the issue of **compatibility** and **merging** of telematics technologies. This is crucial since these two issues will decide whether the most important actors in the domain, car manufacturers, will be in a position to integrate new devices easily and promote end-user acceptance.

7.1.2 Teleservices

The dissemination of teleservices employing sophisticated technology carries a great significance in traffic planning since it is a highly viable alternative which can substitute and/or complement the existing transportation modes in conducting activities.

The degree of willingness by people to change their behaviour from making trips to using tele-services is highly dependant on several factors, including age, family situation, distance to the facility (shop, work, etc) communication behaviour and mobility behaviour.

The **benefits of teleworking** can be numerous: e.g. organisational flexibility and increased productivity for employers, as well as a reduction in travel time and costs and more flexible working hours for employees. There are also various social and economic benefits, such as reducing total traffic, and thus pollution. Teleworking is often seen as one possibility for decreasing transport demand and its environmental effects: teleworking enables potential commuters to work from home or locally at telecottages, telecentres or in a regional office.

Studies at local or country level show that teleworking has the potential to reduce travel (e.g. a 3 - 6% reduction in car travel in Oslo and Bergen, Norway). As well as reducing congestion and pollution it could reduce the need for additional road network capacity. However, there is a risk that latent demand will soak up the road space freed up by telecommuters.

There is also a demand for **video conferencing** with two different motives. The first is to improve communication within a company and with its partners as well to increase the effectiveness of working practices. The second objective is to replace travelling by video conferencing. In particular, a reduction in the demand for air travel of at most 10% is expected, with the highest impact on business trips and long distance trips. However, the new information and communication technologies enhance the possibilities of collaboration with partners from around the world. In itself this generates a higher demand for travel, thus reducing the impact of any travel-replacement by teleworking or videoconferences.

7.1.3 Automated Highway Systems

An automated highway system (AHS), a specially equipped roadway on which vehicles can be operated automatically, is technically the most advanced form of Intelligent Transportation Systems (ITS). It aims at improving road safety, traffic conditions, transportation efficiency (increased traffic volumes and speed) and driver comfort, but also at reducing impacts on the environment.

Alternative concepts range from autonomous (i.e. all of the intelligence is in the vehicle) to infrastructure-controlled (i.e. much of the intelligence is in the infrastructure), as well as varying levels in-between. In addition, AHS vehicles would be fully capable of operating under driver control on all roads.

AHS is an amalgam of several complex technologies and systems working together. It consists of vehicle information, sensor, communication and roadway systems.

The AHS concept is mainly modulated into four families of technical concepts (vehicle/infrastructure couples):

?? *automatic steering of individual vehicles* – providing greater safety and comfort
?? *platooning:* only the first vehicle is steered manually by the driver – increases transport capacity with the creation of "road trains"
?? *automatic platooning* where the platoons are automatically guided (automatic road trains)
?? *vehicles carried by automatically steered supports* – infrastructure capacity is not dependent on the rate of private equipment.

AHS integrate the most up-to-date techniques and products including sensors, transponders, magnetic tracking, image processing, automatic steering, braking, signalling, cruise control, etc. Therefore, for the component suppliers, the success of AHS is increasing their market. The AHS concept itself gives added value to the individual components.

Road hauliers & public transport (coaches) will benefit from time savings and safer driving. Hence they will increase their efficiency & productivity. Individual users also benefit from increased speed, safer driving & greater comfort.

The time savings and increased safety will be consolidated at the state, regional and local authority levels. The quality and regularity of the flow results in fewer air pollutants in comparison with normal traffic conditions. It is also conceivable that the vehicles will evolve towards electric power.

Technological uncertainties: Major technological uncertainties include those associated with systems' ability to reliably detect an obstacle, predict the trajectory of a moving object, assess the threat, and avoid obstacles. In highway conditions, autonomous driving, with the advantage of instantaneous reaction, could replace human driving (human intelligence for driving) in a near future, This is absolutely not the case for open roads.

Uncertainties of support from public actors: The implementation of AHS concepts hinges upon the support of many stakeholder groups. In order to deploy a system successfully, it will be necessary to obtain consensus or buy-in from two general categories of stakeholder groups: the public and private sectors. The public sector dealing with transportation is concerned mainly with the day-to-day activities of building, operating, and maintaining the transportation system. Public officials tend to be reluctant to invest in projects that appear financially risky.

Market uncertainties: When faced with the uncertainties of future technologies, user demand, and commitment from governments and the insurance industry, vehicle manufacturers are likely to be reluctant to make long-term commitment regarding manufacturing and servicing AHS vehicles based on a set of specifications, or based on a particular design. Liability in case of accident is another unresolved issue. Finally, the ability or willingness of consumers to pay for automation features is uncertain. In addition to vehicle cost, affordability of AHS to a user depends on maintenance cost, possible AHS usage cost, and income, all of which are uncertain at this point.

7.1.4 Conclusions

Two main conclusions can be drawn concerning the potential of telematics systems for transport scenarios.

1) The ***convergence of the interest and strategies of the actors involved*** will be a key factor for the success of the deployment of new information systems. With the development of new telematics services, the number of actors involved are constantly increasing. These actors include road operators, private service information providers, and telecommunications actors.

   The lack of stabilisation of technologies make all the actors, particularly some receiver manufacturers, uncertain about the long-term viability of their systems. As a result, the deployment of information systems can be delayed.

2) ***The roles of the actors will change significantly***. For example where information supports are strongly dependant on the physical transport network (e.g. VMS, dedicated traffic information transmitters on motorways), control of the information system rests almost exclusively with the transport operators. With the development of new technologies (GSM, DAB, etc.) the telecommunication network can be totally independent from the physical network.

   For economic reasons, development of new telecommunication systems has to be undertaken in order to host a maximum of services; of which transport information is only a small part. In this perspective, the role of telecommunications actors will become increasingly important in comparison to that of the transport operators, as control, development and installation of information chains shifts to telecommunication operators. This is one of the reasons why public-private partnerships play a key role regarding the development of new information systems.

Only a small selection of the new technologies are likely to succeed in the market, and this choice will be determined mostly by big equipment and car manufacturers. For a transport scenario the following time span is proposed.

Table 14: Implementation of telematics functions in Europe

Time span	Significant function implementation in Europe
2000- 2010	traffic information, guidance, location
2000-2010	Pre- trip information for public transport users
2010- 2020	On- trip/ real time information for public transport users
2010- 2030	Driving assistance and vehicle automation in specific conditions
2020- 2040	total automatic control on highway
2020- 2050	Probable reconfiguration of the private- public transport system
futuristic	total automatic control in any situation

7.2 Operational innovations for Intermodal Transport

7.2.1 Freight Intermodality

This study focuses on innovative organisational forms and technologies and the way they enable a positive development of mutimodal freight transport.

The potential for an enhanced modal shift from road to intermodal transport can be seen in several internal and external dynamics of current rail organisation:

?? the present reorganisation and liberalisation of the railway transport system
?? the separation between infrastructure and rail operation in some EU member states
?? the completion of the Trans-European Network
?? the evolution of the market structure of combined transport (e.g. alliances and the merging of combined transport operators from different market sectors)
?? the evolution of production modes and mentalities in business relations (generating a need for efficient integrated logistics solutions)
?? technical progress (e.g. generalised access to information technologies)
?? growing road congestion
?? the focus on sustainable development

This section gathers and orders ideas on how these issues – especially the technology aspect - can be taken into account in the definition of intermodal transport scenarios.

Policy decisions to increase the potential for multimodal transport can have a strong influence, at national and European level. The objectives of the policies introduced by EU Member States can be classified by the three categories below:

1) Imposing behavioural changes. This concerns measures to contain and select mobility, such as a restriction of HGV traffic at week-ends or during the night, or, as for example in the Netherlands, the rule that freight transport may take priority over passenger transport on the rail but not vice versa. Another option is the internalisation of external costs and road pricing. Here we can mention fuel taxes and motorway tolls.

2) Creating and financing infrastructure. The construction of the Trans-European Networks and the promotion of intermodality enter in this category. Different national network plans, terminal network plans, and investments in principal corridors aim in this direction, (e.g. Alp base tunnels, to connect road-rail transport between Northern and Southern Europe).

3) Developing a more competitive environment. This concerns the liberalisation of market access, the separation of the rail infrastructure management and transport services, and the implementation of rail freeways.

New **strategic alliances** arise between European railway companies such as the joint venture of FS and SBB on the North-South corridor, the future fusion of DB and NS (RCE Rail Cargo Europe) as well as the new partnerships and alliances between combined transport operators. Some of the traditional railway companies are becoming logistics service providers and in this way enter in competition with the combined transport operators. Also, the formerly separate markets of maritime and continental load are merging.

On the customer side, the evolution of production modes and business relations (Just-In-Time, Efficient Consumer Response) needs integrated logistics solutions. The intermodal transport system is becoming a support to these new organisations.[22]

The potential of innovations in operations can be shown by considering Combined Transport Operating Systems (CTOS), namely the combination of the link services (rail and pre-post services) and the node services (node operations and access interface operations).

