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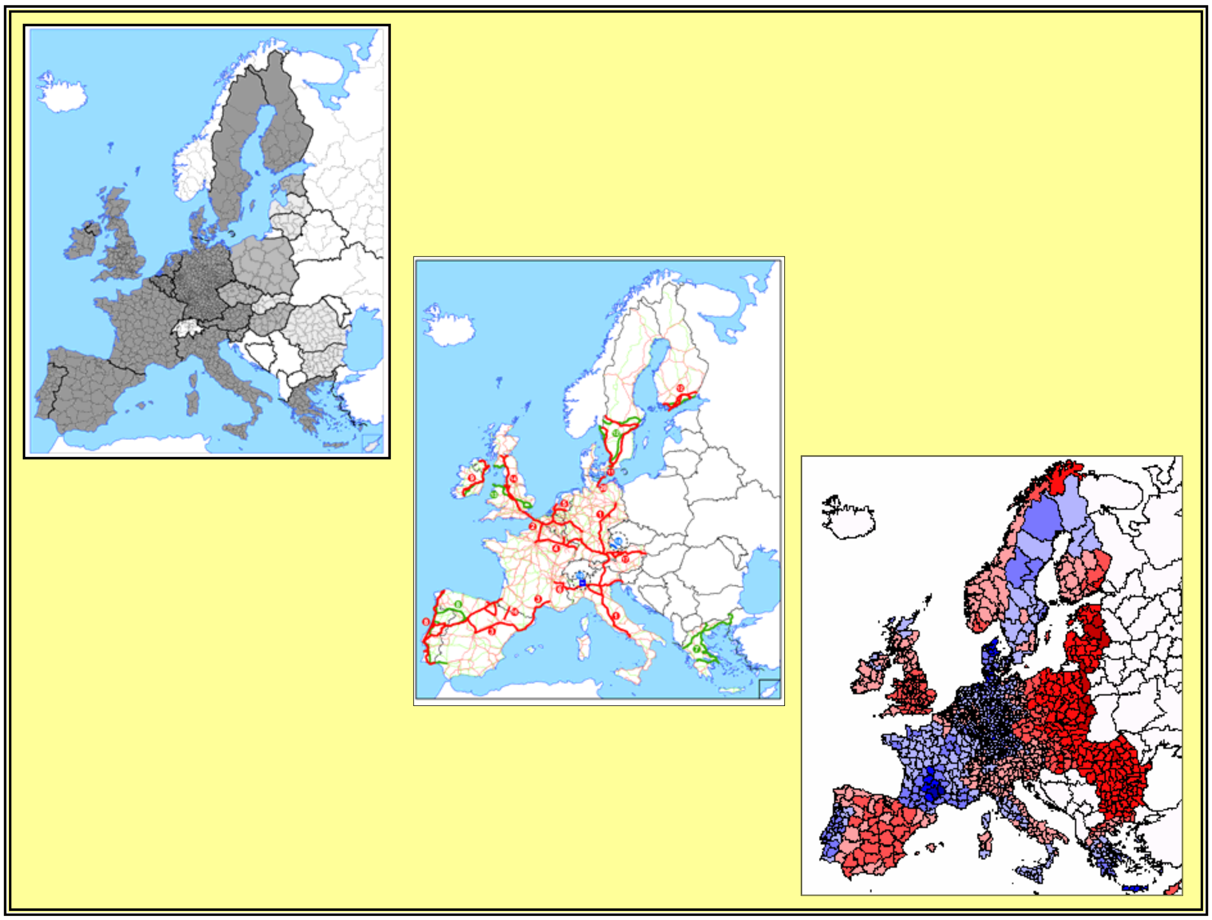
ASSESSING THE INDIRECT EFFECTS OF TRANSPORT PROJECTS AND POLICIES

FINAL REPORT FOR PUBLICATION: CONCLUSIONS AND RECOMMENDATIONS FOR THE ASSESSMENT OF ECONOMIC IMPACTS OF TRANSPORT PROJECTS AND POLICIES

IASON DELIVERABLE D10

The IASON Consortium
March 2004



IASON

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Integrated Appraisal of Spatial economic and Network effects of transport investments and policies

FINAL PUBLISHABLE REPORT

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EXECUTIVE SUMMARY

Background and introduction

A common understanding of rules for the assessment of economic impacts of transport related projects and policies at the EU level is useful in the sense that:

- it helps to make good judgements about alternative transport investment options, both for priority setting and for making good judgements about the rate of return of transport investments;
- it makes trans-border evaluation schemes comparable and can also be used for developing criteria for cross-border investment and compensation schemes;
- it allows comparing policies aimed at stimulating the development in peripheral regions with those alleviating congestion and transit traffic problems in more central located regions of the Community.

This report describes the final results of the IASON project, carried out under the European Commission's 5th Framework Research Programme. The wider objective of IASON is to develop rules for the social cost-benefit analysis of transport projects and policies, with a focus on indirect effects.

The key outputs of IASON are the following:

1. Rules for cost-benefit analysis of transport projects and policies, including an overarching assessment framework and approaches to measure network and socio economic effects.
2. New and improved methods to carry out evaluations: a Spatial Computable General Equilibrium model (CGEurope) and the improved SASI model. These models work on the basis of the new IASON spatial database which covers the whole new Europe at a high level of detail.
3. Guidance on the suitability of the methods for answering various appraisal questions such as the economic value of projects and policies, the spatial distribution of benefits, and the impact on cohesion.
4. Case studies into the socio-economic and network effects of measures proposed in the EU White Paper on the Common Transport Policy, related to the revision of the TENs and Transport Charging.
5. A comparison of results of the case studies with similar calculations using other models and approaches from the TIPMAC (macro-economy/transport linkages) and TRANSECON project (focusing on ex post measurements). These projects are together with IASON part of the same cluster.

The results give answers to the following questions that are of interest to policy makers:

- Does the implementation of the TENs actually improve cohesion?
- How is the welfare gain distributed spatially in Europe by implementation of the TENs?
- How is the accessibility improved of regions in Europe by implementation of the TENs?
- What impact has implementation of SMCP on the local economy of regions in Europe?
- Will implementation of SMCP policy induce modal shift?
- What is the spatial economic welfare gain of implementation of the TINA Network?
- In what way does implementation of the TENs or SMCP policy change the accessibility and cohesion of the peripheral countries and the accession countries?
- What is the spatial economic effect of charging policies?

Research conducted in the IASON project

The starting point for the IASON is the cost benefit framework as derived from welfare economics. In the work the welfare economic framework has been used within which it is possible to compare the contributions of the various analytical approaches. The framework is a necessary basis for providing an interface between the subtasks and for making recommendations for the assessment of transport investments and policies at the EU level. The following definitions have been established:

- Direct effects = effects on behavioural choice within the transport system (route choice, mode choice, departure time choice and destination choice), by users of that part of the network to which the initiative applies.
- Direct network effects = effects on behavioural choice within the transport system (route choice, mode choice, departure time choice and destination choice), transferred by network flows to other users of the network who are not themselves users of the part of the network to which the initiative applies.
- Indirect effects = effects outside the transport market as the result of a transport initiative, typically including the changes in output, employment and residential population at particular locations implied by the choices described above.
- Indirect network effects = effects on the transport network of choices made in those other markets (land and property markets, the labour market, product markets and the capital market), as a result of changes in generalised cost brought about by a transport initiative.

This was followed by the development of a methodology for the assessment of indirect effects that stem from a transport system change or improvement. Indirect effects are potentially significant from an economic point of view where transport prices do not reflect social marginal costs. In such cases, if demand is transferred towards or away from a part of the transport system, but this is not considered in the appraisal, there will be an unaccounted benefit or loss. Two characteristics of transport systems make this rather likely. The first is the presence of economics of scale, scope and density, for example in rail and air markets, where prices may well exceed social marginal costs. The second is congestion, found in many transport markets, where prices will typically be less than social marginal costs. In such circumstances, failure to consider indirect effects will result in an error in the benefit estimate in the appraisal. However, provided that the modelling and appraisal specification is fit for purpose (in terms of study area, modes covered, network and demand representation and so on), then most indirect effects are capable of being captured by conventional transport modelling and appraisal methods. This is our preferred route to considering these effects, namely by quantifying them in a well-specified assessment.

The next step in IASON was to perform a systematic and quantitative analysis of the spatial, network and socio-economic impacts of transport investments and policy with the existing EU-level models SASI and CGEurope and carry out scenario simulations in order to improve the understanding of the impact of transportation policies on short- and long-term spatial development in the EU. The objectives were:

- the extension and refinement of these two models,
- to set up the methodological framework for the assessment of spatial economic impacts of transport projects and policies,
- to describe the system of regions defined and to describe the model requirements of the common data base the “Joint Spatial Economic Database”, and,
- finally, to evaluate the baseline and alternative future year scenarios which are specified in more detail in the definition of transport policy scenarios.

In order to carry out the simulations a number of scenarios were elaborated. The IASON scenarios are meant to evaluate the isolated effects of a specific set of policy measures without the effects of funding the infrastructure projects or the spending of the revenues of the pricing policy. This is in contrast to the macro-economic approach followed in TIPMAC scenarios where the finance loop is closed. In this way the effects of the policy measures can be evaluated without this bias of the arbitrary method how to finance or how to spend the revenues. On the other hand it does not consider the macroeconomic effect of the financing position. The results of TIPMAC show that this has a considerable impact. The models used in IASON for the case studies are the SASI and CGEurope models to measure the indirect effects and the SCENES model to measure the direct transport effects. The table below gives an overview of the different scenarios and which models were used (scenario A through E, totally 18 scenarios).

Group	A	B	C	D	E
Title	Trans European Network (TENs) + TINA	Social Marginal Cost Pricing	Combination Pricing + TENs	Dedicated Rail Freight Network	TIPMAC scenarios
#Scenarios	7 + 5 "van Miert scenarios"	2	1	1	2
Models applied	SASI/CGEurope	SCENES / SASI → CGEurope	SCENES / SASI → CGEurope	SASI→CGEurope	SASI → CGEurope SCENES included in TIPMAC

Key results from scenario analysis of CTP measures

From the various scenario exercises, i.e. model runs, our key conclusions with respect to the economic benefits of the European Common Transport Policy are as follows.

With regard to the overall economic impact of transport projects and policies, we can say that the socio-economic macro trends have a much stronger impact on regional development than transport policy. If one considers that under normal economic circumstances the long-term growth of regional economies is in the range between two and three percent per year, an additional regional economic growth of less than one or two percent as is observed in Western Europe over twenty years can be considered small. With respect to indirect effects per se, there is no evidence that transport infrastructure investment is uniquely or exceptionally highly productive. The additional benefit to the economy which is supplementary to the benefits in the transport system is an order of magnitude lower than the travel cost improvements. For specific regions, however, benefits to the economy can be of the same order of magnitude as the monetized accessibility improvements. Performing a high quality but conventional transport CBA, therefore, in some instances will only give a limited account of the full benefits for these regions.

Concerning the effects of specific policies, SMC based pricing, relative to the base case, has an effect which can be considered large. It replaces an inefficient tax by an efficient charge and thus creates new efficiencies within the economy. Speeding up the TEN-T programme has an effect on GDP which is relatively small. We have not run tests using the macro-level models (ASTRA and E3ME) of TEN-T policy against a baseline without that programme and are therefore not in a position to comment on their effect on European GDP and employment. The tests with the CGEurope and SASI models indicate that the TENs have relatively strong distributive effects to the economy, affecting in particular the East-West growth balance and stimulating the rate of cohesion. High-speed rail projects seem to be more effective in terms of promoting regional economic activity than conventional rail projects, and rail projects seem to be more effective than road projects. All transport pricing scenarios have negative economic effects but these can be mitigated by their combination with network scenarios with positive economic effects, although the net effect depends on the magnitude of the two components. The network scenarios in general reduce disparities in accessibility, but reduce disparities in GDP per capita only if also the TINA projects are implemented. Pricing policies are not favourable for the poorer regions. CGEurope shows a characteristic spatial pattern of pricing scenarios, i.e. disfavouring the peripheral regions. Also, network effects of transport initiatives tend to be additive, i.e. little evidence was found with respect to sub- or superadditivity of transport projects. Although the analysis was performed on a very specific and limited set of projects, our evaluations of the TEN programme yielded results comparable to the added results of individual projects.

Concerning the linkage between accessibility and economic growth, we find that the increases in regional accessibility from TENs policy translate into relatively small increases in regional economic activity. For regions in the European core with all the benefits of a central geographical location *plus* an already highly developed transport and telecommunications infrastructure, additional gains in accessibility through even larger airports or even more motorways or high-speed rail lines may will bring only little additional incentives for economic growth. For regions at the European periphery or in the accession countries, however, which suffer from the remote geographical location *plus* an underdeveloped transport infrastructure, a gain in accessibility through a new motorway or rail line may bring significant progress in economic development. But, to make things even more complex, also the opposite may happen if the new connection opens a formerly isolated region to the competition of more efficient or cheaper suppliers in other regions. The linkage of a transport model (SCENES) with a regional economic (SASI/CGEurope) or a macro economic model (E3ME) combines the benefits of a transport model, which has a detailed underlying network, with the benefits of a model, which measures the economic effect of changes in transport patterns to economic sectors and captures the effects of various investment strategies.

Conclusions and recommendations

The state of the art of appraisal of transport projects and policies is developing rapidly. However, the TEN-T projects and in particular the opening of Europe to the East poses formidable challenges for transport appraisal. Better transport infrastructure will link together places with quite different labour markets, standards of living and access to goods and services. In such conditions the general conclusions are:

- For major projects and policies, a good quality transport sector cost-benefit analysis is vital. This requires adequate data and modelling of the transport networks to generate the inputs to the analysis. A wider economy model linked to a transportation model does offer a way forward in modelling the total effect, including the economic network effects. The outputs of such models include forecast changes in GDP, employment by region and consumer surplus. Conceptually such models generate the total economy-wide benefit of a project or policy.
- An appraisal that is consistent in its treatment of effects from both national and supranational perspective is capable of dealing with cross-border effects. The choice of scale and models is important to highlight these effects.
- The relationship between the total benefit and the benefit measured in a transport-only cost-benefit analysis is understood in principle, but the size of the difference between them in practical cases is as yet poorly understood. Markets which are notoriously imperfect, such as land and labour have not yet been fully incorporated into the wider economy models used within IASON.
- From the perspective of the policy makers, the spatial pattern of gains and losses is important, and spatial economic models can help to identify these. Therefore a consistent approach of transport cost-benefit analysis plus spatial economic modelling may be an attractive combination providing insight into the absolute value, or social rate of return on investment and the spatial and social distribution of winners and losers.

The project has made available a new set of interconnected instruments that now can be used to assess the spatial and economic consequences of transport policies. Besides producing broad pictures of the overall economic impact for the EU, the function of the models is in particular to point the attention of policy makers to those regions, sectors or policy packages where the indirect impacts of infrastructure and pricing policies are above average. While the wider economic impacts can be substantial as transport impacts propagate over time through the economy, these are not necessarily always welfare effects that are additional to the transport impacts. When they are, they can be of significant magnitude, and these cases can now be uncovered by models like CGEurope and E3ME, when linked to the appropriate transport modelling tools.

A variety of concrete large-scale transport initiatives was examined in this study with widely varying results. It depends very much on the nature of the transport initiative and the expected impacts what models can or should be used. If one is interested in pricing policies and refunding of the tax charges is an essential part of the (transport) policy it should be clear that models like SCENES/E3ME and ASTRA are capable to deal with this type of policy. CGEurope and SASI are not capable of dealing with this type of policy since they lack a module to incorporate taxes. If one is interested in changes in the regional or spatial structure of the European economy models like CGEurope are an outstanding example of how to model changes in the regional distribution (and sectoral structure) of the economy. SCENES/E3ME does not produce changes in spatial patterns. Environmental effects are also of policy importance - these can be modelled at the level of the transport network in a European transport model such as SCENES, or at an aggregate level in a macro- economy/environment model such as E3ME.

The models as reported from IASON and TIPMAC follow two major different lines of thought. First, there is the general equilibrium approach focussing on price and market mechanisms and, second there is the dynamic approach focussing on the evolution of the economic system over time. The aim of both is to consider all relevant interaction within a transport – economic system. A clear direction of research would be a) to improve the welfare theoretical basis of the dynamic approach and b) to improve the dynamic capabilities of SCGE-models. The E3ME/ASTRA and the CGEurope/SASI group of models also follow a different philosophy where it concerns the importance of the economic functioning of markets (role of prices) as brought out in the first two economics models cf. the ASTRA and E3ME approaches which treats at a higher level structural technological and behavioural changes in society. Hence, the models answer in principle different questions and answer to the same questions differently.

The IASON-TIPMAC results indicate that at least for large scale transport policies the earlier conclusions on the magnitude of indirect effects are to be extended. One reason for this is that earlier studies are dealing with smaller scale projects which could have an impact. Earlier studies apply to partial policies instead of fully-fledged ones. That has been identified as one source of differences of results for the analysis of indirect effects.

It is our suggestion that a European-level report on the state-of-the-art in modelling and appraisal methodology is now timely, building upon the theoretical and practical advances in IASON. Such a report could, for example, follow the pattern of OEEI in the Netherlands or the UK SACTRA report (‘Transport and the Economy’, 1999). It could both raise awareness of the methods used in IASON, and give advice on best practice in CBA. EC DG-TREN, EIB or ECMT would be the natural proponents for such a report. The new 6th Framework Research project HEATCO will take a first step in the direction of creating harmonized economic valuation measures. Finally, we believe that our work has underlined the key role of transport modelling in the appraisal of public transport initiatives. Future research, therefore, should remain to be targeted at advancing the state of the art of practical transport modelling and forecasting practice at EU level.

TABLE OF CONTENTS

A. INTRODUCTION

A.1 Evaluation of transport investments and policies: state of the art vs. state of practice

Today, several processes are going on in Europe that have dramatic implications on the spatial organisation of human society in Europe in general and on spatial interaction, that is on interregional flows of commodities and people, on financial flows and on the exchange of knowledge and information in particular. Hence, the way how these interactions develop, how they are influenced by regional, national and international political and administrative structures, and whether infrastructure capacities (in the broad sense) meet the growing demands for spatial interaction is of vital importance for the spatial dynamics of the European economy.

Generally, transport initiatives are aimed at improving accessibility or reducing travel times, but the impacts on land use, economic activity and employment are also of interest to policy makers. Cost-benefit analysis (CBA) is widely applied in today's practice to assess these impacts, which demonstrates that it is a useful tool for a wide range of policy decisions including transport policy-making. For projects that are relatively small, not closely interlinked with other projects or policy actions and leading to small repercussions in other markets it often is assumed that it suffices to focus on direct effects which can be measured in the transport market. As soon as large scale projects, project bundles (e.g.: TEN/TINA corridors) or transport policy bundles are to be evaluated the probability that the direct effects will be followed by indirect effects will increase.

The state of practice in the area of cost-benefit analysis of transport projects and policies suffers from the key problem of a significant gap between the *theoretical* capabilities for assessment (given the existing expertise in economics and transport research disciplines) and the way assessment is performed *in practice*. With a view to the upcoming implementation of the Common Transport Policy (CTP) there is an urgent need to reduce this gap. Firstly, the accession process of former Central European countries is progressing is at its climax. Secondly, after almost a decade of support to investments in transport infrastructure of European interest (Turro, 1999) the EU is about to revise the guidelines for the implementation of the TENs. In the meantime, a key new building block of the CTP has become the policy of charging for the use of transport infrastructure. The mentioned shortcomings in evaluation practice are all such that they can become a true critical success factor for the speed and impact of the implementation of the CTP.

The mentioned gap concerns two central aspects of assessment: 1) rules for the (non-) inclusion of impacts in a cost-benefit analysis setting and 2) the development of robust numerical assessment tools that can be used for quantitative decision support. The state of the art in these areas worldwide can be summarized as follows:
At the member state level there is a reasonable amount of practice with the assessment of the direct effects of transport infrastructure. Although the guidelines in these countries differ considerably, there is a broad agreement among experts about the definition of these effects and the required assessment methodologies. In particular in the area of indirect effects, however, there is no unambiguous set of rules for assessment anywhere in Europe which could guide the ex-ante evaluation of transport projects or policies. Some argue that there should be also "second round", "induced-by", "wider economic", "feedback" or "spin-off" effects of policies that we summarize under the heading of indirect effects. In Japan, guidelines and methods for the treatment of indirect effects are somewhat better developed but still in the experimental stage and therefore not published in English. The situation in the USA is similar to Europe, except for the fact that assessment is complicated to a lesser extent by typically EU specific circumstances (enlargement, cross-border effects, cohesion objectives etc).
Assuming that indirect effects exist, three questions remain:

1. are indirect effects relevant for policy assessment?
2. can direct and indirect effects both be used for policy assessment without double counting?
3. how can indirect effects be measured?

Although in the last decade new and advanced quantitative methods have been developed for the evaluation of indirect effects of government policies based on spatial, micro-economic principles (the so-called New Economic Geography), these have hardly found application in the area of transport. It is only recently that the full potential of these methods was recognized by governments through research programmes of e.g. the SACTRA[1] in the UK and OEEI[2] in the Netherlands. The unlocking of this potential for the benefit of the European Community requires a considerable amount of research, to bring together the expertise of economists and transport engineers, to refine the existing methods and to design procedures for the usage of these tools within the framework of transport related assessment projects.

The mission of IASON is to address the above issues through the development of 1) a clear set of definitions and recommendations for rules for assessment procedures at EU level and 2) advanced quantitative assessment tools. Moreover, it applies the methods developed by means of different case studies, concerning the assessment of direct and indirect effects of policy measures proposed in the White Paper on the CTP.

A.2 A project cluster on socio-economic effects in the EU Strategic Transport Research Programme

IASON, together with its sister projects TIPMAC and TRANSECON is an answer to the call for proposals of the European Commission for projects in the 5th Framework RTD Programme. Its terms were laid out in the call under the heading of “Cluster on socio-economic impacts of transport investments and policy and network effects”.

The goal of the IASON project is to improve the understanding of the impact of transportation policies on short- and long-term spatial development in the EU, whilst simultaneously developing a unified assessment framework at the European level integrating network and regional and macro-economic impacts.

TIPMAC aims at combining transport modelling with macroeconomic modelling to study the indirect macroeconomic impacts of transport infrastructure investment and transport pricing policies in the EU. The study focuses on the TEN-T infrastructure projects and transport pricing policies, using the new EU Common Transport Policy and the White Paper ‘Fair Pricing for Infrastructure Use’ CEC (1998a) as starting points.