The innovative hub&spoke and gateway organisations are an efficient combination of both the train operations and the node operations. This does not imply, that there is no place for technological innovations. Cargo Sprinter (reduction of the traction cost) or the project by UPS and Deutsche Post entering the rail market with new high speed rolling equipment are good examples of technological solutions, but in some cases, technical problems can find organisational set-ups. For instance, the shuttle train system has enabled the elimination of wagon shunting.

Organisational innovations are linked to the operators' commercial strategy. They foster the creation of new products, such as efficient and reliable door to door services. At stake is consolidation of the container flows, the improvement of quality and costs of multimodal transport. In addition the implementation of block and shuttle trains presents a considerable economic potential.

The application of **organisational innovations** in rail transport production systems has demonstrated its efficiency. Here the implementation of shuttle trains and gateway terminals shows the potential for rail transport to compete with road transport in terms of price, rapidity, reliability and safety and the innovative utilisation of the hub&spoke system proves that there can be a wide spread geographical coverage through an efficient bundling and distribution of the flows. The future of the network configurations will strongly depend on these developments and as can be seen through case studies[23], these systems have already proved their efficacy.

Additional efficiency is reached by collaborations and partnerships of the combined transport operators. Thus the initial concentration in continental transport is likely to continue during the following decades to improve the supply especially for transnational transport. The provision of more integrated logistics services is another important factor.

?? Organisational developments should be taken in account in the scenario development for 2010, with a strong focus on main traffic corridors.

?? Technical developments could furthermore enhance the developments in organisational changes and should therefore be taken in account for the 2020 scenario.

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[22] Aden, D. (1998) *das Kombinetz ist noch nicht marktorientiert*, Thyssen Haniel Logistic, Deutsche Verkehs Zeitung, 11 July 1998.

[23] see SCENARIOS (1999) Working Paper for C3 report

?? Political decisions are significant in 2010 as well as in 2020. Nevertheless, their slow implementation at a European level considerably reduces their impact.

7.2.2 Passenger Intermodality

From the perspective of **transport policy**, intermodal transport for passengers can further sustainable mobility objectives by increasing the market share of public transport, providing improvements in accessibility, and introducing the use of cleaner vehicles.

For urban trips, intermodal transport aims to reach a better equilibrium between different transport modes (especially in favour of public transport) and to reduce road congestion. For long distance trips, the objective is to provide a high level of integrated service, moving from competitivity between modes to co-operation.

One of the key issues is the relationship between authorities and operators, more precisely, the definition of rules that allow companies to make stable commitments and have a better management of their risks (especially financial). In an urban situation, various organisations usually manage the public transport. The promotion of intermodality thus requires a common ticket (e.g. combining bus and train for suburban commuters). In this context it is also necessary to address regulation issues concerning legal and institutional barriers, collaboration between the public and private sectors and current policies in the EU and Member States.

In order to attract users to an intermodal transport system, the operator has to provide **travel information** which is consistently available through the most appropriate media at all stages of trips. In addition it is necessary to consider the harmonisation of signing legends, integration of modal information and the public availability of information.

Improvements to the ease of use of intermodal transport must also look at the quality of information before and during trip and tariff integration, (with combined tickets, attractive prices and transparent accounting). All these issues require local agreement between the various operators and specific contracts concerning the division of responsibilities. This can be done under the aegis of a public authority.

The principal system attributes for passenger intermodality concern 3 areas: **networks, information** and **payment systems**. The interchanges within networks must be located so as to provide good links between national and regional services and an adequate territorial coverage. Supply side improvements can also be made concerning information and payment systems. This will allow for transport and tracking of personal luggage, and reliable, user-friendly payment systems which cover all modes.

However, these necessary conditions from a planning perspective, must also be coupled with **users' requirements**, concerning the quality of intermodal interchanges (such as comfort, safety, weather proofing and shopping facilities). It is also important to provide for elderly and disabled passengers, and to improve the user-friendliness of electronic interfaces, such as the personal travel assistant. Finally it is crucial to increase public awareness of intermodal transport services and interchanges. These requirements do not pose any implementation or technological problem but do require interoperability.

In conclusion, it is clear that both the *range of services* and an *integrated operating system* are necessary to ensure good accessibility (over distance and in time), ease of use and a suitable level of service (including the tariff).

In an urban context, collaboration between the public and private sectors will help to reach a better equilibrium between modes including the reduction of car parking and freed road space. In an interurban context, the aim is rather to facilitate the current use of various modes, to increase the efficiency as a whole. The aim is that customers should see the transport supply as one integrated service including all the trip features. It means that tariff integration, in particular through ITS is a key aspect for intermodality development in the near future. The focus will be on interconnection platforms.

The development of passenger intermodal transport requires the integration of transport policy, operators services, and the required infrastructure. Political support for these measures will be crucial. Strong enforcement of fair competition rules is also necessary, in order to direct the emerging national monopolies in Europe towards public service, rather than short term profit.

There is huge potential for passenger intermodality; operational innovations as well as new technologies will provide the means to greatly improve communication, planning, and connections. Here again, it can be expected that communication giants will enter the market and provide a large panel of services based on GSM- type technologies (which allows efficient charging, as used in mobile telephones). In the next decades, it is likely that operators will mobilise more resources for the management of transport systems, tariff integration and the provision of timetables than in vehicles and infrastructure.

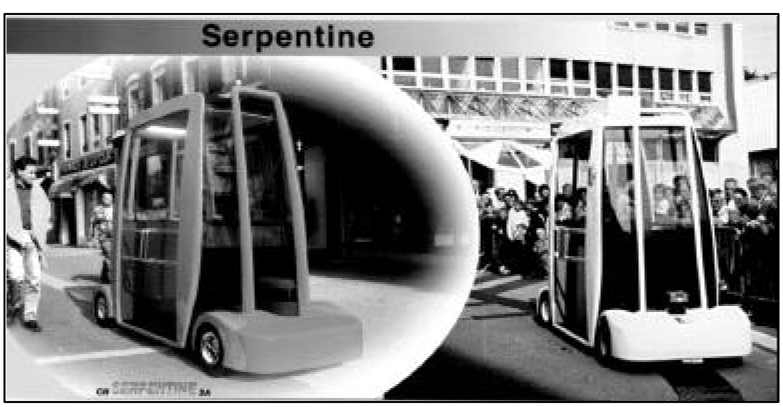
7.3 Alternative Systems

7.3.1 Vehicle Automation

This section gives a brief overview of a new semi-private transport system called "Serpentine". Serpentine is not designed for speed, but for supplying to customers a level of accessibility equal or superior to the private car in urban areas. A pilot line will be built in Lausanne, Switzerland in 2000.

The Serpentine autonomous urban vehicles, are electric and fully automated. Each shuttle is designed to drive up to 7 passengers nearly anywhere in a city, at any time of the day. The Serpentine transport system is highly versatile. It takes its power from induction coils buried under the main roads, and is able to store a small amount of energy in batteries for runs outside equipped roads. Such a technological innovation opens new horizons for public transport, since the electric vehicles are no longer physically bound to their power supply.

Figure 17 Serpentine shuttle in Lausanne, summer 1996, with induction band as power supply and guidance.



In a 20-year perspective, autonomous vehicle networks are likely to develop from clusters at key points of cities and expand, forming stars or spider webs. The electrified lines will then follow the most used routes, whereas less frequent destinations will remain with unequipped roads.

A particular feature of the Serpentine transport system is that the vehicles can group and form virtual trains with up to 10 units ("Serpent" = snake in French). The trains carry up to 70 people at a time and can later ungroup and dispatch customers to their destination. Serpentine therefore has a practical range between the markets for bus and taxi, and has a speed close to that of urban traffic (18km/hour in non-pedestrian zones). Since they are completely automated, Serpentine vehicles can operate 24 hours a day, and with their reliance on energy efficient electricity systems (induction coils or batteries), no emissions are produced in the urban environment.

The first step for the **implementation** of Serpentine in Lausanne is the Ouchy pilot line. The main spot is the new Olympic museum, which attracted some 300 000 visitors in 1996. It is still poorly connected to the urban public transport network. The Olympic museum could have been connected through extension of an existing bus line, but attendance is too irregular to generate any benefit.

The Serpentine system concept takes advantage of irregularity in transport demand, since it provides a **highly elastic capacity**. Technology has not solved the ubiquity issue: not all vehicles can be at the same time at a different place but, theoretically, all the fleet is available for the complete city, which provides a huge –potential– transport capacity. Hence, a relatively small Serpentine fleet can serve many irregularly frequented lines. This would not be the case with conventional bus services.

The following **conclusions** can therefore be drawn:

1. Serpentine has a place as an intermediate transport mode, between buses and cars or taxis. It suits best unevenly frequented lines and door-to-door urban travel.
2. The Serpentine system is significantly more environment-friendly than private motoring in urban areas: it produces no exhaust gases, drives slowly and generates low noise.
3. Such a transport system requires relatively low infrastructure investments due to vehicle autonomy.
4. Serpentine does not enhance social split, but, on the contrary, it tends to supply a "car- like" mobility potential to a larger part of society.
5. The concept is promising in many respects. The results of Ouchy pilot line will show what can be expected in real time operation and what options best suit consumers and operators needs as well as the local community's contingencies.

It is interesting to note that the Serpentine alternative transport system has similarities with the Automatic Highway System (AHS) of San Diego (or CHAUFFEUR in Germany): all concepts involve automatic vehicles.

A scenario for 2010 must take the further deployment of AHS into account. This will be reflected firstly in the costs of equipment, although no important impact on traffic will be seen at a global level. However by 2020 AHS is likely to operational on major corridors, and the use of automated vehicles for public transport in selected urban areas, such as Serpentine, may be more widespread.

7.3.2 Magnetic Levitation

This section deals with magnetic levitation technology that can enable higher travel speeds to be reached for inter-city links. This magnetic levitation - "maglev" for short – has been considered promising for long-distance public transport.

Three different maglev systems were analysed: MLX in Japan, Transrapid in Germany and Swissmetro in Switzerland. MLX and Transrapid are being tested on pilot lines while Swissmetro awaits the pilot line operation licence from the Department of Transport. The driving force for the development of all of these projects is a technology push, since conventional high-speed railway systems would be able to provide similar performances at lower cost.

This, however, may no longer be the case in a longer term future – around 2020- since maglev systems are better tailored for very high speed, say above 600 km/h. Indeed, maglev technology requires no wheels, hence no moving parts for power, levitation or guidance. This opens virtually unlimited perspectives in terms of speed.

The wheel-on-rail technology is based on friction and it concentrates wheel load on only one point of the rail. The **magnetic levitation principle** differs by the fact that it is based on frictionless technology. The load is distributed over a large area of the guideway by means of a so-called "electromagnetic wheel".

The contact free energy transfer system is based on linear generators in the load-bearing magnets, which when in motion induce the power for the supporting/guiding system and for the onboard energy supply. Indeed, maglevs are built like aircraft, but they need no engines on board, no fuel and no wings. The complete Transrapid vehicle weights some 400 tonnes and it carries up to 700 passengers. This gives a performance of 570 kg per passenger, which is similar to an Airbus A 310. For comparison, ICE trains weigh some 960 tonnes, and carry up to 760 passengers, which means around 1.3 tonnes per passenger, which is more than a medium class automobile and twice as much as maglevs. New two storey ICE cars will improve the rate, but will not suffice to fill the gap.

One of the **difficulties** linked with high speed is the violent air displacement around the vehicle head. Some turbulent flows reach the sound barrier, which not only causes a jet-like blast, but also induces violent pressure waves. Vehicles entering tunnels or crossing each other at full speed cause blasts likely to destabilise the vehicles, damage infrastructure at the tunnel entrance and disturb people miles around.

One possibility to avoid serious aerodynamic problems is to dig tunnels that have such a diameter that pressure fluctuations are damped by an air cushion. Another possibility is to get rid of the air. This is the reason behind the Swissmetro vacuum concept.

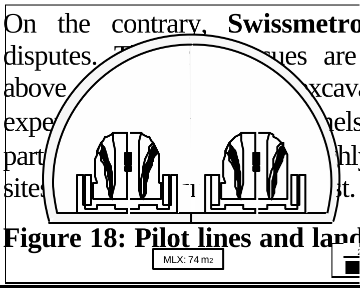
Financial calculations made by institutions that have not been associated with developing the Transrapid, estimate an investment cost of some 9 billion Euro. Recent studies - among others by the developer – have even estimated that the future operating costs will not be covered by fare revenues.

The differences in **demand for the routes** studied is quite significant: for the Tokyo-Osaka route, there were nearly 250'000 passengers/day[24] in 1995, and Lausanne- Geneva, 33'000 or Hamburg-Berlin with less than 10'000[25].

Assuming an actual traffic volume of 1.5 million passengers using the train between Hamburg and Berlin the estimated demand for the Transrapid in 2010 is more than seven times as high as the present annual demand for the classical train. Although this is not totally unrealistic the forecast of 11 million trips for the Transrapid must still be regarded as an optimistic estimate.

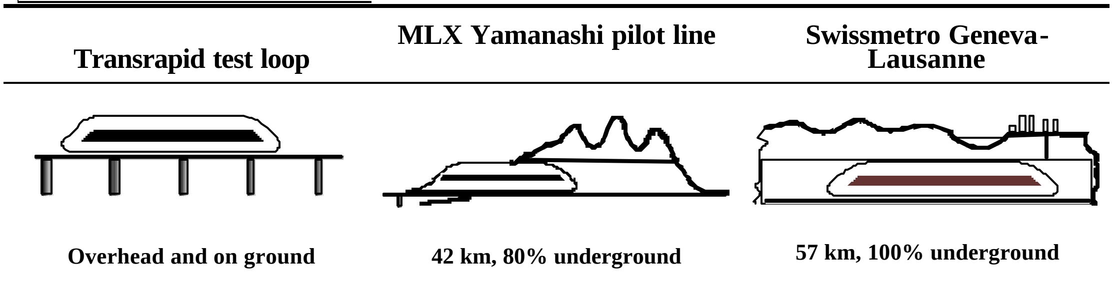
[24] High- speed train only
[25] Both for all modes

The **MLX line** between Tokyo and Osaka will be essentially built next to the existing Shinkansen track. The pilot line, which will be decisive for the choice between maglev/conventional technology, is predominantly in tunnels. On the one hand such a design increases infrastructure costs, but on the other hand it causes less impact on people and simplifies legal land use issues.



On the contrary, **Swissmetro** is fully underground. This therefore avoids the bulk of land use disputes. [illegible]ues are the access to stations, parking places, air ducts for ventilation and, above [illegible]xcavation material. The cost may also be a restrictive factor given the expe[illegible]els. The underground system thus is envisageable only where important part[illegible]hly valued, such as urban areas, areas of outstanding natural beauty or site[illegible]t.

Figure 18: Pilot lines and land use.



The main problem with high speed transport systems is that they generate a lot of noise: the air moved by the vehicle head causes vortices that can reach velocities above the sound barrier, which cause an extremely loud and surprising blast comparable to a jet aircraft. Noise pollution spreads more widely when the infrastructure is above the ground. At similar speed, however, maglev transport systems tend to be quieter than conventional trains.

The maglev transport systems considered in this study are electric-powered, hence entail no direct impact on air quality. Maglev systems would compete directly with air transport services, (with the advantage that maglevs would produce less emissions). The modal shift from car is also expected to be beneficial. The Transrapid developer has estimated savings of up to 95 million litres of petrol per year and reduction of CO_2 emissions by 180 000 tonnes per year, together with concomitant air pollutants.

As with all infrastructure projects, there is an issue of social acceptance and the possibility of those people directly affected opposing the new project. Environmental sensitivity is high in Japan, but concertation and legal action against high-tech projects is difficult. Swissmetro does not directly affect the population and therefore the discussion is more related to the need for the new technology and the economic feasibility. In Germany, infrastructure will be built first where acceptance is the highest, i.e. in the former Eastern part, with a track length of about 70 km. However, the total length from Hamburg to Berlin is about 300 km

It seems that a market-driven implementation of maglev systems in Europe is unlikely because major cities are already connected by high speed trains, and the ones that are not yet connected would not be able to pay for such expensive systems.

The **conclusions** for European transport scenarios can be summarised as follows:

?? Maglev technology will not dramatically change the European landscape by 2010. They will, however, play an increasing role in discussions concerning investments for the improvement/ extension of existing high-speed train network.

?? As a result of socio-economic conditions and environmental sensitivity, Maglev systems are most likely to spread in Asia and in the USA first. They will influence European transport system only in the 2030s - 2050s.

Attention should be given to lower speed maglev systems such as HSST[26], which run no faster than 120 km/h, but require hardly any maintenance, have excellent acceleration ability and generate no noise. The concept is more modern than MLX or Transrapid and seems extremely well adapted to new urban conditions. It could well be used within 2020 – 2030 European metropoles.

7.4 General Conclusions

Having considered the technological, operational and socio-economic performance of the selected innovations, the study concludes as follows:

1. Intelligent transport systems (ITS) will have the most significant impact on the transport supply in the 2020 perspective. Telematics will spread widely, especially as a commercial means of information using the infrastructure and services of the main mobile telecommunication operators. Institutional use for safety and traffic regulation will depend on European-wide agreement on standards and financing schemes.

2. The influence of intermodality on the transport system depends mostly on the development of operational innovations and the degree of implementation of political measures. The development of intermodality concerns organisation more than technology.

3. Information technologies (teleservices) are expected to play a key role in society as a whole, but not so much in the transport system. Indeed, teleservices such as telework and videoconferencing may become a substitute to some business traffic, but they also foster traffic generation by making more time available.

4. Autonomous urban systems are expected to spread from 2010 onwards. They will follow the standardisation of telematic systems, especially automatic debiting systems, on which they heavily rely for operation.

5. Magnetic levitation technologies are difficult to finance and environmental concerns lead to the development of underground solutions. Maglev technologies will not influence notably transport supply in Europe by 2020. However, from 2010 onwards, they will have to be taken into account for planning new connections.

For the next millennium, the best return on investments and compatibility with sustainable development will be found in the optimisation of the organisation of actual transport system. Existing vehicles and infrastructure could perform much better if well co-ordinated. The benefits of alternative technologies will therefore only become significant once intermodal organisation is well mastered, which is the challenge of the next decade. Then the need for more efficient transport means will be felt.