The project TRANSECON aims at the assessment of projects at the local urban level. The method used is an ex-post analysis of large urban infrastructure projects and policy impacts (e.g. metro system, U-bahn, tramway, etc., in total 13 cases studies are included). Based on the selected case studies, the following employment, urban re-generation, economic development effects stemming from urban transport policies and investments can be assessed.

This deliverable focuses on the IASON results but also includes an interpretation of these results in the light of the work done within the wider cluster.

A.3 Ambitions and aims of the research cluster

1. to provide groundwork for harmonization of evaluation practices among member states within Europe by establishing an objective framework for evaluation, building on consensus among researchers and policy makers
2. to advance the state of the art in operational methodologies by demonstrating the capabilities of the latest evaluation tools, improving these capabilities through well-chosen extensions and building a set of tools (software and databases) that can be exploited to the benefit of optimizing EU policy information

[1] Standing Advisory Committee on Trunk Road Assessment

[2] Research Programme on the Economic Impacts of Infrastructure

3. to study specific 'hard' topics that should assist in building the research agenda on topics of specific interest to EU policy makers (led by sustainability goals) which would otherwise be threatened with being left unattended to, not allowing to become addressed in EU policy analysis

B. RESEARCH CONDUCTED WITHIN THE IASON PROJECT

B.1 IASON objectives and scope of activities within the cluster

The objectives for the IASON research included the following:

- improving existing assessment frameworks by ensuring that direct and indirect impacts are clearly distinguished within the appraisal, and that the incidence of benefits and costs, and sources of additionality and/or double counting are transparent.
- performing systematic and quantitative analyses of the network, spatial and socio-economic impacts of transport investments and policy by refining existing EU-level models (a.o. CGEurope, SASI and SCENES) and carrying out scenario simulations;
- facilitating discussions among policy makers and researchers to join assessment experiences from the scientific community and to ensure feedback from the policy-makers as to the relevance and usefulness of research work;
- learning from the experience of applying the framework in practical cases so as to provide recommendations for project analysis of transport investments and policies and for the development of supporting tools and databases.

An improvement in evaluation practice for which the above research actions are a precondition is the establishment of common or harmonised guidelines for transport policy evaluation. This is the subject of the project HEATCO which has commenced in February, 2004 under the 6th EU Framework Research Programme.

Relationships within the project cluster

In the figure below the scope of each cluster project is shown, the TRANSECON project focused on individual projects and observed the impacts on local scale, the IASON focused on policies related to the TEN network and looked at the impacts on regional scale (regions within EU and Accession Countries), TIPMAC assessed EU wide measures and looked at impacts on national and EU scale. Another important difference is that TIPMAC and IASON assess ex–ante the scenarios, TRANSECON is investigating projects ex-post.

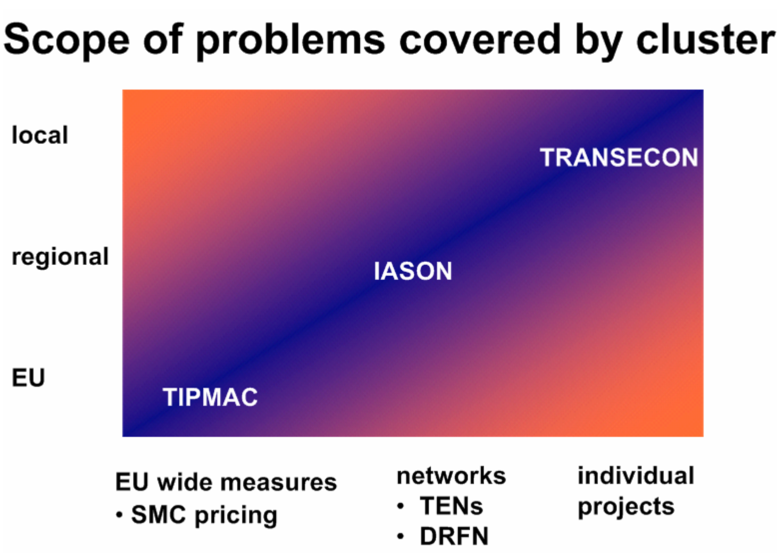

FIGURE 1: DOMAIN OF THE 3 CLUSTER PROJECTS

In table 1 below the main differences in approach within the 3 cluster projects are described. Also an overview is given of the models included in each of the 3 cluster projects.

TABLE 1: OVERVIEW OF USE AND DIFFERENCES IN METHODOLOGIES (PROJECTS) IN THE CLUSTER

Project	Use	Differences in approach	Models included
TIPMAC	To measure the general effect (direct and indirect) of a policy package to the whole economy, which includes national budgets and "who pays".	Closed financial loop, the issue of 'who pays' is incorporated, however no spatial insight	E3ME-SCENES combination ASTRA
IASON	To measure the direct and indirect regional impact on accessibility and cohesion in Europe of a set of policy measures To compare the distribution and generation of effects of specific sets of policy measures. To get regional insight in changes the structure of sectors.	Detailed spatial insight of direct and indirect effects ex ante. Comparison of different sets of policy measures ex ante. Quantitative feedback for prioritisation of projects ex ante. "Clean" effects of policy measures without the influence of financial issues.	CGEurope SASI SCENES Study of network effects with NEAC in combination with CGEurope and SCENES
TRANSECON	Evaluation of existing large local urban infrastructure projects. The goal is to improve the existing project CBA.	Quantitative and qualitative ex post analysis (i.e. survey of stakeholders), other models in cluster are ex-post. Incorporation of land use and spatial development, re-urbanisation effects and development supporting policy. Assessment through a multiplier analysis.	-

B.2 Research activities

B.2.1 An overarching framework for appraisal of transport investments and policies

The system of interest is - primarily - the transport-economy system. Figure 2 summarises the actors and markets involved, and sketches some of the linkages between them. The key markets in the wider economy include the product market (for goods and services), the land and property market, the labour market and the capital market. Those participating in these markets can be grouped broadly into Households, Firms and Government, although the reader will no doubt think of other possible groupings. Individual actors in each group have a range of decisions to make, regarding their involvement in the various markets.

Because of the spatial separation of the Households, Firms and Government, the transport market plays a key role in these decisions. Yet in all cases, the demand for transport is a derived demand - derived from the desire to undertake activities at points other than the starting location. Changes in transport prices affect the attractiveness of these activities, and the agents choose with some expectation of these prices in mind.

Figure 2 is greatly simplified in that it suggests all transactions and communications over distance are channelled through the transport market. These physical movements will generally be supplemented by - and in some cases substituted by - telecommunications. In the capital market for example, trade is very often carried out remotely without face-to-face meetings, and with only the bare minimum of physical materials exchanged. Therefore the role of transport prices (in their most general sense) is extensive but not unlimited in its ability to influence trade.

Note also that Figure 2 omits to mention environmental and accident externalities. This is another set of complicating factors which may need to be addressed in forecasting models, and which are certainly of central policy relevance in assessment (CEC, 2001 - the new CTP).

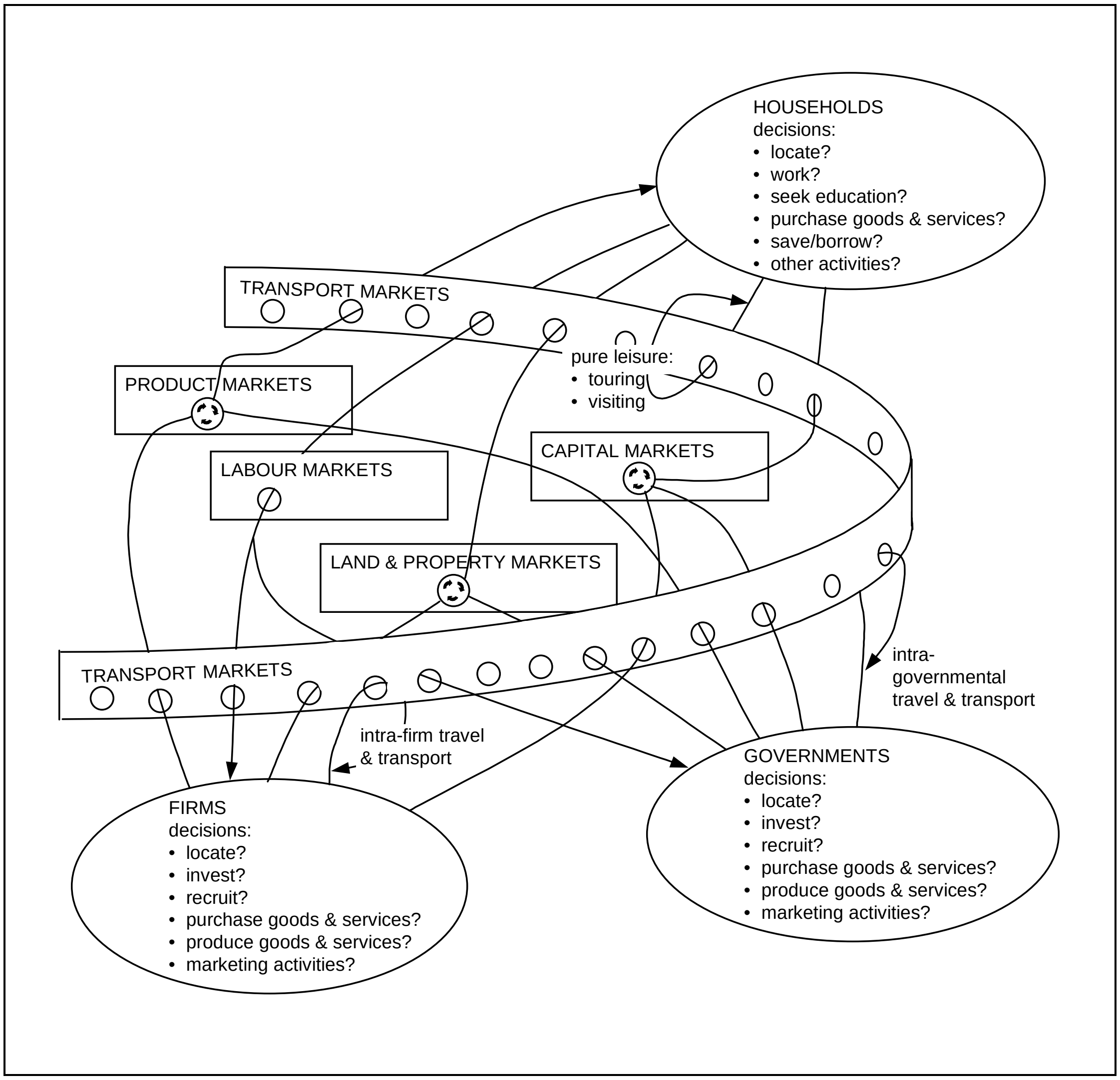

FIGURE 2[3]: LINKAGES WITHIN THE TRANSPORT-ECONOMY SYSTEM

The starting point for the IASON Assessment Baseline is the cost benefit framework as derived from welfare economics. Recent advances in public choice literature may also be of relevance especially when it comes to addressing distributional (equity) impacts of transport projects and policies.

The following issues have been looked at in the light of the theoretical basis:

- handling the direct and indirect impacts of transport projects and policies within a CBA framework;
- dealing consistently with transport impacts and other economic impacts, so as to show the generative effects while avoiding double counting;

[3] Sources: David Simmonds Consultancy/ME&P (1998); IASON partners.

- dealing with the incidence of impacts, including across national borders;
- interfacing with forecasting models;
- providing facilities for risk analysis.

In the work the welfare economic framework has been used within which it is possible to compare the contributions of the various analytical approaches. The framework facilitates the assessment of:
- the quantitative significance of the linkages between direct transport effects and socio-economic effects and the determinants of the relationship between them;
- the incidence of benefits through segmentation of users by type and location and the associated impact on equity and cohesion;
- the capability of the various modelling approaches used in sub-tasks 1-4 to represent the linkage mechanisms described above and to make recommendations for the appropriate use of such approaches in relevant policy contexts.

The framework is a necessary basis for providing an interface between the subtasks and for making recommendations for the assessment of transport investments and policies at the EU level.

Working definitions

- **Direct effects** = effects on behavioural choice within the transport system (route choice, mode choice, departure time choice and destination choice), by users of that part of the network to which the initiative applies.
- **Direct network effects =** effects on behavioural choice within the transport system (route choice, mode choice, departure time choice and destination choice), transferred by network flows to other users of the network who are not themselves users of the part of the network to which the initiative applies.
- **Indirect effects**[4] **=** effects outside the transport market as the result of a transport initiative, typically including the changes in output, employment and residential population at particular locations implied by the choices described above.
- **Indirect network effects =** effects on the transport network of choices made in those other markets (land and property markets, the labour market, product markets and the capital market), as a result of changes in generalised cost brought about by a transport initiative.

B.2.2 Analysis of the network effects of transport policy

The main aim of this subtask is to develop a methodology for the assessment of network effects that stem from a transport system change or improvement. Special attention is paid to cross border effects and effects on nodes and links. The results from the methodology serve as input in a cost-benefit analysis. In this respect several questions can be raised, like:
- What changes and improvements can be identified?
- How can we quantify the changes and improvements?
- What are network effects?
- What are cross border effects?
- What are terminal and intermodal effects?
- How can we define and measure the effects mentioned before?
- How do we have to assess network effects?

[4] Here indirect effects are defined as effects outside the transport market. All models in the IASON/TIPMAC modelling experiment predict total economic effects without distinguishing between direct (within the transport sector) and indirect effects (outside the transport sector). In practice (in some European countries) the results from these types of models are labeled indirect effects (in the sense that total effects are indirectly measured). Policy makers should be aware of the differences in definition. Researchers should be clear about what is incorporated in indirect effects.

- How do network effects serve as input for a cost-benefit analysis?
- What can we learn from other studies and surveys on this subject?

Changes or improvements in transport infrastructure and other policies have several impacts on transport networks and the use of these networks. These impacts (or effects) should be approached in the broadest possible sense looking at the way the user benefits or suffers of these impacts. Also analogies need to be explored with other disciplines and sectors like mathematics, information technology, economy, sociology, physics, electricity, gas, telecommunication, etceteras. After defining the network effects and exploring the analogies, a methodology was developed to assess the network impacts. The methodology is demonstrated for a selection of cases.

Transport network effects are potentially significant from an economic point of view where transport prices do not reflect social marginal costs. In such cases, if demand is transferred towards or away from a part of the transport system, but this is not considered in the appraisal, there will be an unaccounted benefit or loss. Two characteristics of transport systems make this rather likely.
The first is the presence of economics of scale, scope and density, for example in rail and air markets, where prices may well exceed social marginal costs. The second is congestion, found in many transport markets, where prices will typically be less than social marginal costs.
In such circumstances, failure to consider transport network effects will result in an error in the benefit estimate in the appraisal. However, provided that the modelling and appraisal specification is fit for purpose (in terms of study area, modes covered, network and demand representation and so on), then most transport network effects are capable of being captured by conventional transport modelling and appraisal methods. This is our preferred route to considering these effects, namely by quantifying them in a well-specified assessment.

Transport network effects can give rise to situations of super-additivity and sub-additivity (i.e. where the value of the whole is greater or less than the sum of the parts). Super-additivity and sub-additivity will only occur if projects are appraised separately and in the absence of each other, but implemented simultaneously or sequentially. If projects are to be implemented simultaneously or sequentially, either as a package or as separately promoted projects, the correct appraisal should account for all interactions between projects.

B.2.3 Analysis of the spatial and land use impacts of transport investments and policy

B.2.3.1 Introduction

In order to improve the understanding of the impact of transportation policies on short- and long-term spatial development in the EU, the project has gathered empirical evidence about the linkage between the transportation system for goods and for people on the one hand and the dynamics of firm and household location on the other. It has refined and validated existing modelling frameworks for assessing short-term welfare effects as well as long-term locational dynamic implications of transport policy scenarios.

The modelling approaches taken in the project fill part of the framework and focus on the network, spatial and socio-economic impacts of transport policies. They are based on work in the 4th RTD Framework Programme and on recent academic research on a new generation of EU-level spatial economic models with a microeconomic theoretical foundation. The modelling work to a large extent use of databases generated in 4th RTD Framework projects. Output of the modelling work are numerical results on welfare effects, accessibility and locational change in the European Union and in the candidate accession countries in central and eastern Europe plus Norway and Switzerland. The spatial resolution are sufficiently refined for integrating the results into a European system of spatial monitoring. Using the revised models, the project evaluates the compatibility of the spatial implications of transport policy with the spatial 'Leitbilder' (indicative examples) laid down in the ESDP as well as with the objectives of the EFRE and the rural development objectives of the CAP.

B.2.3.2 Possible modelling approaches

There exists a broad spectrum of theoretical approaches to explain the impacts of transport infrastructure investments on regional socio-economic development. Originating from different scientific disciplines and intellectual traditions, these approaches presently coexist, even though they are partially in contradiction (cf. Linnecker, 1997):

- *National growth approaches model* multiplier effects of public investment in which public investment has either positive or negative (crowding-out) influence on private investment, here the effects of transport infrastructure investment on private investment and productivity. In general only national economies are studied and regional effects are ignored. Pioneered by Aschauer (1989; 1993) such studies use time-series analyses and growth model structures to link public infrastructure expenditures to movements in private sector productivity. An increase in public investment raises the marginal product of private capital and provides an incentive for a higher rate of private capital accumulation and labour productivity growth. Critics of these approaches argue that there may be better infrastructure strategies than new construction and that policy measures aimed at increasing private investment directly rather than via public investment will have greater impact on national competitiveness.

- *Regional growth approaches* rest on the neo-classical growth model which states that regional growth in GDP per capita is a function of regional endowment factors including public capital such as transport infrastructure, and that, based on the assumption of diminishing returns to capital, regions with similar factors should experience converging per-capita incomes over time. The suggestion is that, as long as transport infrastructure is unevenly distributed among regions, transport infrastructure investments in regions with poor infrastructure endowment will accelerate the convergence process, whereas once the level of infrastructure provision becomes uniform across regions, they cease to be important. Critics of regional growth models built on the central assumption of diminishing returns to capital argue that they cannot distinguish between this and other possible mechanisms generating convergence such as migration of labour from poor to rich regions or technological flows from rich to poor regions.

- *Production function approaches* model economic activity in a region as a function of production factors. The classical production factors are capital, labour and land. In modern production function approaches infrastructure is added as a public input used by firms within the region (Jochimsen, 1966; Buhr, 1975). The assumption behind this expanded production function is that regions with higher levels of infrastructure provision will have higher output levels and that in regions with cheap and abundant transport infrastructure more transport-intensive goods will be produced. The main problem of regional production functions is that their econometric estimation tends to confound rather than clarify the complex causal relationships and substitution effects between production factors. This holds equally for production function approaches including measures of regional transport infrastructure endowment. In addition the latter suffer from the fact that they disregard the network quality of transport infrastructure, i.e. treat a kilometre of motorway or railway the same everywhere, irrespective of where they lead to.

- *Accessibility approaches* attempt to respond to the latter criticism by substituting more complex accessibility indicators for the simple infrastructure endowment in the regional production function. Accessibility indicators can be any of the indicators discussed in Schürmann et al. (1997), but in most cases are some form of population or economic potential. In that respect they are the operationalisation of the concept of 'economic potential' which is based on the assumption that regions with better access to markets have a higher probability of being economically successful. Pioneering examples of empirical potential studies for Europe are Keeble et al. (1982; 1988). Today approaches relying only on accessibility or potential measures have been replaced by the hybrid approaches were accessibility is but one of several explanatory factors of regional economic growth. Also the accessibility indicators used have become much more diversified by type, industry and mode (see Schürmann et al., 1997). The SASI model is a model of this type incorporating accessibility as one explanatory variable among other explanatory factors.

- *Regional input-output* approaches model interregional and inter-industry linkages using the Leontief (1966) multiregional input-output framework. These models estimate inter-industry/interregional trade flows as a function of transport cost and a fixed matrix of technical inter-industry input-output coefficients. Final demand in each region is exogenous. Regional supply, however, is elastic, so the models can be used to forecast regional economic development. One recent example of an operational multiregional input-output model is the MEPLAN model (Marcial Echenique & Partners Ltd., 1998).

- *Trade integration approaches* model interregional trade flows as a function of interregional transport and regional product prices. Peschel (1981) and Bröcker and Peschel (1988) estimated a trade model for several European countries as a doubly-constrained spatial interaction model with fixed supply and demand in each region in order to assess the impact of the economic integration of Europe in terms of reduced tariff barriers and border delays between European countries. Their model could have been used to forecast the impacts of transport infrastructure improvements on interregional trade flows. If the origin constraint of fixed regional supply were relaxed, the model could have been used also for predicting regional economic development. Krugman (1991) and Krugman and Venables (1995) extended this simple model of trade flows by the introduction of economies of scale and labour mobility. The CGEurope is a model of this type.

B.2.3.3 The SASI model

The SASI model is a recursive simulation model of socio-economic development of regions in Europe subject to exogenous assumptions about the economic and demographic development of the European Union as a whole and transport infrastructure investments and transport system improvements, in particular of the trans-European transport networks (TETN).

The main concept of the SASI model is to explain locational structures and locational change in Europe in combined time-series/cross-section regressions, with accessibility indicators being a subset of a range of explanatory variables. Accessibility is measured by spatially disaggregate accessibility indicators which take into account that accessibility within a region is not homogenous but rapidly decreases with increasing distance from the nodes of the networks. The focus of the regression approach is on long-term spatial distributional effects of transport policies. Factors of production including labour, capital and knowledge are considered as mobile in the long run, and the model incorporates determinants of the redistribution of factor stocks and population. The model is therefore suitable to check whether long-run tendencies in spatial development coincide with development objectives discussed above. Its application is restricted, however, in other respects: The model generates distributive, not generative effects of transport cost reductions, and it does not produce regional welfare assessments fitting into the framework of cost-benefit analysis.

The SASI model differs from other approaches to model the impacts of transport on regional development by modelling not only production (the demand side of regional labour markets) but also population (the supply side of regional labour markets), which makes it possible to model regional unemployment. A second distinct feature is its dynamic network database based on a 'strategic' subset of highly detailed pan-European road, rail and air networks including major historical network changes as far back as 1981 and forecasting expected network changes according to the most recent EU documents on the future evolution of the trans-European transport networks.

The SASI model has six forecasting submodels: *European Developments*, *Regional Accessibility*, *Regional GDP*, *Regional Employment*, *Regional Population* and *Regional Labour Force*. A seventh submodel calculates

Socio-Economic Indicators with respect to efficiency and equity. Figure 3 visualises the interactions between these submodels.