Moreover, alternative technologies imply additional modes. Diversification of transport supply thereby makes intermodality more complex. This complexity will be mastered by means of management procedures and systems that have recourse to information technologies and telematics.

[26] Japanese development, see SCENARIOS (1998) *Potentials of Alternative Systems*, Working paper D8, - Investigation not included in the proposal

8 POLICY ENVIRONMENT AND TREND SCENARIO

8.1 European Transport Policy

This section aims to give a framework for identification of the principal transport policy directions and measures at European level. It highlights the main policy concerns and discusses the development of the Common Transport Policy, in order to identify a number of key policy objectives. In the second section the application of these objectives at national level is further considered.

8.1.1 Development of CTP policy

To identify Common Transport Policy options and to provide a reference framework for comparison of national transport policy strategies, it is necessary to begin with a short presentation of CTP policy development and its guiding principles.

The creation of the Single Market for transport services falls quite squarely within the powers and the objectives of the Community right from its origins in 1957; article 3 of the Treaty of Rome, in fact, refers to the Common Policy for Transport as one of the tasks of the Community, since it is a strategic sector of the economy.

Yet it was not until 1985 that the Commission and Council became more active in the area of Common Transport Policy, following the decision by the European Court of Justice in 1985, which interpreting the Treaty of Rome declared that inland transport of passengers and freight should be open to all community firms, without discrimination as to nationality or place of establishment.

In the same year the Commission's White Paper on the completion of the internal market placed transport at the forefront of its policy priorities, acknowledging the importance of a common policy in response to the expansion of intra-European trade, to avoid distortions in trade flows, due to differing national transport strategies.

Then in 1992, there was further reinforcement of a real Common Transport Policy, with goals and programmes beyond the simple achievement of the single market, when the Commission published its White Paper 'The Future Development of the Common Transport Policy - A global approach to the construction of a community framework for sustainable mobility'.

Therefore, in addition to the aim of removing the remaining restrictions or distortions for the proper functioning of the Community's transport systems, the need for consideration of collateral objectives is also recognised, namely in the environmental domain, as laid down in the Maastricht Treaty. Ratification of this Treaty launched a process of further development of the European Union in general and of the CTP in particular. Besides the completion of the single market, other goals for the CTP were stressed, namely improvements in safety, sustainable growth respecting the environment, relations with non-member states and the quality and effectiveness of transport infrastructure (with emphasis on development of a Trans-European Transport Network).

The fundamental objectives of the Common Transport Policy are the same as those of the Union Treaty (Maastricht) and include promotion of harmonious and balanced development, sustainable and non-inflationary growth respecting the environment, a high level of employment and social protection and strengthening of economic and social cohesion, which in the transport domain is interpreted as the improvement of the accessibility of regions in order to correct imbalances and to secure effective mobility. Another important change brought about by the Maastricht Treaty was the introduction of the concept of subsidiarity, which requires decisions to be taken and implemented at the lowest level where decisions can be taken effectively.

8.1.2 CTP goals and guiding principles

As already noted, the European Union Common Transport Policy has evolved considerably over the last 15 years. The primary objectives of the CTP remain the efficient functioning of the European transport system within the **Single Market**, and strengthening of **economic and social cohesion** to reduce regional differences within the European Union.

To this end the policy objectives of the last few decades have been based on the progressive removal of legal or institutional barriers in order to improve the functioning of the transport markets by removing distortions. For social and cohesion objectives, Common Transport Policy has aimed to reduce regional disparities through the construction of new infrastructure, to connect peripheral and rural regions with the central regions of the Community. In addition the CTP has sought to develop its relations with non-member states with a view to enlargement of the European Union.

One more recent feature of the CTP is the attention given to **environmental considerations**, with for example, publication in 1992 of the Commission's green paper on the impact of transport on the environment. Furthermore in the 1998 white paper, the Commission proposes the principle of **internalisation of external costs** through a framework charging system, whereby infrastructure charges are based on the "user pays" principle, and all users of transport infrastructure pay the marginal social costs, including environmental and other external impacts.

Some of the measures to improve environmental effectiveness of transport systems will be undertaken most effectively at the European level, while many others will be more appropriately pursued at the national or local levels. For example, actions to promote the "Citizens' Network" and particularly public passenger transport at a local level are most effectively carried out at the local, regional or national levels. In this case the role of the European Union is only to inform and promote the policy, and to create the conditions for such policy actions.

In **urban areas** it is necessary to promote greater use of public transport (see Green Paper on the Citizens' Network) as an essential measure for safeguarding the environment. This will require public and private investment, accompanied by initiatives aimed at informing/dissuading the public. In the White Paper on the future development of the CTP, it is revealed that the objective of urban environment policy is to ensure that there are efficient and effective alternatives to the private means of transport.

8.1.3 European Policy Initiatives and Legislation

The European policy measures identified here have been analysed on the basis of recent European Union policy documents, the main ones consisting of :

?? "*White Paper on the future development of the CTP: a global framework for sustainable mobility* " [COM(92) 494 December 2, 1992]
In this paper it is stated that transport is never neutral from the environmental standpoint; therefore, if the European Union is to achieve its environmental objectives, (as laid down in the Fifth Program of Environmental Action), all transport policies must have a special concern with the consequences for the environment.

?? *"Green Paper on the impact of transport on the environment"* (Brussels 1992)
In order for the future development of the CTP to achieve the objective of sustainable mobility, this paper notes that transport must not only efficiently meet market demand, but must also do it at the lowest possible cost to the environment.

?? "*CTP Action Programme 1995-2000*" [COM (95) 302 July 12, 1995]
Presentation of priority actions for the coming period.

?? "*The Citizens' Network - Fulfilling the potential of public passenger transport in Europe*" [COM(95) 601 November 29, 1995]

This green paper published in 1995 is dedicated to the conditions and examples of best practice for urban mobility that does not harm the quality of life in cities. It is related to the trends and policy requirements in urban transport and has as fundamental aspects the discussion on policies towards an integrated transport network contemplating several aspects (Citizens' Network quality checklist) - accessibility to vehicles and infrastructure, affordability in terms of fares levels, and availability in terms of coverage of services, safety/security, travel convenience and environmental impact. It states the issues of a sustainable development where public and private transport are side by side with the needs of the citizens and of the environment, paying attention to dissemination of "best practices".

?? *"Towards fair and efficient pricing in transport - Policy options for internalising the external costs of transport in the European Union" [COM(95) 691 December 20, 1995]*

This green paper tackles the issue of externalities in transport and the possibilities for their internalisation. The document aims to demonstrate the unsustainability of present trends of transport growth, based on the environmental aggressions caused, while at the same time arguing for the importance of transport for economic growth, competitiveness and employment.

Recognising the need for continuation of action in the regulatory and other internal market policies, it states that these have been shown to be insufficient in providing satisfactory guidance to the generation of transport activities, inasmuch as the harm they cause to the environment continues to grow, in spite of the fact that the level of aggression by each vehicle.mile has been considerably reduced.

The key for a correction of this trend is seen as the introduction of pricing systems such that each traveller has to cover the full cost he or she generates, both internally - i.e. to the direct provision of his/her displacement - and externally - i.e. to others who bear no direct relation with that activity. It is hoped that, in transport like in other domains, prices will have a strong role in determining consumers' choices, and that this internalisation of external costs will be decisive in finding the selection of mobility that protects the environment without damaging economic growth or creating discrimination.

?? "*White paper on a strategy for revitalising the Community's railways*" [COM (96) 421 30 July 1996]

In 1996 this white paper pointed out some additional steps considered vital to reach the goals that had been already at the basis of the directive 91/440.

This document tries to go beyond the direct effects of directive 91/440, discussing measures that would bring new life to the Community railways, bringing them to a condition of lower dependency on public money. There is now widespread recognition that the mere separation of accounts between infrastructure management and transport operations has not been enough to provide a surge of efficiency in railways, and the introduction of change has been slow and bland in most countries.

This paper thus argues for a new type of railways, in which the companies are established with real managerial independence and with resources that allow them to define and implement competitive strategies. One key element for this - besides the adequate provision of equity - is the clear separation of responsibilities between authorities and companies, namely in the area of public service.

In parallel, the need for strong improvement in the integration of networks is recognised. Historically, national railways have developed national systems, with several technological choices made in adjacent countries making it much less efficient or even impossible for the trains of one country to circulate on the network of the other. Interoperability is thus a vital feature for the new railways. The process for its progressive realisation is being carried out with joint work by the Commission, the member states and the industry.

The white paper goes on to establish programmed actions to be achieved, among them the creation of some railway corridors, where all procedures would be adopted for a particularly fluid circulation of international trains.

?? *"Communication about connecting the Union's transport infrastructure network to its neighbours"* [COM (97) 172 April 23, 1997]

Following the acceptance of the concept of Trans-European Networks in 1992, significant work and many discussions have been held to decide on their definition, location and especially financing. The dimension of the intended networks is such that it has easily been recognised that public money alone would not be able to finance their construction in a reasonable time horizon. In this context it is also important to consider the 10 Pan-European corridors, defined in the Helsinki corridor study.

?? "*Intermodality and intermodal Freight Transport in the European Union*" [COM (97) 243 May 29, 1997]

This Communication, issued by the Commission to the Council, European Parliament, Economic and Social Committee, and Committee of the Regions restates the importance of intermodality for freight transport in the EU, proposing a strategy and a series of actions to achieve sustained progress in this direction.

?? *"White Paper – Fair Payment for Infrastructure Use: A phased approach to a common transport infrastructure charging framework in the EU"* [COM (98) 466 July 22, 1998]

Following the Green Paper of 1995, this White Paper proposes a gradual and progressive harmonisation of charging principles for infrastructure use, to be based on the "marginal social cost" principle.

At present there is a great diversity of infrastructure charging systems across modes of transport and Member States, which undermines the efficiency and sustainability of Europe's transport system. The Commission proposes that charges should be based on the "user pays" principle, so that all users of transport infrastructure should pay for the costs, including environmental and other external impacts, at, or as close as possible to the point of use.

It is noted that changes to charges may not automatically mean a change in final transport prices, since commercial operators may adjust their use to lower their costs. In addition Member States can still continue to support the provision of public services through subsidies to transport operators. The Commission proposes a step-by step approach to implementation in order to give transport users and providers time to adjust. This position can be contrasted with the earlier Green Paper of 1995, in which full cost recovery by mode, rather than marginal social cost was proposed.

8.2 National Transport Policy

In this second section, it is useful to consider the application of specific transport policy goals at national level, in order to compare the variations between national approaches and the perspective for further harmonisation of some areas of policy.

For SCENARIOS a survey on national transport policy was carried out though questionnaires sent to transport researchers and experts in the member states. This information made possible an identification of national policy goals for comparison in relation to the European policy objectives identified above.

8.2.1 Specific goals of national transport policy

This section focuses on the principal goals of transport policy in the member states, with the associated numerical targets and aims to highlight the potential conflicts with EU policy goals.

From the results received, through the variations in style we can see the following elements are present in the specific goals of many countries :

?? ***Fight congestion and environmental aggression:***
Changes in modal split; Better (more ecological) technologies and increased used of telematics; Control the need (demand) for mobility, desirably decoupling its growth from economic growth; Improve public transport;

?? ***Increase traffic safety:***
Concerning severe road accidents & hazardous goods

?? ***Improve performance of freight transport sector:***
Logistics; Intermodal transport; Maritime transport

But at the same time there are some issues that only apply to a limited number of countries (which does not mean they are not relevant to other countries):

?? ***Competition in the transport sector:***
Harmonisation of terms of competition in the EU (Germany); Feasibility of national transport sector (Finland); Market share of Dutch road hauliers (Holland); Social conditions and modernisation of road transport industry (France)

?? ***Land-use impacts of transport:***
Capital value and land used by transport infrastructure (Finland); Reduce countryside fragmentation (Holland)

?? ***Special administrative and political circumstances:***
Ensuring consistency of policy between different levels of administration and across sectors (Belgium, Flanders, with a recent federal administration); Acceleration of privatisation, restructuring large transport enterprises, overcome monopolies (Poland, preparing membership)

The reply of Belgium has one additional entry of great interest (Promoting a social support basis for the changes), that may well become crucial in most countries for acceptance of some of the actions to be taken in the near future. Possibly, in those other countries this need is recognised but not acknowledged.

In relation to the **existence of numerical targets** associated with the specific goals above, only one country has made this step with a clear answer (Holland), while another is making the effort (Finland) but is still under way. For France a specific numerical target is mentioned with respect to combined transport. Although of a different nature, there were positive answers for Portugal and Poland, in which there are target dates to achieve the desired infrastructure projects, and structural transitions respectively. Although an assessment of the current situation with respect to the variables for which there were targets, the answers received did not address this request. The following table shows the (non-void) answers on this topic:

8.2.2 Targets associated with those goals

It is then useful to consider the information below which relates the above goals to certain defined targets in the Member States transport policies.

Targets associated to policy goals		
Country	**Position Passengers**	**Position Freight**
Denmark	Emissions: - CO_2 - stabilisation at 1988 level before 2005 and 25 per cent reduction before 2030; - NO_x and HC - reduction by 40% before 2000 as compared to 1988 level, and by 60% before 2010. A 50% reduction in urban areas is expected prior to 2010; - Noise - number of houses being exposed to noise above 65 dB must not exceed 50.000 in 2010 (70% reduction to present number).	
Finland	Targets under discussion for - CO2 emissions - fatal road accidents	- Share of logistic costs in industrial products (move to European average)
France	No specified targets but some laws have been passed (or circular). Investments Funds for Land Transport (Regional Planing Law), 95, Noise Law (to lower Noise nuisances of infrastructure), Air Law (dec. 96) with obligation of Urban Travel Plans (towns >100 000 inhab.), Law which creates Rail National Network (in 97), access criteria for master plans. Only for combined transport an objective of + 10 % per year has been mentioned	
Holland	Yes: - Nox redux 75%, CO2 redux 10% - Noise standstill at 55 dB - Accidents: Fatalities redux 50%, injuries reduced 40% - Public Transport: double peak capacity; PT travel time <= 1.5 times car travel time; integrate with HSR network - Congestion on motorways: Hinterland links to main ports <= 2%; other roads <= 5%	Yes, targets in definition of goals themselves.
Portugal Sweden	- Only calendar for completion of main infrastructure projects ? ? Long term and intermediate objectives for emissions of Co2, Nox, Sulphur, VOCs ? ? Long term goal for road safety is zero deaths	
UK	? ? Road casualties by 2000 1/3 lower than average in 1980-85 ? ? CO2 emissions by 2010 reduced 20% from 1990 levels ? ? Number of bicycle trips of 1996 doubled by 2002 and quadrupled by 2012	
Poland	Short-term (1996-1999): - preparation and ratification of legal acts; restructuring of transport enterprises; start motorway construction and railways modernisation Medium term (1997-2005): - infrastructure modernisation; development of multimodal transport Long term (after 2006): - infrastructure development	

8.2.3 Claim of potential conflict between national and EU transport policy

In a further question concerning the claim of potential conflict between national policy goals and EU policy goals, a few affirmative answers were received. Careful inspection of these claims reveals that in reality most of them do not relate to EU policy as announced but to the difficulties of agreement among member countries at the Council level when it comes to approval of legislation.

Significant exceptions come in the following areas:

a) in the area of car emissions, where Holland argues that car producing countries are more lenient than they would otherwise be;
b) in the area of port competition where Holland dislikes the regional cohesion interference with free competition, while at the same time using free rail access when in connection with its main port Rotterdam;
c) in harmonisation of truck weights and axle loads (where the positions inevitably are associated with the desired strength of road haulage);

and also in the transition problems for the Polish transport sector.

<table>
<tr><th colspan="3">Claim of potential conflict with EU transport policy</th></tr>
<tr><th>Country</th><th>Position Passengers</th><th>Position Freight</th></tr>
<tr><td>Finland</td><td colspan="2">Intermodality and greater share of rail transport for passengers may be difficult because of low population density and low traffic volumes</td></tr>
<tr><td>France</td><td colspan="2">This will never been claimed “publicly”: all the Policy objectives are supposed to be compatible with the European objectives, even if, sometimes excesses of international competition are criticised (cf. recent road conflicts in France)</td></tr>
<tr><td>Germany</td><td>-</td><td>Apparent inconsistency between the tarification of traffic in the Alps region and in the rest of the EU</td></tr>
<tr><td>Greece</td><td>- Olympic Airways against air deregulation</td><td>- Private carriers against open cabotage and priority of rail</td></tr>
<tr><td>Holland</td><td>- Non harmonisation of fuel prices results in cross-border trade
- NL has stricter emission targets than car producing countries
- NL mainport policy possibly distorting EU airport competition</td><td>- Truck weight harmonisation (strong NL interests)
- EU support to peripheral regions hinders free seaport competition
- Eurovignette conflicts with NL idea of variabilisation
- Non harmonisation of road pricing measures</td></tr>
<tr><td>Sweden</td><td colspan="2">- Not exactly conflicts, but recognition of need of a strategy to harmonise current EU legislation with national policy goals</td></tr>
<tr><td>Poland</td><td colspan="2">- Threats for Polish firms (decreasing competitiveness)
- Disadvantages from short term adaptation to EU conditions</td></tr>
<tr><td>Switzerland</td><td colspan="2">- Maximum weight of EU trucks admitted on Swiss roads</td></tr>
</table>

8.2.4 Conclusions

Although many exercises of comparison can be carried out on the basis of the surveys like that considered above, the main conclusion is that, besides the differences of style, the underlying logic of most countries is relatively cautious: the transport system is the binding element in modern, complex structured economies, and any drastic constraints that may be imposed on its current way of functioning may be accompanied by grave dangers of rupture on several fronts.

Consequently, changes in behaviour of economic actors have to be achieved through a carefully weighted mix of supply side incentives (carrot) and demand management measures like price adjustments or access limitations (stick).In the current period of high unemployment in many European countries, it is expectable that politicians try even harder than usual to avoid those risks of rupture.