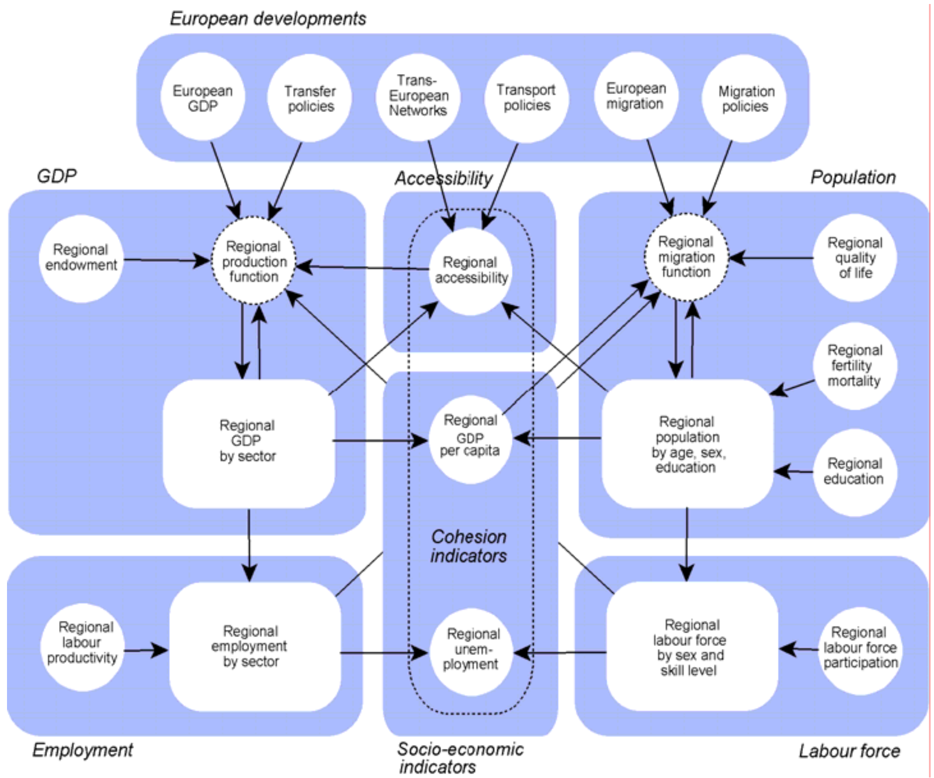

FIGURE 3: THE SASI MODEL

The spatial dimension of the model is established by the subdivision of the European Union and the 12 candidate countries in eastern Europe in 1,245 regions and by connecting these regions by road, rail and air networks (see Annex). For each region the model forecasts the development of accessibility, GDP per capita and unemployment. In addition cohesion indicators expressing the impact of transport infrastructure investments and transport system improvements on the convergence (or divergence) of socio-economic development in the regions of the European Union are calculated.

The temporal dimension of the model is established by dividing time into periods of one year duration. By modelling relatively short time periods both short- and long-term lagged impacts can be taken into account. In each simulation year the seven submodels of the SASI model are processed in a recursive way, i.e. sequentially one after another. This implies that within one simulation period no equilibrium between model variables is established; in other words, all endogenous effects in the model are lagged by one or more years.

The mathematical specification of the original SASI model is contained in EUNET/SASI Deliverable 8 (Wegener and Bökemann, 1998). The implementation of the original SASI model, i.e. the application of empirical data to it and the estimation and calibration of its parameters, was described in EUNET/SASI Deliverable 11 (Fürst et al., 1999). The software system of the original SASI model was described in EUNET/SASI Deliverable 13 (Wegener et al., 2000a). The results of the demonstration scenario simulations with the original SASI model were presented in EUNET/SASI Deliverable D15 (Fürst et al., 2000).

In IASON, the SASI model was updated and extended in several dimensions relating to *model theory*, *model data* and *model technique*. Below, these model extensions are summarised.

New ideas from growth theory as well as new evidence on firm location was reviewed and transformed into operational indicators of locational advantage and disadvantage and incorporated into the econometric approach. The following changes were implemented:

- *Rates v. levels*. The traditional production function approach relates the *level* of output to the *level* of infrastructure. New growth theory suggests that a link might also exist between the level of infrastructure and the *rate* of growth, because good accessibility means good access to diversity making research and development more productive. This effect is incorporated into the model functions by exploring the feasibility of forecasting *rates* of change of regional economic development rather than the *levels* of regional production,
- *Productivity*. The feasibility of forecasting regional sectoral labour productivity endogenously as a function of accessibility and other variables instead of using exogenous productivity forecasts is explored.
- *Accessibility*. In the accessibility calculations, not only travel time but also transport costs are considered. The possibility to explicitly consider wage levels and/or production costs of potential suppliers in other regions in the accessibility submodel is examined. This will enhance the contribution of the accessibility indicators to the explanation of regional economic development in the regional production functions.
- *Policies*. The model was made more responsive to non-transport policies, such as regional economic policies or immigration policies, and to a broader range of transport policies, such as policies addressing intermodality and congestion.
- *Cohesion indicators*. The cohesion indicators used for assessing the impacts of transport policies were expanded and critically assessed with respect to their possible implicit bias towards convergence and divergence. One of the findings of the SASI project was that the choice of cohesion indicator, i.e. whether relative or absolute differences are calculated, is critical for whether transport infrastructure projects have a cohesion effect or contribute to spatial polarisation.

A Common Spatial Model Database was created to be used by both the CGEurope and the extended SASI model. This incorporated the following steps:

- *Disaggregation*. The existing SASI regional model database was disaggregated from 201 NUTS-2 regions to 1,083 NUTS-3 regions in the present 15 member states of the European Union, introducing six economic sectors instead of the previous three. The following six economic sectors were considered:
  - Manufactured products
  - Market services
  - Agriculture, forestry and fishery products
  - Fuel and power products
  - Building and construction
  - Non-market services
- *Updating*. The resulting 1,083-region database was updated to include more recent data.
- *Extension*. The database for calibration/validation was extended by additional variables, such as labour productivity and wage levels and/or production costs by sector.
- *Candidate countries*. A similar model database for the 162 regions in the 12 candidate countries (see Annex) was established.
- *Transport networks*. The road, rail, air and inland waterway transport networks to be used by the two models were refined, extended and updated to include the 12 candidate countries and the related extensions of the trans-European networks, to connect the new high-resolution system of regions and to incorporate expected network changes after 2016 until 2021.

One of the results of the SASI project was that the state of the art of calibrating and validating dynamic models of the kind of SASI *over time* is poorly developed. Efforts are therefore made to calibrate and validate the extended SASI model with time-series data of regions and countries, also with respect to model variables not considered as output indicators.

In addition, work on the extension of the SASI model software system was done in three respects:

- The model dimensions were extended to incorporate the new system of regions with up to 1,500 regions.
- The model software was ported to a software development environment with full Windows integration with multiple windows, dialog boxes and pull-down menus.
- The graphical user interface of the model was enhanced by visual output in the form of online time-series plots, choropleth maps and 3D representations of spatial distributions, as well as offline comparison between simulated scenarios.

B.2.3.4 The CGEurope model

Introduction

CGEurope is a multiregional, and in its extended version developed for IASON multi-sectoral, computable general equilibrium model, incorporating innovative features from recent developments in the literature like product diversity and monopolistic competition, explicit modelling of out-of-pocket as well as time costs of business transport as well as private passenger transport. The way transport cost changes are modelled in this framework is as follows. After having calibrated the model such that the data of a benchmark year are reproduced, transport costs or travel times are changed exogenously and the new equilibrium system is solved. The main indicator for the regional consequences one is looking at is the welfare change of regional households, as measured by the households' utility functions. Though an ordinal utility index as it stands has no operational meaning, it can be transformed to the so-called Hicks measures of variation. They measure the welfare change in monetary terms. CGEurope is confined to the regional welfare effects resulting from the use of the transport infrastructure. Effects from the construction phase, from financing and maintenance are not considered. We also do not include local traffic including commuting, even if it is commuting over longer distances crossing the borders of the regions in our system.

Model description

CGEurope is a multiregional model for a closed system of regions, treating separately each region and linking them through endogenous trade. The world is subdivided into a large number of regions . Each region shelters a set of households owning a bundle of immobile production factors used by regional firms for producing goods and services. The new version of CGEurope distinguishes six different sectors, five of which are tradable and one non-tradable (local) good. Beyond factor services, firms also use local goods and tradables as inputs. The firms in a region buy local goods from each other, while tradables are bought everywhere in the world, including the own region. Produced tradables are sold everywhere in the world, including the own region. Free entry drives profits to zero; hence, the firms' receipts for sold local goods and tradables equal their expenditures for factor services, intermediate local and tradable goods and transport.

Regional final demand, including investment and public sector demand, is modelled as expenditure of utility maximising regional households, who spend their total disposable income in the respective period. Disposable income stems from returns on regional production factors, which, by assumption, are exclusively owned by regional households, and a net transfer payment from the rest of the world. This transfer income can be positive or negative, depending on whether the region has a trade deficit or surplus. Transfers are held constant in our simulations. Introducing fixed interregional income transfers is a simplified way to get rid of a detailed modelling of interregional factor income flows, and of all kinds of interregional flows of private and public funds. Households expend their income for local and tradable goods as well as for travel. The vector of travel demand is differentiated by purpose of travel and destination. Households gain utility from a set of activities connected with travel (like tourism) and suffer from disutility for spending travel time.

The factor supply is always fully employed due to the assumption of perfect price flexibility, which implies the assumption that the rate of unemployment remains unaffected by the exogenous influences under study. Analysing effects on unemployment requires a deeper study of the structure of labour markets, which is not part of this project. We assume complete immobility of factors, which means that interregional factor movements as a reaction to changing transport costs is not included. The other extreme assumption would be perfect factor mobility, but this is not realistic. Immobility is taken as a first approximation for short-term effects. The best choice would be mobility, but an imperfect one. There are ways of introducing such an assumption, but theoretically consistent approaches require forward-looking dynamics, which are too complicated to be introduced into our model in the present stage of its development.

Firms representing production sectors are of two kinds, producers of local goods and producers of tradables. Each local good is a homogeneous good, though one equivalently may regard it as a given set of goods, such that the good's price is to be interpreted as the price of a composite local good. The market for tradables, however, is modelled in a fundamentally different way. Tradables consist of a large number of close but imperfect substitutes. The set of goods is not fixed exogenously, but it is determined in the equilibrium solution and varies with changing exogenous variables. Different goods stem from producers in different regions. Therefore, relative prices of tradables do play a role. Changes of exogenous variables make these relative prices change and induce substitution effects.

Households act as price taking utility maximisers. They have a nested CES utility function representing substitution between goods and travel activities, between goods from different sectors, between different kinds of travel activities, between destinations for each kind of travel and between varieties for each kind of goods. In the disutility version for modelling the burden of travel time, a travel time disutility is subtracted from the households' utility function in an additive separable format.

Firms maximise profits. Local goods producers take prices for inputs as well as for local goods sold to households and other firms as given. The production functions are linear-homogenous nested-CES functions. The lowest CES nest makes a composite out of the bundle of tradables. For the sake of simplicity, it is assumed to be identical for all users and to be the same as the respective CES nest in the households' utility function. Due to linear homogeneity, the price of local good equals its unit cost obtained from cost minimisation under given input prices.

Tradable goods producers take only prices for inputs as given. They produce a raw output by a technology designed in the same way as for local goods producers. Instead of directly selling their output, however, they transform the homogeneous raw output into a final differentiated output. The respective technology is increasing returns, with a decreasing ratio of aver-age to marginal input. Firms are free to compete in the market for a tradable good, which al-ready exists, or to sell a new one not yet in the market. The latter turns out to be always the better choice. Hence, only one firm monopolistically supplies each good, which is aware of the finite price elasticity of demand for the good. The firm therefore sets the price according to the rules of monopolistic mark-up pricing. This choice, of course, is only made if the firm at least breaks even with this strategy. If it comes out with a positive profit, however, new firms are attracted opening new markets, such that demand for each single good declines until profits are driven back to zero.

This is the well-known mechanism of Chamberlinian monopolistic competition determining the number of goods in the market as well as the quantity of each single good (see Krugman, 1993, Fujita et al., 1999, Bröcker, 1998a). Due to free entry, the price of a tradable good just equals its average unit cost. It turns out that under the assumption of a constant price elasticity of demand for each variety of goods, which is valid in our framework, output per variety is also constant, such that output variations come in the form of variations in the number of varieties, and real output is the endogenous measure of variety.

Certainly, assuming local markets to be perfectly competitive lacks empirical plausibility. Local goods producers may in fact exert some monopoly power, local goods might be diversified, just like tradables, et cetera. The reason why this assumption is nevertheless preferred is that this is the simplest way to get rid of the local sectors, which only play a secondary role in an analysis focusing on interregional trade. Another choice without major technical problems would be to assume monopolistic competition for the local sectors as well. This, however, is not recommended, because it introduces a size-of-region effect. Large regions in our system (like the Asian part of Russia, for example) would support a high diversity of local goods, generating an unrealistic low prices of composite local goods, given the factor price(s) and technology in the region.

Three features give the CGEurope model its spatial dimension:

- the distinction of goods, factors, firms and households by location,
- the explicit incorporation of transport cost for goods (and services, regarded as a special kind of goods), depending on geography as well as national segmentation of markets, and
- the explicit incorporation of private passenger travel, with time costs and out-of-pocket costs depending on geography as well as national segmentation of space.

Summarising the basic philosophy of our approach, it obviously strongly relies on neo-classical ideas, even though it departs from the traditional computable general equilibrium approach by allowing for imperfect markets. In other respects, however, the strictness of neo-classical assumptions is retained: firms and households act perfectly rationally, prices are flexible, and markets are cleared, including labour markets. Though these assumptions are often criticised for contrasting with reality, there is no better choice. Even if households don't maximise utility subject to a budget constrained, it is not questioned that they react on prices and that the budget constraint must eventually hold. Neo-classical demand theory is just an easy way to represent these reactions consistently in a formal way. Similar comments apply to modelling reactions of firms.

The issue is not whether the model is close to reality; no model will ever be so. The issue is which is the best way to represent fundamental mechanisms detected by theory in a quantitative approach. In this context, marginal returns of making a model more complicated have to be traded off against marginal costs. More realistic models like large-scale econometric or input-output models with many sectors might offer a more realistic description, but are much more expensive and offer less possibilities for studying the interaction between prices and quantities in a theoretically consistent framework.

Model extensions in IASON

Compared to the previous version of CGEurope (for a description see Bröcker, 1998a) the new version to be implemented in IASON is extended in the following respects:

- The previous version had only two sectors (tradable and non-tradable), while the new one differentiates between six sectors, including one sector producing the transport service using factors and intermediate inputs.
- The previous version took only transport costs in interregional trade into account, while the new one also includes costs of private passenger travel.
- The new version of CGEurope models the use of resources for transport in a more sophisticated way than the previous one by including explicitly an activity producing the transport service.
- Finally, the transport network from which the cost measurement is derived is much more re-fined, based on the networks developed within SASI, SCENES and ETIS.

Since the start of IASON, we have developed the new model version in a way that allows for calibration with existing data. In particular, the following tasks have been successfully carried out:

Sectoral and regional coverage

Definition of new sectors and regions. The previous version of CGEurope covered 805 regions for one tradable and one non-tradable manufacturing sector only and was based on Eurostat's Regional Accounts. The extended version developed over the last seven months covers six activities (including services) and a wider range of regions – 49 countries and country groups and 1,341 regions (for a detailed description see the annex). Taking data availability into consideration, however, it will not be possible to have results with full sectoral detail and full regional detail at the same time. It is therefore necessary to run two different versions of the model, one with aggregated regions, and another with full regional detail but aggregated sectors.

Model structure

Setting up the system of equations describing the multi-sectoral system of the new model. The main problem, which had to be solved, was to design the model in a way allowing calibration with limited information on a sub-national regional scale.

Travel demand

Developing a new approach to model passenger travel behaviour in a microeconomically consistent framework that can consistently be integrated into the general equilibrium context. In particular, we had to include monetary travel costs as well as time costs into this frame-work, because time costs are an important determinant of travel behaviour and the change of time costs is an essential element of households' welfare. We succeeded in fulfilling three requirements, namely (1) to derive behaviour and welfare measures from one single theoretical formulation, (2) to specify travel preferences in a way that observed dispersed travel behaviour can realistically be reproduced, and (3) to make things sufficiently simple such that the parameters can be calibrated with minimum data requirements. We need data for expenditure shares for interregional travel (excluding commuting and other kinds of local travel) and for interregional travel flows in quantity terms. The latter may also be rough estimates based on gravity-like hypotheses. For a rough technical explanation of the theory of household behaviour applied in the new model version, see the two following sections.

Calibration

Developing a calibration procedure working with a limited database without a full multiregional social accounting matrix. In this respect, our approach deviates from available work in the fields of computable general equilibrium modelling. Usually one has original or derived full information about monetary flows between each agent (firm or household) in each region for the benchmark year. This covers trade by sector between firms, trade between firms and households, factor expenditures flowing from firms to households and interregional capital flows, it will be impossible to obtain a full data-base at a sub-national (NUTS-2) level. Hence, we have developed a different approach, effectively combining information on the distribution of sectoral output by region with national and international information on national accounts and international trade (see the following section). We assume identical preferences and technologies for different regions within one nation, such that national information is sufficient for calibrating technology parameters (for a full technical description see Bröcker, 1995, 1998a and 1998b).

Interregional trade on the sub-national level is not observed either, but derived from the calibrated equilibrium solution. The essential hypothesis in this context is that customers of traded goods substitute between varieties stemming from different regions, taking prices and interregional transaction costs into account. These transaction costs also include international trade impediments (cross-border effects), which are indirectly quantified by adjusting estimated trade flows to the international totals available from international trade statistics. Even though these calibration techniques have already been used in the former CGEurope, applying them in the extended multi-sectoral framework is much more complicated, and we had to set up the nonlinear system of calibration equations needed to solve this problem. The solution algorithms for this system envisaged still wait for their test in the large real world application.

B.2.3.5 SASI and CGEurope: a comparative perspective

The effects of policies on the spatial distribution of GDP are modelled by the SASI model. In particular, the results of the SASI model provide new insights into the effects of TEN investments or SMCP policy on the Gross Regional Product, regional unemployment and accessibility of regions.

The welfare generation effects are modelled by the CGEurope model. The results of the CGEurope model give an answer to the following questions important to policy makers with regard to the effects of TEN investments or SMCP policy to regions in the European Union and accession countries:

- What is the impact on regional welfare increases as a result of indirect effects?
- What are the changes in goods prices in the regions and how do the changes differ per sector?
- What is the impact on income and consumption of households?
- What is the impact on consumption in regions for different economic sectors?
- Does the policy increase cohesion or is it anti-cohesion?

In SASI a policy scenario is a time-sequenced programme for addition or upgrading of links of the trans-European road, rail and air networks or other transport policies, such as different regimes of social marginal cost pricing between 2001 and 2021. For CGEurope, a policy scenario consists of the rail, road and air travel and freight cost matrices reflecting the network with the network or pricing policies implemented, which can be combined with either 1997 or 2020 regional data.

Both models used the same system of regions, the same network data and a common database of regional socio-economic data to examine the above policy scenarios. Both models forecast changes in regional GDP per capita in 2020 induced by the policies, or more precisely, differences in regional GDP per capita between the policy scenarios and the reference scenario in 2020. The results of the two models can therefore be compared.

Both models, the SASI model and the CGEurope model, were applied to examine the same set of 18 transport policy scenarios, described in the next section. For 5 out of the 18 IASON scenarios the SCENES model was applied too, as many of scenarios concern infrastructure investment for which the SCENES model itself is not too reactive. In the TIPMAC project 4 scenarios were defined, which were evaluated with E3ME-SCENES and ASTRA, 2 TIPMAC scenarios were implemented in IASON as well (see next section).

Analysing the relationship between and the size of direct and indirect effects of transport policy presents one of the objectives of the IASON project. For this purpose the models of the IASON-TIPMAC project cluster are analysed concerning the direct and indirect effects they are covering. In D8 the specific reactions of these models to the IASON or TIPMAC policy alternatives are shown. In the core of the analysis are the economic indirect effects including distributional effects. Environmental effects and accidents, though being also indirect effects, are excluded as it is assumed that this is dealt with considerably in current CBA practice, though still not necessarily exhaustive. But the issue of possibly including economic indirect effects into CBA by using sophisticated and large scale modelling approaches is rather new.

B.2.4 Case study scenarios

In this section an overview is given on the different policy scenarios used within IASON. The scenarios are based on the White Paper on the European Transport Policy for 2010: Time to decide. Beside scenarios developed within IASON, a common set of scenarios was developed in conjunction with the TIPMAC project. We describe these first.

TIPMAC scenarios

Scenarios analysed in TIPMAC are developed in close communication with Commission services to reflect today's policy requirements, in D1 of TIPMAC these scenarios are described in detail. Baseline for policy analysis is provided by the business-as-usual scenario (BAU). The BAU scenario includes policy measures defined by the White Paper on the European Transport Policy (ETP) (CEC 2001) and implementation of the Trans-European Transport Networks (TEN) according to current time plans. TEN investments in BAU are financed by national budgets and fuel tax. Three main scenarios are compared against BAU. They comprise a faster implementation of TEN financed by increased fuel tax; secondly a faster implementation of TEN financed by Social Marginal Cost Pricing (SMCP) of all transport plus refunding the remaining revenues to the consumers via income tax reductions; and thirdly introduction of SMCP plus refunding via income tax reductions leaving the TEN implementation unchanged as in BAU. In the scenarios including SMCP existing road tolls are abolished.

Each scenario is characterised by coupling specific options concerning timing and type of investment in the completion of the Trans European transport Network programme (TEN-T) with alternative strategies that can be considered for its funding.

1) The reference, or Business-As-Usual, scenario describes a do-nothing context in which, in the absence of further Commission action, future evolution in transport demand and supply is the result from continuation into the future of past trends. Within EU regulation on place in year 2001, the evolution of the status quo scenario reflects a variety of national approaches to transport taxation, charges and investment. In such a BAU context, investment on the TEN-T projects is spotted among different projects that are assumed to be completed until 2020.
2) On the basis of the reference scenario, a first scenario variant is designed to test macroeconomic impacts of completing the same amount and type of TEN investments as scheduled in the Reference Scenario in a context in which Social Marginal Cost Pricing (SMCP) is adopted as the key criterion to harmonise infrastructure pricing in the EU.

Two alternative scenarios are then designed, each one conceived to anticipate investment; so that all core TEN-T projects are in operation by year 2020. Also the impacts of an anticipated completion of core TEN-T projects are tested against alternative options to raise the resources necessary for their funding:

1) In a variant of 'quick core TEN-T scenarios, the bulk of additional funds is made available by means of increasing taxation on fuel.
2) In the other variant, infrastructure charges are levied at social marginal costs.

A synthetic description of key options in each one of the four scenarios is reported in table 2. Comparing the impacts of the three alternative scenarios against the Business-as-Usual reference scenario will allow for identifying the cost of delayed, partial completion of strategic transport investment in the Union as well as for assessing macroeconomic impacts of alternative fiscal and pricing strategies to fund such investment.

TABLE 2: DESCRIPTION OF THE FOUR TIPMAC SCENARIOS

	1 **Business-as-Usual**	**2** **Social marginal cost pricing**	**3** **TEN-T core projects speed up + fuel tax**	**4** **TEN-T core projects speed up + social marginal cost pricing**
ETP2010	*All and only those measures that do not require significant changes in national transport policies*			
TEN-T core projects	*Slow implementation* *All completed by 2020*		*Fast implementation* *All completed by 2020*	
EU contribution to TEN-Ts	*Spread over all TEN-Ts*		*Concentrated on core projects* *20% EU contribution*	
Other sources of investments	*National budgets*	*SMCP revenues* *National budgets*	*Fuel tax revenues*	*SMCP revenues* *National budgets*

In the table below the average levels of charging according to the TIPMAC SMCP scenario is given. The TIPMAC figures for SMCP charges are based on UNITE and RECORDIT[5].

TABLE 3: DETAILED TIPMAC SMCP SCENARIO (CHARGING IN EUROCENT PER PASSENGER/TONKILOMETRE)

P/G	MODE	EU15	AT	BE	CH	DE	DK	FI	FR	GR	IR	IT	LU	NL	NO	PT	SP	SW	UK
Goods	HGV	2.40	2.73	2.52	1.53	2.03	1.90	1.85	2.60	1.99	1.97	3.98	3.19	2.66	2.63	2.05	2.57	2.52	1.32
Goods	Medium Truck	6.48	7.37	6.81	4.14	5.47	5.13	5.01	7.03	5.39	5.32	10.73	8.61	7.19	7.10	5.54	6.95	6.81	3.57
Goods	Rail	0.28	0.31	0.35	0.30	0.35	0.28	0.15	0.46	0.19	0.22	0.34	0.35	0.32	0.29	0.18	0.22	0.17	0.25
Goods	IWW	0.26	0.35	0.38	0.37	0.31		0.12	0.38			0.31	0.38	0.34				0.15	0.23
Goods	SSS	1.21		2.01		1.20	0.58	0.25	2.56	2.30	0.37	1.73		0.38	0.43	0.72	0.60	0.70	0.43
Passengers	Car	5.94	7.36	4.61	6.87	7.13	5.23	4.31	7.70	5.71	5.11	6.54	8.61	6.47	6.88	4.49	5.42	3.33	3.07
Passengers	Bus/Coach	2.49	3.13	3.21	3.21	2.79	2.06	1.39	3.39	2.15	1.64	2.86	3.56	2.76	2.00	1.67	2.08	1.57	2.42
Passengers	Train	1.56	2.07	1.83	1.90	1.72	1.77	0.76	1.68	1.00	1.36	1.62	1.83	1.69	1.82	1.01	1.18	1.90	1.48
Passengers	Ferry	1.90	-	2.14	2.51	2.07	2.18	1.80	2.02	1.23	1.74	1.99	2.14	2.01	2.29	1.26	1.44	1.89	1.80
Passengers	Air	3.73	3.93	4.07	4.57	4.03	3.88	3.39	3.93	2.40	3.18	4.27	3.84	6.44	3.99	2.49	2.76	3.32	3.64

IASON Scenarios[6]

The IASON scenarios are based on pricing and infrastructure policy measures:

- Implementation of Social Marginal Cost Pricing
- Implementation of the Trans European Network (especially of the TEN priority projects)

The IASON scenarios are meant to evaluate the isolated effects of a specific set of policy measures without the effects of funding the infrastructure projects or the spending of the revenues of the pricing policy. This is in contrast to the macro-economic approach followed in TIPMAC scenarios where the finance loop is closed. In this way the effects of the policy measures can be evaluated without this bias of the arbitrary method how to finance or how to spend the revenues. On the other hand it does not consider the macroeconomic effect of the financing position. The results of TIPMAC show that this has a considerable impact. The models used in IASON for the case studies are the SASI and CGEurope models to measure the indirect effects and the SCENES model

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[5] TIPMAC Transport infrastructure and policy: a macroeconomic analysis for the EU Deliverable D1: Common assumptions and scenarios, 2002

[6] In annex 1 a detailed description of the IASON scenarios is included

to measure the direct transport effects. Table 4 gives an overview of the different scenarios and which models were used.

TABLE 4: OVERVIEW OF IASON SCENARIOS

Group	A	B	C	D	E
Title	Trans European Network (TENs) + TINA	Social Marginal Cost Pricing	Combination Pricing + TENs	Dedicated Rail Freight Network	TIPMAC scenarios
Scenarios	7 + 5 "van Miert scenarios"	2	1	1	2
Models applied	SASI/CGEurope	SCENES / SASI → CGEurope	SCENES / SASI → CGEurope	SASI→CGEurope	SASI → CGEurope SCENES already in TIPMAC

SMCP scenarios

The pricing scenarios (B- and C-scenarios) of IASON are based on the External Costs of the RECORDIT project. The principle of social marginal cost pricing entails that each transport unit (truck, bus, car, train etc.) should pay for:

- marginal costs of infrastructure damage;
- marginal external cost of air pollution and global warming;
- marginal external cost of accidents;
- marginal external cost of noise;

but should not pay for/receive:

- the fixed costs of infrastructure provision (including investments);
- any other taxes/subsidies over and above the applicable rate of VAT.

In the IASON B- and C-scenarios, the SMCP figures are spatially distributed using population density (for HGV see figure 4) and are introduced on top of existing fiscal charges.

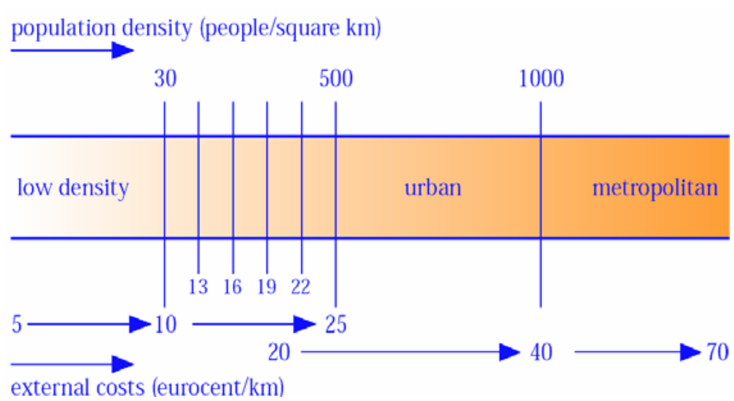


FIGURE 3: EXTERNAL COSTS FOR HGV BASED ON POPULATION DENSITY (SOURCE RECORDIT)

In the table below the average charging levels, as resulting from applying the method of applying spatially differentiated charging levels, are given. The rationale for applying a spatial differentiated scheme based on population density is that external costs vary with the population density as was supported by RECORDIT (FP5 project)[7].This is different approach than followed in the TIPMAC scenario where one average level for the entire country is applied. Besides also the opportunity was taken to correct some of the inconsistencies resulting from applying within the TIPMAC pricing scenario[8].

TABLE 5: DETAILED IASON SMCP SCENARIO (CHARGING IN EUROCENT PER PASSENGER/TONKILOMETRE)

Mode	EU15	AT	BE	DE	DK	FI	FR	GR	IR	IT	LU	NL	PT	SP	SW	UK
Heavy Truck	1,45	1,30	2,20	1,90	1,60	0,75	1,60	1,30	1,30	1,60	1,60	2,50	1,60	1,30	0,75	1,90
Medium Truck	3,92	3,51	5,94	5,13	4,32	2,03	4,32	3,51	3,51	4,32	4,32	6,75	4,32	3,51	2,03	5,13
Car	2,82	2,26	4,00	6,50	4,31	1,22	3,14	2,13	2,14	2,00	2,59	5,81	3,38	0,62	1,16	2,21
Bus/Coach	1,78	1,40	3,49	3,15	2,10	0,47	2,38	1,53	0,90	1,33	1,51	3,08	1,55	0,38	0,59	3,94
Rail	0,62	0,56	0,95	0,77	0,60	0,43	0,58	0,53	0,49	0,71	0,65	1,06	0,58	0,53	0,44	0,79
Train	1,99	2,80	2,73	1,99	1,83	2,05	2,47	1,55	1,46	1,96	1,92	3,05	1,66	1,54	1,99	2,43
IWW	0,31	0,35	0,38	0,31	0,00	0,12	0,38	0,00	0,00	0,00	0,43	0,34	0,00	0,00	0,15	0,00
SSS	1,02															
Ferry	3,69															
Air	3,90	3,96	4,03	4,06	3,91	3,41	3,96	2,42	3,20	4,29	5,64	6,47	2,50	2,78	3,35	3,67

Overview of SASI and CGEurope Scenarios

The scenarios simulated with the SASI and CGEurope models can be classified into six categories (for detailed information about these scenarios see Deliverable 6):

- Reference Scenario. Scenario 000 is the base or reference scenario serving as the benchmark for the comparisons between the results of the policy scenarios.
- Network scenarios. Scenarios A1 to A62 implement different assumptions on the further development of the European transport networks, i.e. they vary in the number, selection and timing of implementation of network links.
- Pricing scenarios. Scenarios B1 and B2 examine different schemes of social marginal cost (SMC) pricing. They differ in the kind of pricing regime. These scenarios do not implement any network development, i.e. the pricing scenarios are applied to the networks of the reference scenario.
- Combination scenario. Scenario C1 is a combination of network scenario A1 and pricing scenario B2.
- Rail freight scenario. Scenario D1 assumes the development of a dedicated rail freight network in Europe.
- TIPMAC scenarios. Scenarios E1 and E2 represent combinations of network and pricing scenarios corresponding to the assumptions made in the TIPMAC project.

Table 6 presents a list of all scenarios, subdivided into these six categories with a brief description of their main features.

[7] REAL COST REDUCTION OF DOOR-TO-DOOR INTERMODAL TRANSPORT Deliverable D6: Imbalances and inefficiencies of the current pricing System, 2002).

[8] According to the TIPMAC some countries with low population densities would have on average higher charges than the more dense populated countries.

TABLE 6: DETAILED IASON INFRASTRUCTURE SCENARIOS

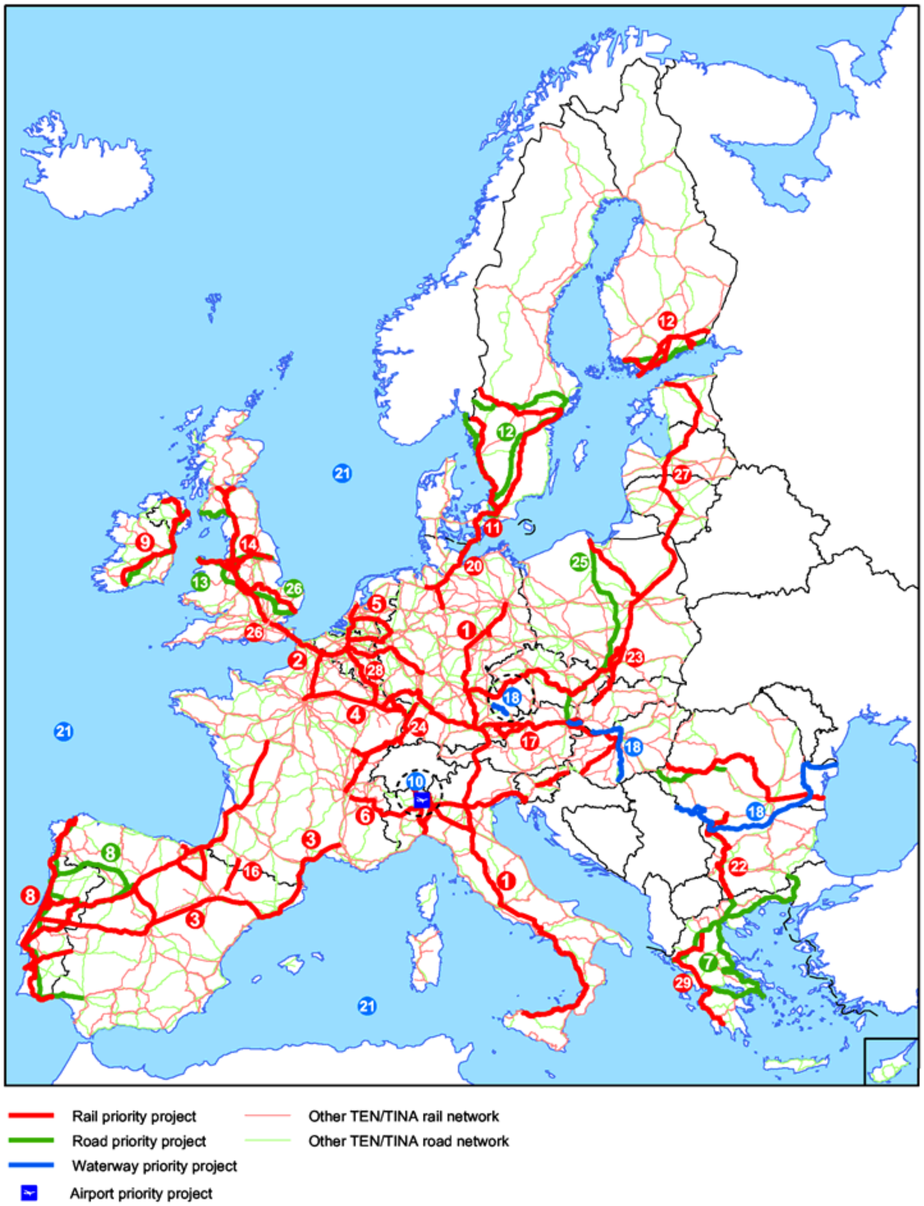
Scenario	Code
000 Reference scenario	
Reference scenario	000
A Network scenarios	
Implementation of all TEN priority projects (Essen list)	A1
Implementation of all high-speed rail priority projects (Essen list)	A21
Implementation of all conventional rail priority projects (Essen list)	A22
Implementation of all road priority projects (Essen list)	A23
Implementation of all rail priority projects (Essen list)	A24
Implementation of all TEN and TINA projects	A3
Implementation of all TEN projects	A4
Implementation of new priority projects	A51
Implementation of new priority rail projects	A52
Implementation of new priority road projects	A53
Scenario A3 plus implementation of additional projects in candidate countries	A61
Scenario A3 plus implementation of maximum projects in candidate countries	A62
B Pricing scenarios	
SMC pricing applied to road freight	B1
SMC pricing applied to all modes (travel and freight)	B2
C Combination scenario	
Scenario A1 plus Scenario B2	C1
D Rail freight scenario	
Dedicated rail freight network	D1
E TIPMAC scenarios	
TIPMAC business-as-usual scenario	E1
TIPMAC fast implementation scenario	E2

At the time of carrying out the IASON project the “van Miert group” or the High-Level Group on the trans-European transport (TEN-T) came with a revision of the TENs and provided a new list of priority projects. By "new list" we mean the new priority projects as specified in the proposal of the Commission COM(2003) 564 final[9]. These are included in the three additional scenarios:

A51 All TEN priority projects (new list);
A52 All TEN rail priority projects (new list);
A53 All TEN road priority projects (new list).

Because these new priority projects include projects from the TINA network, they were not included the full set of TINA projects in the three additional scenarios but in 2 separate scenario’s (A61 and 62). The figure below shows a map of the priority projects.

[9] available at the TREN website at http://europa.eu.int/comm/ten/transport/revision/doc/revision_1692_com_2003_0564_en.pdf



SCENES scenarios

As described in the introduction, the SCENES model is used to measure the direct transport effects of a policy measure. Because of the large effort it takes to run the model, the three most important IASON scenarios were chosen to run with the SCENES model to measure the direct effects of transport pricing and investment in infrastructure (TENs).

1. SMC pricing applied to road freight (IASON B1-scenario): Road freight traffic causes externalities such as air pollution, accidents, congestion, noise, etc. What would be the impacts of a charging regime in which road freight traffic fully covered its external costs? To inform the debate, a charging regime derived from external cost estimates from RECORDIT has been tested using the SCENES Regional Economic and Transport Model (SCENES 2001a, 2001b), for the year 2020. The model compares a base scenario against an alternative scenario that includes the charging. As described the population density (on NUTS2 level) is

used to determine the level of the charging. This scenario is described in more detail in IASON Deliverable 7.

2. SMC pricing applied to all modes (IASON B2-scenario): Is basically the same as the pricing scenario only applied to road freight but includes all other modes as well based on the SMC figures of the RECORDIT project.

3. SMC pricing applied to all modes and fast implementation of the TEN priority projects (IASON C-scenario) is a combination scenario where the effects of pricing can be evaluated together with the implementation of the TEN priority projects.

Network effects case studies
The purpose of these case studies is to test the methodology for the assessment of network effects stemming from a transport initiative by means of a case study and to provide results that support the case study on the indirect effects of transport pricing with CGEurope and SASI. This work is described in more detail in IASON Deliverable 7.

To investigate transport network effects, a case has been selected to test the methodology of transport network effects. This case comprises all the projects in three TEN corridors. These corridors are (1) Paris – Bratislava, (2) Berlin – Messina and (3) Lyon – Budapest. The first and third corridor are east-west corridors and more or less parallel. The second corridor is north-south directed.

B.2.5 Comparable Scenarios

In IASON and TIPMAC the SCENES model is used to assess the direct transport effects. In IASON the focus is on the spatial economic indirect effects. As described a Computable Spatial General Equilibrium (CGEurope) and a spatial economic model (SASI) are used in IASON. These models have a high spatial detail and can produce results of the effect of the policy measure on the improvement on regional accessibility and how welfare is distributed spatially over regions, and therefore they can give results on the improvement of cohesion as a result of policy measures. The focus in TIPMAC is on indirect macro economic effects stemming from the policy measures. A macro-economic model (E3ME) is used in combination with a transport network model (SCENES) and separately a system dynamics model (ASTRA) is used to compare with a standard macro economic analysis.

The Common Transport Policy as described in the White Paper "European transport policy for 2010, time to decide" and the most recent planning documents on the TEN and TINA networks is used as basis for the scenario definition. In IASON and TIPMAC different scenarios are defined and are built on two themes:

- Implementation of TEN priority projects
- Implementation of Social Marginal Cost Pricing

An overview of the scenarios and models that were included in IASON and TIPMAC is listed in the table below. In the annex an overview of the different SMCP schemes used is given, the distinction is that within IASON a regional differentiated charging scheme is adopted according to the population density. Within TIPMAC the charge is valid for the whole territory within a country. In the annex an overview of the TEN priority projects is given, the majority concerns railway projects. As it can be observed in the table below, comparisons between the models can be made for the TIPMAC scenarios E1 and E2.

TABLE 7: OVERVIEW OF MODELS AND SCENARIOS USED IN IASON (A1, B1, B2, C, E1, E2) AND TIPMAC

	A1[10]	B1	B2	C	E1 (TIPMAC BAU)	E2 (TIPMAC FAST TEN+ SCMP)	TIPMAC FAST TEN + Fuel tax	TIPMAC Slow TEN + SMCP
Description of Scenario	Fast implementation of TEN priority projects	IASON SMCP figures "on top" diversified by NUTS3 regions using population density applied to Road Freight only	IASON SMCP figures "on top" diversified by NUTS3 regions using population density applied to all modes for freight and passenger	Combined scenario: B2+A1	Slow implementation of Ten Priority projects	Fast implement-ation of TEN priority projects and TIPMAC SMCP figures applied on country level.	Fast implementation of TEN priority projects with a Fuel Tax "on top"	Slow implementation of Ten priority projects and TIPMAC SMCP figures applied on the country level
SASI (uses SCENES cost functions)	X	X	X	X	X	X	-	-
CGEurope (uses SASI cost-time matrices)	X	X	X	X	X	X	-	-
SCENES	-	X	X	X	X	X	-	-
ASTRA	-	-	-	-	X	X	X	X
E3ME (feedback loop with SCENES)	-	-	-	-	X	X	X	X

Given the framework described in this section, the direct and indirect effects of transport policies can be calculated and compared for a few scenarios'. Effects have been analysed for 4 scenarios:

- IASON A1 compared to IASON Reference (Code TENtoREF), which allows the analysis of the direct and indirect impact of the implementation of the TEN priority projects in the models. A comparison can be made between CGEurope and SASI for indirect and SCENES and ASTRA for direct effects.
- IASON C1 compared to IASON Reference (Code TEN-SMCPtoREF), which allows the analysis of the direct and indirect impact of the implementation of the TEN and a parallel introduction of zonal SMCP as distinctive from TIPMAC where national averages are used. A comparison can be made between CGEurope and SASI for indirect and SCENES and ASTRA for direct effects.
- TIPMAC FAST TEN financed by fuel tax to TIPMAC BAU (Code TEN-FUELtoBAU), which allows analysing the impact of the faster implementation of the TEN. This can be done for ASTRA, E3ME/SCENES.

[10] In IASON more scenarios were elaborated for the infrastructure scenarios, see D6.

- TIPMAC FAST TEN financed by SMCP to TIPMAC BAU (Code TEN-SMCPtoBAU), which allows the analysis of the impact of the SMCP that dominates the faster implementation of the TEN. A comparison can be made between all models for direct and indirect effects.

The comparison between de different models for the above listed scenarios will be done in section C.3.6 of this report.

B.2.6 Development and maintenance of a discussion platform

A discussion platform was installed to enable interaction between all the subtasks within the cluster. It looked at the building of the overall frameworks at the first stage of the projects. It improved the consistency of the approaches and results. Finally, it has brought together experiences from the supplying (scientific) community as well as the decision-making community for establishing guidelines for the transport project assessment at the EU level.

The project aimed at making maximum use of experience in recent national policy studies concerning transport policy assessments. In order to allow a transfer of this knowledge to the European level, the consortium was built up around key participants of these studies in the UK, Germany, France, The Netherlands, and Hungary. Additional panel members with a broad theoretical and practical knowledge participated from Italy, Portugal, Finland, Spain, Switzerland and Japan. This group of panel members discussed the proposed approach for project impact assessment and supply recommendations for the further implementation of the framework from a scientific and policy point of view. The consortium parties also participated in the thematic network on Project and policy assessment methodologies (TRANS-TALK).