There are still differences in national policies, but they result not from a different logic but from a different stand point, for example, depending on the level of development, or population density. There do not seem to be any significant conflicts between national transport policies of different countries, but only *different national interests* (of a more general economic nature) which have an effect on the elaboration of those policies. It may therefore be hoped that, where common interests outweigh the differences between the parties, negotiation and conciliation mechanisms can be found, to work towards a compromise solution.

8.3 A European Trend Policy Scenario

Although decisions continue to be taken at many different institutional levels (European, national, regional and local), it is becoming possible to identify common trends in the evolution of transport policy in Europe, as countries become increasingly interdependent and interrelated through networks. In addition the strong directional influence of European directives has served to harmonise member state transport policies.

For the SCENARIOS policy reference scenario, the two key European policy objectives of Liberalisation and Harmonisation were selected for the trend position. In this section a global policy trend scenario is proposed, considering the impact of these policies on the European economy and environment. A second section considers the impact of these policy directions on specific sectors : passenger and freight transport by mode, for short and long distances.

This trend policy scenario was applied in the Pilot Strategic Environmental Assessment of the Trans-European Transport Network, in relation with the STREAMS, MEET and COMMUTE projects of the 4th Framework Programme.[27]

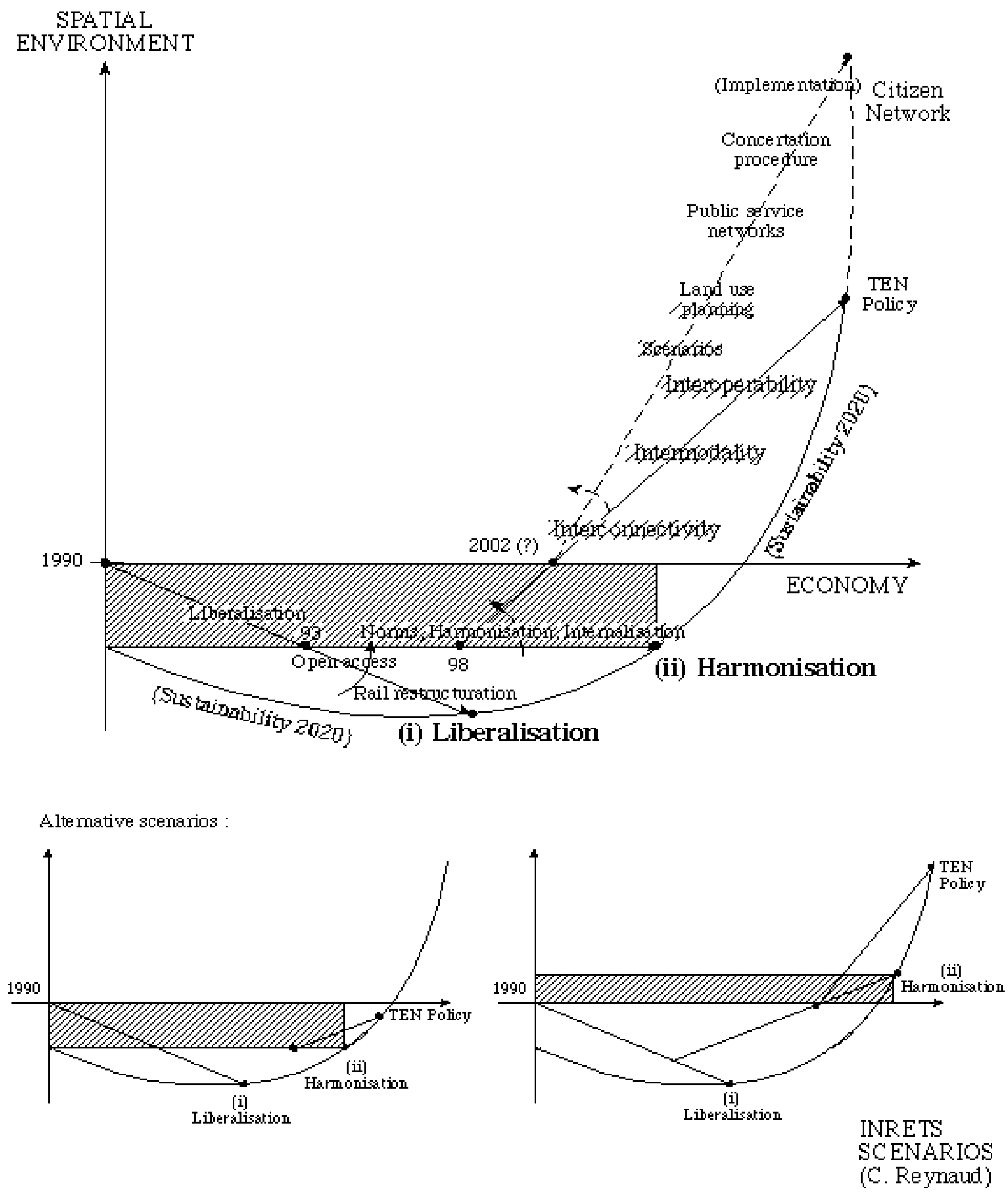
8.3.1 Representation of a trend policy scenario

The progression of the Liberalisation and Harmonisation policies was plotted on a curve which reflects the anticipated impact of these policies on the economy and the environment. These impacts were envisaged by following present EU policy implementation trends in relation to the transport environment. The trend policy scenario therefore assumes that there will be continued political will to implement the agreed policy principles of liberalisation, harmonisation and the internalisation of externalities. It also assumes that oil prices will remain stable at around $25 per barrel. Therefore changes in fuel prices are the result of changes in taxation.

As can be seen (Figure 19), the Liberalisation and Harmonisation policies give considerable improvement for the economy but are not likely to improve the environmental position from the base year. Although Liberalisation brings considerable economic gains, it has a negative net impact on the environment. The Harmonisation policies aim to counterbalance such negative effects, with implementation of new technical norms and the internalisation of external costs. However, given the extent of the modal shift to more polluting modes (road and air) under Liberalisation, it is estimated that a tuning of market mechanisms will not be sufficient to *reverse* the trend, towards non-road and intermodal alternatives.

[27] Pilot SEA of the Trans-European Transport Network (2000), Final Report

Figure 19: 2020 Trend Policy Scenario



In order to achieve greater gains on the environmental axis, more voluntarist common policy actions for improved land planning, infrastructure and cohesion, such as the "TEN" policy will be required. This policy would include complementary actions such as the promotion of intermodality, interconnectivity and interoperability issues. Eventually in a longer term perspective, environmental and spatial gains could be consolidated and further advanced with a "Citizens' Network" policy, embracing greater public management of supply and demand, land use planning and a strengthening of concertation procedures at all levels.

However in this section we focus upon the reference position of Liberalisation and Harmonisation policies. The estimated environmental and economic gains/losses resulting from these two policies (the change in the base year position) is shown by the shaded area on the trend policy curve.

8.3.1.1 Liberalisation

This scenario comprises the policy phases of liberalisation and open access. In relation to the trend policy curve, these policy objectives represent a move from the base year to point (i) "Liberalisation". As can be seen from the diagram, liberalisation gives considerable economic gains resulting from greater economic efficiency (due to increased competition) and a likely reduction in public debt with the restructuring and reorganisation of publicly owned transport operators. These benefits have already been seen in the road and air sectors.

However as this policy does not change environmental standards, with further competition and the strengthening of market mechanisms a greater exploitation of the natural environment may result. Environmental considerations will be addressed by the complementary Harmonisation policy. Co-ordination at a European level is ensured through the issuing of directives, implemented at national level. These directives relate to the partial or full liberalisation of all transport sectors : road, rail, air, inland waterways and maritime transport.

8.3.1.2 Harmonisation & Internalisation

This second part of the policy reference scenario (point (ii) on the curve) considers the market regulations applied following liberalisation, to ensure that increased competition does not result in the deterioration of social or safety conditions.

New technical developments (particularly those improving the environmental performance of cars and trucks) will also enable the application of new Europe-wide technical norms and measures. Such measures will be related to the internalisation of externalities and will ensure that cohesion and environmental standards are respected by the newly liberalised transport sectors.

In contrast with the liberalisation position, this harmonisation policy leads to some improvement in environmental terms, but a relatively smaller increase in economic benefits, as there is no new stimulus for competition. The combination of liberalisation and harmonisation policies thus result in considerable economic benefits and a small gain in environmental terms, although (on the main trend policy curve) this gain does not reveal any improvement on the base year position. As noted above, harmonisation should help to reduce the negative environmental effects of liberalisation, but in itself is not likely to be sufficient to re-orientate present trends towards a more sustainable development.

For example, in the road transport sector harmonisation measures are being applied to guarantee social and safety conditions for workers, in the face of increasing competition in a liberalised European market. The effectiveness of such measures will however be dependent upon the efficiency of control measures at European level.

With reference to the CTP objectives of environmental protection and sustainable development, the principle of *internalisation of externalities* has been agreed and accepted at European level. However in practice it is proving difficult to translate such a policy into acceptable proposals, and few decisions on levels of taxes or pricing have been taken. A recent report published by the ECMT (1997)**,** on this subject, estimates the increase in price for different modes if external costs are internalised, and also where the full cost of infrastructure will be borne by the user. The results show an increase in road transport, especially for goods.

Many other analyses concern CO2 emissions and proposals for an increase in fuel tax. New technical norms are have also been established for the reduction of levels of emissions in order to comply with EURO II to EURO IV norms (reduction rate as regards the Euro levels). The application of these measures will further reinforce the environmental gains achieved by harmonisation.

8.3.2 Freight and Passenger trend policy scenarios

As mentioned above, the effect of implementation of a policy will vary from one sector to another, as each sector of transport activity is governed by different determinants. It is thus important to focus on specific areas of transport activity and market segments in order to estimate the full impact of a policy for a trend position.

For **all sectors** salaries are continuing to increase, but this is likely to be compensated by an even stronger growth in labour productivity (of up to 2% - 3% per year). There is also a context of general improvement in quality and safety with strong penetration of new information technologies at constant price.

In the **freight** transport sector there has been a growth in international and long distance transport for all modes with strong competition within and between modes. Profound changes in logistics have affected both transport and industry and have resulted in new logistics centres being set up. For short distance freight traffic there is an increasing concern by local authorities about the impact of urban traffic, particularly since road transport has a virtual monopoly in this area. The development of light trucks and logistics changes have also stimulated short distance road freight transport.

For **passenger** transport, the trend policy scenarios should be set in the general context of the dominance of car use for long distance trips (at over 85%) as well as short distance trips. Leisure trips have become more frequent although are often shorter. The ageing population is likely to have a generation effect on mobility rates (increasing mobility for older generations). In relation to medium and long distance travel strong competition between HST and air transport is likely to continue over these distances (approximately 400 – 800 km). At a local level, urban sprawl and the development of suburban traffic implies longer trips. This trend is further encouraged by profound changes in distribution and the expansion of large out-of-town shopping centres. Yet the private car does face competition from public transport on some well serviced parts of metropolitan areas, particularly on dense corridors.

?? ***Freight***

In the ***Liberalisation*** scenario for freight there is a decline in costs for road transport with increases in productivity and strong competition (although weaker competition and congestion over short distances will result in increased costs). Increased productivity and competition are also likely to reduce costs for maritime transport. As road transport dominates long distance freight transport, this decline in costs is likely to have a significant effect on the market.

For rail however, the liberalisation policy will bring productivity and operational gains through greater managerial efficiency, but at the same time costs will increase due to the new requirements of budgetary equilibrium. This may result in higher tariffs for users but will give a certain level of economic gain in terms of a reduction of public debt. Similarly for waterways the increase in infrastructure charges is likely to impact upon costs and tariffs despite increased competition on some key routes.

As may be expected, the ***Harmonisation*** scenario has a particularly strong impact on road transport due to increases in fuel prices, tougher pollution norms and more stringent conditions for urban circulation. Moreover, improved technical norms will considerably reduce negative impacts on the environment (estimated at up to 75% with EURO II to EURO IV norms).

Those modes less affected by petrol price rises (rail, combined transport, maritime and waterways) will witness stable prices. Yet in the overall trend scenario, the stability of long distance road prices implies that there will be no dramatic change in equilibrium in favour of non-road transport modes or intermodal alternatives.

?? ***Passengers***

For passengers the ***Liberalisation*** policy scenario shows lower costs for the two sectors of air and long distance coach transport. Increased competition and improved engine efficiency will be responsible for cost and tariff reductions in these sectors. For long distance car trips, prices are expected to remain stable and as the vast majority of passenger trips are by road, the liberalisation policy is not expected to have a negative influence on the overall level of passenger transport.

In contrast, for passenger rail, liberalisation is likely to result in higher costs due to restructuring. Like freight transport, rail tariffs may rise under this scenario, but can be compensated globally by increased economic efficiency and a reduction in public debt. At a regional and local level, short distance road trips may witness higher costs due to congestion and increases in related expenses such as parking. However local and urban transport is not directly under the influence of EU policy and is more related to local planning and traffic policies.

The introduction of ***Harmonisation*** policies (including internalisation of externalities) produces increases in costs for all the passenger modes except rail and short distance public transport. Long and short distance car journeys will be particularly hit by fuel tax increases and road pricing.

The trend policy scenario thus shows that private car transport will experience the highest cost rises, but that costs for air transport will fall slightly. Bus and rail services are likely to experience stable or slight cost increases, although these will be relatively lower than the cost rises for private road transport.

FREIGHT	**(i) Liberalisation**	**% of total cost/year**	**(ii) Harmonisation**	**% of total cost/year**	**2020 Trend Policy Scenario**
Road: *Long distance*	?? ? in productivity (with +30% more if 44t is generalised) and ? in quality of service ?? quick adaptation to logistics changes ?? decrease in prices due to strong competition at national and international level	- 1%	?? Harmonisation of social conditions ?? ? fuel taxes to internalise of external costs (affects local traffic more than international/interregional traffic) ?? technological improvements ? diminution of external effects	+1 %	0 %
Short distance	?? ? cost of local transport due to weaker competition (monopoly situation of trucks) ?? More difficult traffic flow in dense areas ?? ? in costs due to congestion	+0.5%	?? ? fuel taxes to internalise of external costs (5% of cost over 10 years) ?? More stringent conditions for urban circulation. ?? Increase in salaries (up to 50% of total costs) ?? development of light trucks and increasing development of city logistics	+1.5 %	+ 2%
Rail:	?? ? competition (particularly with road transport) and development of commercial strategy ?? ? in infrastructure charges (budget equilibrium) ?? improvement of operating systems (long trains, better use of wagons, network specialisation)	+ 2%	?? harmonisation of tariffs and social costs at European level	0 %	+2%

FREIGHT	**(i) Liberalisation**	**% of total cost/year**	**(ii) Harmonisation**	**% of total cost/year**	**2020 Trend Policy Scenario**
Waterways:	?? liberalisation and ? in price for some specific traffics where competition is possible (main waterway basins) ?? ? in infrastructure charges	+1%	?? development of specialised logistics for bulks or containers	0 %	+1 %
Maritime and ports	?? ? productivity with use of bigger containerships and information technologies ?? strong competition ?? significant ? in freight prices ?? liberalisation of SSS	- 1%	?? Internalisation of costs ?? improved quality in ports	0 %	- 1 %
Combined transport	?? improvement in transhipment terminals (maritime and inland) - low cost overall ?? adaptation to market requirements in logistics ?? but significant ? in rail infrastructure charges	+1.5%	?? ? in road terminal transport in dense areas ?? harmonisation of rail tariffs at European level	0 %	+1.5%

PASSENGERS	**(i) Liberalisation**	**% of total cost/year**	**(ii) Harmonisation**	**% of total cost/year**	**2020 Trend Policy Scenario**
Road *Long distance*	*Cars:* ?? Constant price of new cars – increase in diesel cars with more efficient engines (? unit consumption). ?? small reduction in car occupancy *Coach:* ?? increased competition	0 % - 1%	?? Generalisation of tolls ?? ? in fuel taxes at least in a first period (internalisation of external costs). ?? Technical improvement and more stringent pollution norms ?? congestion problems in some areas of network, particularly during vacations	+ 2 % + 1 %	+ 2 % 0 %
Short distance	*Cars:* ?? ? congestion, ? in parking prices ?? ? in small urban cars, ? in car occupancy *Public transport:* ?? Budget constraints ?? ? in prices	+1 % +1 %	?? More voluntary policies to reduce car use in metropolitan or dense areas ?? ? tax on fuel and tolls *Public transport :* ?? diversification of services, metro, light rail, buses, small buses and cars for public use ?? development of land use policy	+ 1.5 % 0 %	+ 2.5 % + 1 %
Rail:	?? ? in charges for infrastructure (including new infrastructure for HST).	+1%	?? development of HST network (including tilting technologies) ?? harmonisation of price increases	0 %	+1 %
Air	?? ? in price due to competition after full liberalisation in 1998	- 1 %	?? More congestion and environmental problems in dense areas ?? improvement of aircraft (noise and pollution)	+ 0.5 %	- 0.5 %

9 CONCLUSIONS

The SCENARIOS project has taken a forward-looking approach to the construction of European reference scenarios for socio-economic and spatial variables, transport demand, and supply, and the policy environment. The aim has been to highlight the most important medium and long-term trends, given the past and present development of key variables.

Results are given for the external environment with definition of a reference scenario. For a 2020 horizon, it is expected that GDP in Europe will continue to increase steadily, but that the population will decline slightly from around 2010-2014. However, such general trends must be taken with caution, since there will be significant differences between regions, in relation to their potential development factors and the external economic environment.

Considering transport demand, the main trends were highlighted for freight and passenger transport. For passengers these include the increase in journey lengths and changing lifestyles, which tend to reinforce dependency on the car. Population trends are also crucial as Europe faces an ageing population, but with a higher proportion of car drivers than in past cohorts, who are expected to maintain their car use into old age. For long distance trips, globalisation trends and the development of international tourism are key determinants.