Workshop 1 concerned the state of the art in impact assessment of transport projects and policies. Its objectives were to 1) provide a summary of theoretical assumptions behind cost-benefit analysis, and links to transport project assessment; and 2) to agree on a taxonomy and set of definitions of project impacts (external, internal, direct, indirect etc.)

Workshop 2 focused on 1) rules for the (non-)inclusion of indirect socio economic impacts and network effects in assessments and 2) new approaches for the specification of indirect costs and benefits within a CBA framework.

Workshop 3 treated the results of case studies with a number of transport and regional economic models on direct and indirect impacts of transport projects and policies, using a.o. the SCENES transport model, the CGEurope model, the SASI model and the ASTRA system dynamics model.

The closing conference of the project presented the conclusions and recommendations of IASON and the projects in 2 related subtasks: TRANSECON and TIPMAC.

B.2.7 Towards recommendations for impact assessment and development of tools and databases

The overall aim of this research project is to develop guidelines to improve existing EU practices concerning methods for transport infrastructure assessment, as well as the models and databases which support assessments for projects and programmes of European, national and local (city) level interest. An important objective therefore is to ensure that the lessons learned from all the sub-tasks are brought together in a set of recommendations for project assessments which:

- advises on the relative merits of the different modelling techniques used in the research programme for the various different contexts of EU infrastructure policy.
- provides rules for specification and inclusion of different impact categories for project assessment within which the direct transport impacts, the wider economic impacts and the strategic environmental impacts can be systematically handled.

- ensure that the method is capable of handling distributive effects between transport users, operators, the public and Government, and between competing locations, including across national boundaries.

B.3 Project outputs delivered

The contributions of the IASON project to policy and research lies in 3 key areas:

1) recommendations for project evaluation in Europe (deliverables: D1, D4, D5, D9)
2) new models and data and methodological insights (deliverables:D2, D3, D9)
3) new findings about the expected impacts of the CTP (deliverables:D6, D7, D8)

TABLE 8: IASON DELIVERABLES

No	Title	Description
1	IASON project assessment baseline	Summary of state of the art, taxonomy of impacts and definitions
2	Methodology for the assessment of spatial economic impacts of transport projects and policies	Model specifications of the new SASI and CGEurope, assessment approach
3	Spatial economic database	Database and description
4	Methodology for the assessment of network effects of transport projects and policies.	Definitions and rules for measurement
5	Methodological advances in assessment of transport projects and policies within a European context	Recommendations for rules for CBA, and modelling improvements
6	Modelling the socio-economic and spatial impacts of EU transport policy	Scenarios, policies, model outputs incl. comparison of models for CTP case studies
7	Network effects of transport projects and policies: case studies	Scenarios, policies, model outputs for CTP case studies
8	Consolidated results of case studies in transport project assessment	Summary and comparison of case study results
9	Proceedings of the discussion platform meetings	Conclusions of discussion platform. Annex with conference details.
10	Final report for publication: Conclusions and recommendations for the assessment of economic impacts of transport projects and policies	Synthesis of findings and recommendations for project assessments.

C. KEY PROJECT RESULTS

C.1 Consensus on the conceptual and empirical dimensions of indirect effects

C.1.1 Concepts and policy relevance of indirect effects

The user benefits of transport initiatives are conventionally estimated in the transport market, subject to the assumption of perfect competition, constant returns and no externalities in the transport using sectors. In such a case, all the direct transport benefits flow through into final prices so that the direct transport benefits are exactly equal to the final economic benefits; there is ZERO additionality. In practice, however, there are three categories of reason why the "true" net social benefits of a project might differ from the measured transport efficiency benefits.

First, the actual measured transport benefits will almost certainly be incomplete (see for example Mackie and Preston, 1998). The features outlined above are in practice demanding to achieve, and it is not cost-effective to meet them exactly. For example, study areas will be too small, networks may be incomplete, not all behavioural responses will be represented, and values may be average rather than market-specific. Where study areas are determined by political or jurisdictional considerations (e.g. international boundaries) rather than pure transport considerations, some of these effects may be amplified (see for example Roy (1995) on omitted benefits of the Paris-Brussels-Köln-Amsterdam-London high speed rail network (PBKAL)). In considering real schemes, these limitations are very often recognised. To give an example, suppose a small road scheme is evaluated using a uni-modal fixed trip matrix of a tightly defined study area. Then there will be effects outside the study area, and trip redistribution and other responses not considered within the modelling exercise.

Secondly, supposing the actual measured transport benefit to be "correct", there are vertical linkages to be considered between the transport sector and the transport-using sectors. Where prices in the rest of the economy do not equal social marginal costs, the correctly measured transport efficiency benefit will not equal the final economic system benefit (see below).

Thirdly, the measured efficiency benefits do not take account of any relevant distributive considerations, whether expressed as formal weights or otherwise [but standard values of time and safety avoid biasing benefits towards high income individuals]. If projects contribute to (or take away from) social objectives, then this introduces a further dimension to the analysis.

In real world appraisals, all three reasons are likely to be relevant and to make things more difficult, they are not independent - they interact with each other.

A useful framework for considering the relation between direct and indirect effects is set out in figure 5 below. On the left hand side of the figure are the direct impacts usually considered in appraisal, including the **direct transport network effects.** These are the effects in the transport network of a transport initiative allowing for the relevant set of behavioural responses by transport users. These are the transport market responses and they are accounted for in the user benefits. A fully specified transport model (but holding the pattern of land-use fixed) would pick these up.

On the right hand side of the figure are the **indirect effects** not considered in a transport cost-benefit analysis. These arise because the changes in accessibility accounted for in the transport model may stimulate changes in zonal attractiveness. Then there are indirect effects, one example of which is agglomeration effects. Improved accessibility stimulates travel to a zone, which in turn stimulates intensification of land-use (shopping, offices, etc), with further consequences for land, labour and product markets. This is roughly similar to the term 'wider economic impacts' used in SACTRA (1999). These wider land-use and other market responses may then create further impacts in the transport markets, called indirect transport network effects.

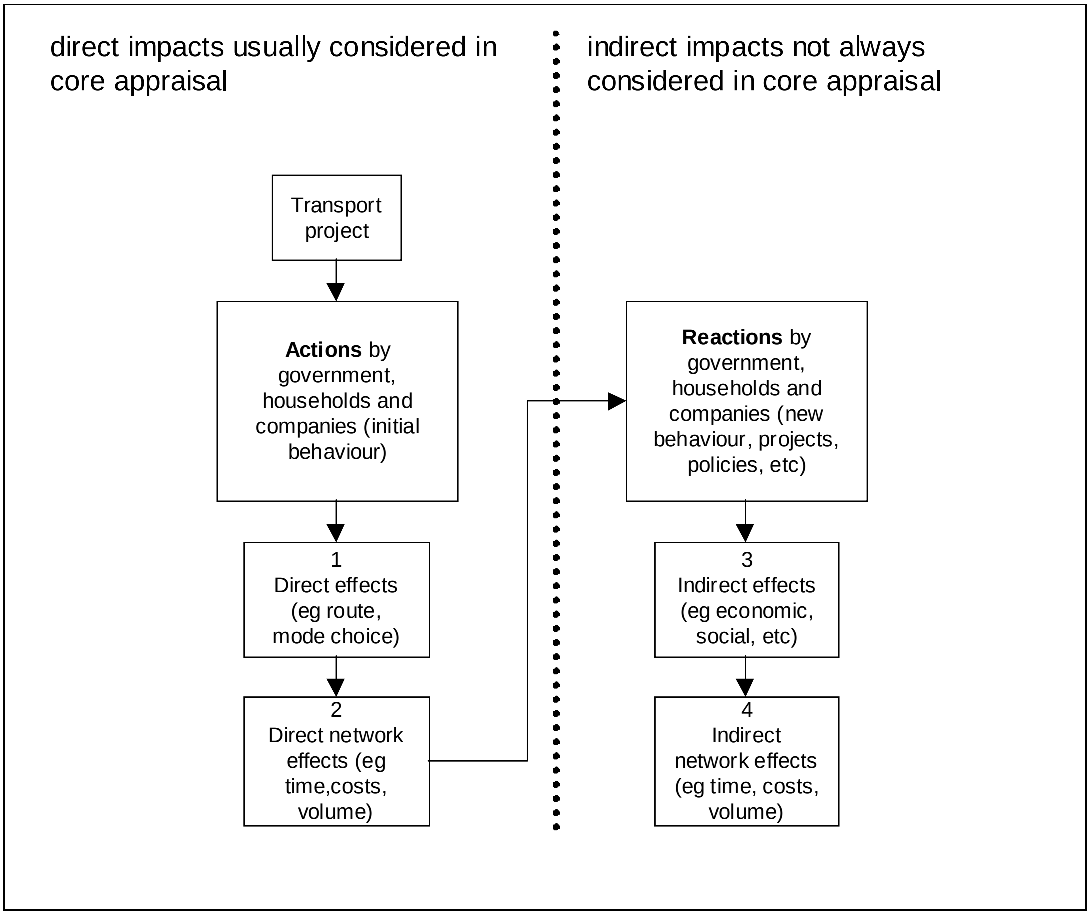


FIGURE 5: DIRECT VERSUS INDIRECT IMPACTS OF TRANSPORT INITIATIVES

Figure 5 deviates slightly from the definitions of direct and indirect effects as given above, but it gives some useful insight in the way indirect effects are generated throughout an economy.

Which of the above categories of effects are captured within a transport cost-benefit analysis depends on the nature of the transport model and the behavioural responses represented. But taking a reasonably complete transport model in today's terms (say a well-specified four-stage model) then we can say:

- direct effects – YES these are captured;
- direct network effects – YES, within the limits of the network model – in practice capture is limited by the model's study area; by the set modes and behavioural responses covered, etc. – a well-specified conventional model at the EU level should be able to incorporate these effects;
- indirect effects – NO, these are not part of the transport models used widely in assessment, however they have played a role in models used in EU research, including notably EUNET (CEC, 2001) and SASI (Wegener, 1998), versions of which were developed within IASON;
- indirect network effects – NO, except again the research examples.

While extending the assessment from transport CBA to a complete economic system CBA is conceptually desirable, it is important to be aware of the pitfalls and traps which need to be avoided. In particular, indirect effects cannot straightforwardly be added to direct effects in cost-benefit analysis because they are partly or wholly the same benefits transmitted from the transport market into the labour, land or product market.

In the benchmark case of all-round perfect competition with constant returns and no externalities, all the indirect benefits are transmitted; there is zero additionality. So, for additionality we need to focus on the sources of market imperfections – imperfect competition increasing returns and externalities – and to model the impact of changes in the transport system on these imperfections.

Even in the benchmark case, however, there is much policy interest in the distributive effects of transport initiatives. This requires the appraisal to indicate the relevant spatial and social distribution of impact (key challenge for modelling) together with a basis for evaluating the relevant social impact such as employment effects (key challenge for appraisal).

Policy-makers have shown a clear interest in distribution, in particular the effect of transport initiatives on people in target regions such as the Structural Funds designated areas, or accession countries. Spatial economic models offer the potential to forecast the spatial distribution of benefits (and costs) in a more persuasive way – because they explicitly model the behaviour of the wider economy in response to transport and they can address the final incidence of benefits as well as the initial transport-sector incidence.

Policy makers have also signalled their interest (in particular through the CTP) in a number of aspects which do not usually form part of cost-benefit analysis outputs. At the 1st IASON workshop (Nellthorp, 2001), a brainstorming exercise was used to help identify specific indicators which addressed these aspects of policy interest, and the following were proposed:

- European competitiveness vs. US and Japan (quantitative indicator may be the trade balance or the value of exports);
- environment; CO2 emissions; NOx emissions; CH3 emissions; deaths from exposure to particulates, etc.
- productivity measures;
- reduction of public expenditure – shadow price of public funds with Maastricht constraints;
- 'balanced development' in the blue banana vs. the rest of Europe (quantitative indicator could be GDP per capita by region);
- employment/unemployment – believed to be highly relevant to cohesion;
- GDP growth in key sectors;
- accessibility (on a logsum generalised cost measure).

We note that many of these relate to the 'indirect impacts' defined in this deliverable, including employment change, output growth and competitiveness. Looking at these impacts it is obvious that they are not independent, e.g. reduced employment with constant output means higher competitiveness. We therefore take reassurance that by bringing these effects into the analysis we are ensuring that CBA does extend its policy relevance, as well as its analytical scope.

C.1.2 Empirical issues and transport/economy models

Having defined these categories of effect let us now consider how they are practically related in operational and empirical terms in transport modelling. The crucial point is that there is a large degree of overlap. Direct transport effects will, depending on demand and supply elasticities, be partially or wholly passed through to consumers, workers, landowners in the form of changes in prices, wages and rents. So adding together the direct transport effects and the indirect effects as defined above would lead to substantial double-counting of the same benefit at two 'stages' of the economic process and would therefore be unacceptable.

For the purpose of economic appraisal of transport projects, we therefore face a conceptual choice. The first option is to have a single comprehensive model of the economic system, including the transport system, out of which come the benefits of transport initiatives in terms of changes in prices, wages and rents. The second is to measure the direct transport effects in a transport model and then to seek to measure the additional indirect effects in the rest of the economy. In practice, this second approach – a transport network model linked to an economic model – seems more tractable. So then we arrive at one of the key questions for IASON – given a well-conducted transport network model and appraisal which captures the direct transport effects, how significant are the additional indirect effects in relation to the direct effects?

Generally, there is not much empirical evidence on the magnitude of indirect effects. Empirical estimates vary by:

- the policy measures evaluated;
- the characteristics of the surrounding networks and study area;
- the degree of sophistication and inclusiveness of model.

How big are additional, indirect benefits likely to be? The results from the IASON and TIPMAC modelling work add some further case study evidence to previous findings on this topic though they differ significantly from the previous findings presented in the following sections.

Additional benefits: previous findings

Venables & Gasiorek (1999), using a pioneering, stylized SCGE model, found that in the UK situation if a transport project were able to reduce the cost mark-up on trade from 20% to 10%, then the additional benefits could be in the region of 30% of B_{TCBA} (their Table 3). Newbery's review of their findings, however, indicates that the additional benefits need to be scaled down by a factor of 10 (Newbery, 1999; SACTRA, 1999, p100). The SACTRA committee's final comments on the matter (p102) indicate that they found additional benefits in the region of 6-12% plausible. The evidence suggests, then, that the scale of the additional benefits due to 'product market imperfection' is limited (at least in the UK case).

An earlier wider-economy model by CEBR and Rana Roy (EC, 1997; Roy, 1996), found that a "first tentative assessment" of the stimulus to GDP due to the 14 'Essen' TEN projects was +0.19% by 2022. Theirs was a multi-country macro-economic model (QUEST) in which the main linkage from transport improvements to GDP in the medium-long term was through total factor productivity.

We have already noted that in the Dutch RAEM model, Oosterhaven and Knaap (2004) found that investment in very high speed rail technology could stimulate GDP by +0.16% (in year 2020). However, in neither the QUEST nor the RAEM cases are we able to compare the 'transport sector only' and 'economy-wide' measures of benefit.

Additional benefits: new results

From the IASON and TIPMAC results available, we are able to add the following observations:

- Bröcker (2003) and colleagues have found that the GDP uplift from most of the IASON/TIPMAC policy scenarios excluding pricing is between +0.13 and +0.31% (the issue of the pricing scenarios is discussed in D6 and D8). This is "small compared with what some policymakers would like to think". It equates to a 3 to 5% rate of return on expenditure at the most. This can be compared with Aschauer's finding of a 50-60% rate of return, or CEBR/Roy's 11% rate of return.
- based on empirical comparisons of welfare measures in the scenarios tested using SCGE, Bröcker (2003) and colleagues conclude that at the aggregate European level, the welfare gains are *neither sub-additive nor super-additive* compared with the standard consumer surplus measure used in transport CBA.
- Köhler (2003) finds that in the TENs+fuel tax scenario, the stimulus to EU GDP is of the order of +0.05%, and the stimulus to employment is identical. The effect on CO_2 emissions is +1.3%.

- For the same scenario Schade (2001), using the ASTRA model, reports an increase of EU15 GDP by 0.32% for the year 2020 equalling a rate of return of 3.5% over 18 years, which would increase considering a longer period.

There is an additional issue over the inclusion or exclusion of externalities – pollution and accidents. These may be included or excluded, *in principle*, with any of the above models. *In practice,* there is a tradition and a need of including them in transport CBA (see the 'Project Appraisal Baseline' – Mackie et al, 2001), whether using 4-stage transport models or linked transport-economy models. The SCGE models presented in IASON do not contain these effects. That omission would need to be addressed if they – or any other type of model - were to become state of the art models for investment appraisal purposes, but is not a serious technical obstacle – more a matter of investing in the necessary model development.

Another consistency issue arises over non-working travel time. This is a slightly more difficult issue. SCGE models do not seek to model the full set of activities, which use the transport system – transport is primarily an input to production. In this respect 4-stage and linked transport-economy models may actually be broader than SCGE, and certain benefits on the consumers' end will be neglected by the SCGE modelling approach .

Economic models such as those that were presented here are all capable *in principle* of representing direct transport effects and direct transport network effects, either directly or by being linked to a transport model. There are some issues *in practice* over the scope of the applied models, since by their nature, some of the more advanced economic models discussed in IASON have not yet adopted state-of-the-art representations of the transport network.

The key difference comes in the representation of indirect effects. Linked transport-economy and SCGE models (and other modelling approaches such as systems dynamics and quasi-production functions) explicitly address the impact of transport system changes on the wider economy, although the precise methodologies are distinct. Transport models are limited to:

- an explicit representation of some behavioural responses – mode switching, re-routing, etc.;
- only implicit representation of a wider set of responses (which actually take place in product markets, land and property markets and labour markets) in the form of generalised behavioural elasticities – for example, elasticities of demand with respect to own price or to the prices of substitutes and complements.

However, such limitations are not necessarily problematic; from the decision-maker's point of view, models do not always need to be complex. A question decision-makers often ask is "how robust is the decision"? In other words, is there anything to be gained in terms of increased expenditure on analysis? The answer depends on the seriousness of market imperfections, the significance of spatial and social distribution effects and the sensitivity of the decision to appraisal sophistication.

TABLE 9: SCOPE OF ALTERNATIVE MODELLING APPROACHES

Model type	Direct transport effects	Direct transport network effects	Indirect economic effects	Indirect transport network effects
4-stage transportation model	Included*, **	Included*, **	-	Only through elasticities
Linked transport-economy model	Included*, **	Included*, **	Land use change (endogenous); residential location effects; (sometimes) business relocation effects. Fixed GDP and employment totals are *redistributed* by the model.	Included***
Linked transport-economy model + Macroeconomic model	Included*, **	Included*, **	Land use change (endogenous); residential location effects; (sometimes) business relocation effects. Dynamic GDP stimulus predicted using the macro-economic model.	Included
Integrated transport – meso- and macroeconomic model	Included*, **	Included*, **	Land use change (sometimes); Trade patterns Employment effects Dynamic regional GDP stimulus	Included
Transport model/Spatial CGE model	Included*, ** if linked with a transport model	Included*, ** if linked with a transport model	Patterns of production and trade, determined by a spatial economic equilibrium. Employment effects (sometimes). Residential relocation. (sometimes)	Included, if SCGE is iteratively solved with the transport model

* – subject to satisfactory definition of the Study Area– this is an issue for all models.

** – subject to satisfactory definition of the Transport Network to include all substitutes and complements that may be affected by the initiative – this is an issue for all models, but particularly for the more advanced economic models (SCGE) where the focus is often on the determinants of production and trade, rather than on detailed definition of the transport network (see below).

*** – subject to the limitation that the model includes *redistributive* indirect effects only – it cannot predict any changes in total GDP or employment.

'-' indicates 'Not included'.

It must be stressed that the approaches described in table 9 offer *alternatives* in measuring the economic impact of transport initiatives. The results of TCBA and of SCGE models should not be added together – to do so would be to *double count* the direct benefits (and any portion of the indirect benefits captured through elasticities by 4-stage modelling). Rather, the *difference* between the SCGE result and the 4-stage modelling result (in a comparable set of tests of a given project or policy) can be seen as the *additional* benefit from considering these wider impacts. As SACTRA (1999) noted, this additional benefit may be either positive or negative.

C.2 A set of improved models for CBA

C.2.1 Models for direct and indirect effects

In total five models were used in IASON for the analysis of direct and indirect effects. Basic features of the models are discussed earlier. The models are linked to each other to form model combinations such that a model combination at least consists of one transport model to measure direct effects and one economic model to measure indirect effects. Two models are available that model direct effects: SCENES and ASTRA.

The measurement of direct effects in IASON follows current CBA practice using generalised cost changes of a policy respectively changes of consumer surplus (see IASON D1). The indicators for measuring direct effects are the same for both models: consumer surplus, cost changes and (monetised) time changes. Additionally, in ASTRA new transport is generated of which the benefits could be monetised by the generalised cost of this induced transport as it has to provide at least this amount of benefits to influence the choice of the transport user. The separate consideration of induced transport would only be necessary if generalised costs would be used for the analysis of indirect effects. Consumer surplus considers these benefits automatically. On the other hand four models are available that model indirect effects: CGEurope; E3ME; SASI and ASTRA.

In order to improve its capabilities for assessment of EU level transport policies, the CGEurope and SASI models were improved in a number of directions (see the IASON Deliverable D2). The new CGEurope differentiates between six sectors, including one sector producing the transport service using factors and intermediate inputs. It includes costs of interregional trade and private passenger travel and models the use of resources for transport in a more sophisticated way than the previous one by including explicitly an activity producing the transport service. Further extensions of SASI concerned the addition of transport costs beside transport times as key determinant of accessibility and new indicators for e.g. outputs regarding cohesion. The transport network from which the cost measurement is derived is much more refined, based on the networks developed within SASI, SCENES and ETIS. A new socio-economic database was built to serve as common platform for both models, which now describes over 1200 regional economies for the EU27.

The measurement of indirect effects differs between the models due to the focus and theory behind each model. CGEurope uses equivalent variation as its core indicator, while the others are focused on GDP respectively GDP per Capita. E3ME and ASTRA provide further possible social product measures like consumption or disposable income. GDP respectively GDP per Capita has to be taken as common indicator for the analysis of indirect effects as this can be derived from all models, though it includes only the material welfare improvements. Furthermore, employment figures should complete the analysis since these offer a further dimension to the mere material GDP indicator. It is emphasised that simply adding employment and GDP impacts would be an issue of double counting, such that employment here should only provide a proxy for a social indicator.

From the point of view of welfare economics consumer surplus and producer surplus in the transport sector would be the appropriate indicator for direct effects. This should be compared with changes in equivalent variation of households because this is the corresponding indicator for indirect effects. However, in practice, the direct effect models do not provide producer surplus neither do the indirect effect models, with the exception of CGEurope, measure equivalent variation. In general a comparison can focus on consumer surplus as it is a (partial) welfare economic indicator. The overview of various effects provided by each model is given in Table10.

TABLE 10: GENERAL STRUCTURE OF ANALYSIS OF DIRECT AND INDIRECT EFFECTS

		Models	
		Direct Effects	Indirect Effects
Evaluation		4-stage transport model	SCGE / Wider economic modelling system
Direct Effects	Consumer Surplus (Generalised Cost + induced transport)	SCENES (Links) ASTRA (OD Matrix)	---
Indirect Effects	Household equivalent variation	---	CGEurope
	GDP	---	CGEurope SASI E3ME ASTRA

The following table identifies implemented mechanisms for each model showing which mechanisms are important, not available, endogenously or exogenously implemented in the models.

TABLE 11: OVERVIEW ON MECHANISMS OF EACH MODEL

	Comment or Priority and Use for Analysis	SASI	E3ME-SCENES	CGEurope	ASTRA
Population					
Population development	Births, deaths, migration as a driver of passenger transport	i	ex	c	en
Economic mechanisms					
Equivalent Variation	Main output of model	na	na	i	na
GDP endogenous	Main output of model	i	i	en	i
Employment	Sectoral shifts, affected by transport	en	i	c	i
Consumption	Sectoral shifts, refunding	na	en	na	en
Investment	Sectoral shifts, in-/decrease	na	i	na	i
Export	Changed spatial patterns, in-/decrease	na	en	i	en
Government	Revenues, consumption, investment, debt, affected by transport	na	na	na	en
Technical Progress	Affected by transport	na	en/ex	na	en
Price level	Affected by transport	na	en	i	na
Transport-Economy Linkages					
Transport expenditures	Modal shifts cause sectoral consumption shifts, budget constraint	na	en	en	en
Transport investments	Modal shifts cause sectoral investment shifts	na	na	na	en
Transport cost	Intermediates of production	na	en	en	en
Transport times	Productivity	en	na	na	en
Accessibility	Migration and GDP (SASI), Export patterns (CGEurope, ASTRA)	i	na	en	en
Transport mechanisms					
Flexible generation	Sectoral output+trade cause changes in transport generation patterns	na	en	na	en
Flexible distribution	Shift of transport distances	na	en	na	en
Modal-shift	Multi-modal competition	na	en	na	en
Route choice	Time and cost changes	(en)	en	na	(en)
Distributional Analysis					
Spatial distribution	Spatial detail and changes of spatial patterns	i	(en)	i	(en)
Sectoral distribution	Sectoral detail and changes of sectoral patterns	(en)	i	na	i
Social distribution	Effects on groups of households or persons	na	na	na	na

Legend: i = important element of model, en = endogenous, ex = exogenous, na = not available, c = constant

C.2.2 When to apply models of the wider economy

In order to compare the results on the measured transport benefits and total system benefits of an intervention the following items are absolutely necessary (as is shown in IASON and TIPMAC):

- Same project/policy definition
- Same definition of benefit measure – implications for producer surplus, leisure time, accidents, environment, GDP versus economic welfare
- Same assumptions re closure of funding loop – implications for CBA versus macro modelling

Key determinants of the outcome on indirect effects are:

- The number of markets modelled (labour, land, goods, transport)
- The relevant elasticities and P/MC divergences in those markets
- The strength of the forward and backward linkages between transport and the wider economy
- The treatment (or not) of dynamics.
- There is a need for clarity and transparency of exposition in relation to these points.

There is a need for clarity and transparency of exposition in relation to these points; in the sense that researchers should point out what determinants are dominant on the outcome. In the table below we have summarised the evaluation practice for different project types. For large projects it is recommended to apply besides good quality transport model a spatial equilibrium model and/or a macro model (depending on the type of project). We note that a "fit for purpose" good quality transport model will be different, according to the type of project being appraised.

Project type	Transport model	Wider economy model	How to measure benefits
Incremental infrastructure improvement – small to moderate Δ in GC (Generalised Cost)	Good quality transport model	Qualitative market research	Transport Cost Benefit Analysis
Step-change in regional accessibility OR pricing policy reform = large Δ in GC	Good quality transport model	Spatial CGE/ macro model[11]	Equivalent variation at household level / aggregate GDP change

In IASON, and also in TIPMAC, economic models have been combined with transport models which are in principle the tools to model direct and indirect transport network effects including supply side issues and demand/supply interaction. Elaborate databases were developed which map the interregional and intersectoral linkages through with economic impacts of transport policy will propagate. The degree to which it is necessary to use more sophisticated models for making the indirect effects of policies explicit, will depend on the type of effects occurring and their expected magnitude. In practice transport modelling and evaluation may fall short of the ideal analysis required for a full account of benefits of transport policies:

- Land use responses may be excluded (i.e. the indirect transport network effects maybe excluded);
- Modelling may not cover all behavioural responses (e.g. trip re-timing);
- Macro-economic linkages as the various ways of returning incomes of transport pricing to the economy may influence the benefit-cost ratios

[11] It should be noted that these models are still experimental

- Elasticities may be rough and ready values. Therefore it may not be clear how well direct and indirect network effects are being picked up by the model, and if so, to what extend we can separate them;
- Networks may be incomplete, so that there are effects outside the studied modes, areas and networks; and
- Supply-side modelling may not be very sophisticated, and not all demand /supply feedbacks may be considered.
- Benefits to non-travellers (option values) maybe excluded.

Obviously, the greater the extent that these points are true, the greater the potential for effects which are unmeasured within the appraisal (both positive and negative). Typical cases in which it may be worthwhile to explicitly consider indirect effects include e.g. 1) large infrastructure schemes connecting regions at a different stage of their economic development or 2) large transport pricing schemes where a) behavioural reactions are assumed to be considerable and b) the indirect effects of returning financial flows to the economy can be substantial.

However, there are also valid modelling reasons why some of these characteristics maybe excluded. Such issues, as set out below, are the ones where we believe more investigation is necessary:

- Data availability: models, particularly network models, are data hungry. A model is also only as robust as the data that underlies it. Unfortunately data can also be very expensive to obtain – prohibitively in some situations. Thus whilst a modelling tool maybe available to capture all the required effects, data limitations may limit the specification of the model.
- Convergence: transport models, and models in general, simplify the decision making process into a number of discrete choices, which then tend to be linked as a form of sequential decisions. The use of a sequential decision making structure implies that a model will invariably not achieve equilibrium on the first pass through the decision tree. Typically a number of iterations of the model's simulated decision making process are required to achieve equilibrium. Such an iterative process can lead to two problems: firstly whether convergence to equilibrium will ever be achieved and secondly the uniqueness of that equilibrium.
- Spatial and Temporal Linkage: The differing spatial and temporal requirements of each model within a full modelling hierarchy give rise to complex problems at the interface between the models regarding the treatment of costs and demands as they are passed from one model to another. Whilst it can be relatively straightforward to aggregate costs as one moves from one level of aggregation to a higher level, it is more difficult to disaggregate demands on the reverse pass.
- Model Run Times: model run times are related to level of model detail, particularly zonal detail. Requirements for multiple iterations, in many time periods, to achieve satisfactory convergence may give rise to unfeasibly large model run times (from the practical perspective of using the model as an analytical tool to optimise transport policy).
- Technical limitations: whilst certain model types have had a long history other models such as micro-simulation models and SCGE models are techniques that are still in their infancy. As such the application of such models to solve certain problems may require new innovative techniques that have not previously been applied in a practical context.
- Economic valuations: the ability to place an economic value on a change in a transport related impact (e.g. travel times, accidents, noise, etc.) is an evolving science. Whilst in principle techniques exist for valuing most goods, in practice only a few have been valued successfully.

C.3 Results of model experiments with Common Transport Policy measures

The IASON results are described by SCENES for direct effects and SASI and CGEurope for indirect effects whereby SASI is concentrating on distributive effects and CGEurope on distributive and generative effects. Further, SASI is a dynamic model and CGEurope a comparative static model[12]. We also report briefly on the results of a network analysis where results from CGEurope were fed back into the NEAC network model in order to study induced traffic responses on CTP measures.

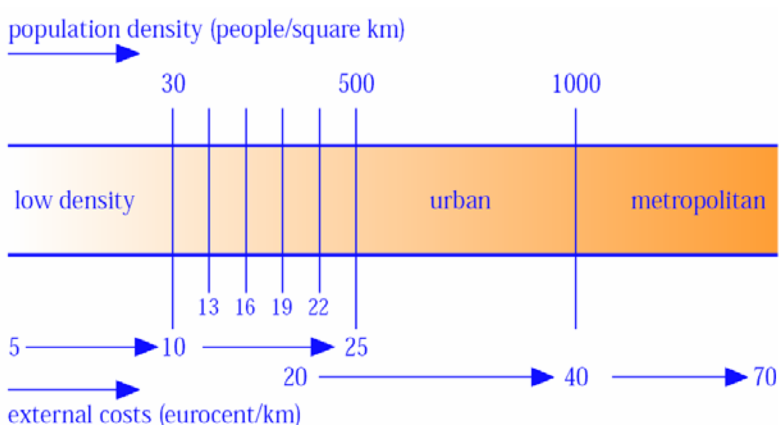
From these model runs, our global conclusions with respect to the European CTP are:

1) SMC based pricing, relative to the base case, has an effect which can be considered large. It replaces an inefficient tax by an efficient charge and thus creates new efficiencies within the economy.
2) Speeding up the TEN-T programme has an effect on GDP which is relatively small. We have not run tests using the macro-level models (ASTRA and E3ME) of TEN-T policy against a baseline without that programme and are therefore not in a position to comment on their effect on European GDP and employment. The tests with the CGEurope and SASI models indicate that the TENs have relatively strong distributive effects to the economy, affecting in particular the East-West growth balance and stimulating the rate of cohesion.
3) There is no evidence that transport infrastructure investment is uniquely or exceptionally highly productive. The additional benefit to the economy which is supplementary to the benefits in the transport system is an order of magnitude lower than the travel cost improvements. For specific regions, however, benefits to the economy can be of the same order of magnitude as the monetized accessibility improvements. Performing a high quality but conventional transport CBA, therefore, in some instances will only give a limited account of the full benefits for these regions.

The project has produced a large amount of data and maps such as shown in the figure below, that provide detailed indications of regional and sectoral responses to the CTP measures. In the following we explore in more detail the main outcomes of the various model runs. We look at the conclusions from the transport model system analyses with SCENES and NEAC (network effects), the regional level analyses with CGEurope and SASI and, finally, for comparison purposes, the national and EU-level analyses with the combined SCENES/E3ME and ASTRA models.

C.3.1 The direct effects of the CTP: Transport system analyses with SCENES

The SCENES Regional Economic and Transport Model was applied to assess the effects on the transport system of a charging of road freight transport. The starting point for the charging regime applied is the table of external costs from RECORDIT, as shown earlier (see figure 4) in this report and repeated here for convenience:



Charges were applied to Interzonal links as follows[13]:

[12] For detailed results of the models see the annex and the IASON website and IASON D5, D7 and D8.

1. Each link is charged pro-rata by distance with the appropriate values for each SCENES zone or *mountainous* area it passes
2. The zone-specific heavy lorry charge in cents/km is determined from the above table and based on a detailed breakdown by zonal population density.
3. Exogenous lorry charge were calculated from: Σ link distance within zone x charge/km for that zone

For Intrazonal trips, *effective* zonal densities were determined and related to the charging levels and used for identifying the charges to apply for *shorter* Intrazonal freight links (<=20 km). The *longer* intrazonal freight movements (>20 km) are charged as interzonal links using the zonal average population density. Apart from this distinction the method employed is the same as for Interzonal links, with the exception that when a zone overlaps a *mountainous* area the proportion of overlap by area has been used as the weighting factor by which to apply the mountainous charge rate. The remainder is charged at the intrazonal rate (for shorter intrazonal trips), or interzonal rate (for longer intrazonal trips). Light trucks and intrazonal movements were assumed to be charged at a level of 81% of the interzonal, heavy goods vehicle trips. This assumption is based on a detailed inventory of external costs as carried out within the TIPMAC project and explained in Section B.2.4.

This charging regime was tested using the SCENES model, for the year 2020. The model compares a base scenario against an alternative scenario that includes the charging. It indicates the following impacts:

- Changes in the routes used by trucks
- Changes in the fleet of trucks
- A shift to combined transport, including rail and shipping
- Increased sourcing of production inputs and consumer goods from local suppliers
- Changes between EU regions in the location of manufacturing and service industries.

We elaborate on the key impacts observed below.

Less traffic in urban areas. As roads in urban and metropolitan areas are charged at a higher level, road freight traffic tends to move away from these areas, and concentrate on the more rural, interurban routes. This increases the journey lengths by trucks for some movements, but it reduces the overall exposure of the population to the truck traffic.

Higher proportion of the larger trucks. The charges on each small/medium truck (typically 7.5 to 10 tonnes gross vehicle weight) are 81 percent of those on a heavy truck (typically 33-40 tonnes gross vehicle weight). But the cost per tonne carried rises more sharply for the small/medium trucks, because there are fewer tonnes of payload on the small/medium trucks to absorb the charges. The cost increase encourages the use of larger trucks, and hence better consolidation of road freight. This impact varies by commodity, however.

Growth on combined and intermodal transport. A modest two percent of road freight tonnes is transferred to rail and coastal shipping. However, these are the medium to long distance movements. In the EU, six percent of road tonne kilometres shift to rail and shipping. Nevertheless, the model shows that without reductions in local distribution costs for rail and water-borne freight, the extent of modal shift from road will be very limited for unitised cargo.

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[13] We refer the reader to the IASON D8 for a more detailed explanation of this approach for entering charging values in the SCENES model

Changes in trade and industrial location. Approximately half of the reduction in total truck traffic stems from long term changes in the patterns of trade. As road costs rise, production inputs and consumer goods are sourced in greater proportions from suppliers nearby. This leads to changes in the location of manufacturing and service industries within the EU.

Figure 6 provides an overview of the present transport cost levels and the reductions in transport performance (tonkm) after charging, for different categories of goods. It shows that the sensitivity to charges differs considerably among these goods types. The traditional bulk and semi-bulk products reduce their tonne kilometres more readily, through shortening of trips as well as modal shift. The value dense, finished products, such as food, machinery and other unitised cargo, tend to have much smaller falls in road traffic levels, in spite of considerable rises in road freight costs.

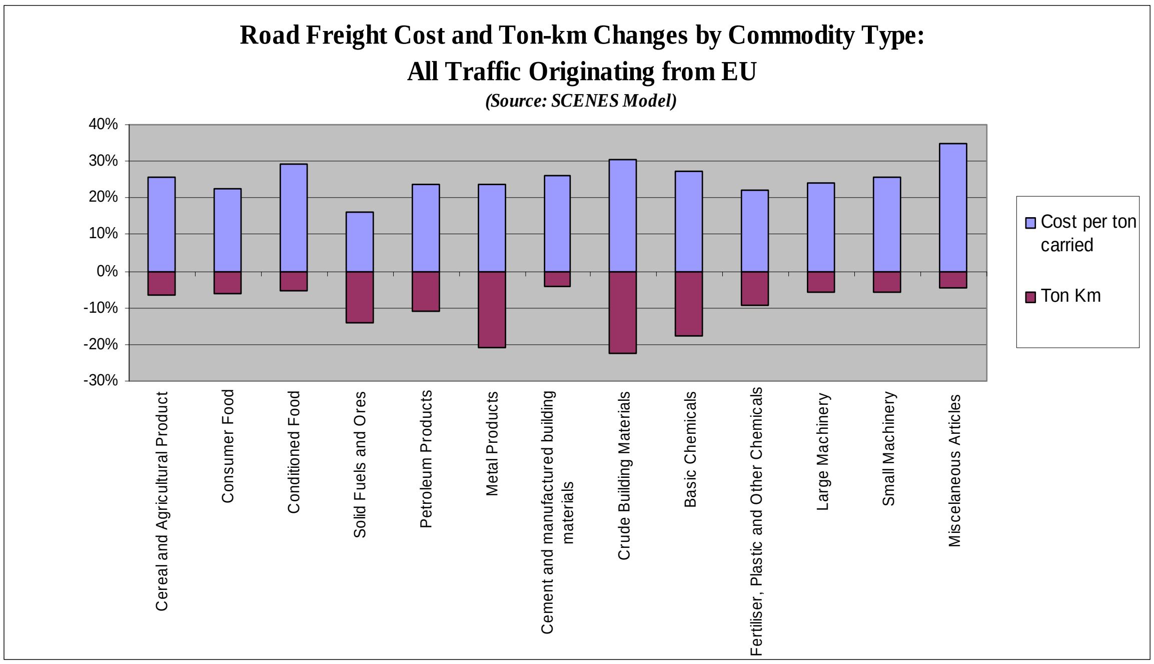

FIGURE 6: ROAD FREIGHT COST AND TONNE-KM CHANGES BY COMMODITY TYPE: ALL TRAFFIC ORIGINATING FROM EU

Figure 7 shows the total tonne kilometre changes by country, for traffic originating from the EU. Tonne kilometre reduction tends to be small in the periphery, especially in Greece and Ireland, and also in Spain, Portugal and Finland. Road freight traffic from the core regions, especially Germany, sees reduction in tonne kilometres higher than the EU average. The level of charging in the peripheral countries is lower. Nevertheless, the changes also reflect the availability of non-road alternatives in different countries.

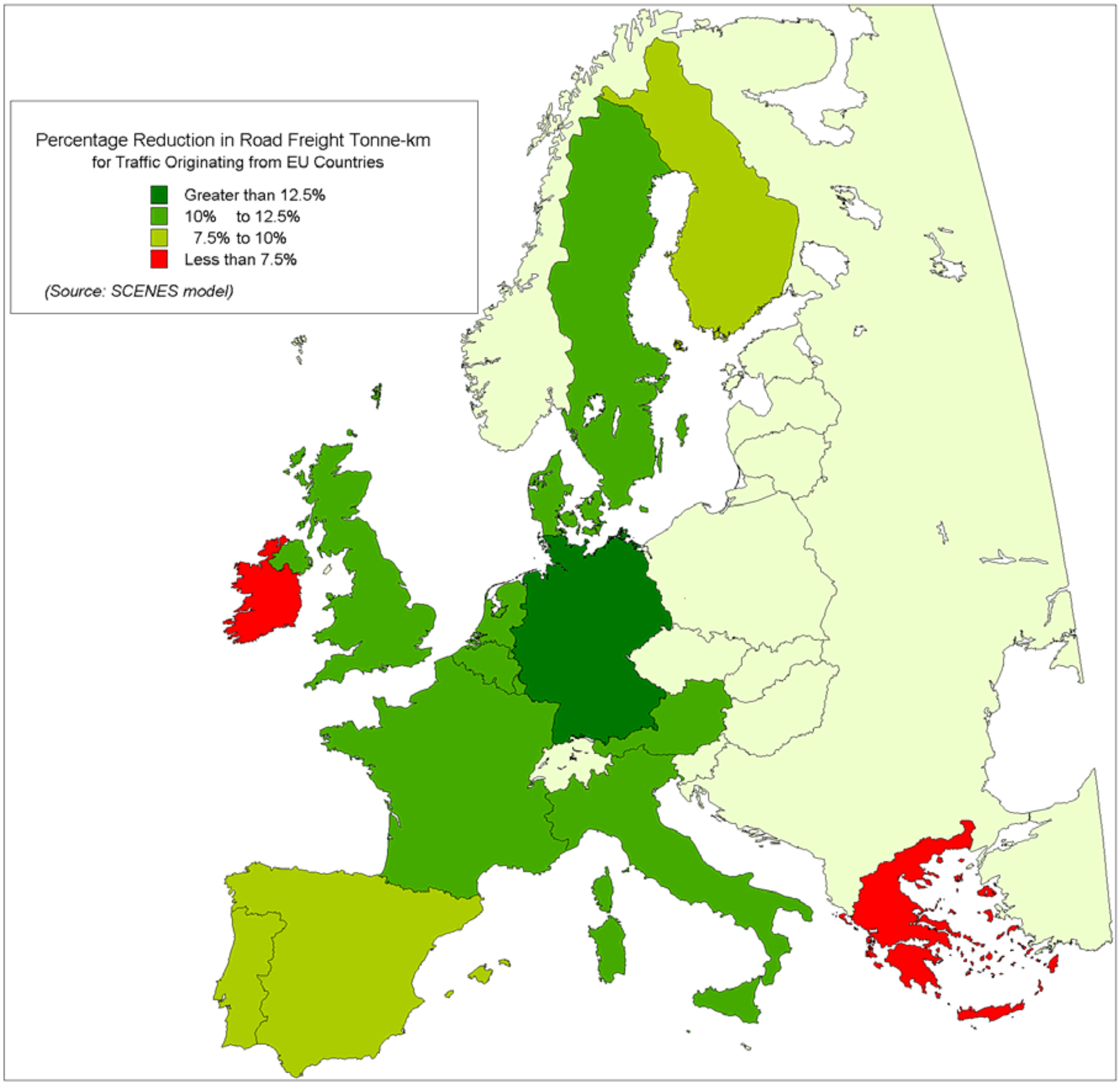

FIGURE 7: PERCENTAGE REDUCTION IN ROAD FREIGHT TONNE-KM BY EU COUNTRY OF ORIGIN

The corresponding reduction in CO2 equivalent emissions, shown in figure 8, mirrors the spatial pattern of tonne kilometre changes. However, the extent of reduction is greater, reflecting the improved efficiency in the use of trucks.