For freight transport, the main external trends were shown to be globalisation, networking, information and communications technologies and the greening of business. Most of the external trends point to an increase of freight transport especially intercontinental and international trips. Electronic commerce and the greening of business are developments that may in the long term slightly reduce overall growth, although they may increase the efficiency of production and trade.

Scenarios for transport supply are an essential part of any future analysis: it cannot be assumed that prices and competition between modes will remain unchanged. The key to the development and application of operational innovations and new technologies lies in their dissemination, at a technological, operational and socio-economic level. Taking this approach it was concluded that at a 2020 horizon, telematics and intelligent transport systems (ITS) will have the greatest impact of all the new technologies considered. Operational improvements accompanied by political measures, will support the further development of intermodality. Teleservices may have various impacts on transport, for example while telework and videoconferencing may reduce business travel, they can also foster traffic generation by making more time available. Alternative technologies such as autonomous urban systems may be used from 2010 onwards, but the further development of very costly magnetic levitation technologies seems unlikely.

Consideration of the policy environment reveals both the increasing levels of decision making (European, national, regional and local level) and the increasing interdependence between the different institutions, given European cooperation and legislation. In the present context, it seems that those measures most likely to be implemented will involve demand regulation and pricing, rather than infrastructure improvements, in order to attain the main goals of Common Transport policy: economic growth, economic and social cohesion, and sustainable development.

These elements of a reference scenario must be accompanied by a policy reference so that assumptions regarding trends in costs, prices and transport infrastructure networks can be integrated. Transport policies are often incorporated into scenarios in a highly incomplete manner, despite the fact that they have a very strong impact on the conditions, costs and prices of transport supply, either directly (new investment in a type of service) or indirectly (through the rate of taxation or tarification rules). It would be over-simplistic to disregard changes in the relative prices between modes or in the supply conditions.

In relation with the Pilot Strategic Environmental Assessment of the TEN-T, the SCENARIOS project produced a policy reference on the basis of a liberalisation and harmonisation policy at European level (base year 1994). For road, this policy trend scenario showed a decrease or no change in costs under the liberalisation policy, followed by an increase in costs with the implementation of harmonisation measures. For rail, costs will increase more significantly under the trend liberalisation policy scenario, but will remain stable under a harmonisation policy.

The prospective approach taken in SCENARIOS did not, however, produce quantitative projections of traffic volumes - this was the task of 4th Framework Programme modelling projects, such as STREAMS. Yet since the research was not directly linked to a specific model, it was able to consider a wider range of factors, not just those inputs necessary for a modelling exercise. Present models can only reproduce a limited number of elements of the transport system, and so it is not always possible to integrate important organisational innovations, for example to take into account the increased efficiency of new operating systems like shuttle and block trains.

In SCENARIOS a number of recommendations were made for improvement of strategic model design. The integration of new elements was highlighted, for a better description of the transport system and its environment, including an improved representation of new technology, the design of transcontinental models and improved design of traffic conversion models. The representation of scale, was also identified as in need of improvement, concerning the level of aggregation at which elements of the transport system are described. Finally concerning the actual modelling process, recommendations were made with respect to the practice of model design, with a view to a quick diffusion of modelling research experiences.

Given the importance, but also the limitations of transport models, and the wide range of uncertainty, the scenario approach is increasingly used by forecasters, both as an input to a modelling exercise, and as an independent tool for prospective analysis. In the POSSUM project, a more normative, policy-orientated approach was taken, to construct a future state of the transport system, according to a number of predefined criteria concerning quality of life and the environment. This method places the emphasis on the policy direction needed to achieve this state, in contrast to the forward-looking methodology of SCENARIOS. Yet these two processes are not incompatible, on the contrary, a retrospective or back-casting method, can enrich the prospective analysis, by providing greater insight into decision-making procedures and by explaining the impacts of specific measures. The SCENARIOS project, must therefore be taken in the context of POSSUM scenarios, and STREAMS model results, which together provides greater insight into possible choices of transport policy.

10 LIST OF PROJECT DELIVERABLES

SCENARIOS (1998) *Socio-economic External Developments, Spatial Dynamics and their relations to Transport*, Deliverable C1.

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Annex – Review of Strategic Transport Models

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12 ANNEX: REVIEW OF STRATEGIC TRANSPORT MODELS

12.1 Introduction

This section presents the results of the SCENARIOS study into some elements of 4th Framework Research Programme modelling[28]. It aimed to review the reported experiences in terms of their suitability for strategic policy making, and subsequently to provide recommendations for further work.

However, it must be noted that this study does not present a comprehensive review of all modelling work in the Strategic Area research programme, since the report was written midway through the 4th Framework Research Programme. As a consequence, most of the public deliverables giving results of modelling work in other Strategic area projects were simply not available yet. Thus, the analysis given must not be understood as a comprehensive review of work completed in other projects.

It should also be noted that since this study was completed, some of its conclusions and recommendations have been implemented in subsequent modelling projects (e.g. SCENES).

The study aims to develop its own narrative, based on a previous SCENARIOS working document[29], which sets out some fundamental issues with regard to strategic modelling based upon model requirements and generic modelling issues. The main objectives were therefore to make an analysis of modelling structure available in other projects in the Strategic area; and secondly to provide recommendations for modelling.

The approach taken was (model) "demand-led". The starting point was the requirements for strategic models and issues which need to be addressed when choosing a suitable model. The treatment of these models was not be mathematical, but rather of a conceptual nature, aiming to relate the needs of policy makers with fundamental principles for model design. Various examples were given as to how projects in the Strategic Programme met the requirements of strategic policy making and how they tackle these issues. Identified gaps led to recommendations for further research.

This Annex presents a brief summary of the report, outlining the main findings with respect to requirements for strategic modelling. It then shows the further methodological analysis of modelling approaches, and finally proposes recommendations for future strategic modelling projects.

12.2 Requirements for strategic modelling

Strategic modelling should be directed at supporting strategic policy making, which is defined as policy-making of interest to European-scale policy makers, with a tendency towards long term and multisectoral issues. This leads with the policy-makers' orientation but pays attention to the advantages of recognising temporal and multisectoral perspectives. Along with this definition, a number of both general and detailed requirements were given:

?? Strategic models must be able to represent, in sufficient detail, the operation of the specific strategic transport instruments that might be of interest to the policy-maker.

[28] see SCENARIOS (1998) *Recommendations for Future Developments in Strategic Transport Modelling*, Deliverable C4

[29] SCENARIOS (1998) *State of the Art: Descriptions in passenger and freight modelling in relation to external developments*, Working Paper D10

?? They must (collectively) be able to provide required input for assessment methods, concerning e.g. environment and equity impacts of policies.

?? Strategic models should be *complete* (representing different structural dimensions of society, e.g. socio-economic as well as cultural and technological) and *connected* (representing the interdependencies between these structures).

?? In view of the likelihood of EU enlargement, the should be able to represent potential new member states of the EU along with current members.

?? In the long term, it is likely that strategic network models of the whole world will be created, to represent the internal movements of different continents, as well as the flows of passengers and freight travelling between them.

12.3 Analysis of key strategic modelling methods

The SCENARIOS Working Document D10 listed and discussed a number of key modelling methods, given as pairs of “rival” design concepts:

?? Subjective versus objective

?? Rationalist versus empiricist

?? Steady-state versus dynamic

?? Evolutionary versus revolutionary

?? Substitutability versus exchangeability

?? Descriptive versus prescriptive

?? Aggregate versus disaggregate

?? Macrosimulation versus microsimulation

?? Stochastic versus deterministic

Overall, we find that models developed in the Strategic area are reasonably well equipped to deal with strategic policy issues. The detailed treatment of individual design concepts also reveals, however, that there exist gaps in present modelling theory and practice which, when eliminated, could bring closer the output of strategic modelling studies to the information needs of strategic policy making.

The key results of the discussion concern a list of recommendations for strategic modelling in the future, which is reproduced in brief below.

12.4 Key recommendations

The recommendations of the study are set out along three subjects, by which research on strategic modelling can be improved. These are:

The introduction of new elements in models of the transport system: these concern additions concerning elements and aspects of the transportation system and its environment that are not described sufficiently well in strategic models. The topics treated include

?? an improved integration of representations of new technology;

?? design of transcontinental models;

?? improved design of traffic conversion models;

?? more detailed modelling of dynamics in the system;

?? aprpoaches for microsimulation;

?? explicit modelling of logistics processes.

An improved representation of scale: different problems can occur with choosing the level of aggregation at which to describe elements in the transport system due to statistical data inadequacy, conflicts in representation at different levels of detail and the complexity of models. The recommendations focus on:

?? explicit treatment of intrazonal equity;

?? the representation of local traffic in interzonal models;

?? approaches for time of day disaggregation;

?? choices with respect to stochastic modelling;

?? improvements in demand segmentation;

?? effects of disaggregate methods on transport database design.

Improvements in modelling practice: with a view to a quick diffusion of modelling research experiences, a number of recommendations are made with respect to the actual practice of model design. The key issues in this field concern:

?? using link counts to estimate O/D matrices;

?? the explicit treatment of subjectivity;

?? substitutability and exchangeability of models;

?? transferability of behavioural parameters;

?? standardisation of modelling assumptions;

?? issues of mathematical form of models;

?? better exploitation of previous research.