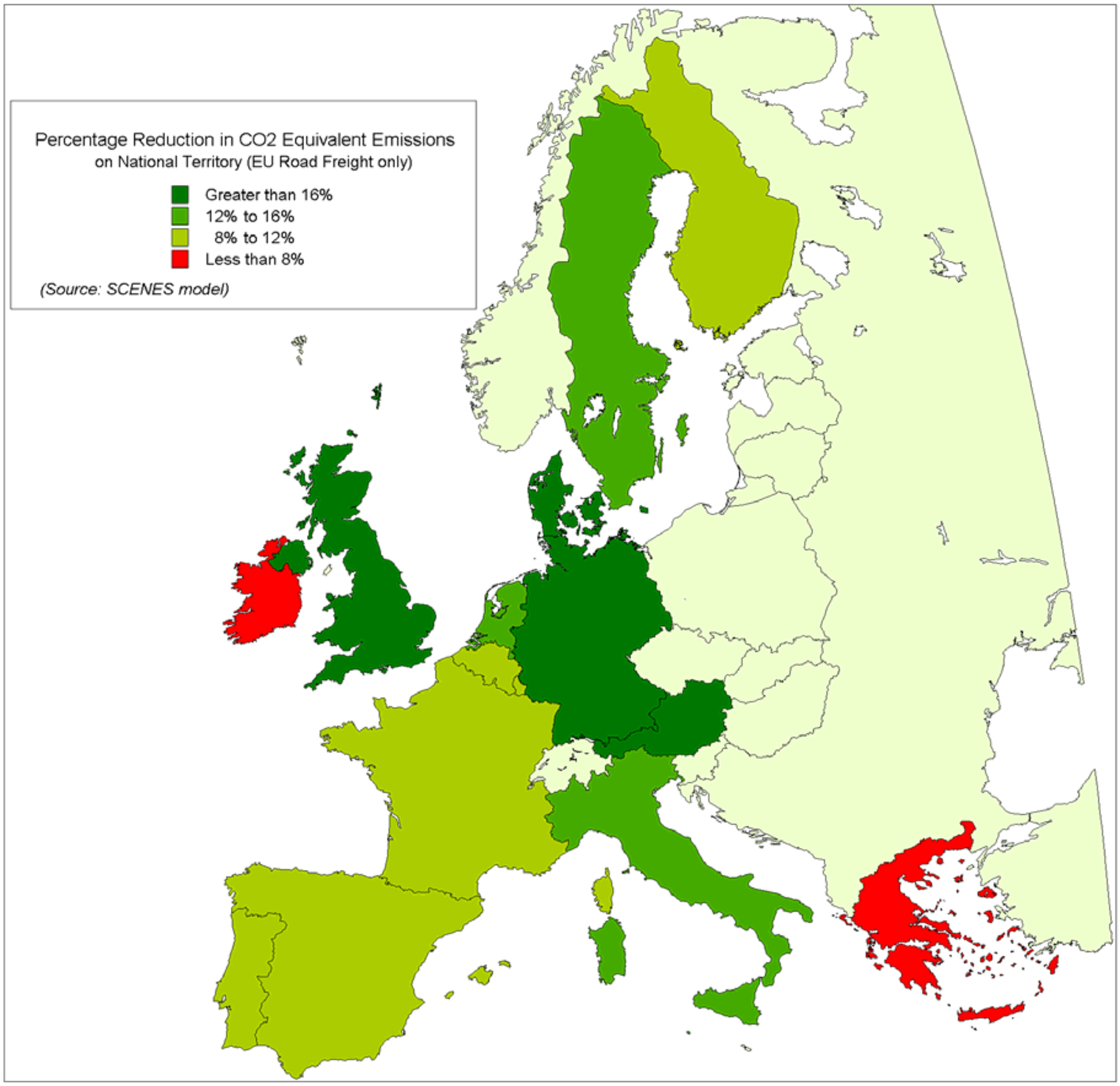

FIGURE 8: PERCENTAGE REDUCTION IN CO2 EQUIVALENT EMISSIONS ON NATIONAL TERRITORY (EU ROAD FREIGHT ONLY)

In-depth studies elsewhere have shown that the kilometrage charging is likely to trigger other changes, such as in vehicle technology, in the operations of haulage firms, and in the management of freight logistics. The revenue collected from the charging regime is substantial and the way in which the revenue is used in the national and regional economies will have a key influence on the level of the benefits. Research work is on-going in the IASON project and others to appraise these different strands of changes, so that a comprehensive assessment can be carried out to aid the policy decisions.

Summary

The results of the transport model SCENES show that the reduction of road freight emission (C02) is much higher when SMCP for HGV is charged alone, than in the case of SMCP charged on all modes. An explanation can be found in the fact that if all modes are charged by SMCP, there is less incentive to shift to another mode than when only road is charged. Relative charges in relation to charges for other modes are important drivers for modal shift. Other projects (notable MC-ICAM an FP5 project) show this inelasticity for road transport as well. Charging per commodity group is feasible (and certainly possible to compute in modelling exercises); however, in the "real world" it is not an option to charge by commodity transported. More importantly, however, it has become evident from the research that a closer and systematic look is needed into the various elasticities of the models, beyond those related to the choice of mode of transport, i.e. related to generation and spatial distribution of flows. These explain perhaps even to a higher degree the behavioural responses in the system to SMCP policies. The project timeframe did not allow to perform such a systematic (and among models: a comparative) analysis; nevertheless, the findings indicate that responses go well beyond a modal shift.

The pattern of responses that is forecast is complex, precisely because these responses are the cumulative balance of:

- a variety of behavioural responses (route, truck size, mode and destination switching)
- resulting in turn from differences in charges by area, truck size and type of commodity (due to differences in loads per vehicle), and
- resulting from differences in the local availability of alternatives to road transport between zone pairs as well as between commodity types. Models that fail to represent the richness of this range of behaviour are unlikely to provide reliable estimates of the impacts of marginal cost pricing policies.

There is evidence from the model results that the peripheral countries such as Greece, Sweden, Finland and Portugal are affected more than might be otherwise expected, due to their need to pay high cost increases caused by their long lengths of haul to markets in the heart of Europe.

Despite the fact that they have on average the highest charges within the country, the Benelux countries have low overall responsiveness as a result of their shorter lengths of haul and their accessible location within the EU.

C.3.2 Indirect effects of the CTP: analyses with SASI

C.3.2.1 Introduction

With the extended and re-calibrated SASI model, the following 18 policy scenarios as described previously 2 were simulated:

Network scenarios:	A1	TEN priority projects
	A21	High-speed rail priority projects
	A22	Conventional rail priority projects
	A23	Road priority projects
	A24	Rail priority projects
	A3	All TEN/TINA projects
	A4	All TEN projects
	A51	New priority projects
	A52	New priority rail projects
	A53	New priority road projects
	A61	A3 + additional projects in CC12
	A62	A3 + maximum projects in CC12
Pricing scenarios:	B1	SMC pricing road freight
	B2	SMC pricing all modes travel/freight

Combination scenario:	C1	A1+B2	
Rail freight scenario:		D1	Dedicated rail freight network
TIPMAC scenarios:		E1	TIPMAC business-as-usual scenario
		E2	TIPMAC fast TEN + SMC

In addition, the do-nothing or base scenario 000 was simulated as reference or benchmark for comparing the policy scenarios. As also described, the reference scenario is defined as a fictitious development in which no transport infrastructure projects or other transport policies are implemented after 2001. All assumptions for the policy scenarios (e.g. with respect to fertility, mortality, migration, productivity and labour force participation) are identical to those for the reference scenario except the policies under investigation themselves, so that all differences between the policy scenarios and the reference scenario can be unequivocally attributed to the policies examined.

All simulations start in the year 1981 and proceed in one-year time steps until the year 2021. Figure 9 shows as an example population development aggregated by country. Because of the one-year simulation period, the common IASON base year 1997 and target year 2020 are part of the simulation. The left half of Figure 9 represents the known past and calibration/validation period of the model. The yellow-shaded right half of the figure is the forecasting period of the model. All policy scenarios are identical and equal to the reference scenario until the year 2001.

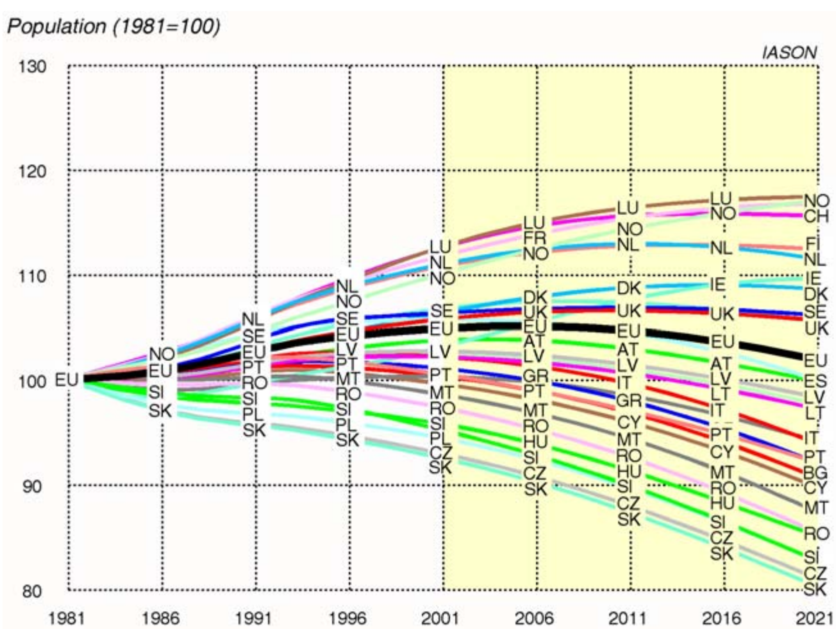

FIGURE 9: CALIBRATION/VALIDATION PERIOD AND FORECASTING PERIOD OF THE SASI MODEL

C.3.2.2 Accessibility

Accessibility is a core concept of the SASI model. The maps in Figures 10 to 13 show the four types of accessibility indicator calculated in SASI and used as explanatory variables in the regional production functions:

- accessibility rail/road (travel)
- accessibility rail/road/air (travel)

- accessibility road (freight)
- accessibility rail/road (freight)

The familiar pattern of the highly accessible European core with its peak in the Benelux countries, west and south-west Germany, Switzerland and northern Italy emerges, leaving the Nordic countries, northern England, Scotland and Ireland, Portugal and Spain, southern Italy and Greece as clearly peripheral in the present European Union. Of the accession countries in eastern Europe, the Czech Republic, Slovakia, Hungary and parts of Poland belong to the European core, whereas the Baltic states and Romania and Bulgaria (and of course the two island states Cyprus and Malta) remain peripheral.

Figures 14 to 18 show the changes in accessibility caused by the policies in selected policy scenarios (or more precisely, the difference between the accessibility in the policy scenario and the accessibility in the reference scenario in 2020). The classes of the legend and the colour code are identical in all maps to allow easy comparison. Red colour shades indicate positive differences (i.e. the accessibility in the policy scenario is higher), whereas blue indicates negative differences.

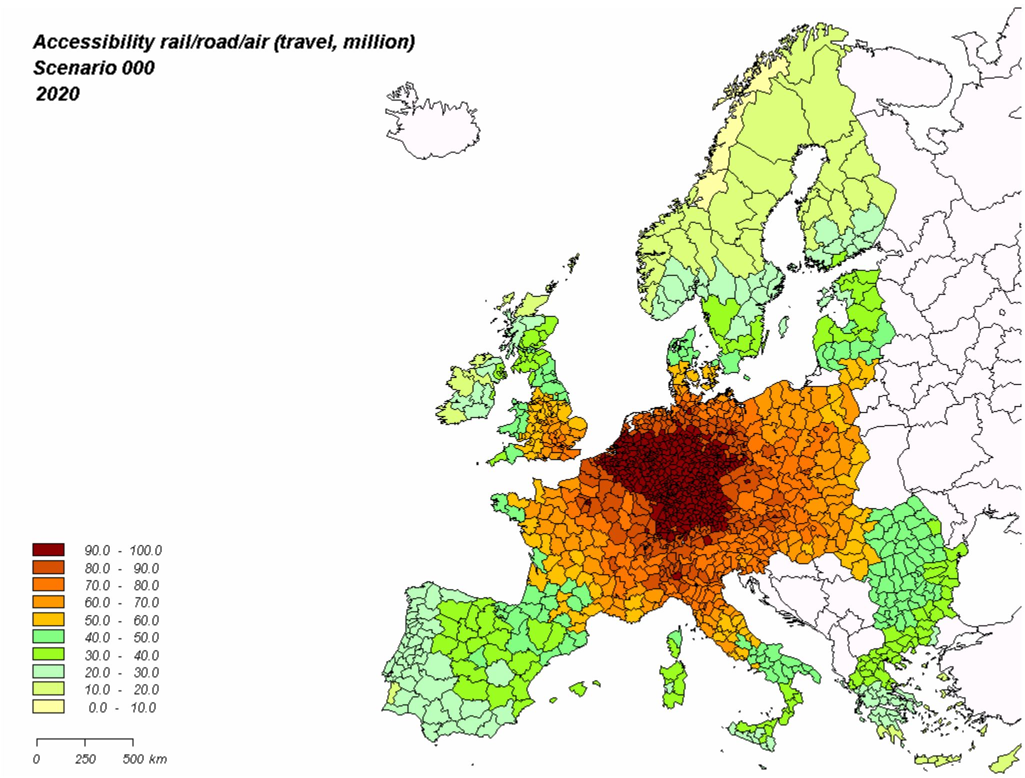

FIGURE 10: REFERENCE SCENARIO 000: ACCESSIBILITY RAIL/ROAD (TRAVEL, MILLION) IN 2020

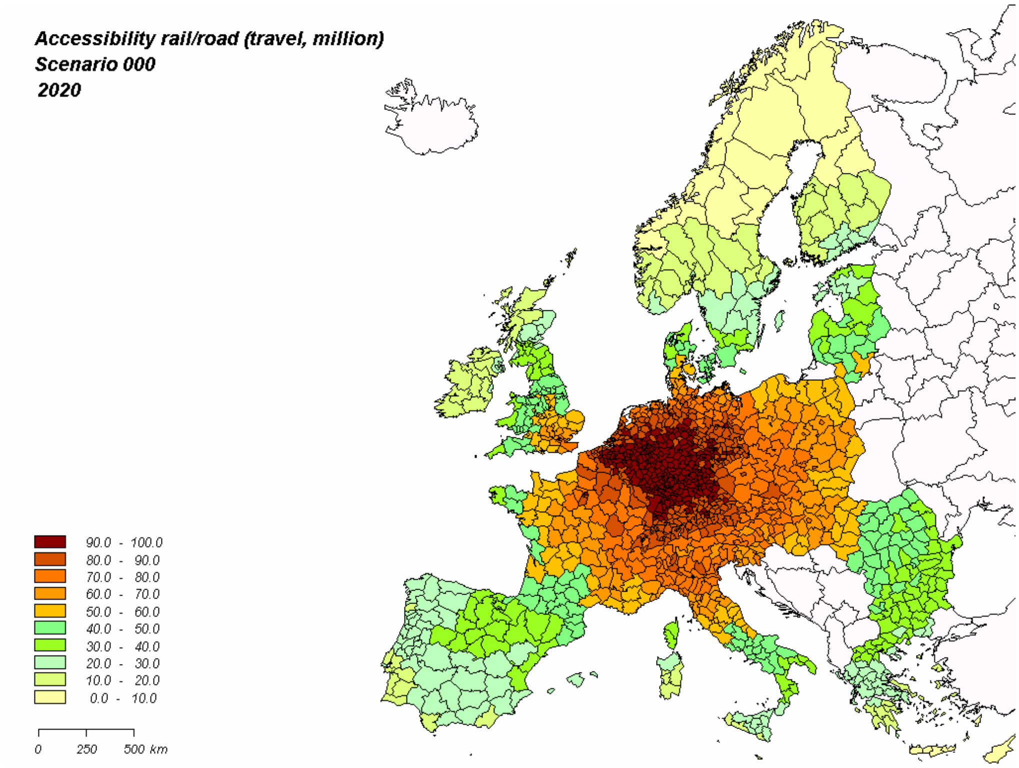

FIGURE 11: REFERENCE SCENARIO 000: ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL, MILLION) IN 2020

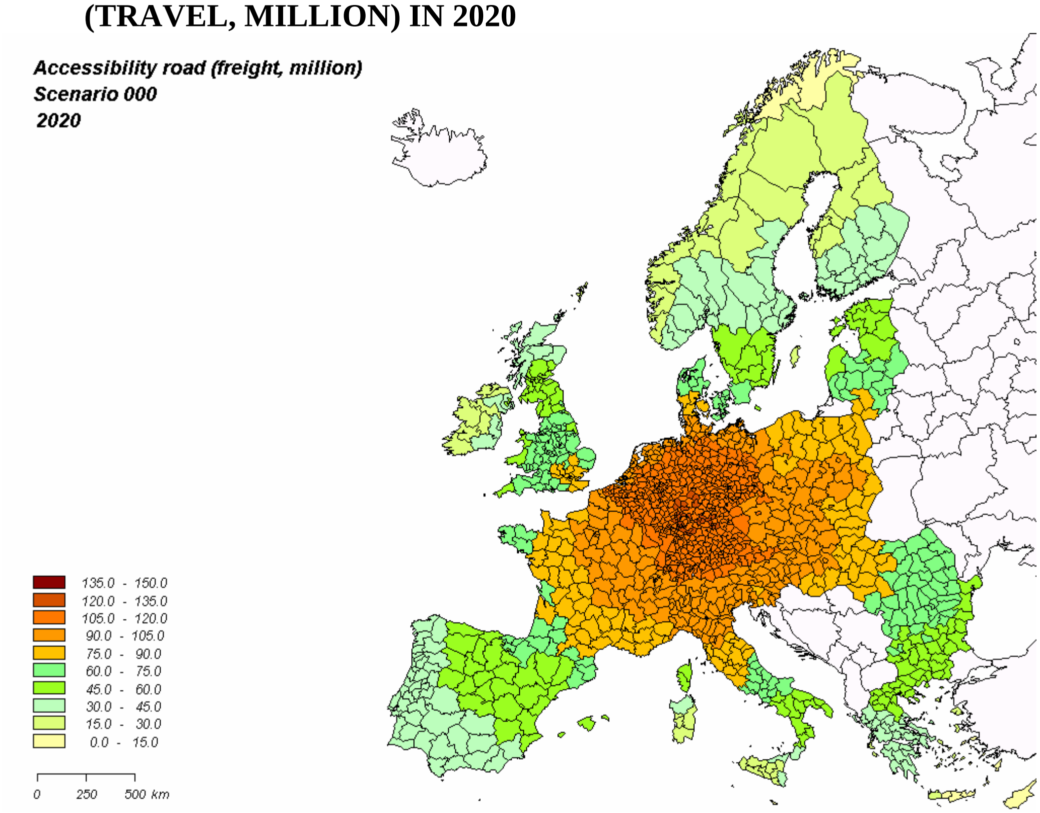

FIGURE 12: REFERENCE SCENARIO 000: ACCESSIBILITY ROAD (FREIGHT, MILLION) IN 2020

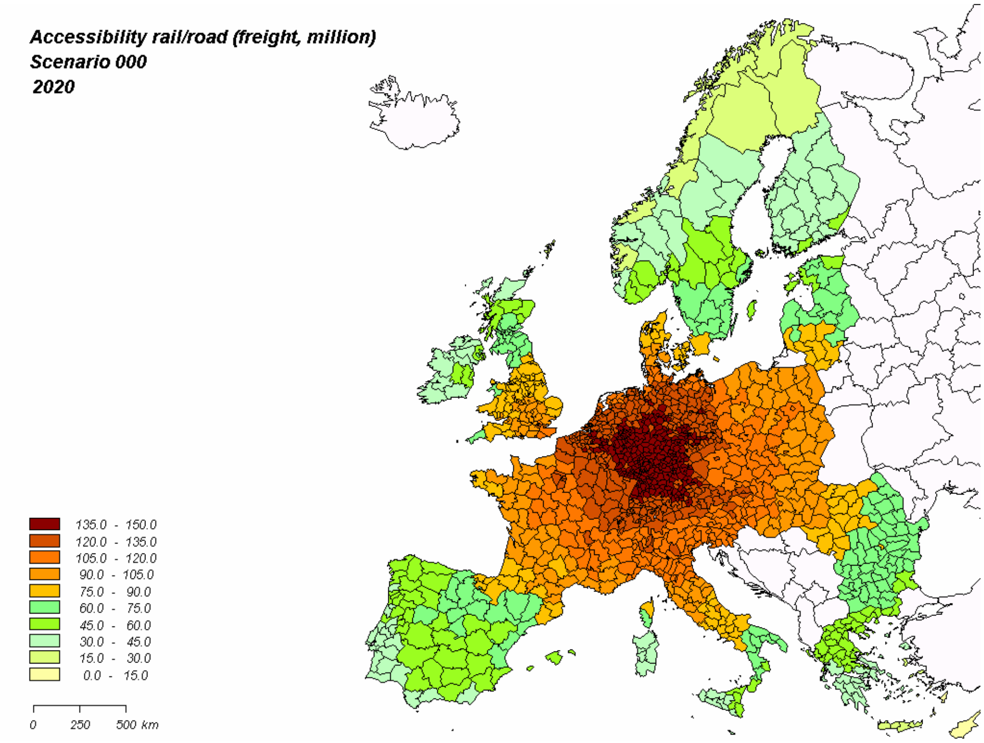

FIGURE 13: REFERENCE SCENARIO 000: ACCESSIBILITY RAIL/ROAD (FREIGHT, MILLION) IN 2020

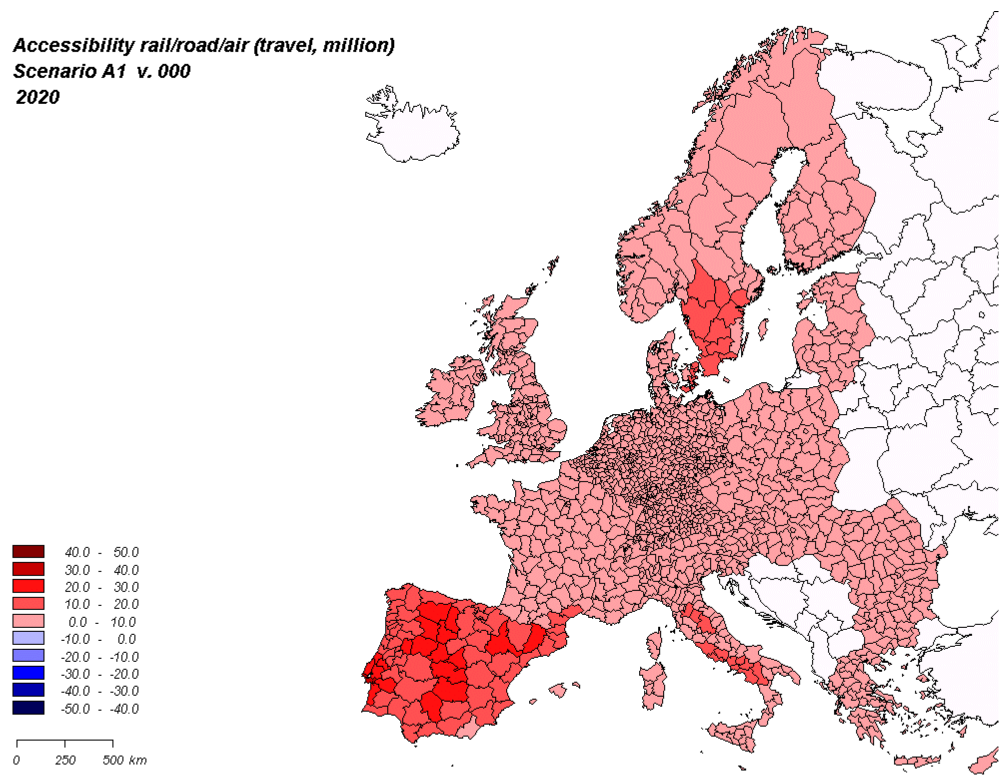

FIGURE 14: PERCENT CHANGE IN ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL) BY TEN PRIORITY PROJECTS (SCENARIO A1)

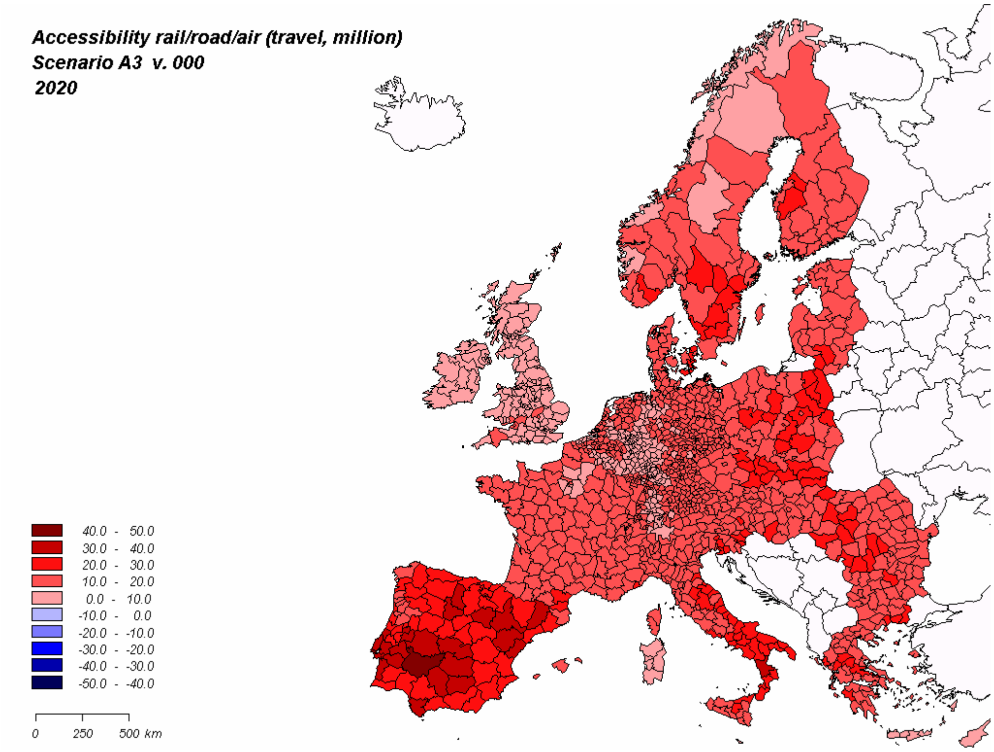

FIGURE 15: PERCENT CHANGE IN ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL) BY ALL TEN/TINA PROJECTS (SCENARIO A3)

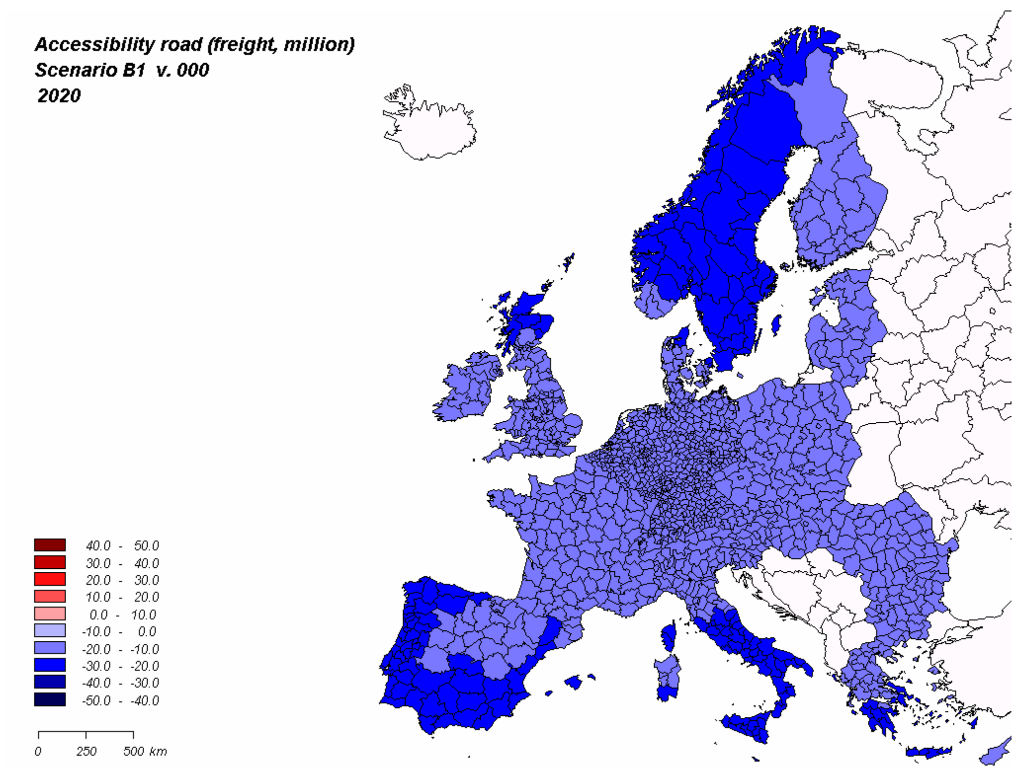

FIGURE 16: PERCENT CHANGE IN ACCESSIBILITY ROAD (FREIGHT) BY FREIGHT ROAD PRICING (SCENARIO B1)

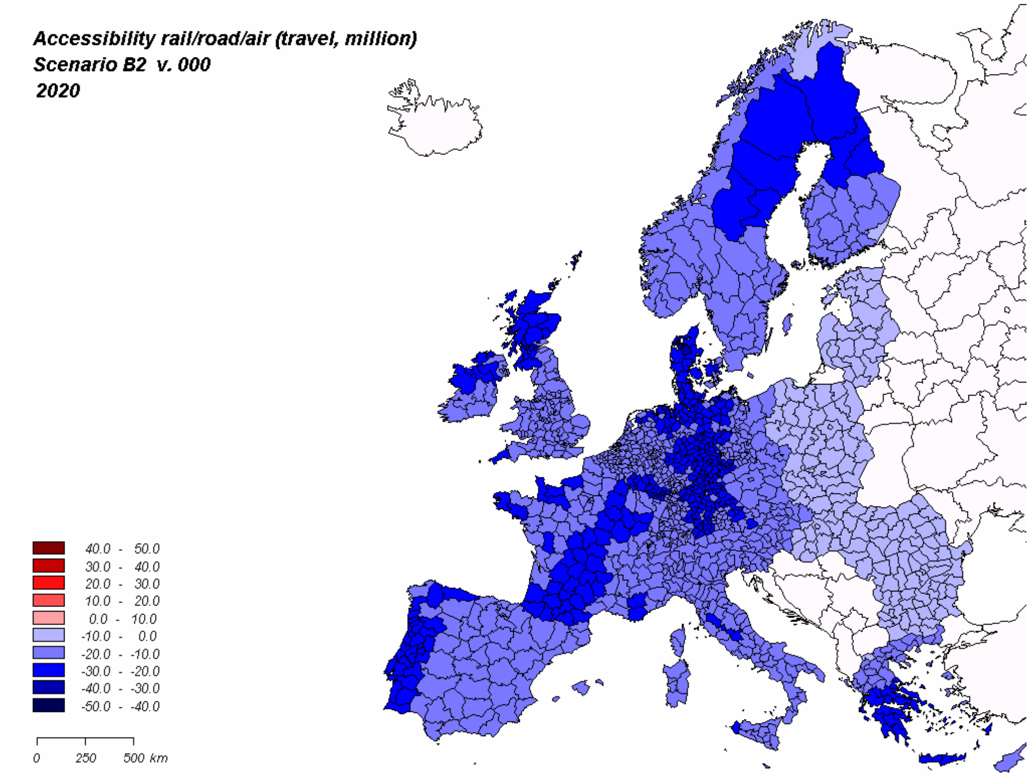

FIGURE 17: PERCENT CHANGE IN ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL) BY PRICING OF ALL MODES (SCENARIO B2)

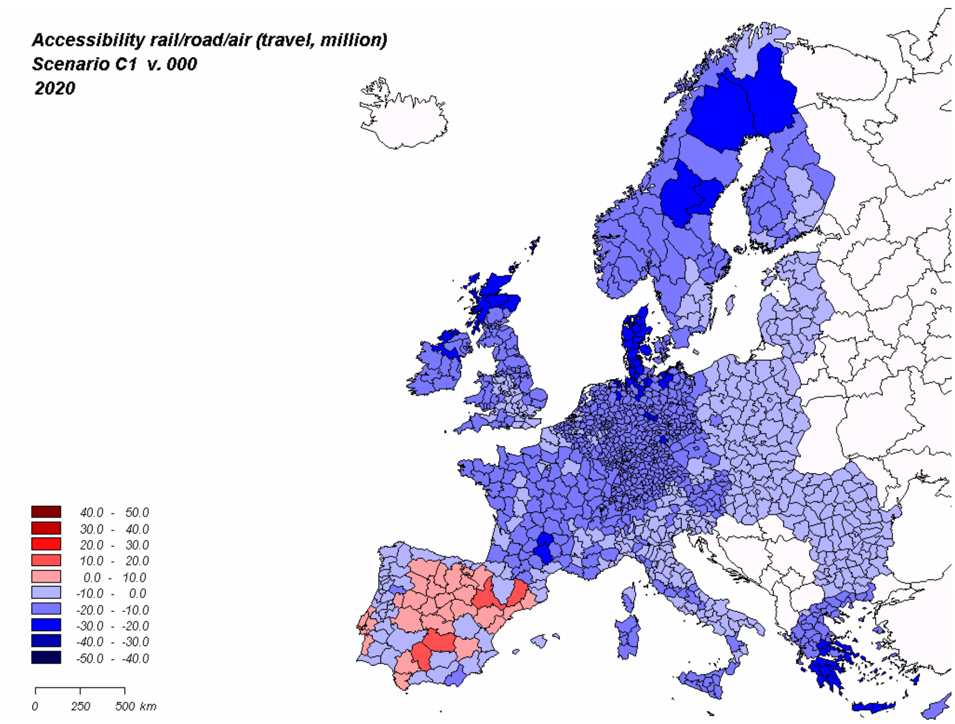

FIGURE 18: PERCENT CHANGE IN ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL BY COMBINATION OF SCENARIOS A1+B2 (SCENARIO C1)

As to be expected, the network scenarios A1, A3, A51 and A62 improve accessibility everywhere but to a different degree and not equally in all parts of Europe.

The 'classical' TEN priority projects of the Essen list (Scenario A1) aimed primarily at improving the accessibility of the peripheral regions in the Mediterranean and the Nordic countries (see Figure 14). Today, with the enlargement of the European Union, the task of better linking the accession countries in central and Eastern Europe to the European core has become more important. If all network links designated as TEN and TINA are assumed to be implemented as in Scenario A3, the gains in accessibility are much larger and more evenly distributed over the European territory (see Figure 15).

Conversely, all pricing policy scenarios reduce accessibility because per-km costs are included in the generalised-cost function. It is important to note that in all pricing scenarios marginal social cost pricing is applied only to transport links in the present European Union. If only freight transport on roads is priced, as in Scenario B1, the regions most affected are therefore peripheral regions in the present EU member states which depend on long-distance connections to markets – road accessibility by lorry goes down by more than twenty percent in parts of Portugal, Spain, southern Italy and Greece, and in the North in Scotland and Sweden, with Norway also affected (see Figure 16). In the more comprehensive pricing scenario B2, in which all modes and both travel and freight are subject to pricing, the effects are concentrated in the central regions which depend on business and leisure travel, whereas the candidate countries in eastern Europe are only little affected (see Figure 17).

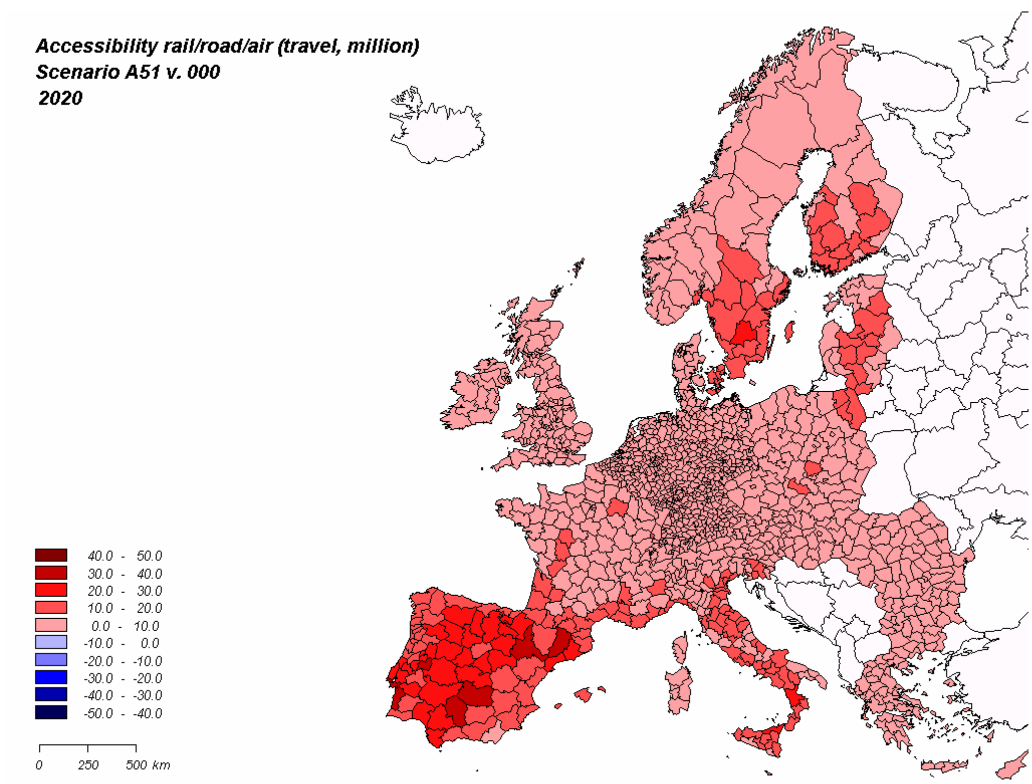

FIGURE 19: PERCENT CHANGE IN ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL) BY NEW PRIORITY PROJECTS (SCENARIO A51)

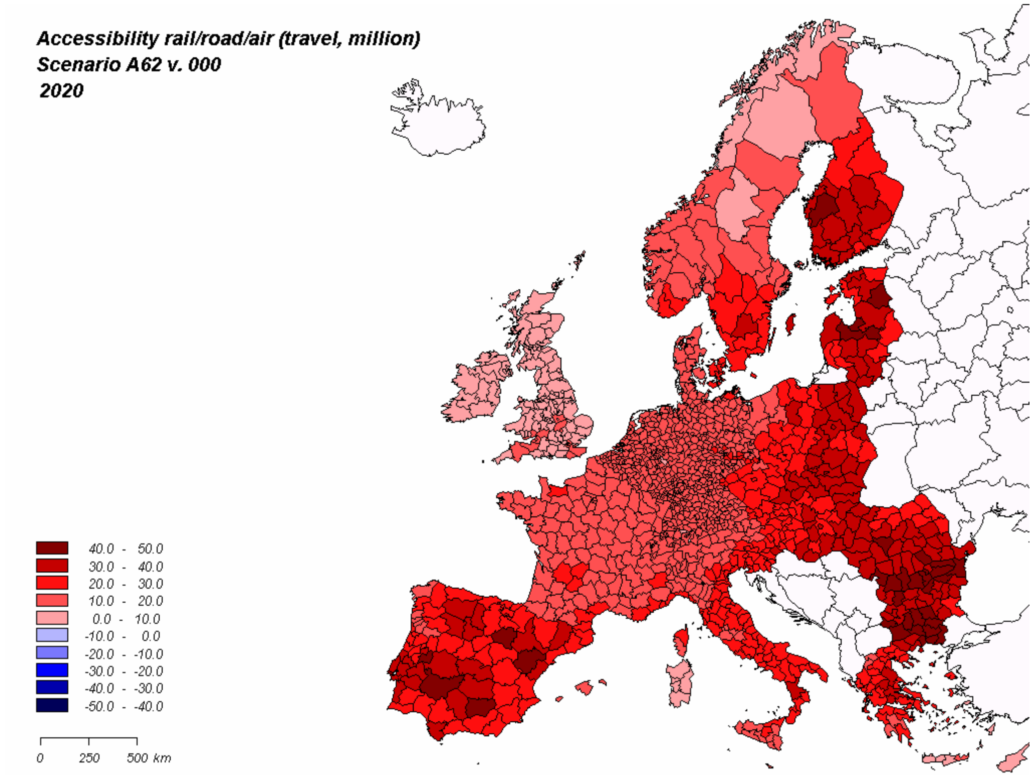

FIGURE 20: PERCENT CHANGE IN ACCESSIBILITY RAIL/ROAD/AIR (TRAVEL) BY A3 + MAXIMUM PROJECTS IN EASTERN EUROPE (SCENARIO A62)

Figure 18 shows the combined effects of network scenario A1 and pricing scenario B2 (Scenario C1) on multimodal travel accessibility. Now the increased costs due to transport pricing are partly offset by the positive effects of the network improvements, for some Spanish regions the balance is positive. However, because more network improvements in Scenario A1 are located in peripheral regions, the core of Europe with the highest accessibility (see Figures 10 to 13) is now losing more in accessibility than many peripheral regions.

Figures 19 and 20 present the effects of the additional network scenarios on accessibility. If one compares the accessibility effects of the new list of priority projects of Scenario A51 (see Figure 19) with those of the Essen list of Scenario A1 (see Figure 14), the differences seem not very great. However, the new projects in Poland and the Baltic states, which also improve accessibility in Finland, can be clearly identified. Figure 20 showing the effects of the most optimistic interpretation of the TINA outline plan in Scenario A62 should be compared with Figure 15, in which only the minimum implementation scheme of TINA projects in Scenario A3 is assumed. The results are quite spectacular with accessibility increases in Poland, Slovakia, Romania and Bulgaria and the Baltic states between 40 and 50 percent. Again, Finland participates in these gains, but also central Europe gains because of the improved access to eastern markets.

Table 12 and Figures 21 and 22 summarise the accessibility effects of all simulated policy scenarios.

TABLE 12: SASI MODEL RESULTS: ACCESSIBILITY

	Scenario	Accessibility difference between policy scenario and reference scenario in 2020 (%)			
		EU15	CH+NO	CC12	EU27+2
A1	TEN priority projects	+6.42	+4.72	+2.48	+5.68
A21	High-speed rail priority projects	+5.50	+3.28	+2.20	+4.86
A22	Conventional rail priority projects	+0.82	+0.90	+0.18	+0.71
A23	Road priority projects	+0.32	+0.81	+0.15	+0.30
A24	Rail priority projects	+6.16	+4.05	+2.35	+5.43
A3	All TEN/TINA projects	+12.74	+11.09	+14.40	+12.99
A4	All TEN projects	+11.06	+9.61	+5.07	+9.96
A51	New priority projects	+8.20	+7.06	+5.78	+7.74
A52	New priority rail projects	+7.84	+6.37	+4.96	+7.29
A53	New priority road projects	+0.48	+0.92	+1.01	+0.59
A61	A3 + additional projects in CC12	+13.74	+11.80	+17.18	+14.30
A62	A3 + maximum projects in CC12	+14.93	+12.73	+22.96	+16.30
B1	SMC pricing road freight	–4.44	–4.90	–5.65	–4.67
B2	SMC pricing all modes travel/freight	–13.37	–13.01	–9.46	–12.67
C1	A1+B2	–6.55	–8.24	–6.68	–6.61
D1	Dedicated rail freight network	+18.78	+17.95	+12.42	+17.63
E1	TIPMAC business-as-usual scenario	+12.55	+10.56	+14.32	+12.82
E2	TIPMAC fast TEN + SMC	+4.75	+1.59	+11.58	+5.89

Table 12 shows for each policy scenario the percentage difference in accessibility between the policy scenario and the reference scenario in 2020 for four groups of regions: the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total study region (EU27+2). As accessibility indicator here the sum of two of the four accessibility indicators used in SASI was applied: accessibility rail/road/air (travel) and accessibility rail/road (freight).

As it was already observed, all network scenarios have a positive effect on accessibility. The degree of improvement, obviously, is a function of the number of projects and the volume of investment. The high-speed rail priority projects are much more effective than the conventional rail projects, and the rail projects are much more effective than the road improvement projects, but this may be caused by the greater number of high-speed rail and rail projects in the two priority lists. Not surprisingly, if all TEN and TINA projects are implemented, the effects are more substantial, and if even more projects are implemented as in Scenarios 61 and 62, the effects are even larger. Remarkably, the largest accessibility effect is achieved by the dedicated rail freight network of Scenario D1, presumably because of the general technical improvement of the rail network assumed in Scenario D1.

Transport pricing policies, on the other hand, reduce accessibility. Again not surprisingly, the more profound effect occurs if all modes and both travel and goods transport are subjected to pricing as in Scenario B2. If both network and pricing scenarios are combined as in Scenario C1, the outcome depends on the pricing level – in Scenario C1 the negative impacts of the pricing outweigh the positive impacts of the network improvements.

Figures 21 and 22 present the same information in graphical form. Figure 21 shows the development of accessibility (as defined above) between 1981 and 2021 in the present European Union (EU15) and Figure 22 the same for the twelve candidate countries (CC12). Each line in the diagram represents the development of accessibility in one scenario, the heavy black line the reference scenario. As noted before, all scenarios are identical until the year 2001. The lines are colour-coded to indicate the scenario groups.

In the reference scenario accessibility increases after 2001, although in it no network improvements are assumed after 2001. These increases are due to the reduction of waiting times at borders and political, cultural and language barriers through the enlargement of the European Union and further integration assumed for all scenarios. It is obvious that these effects are much stronger for the accession countries than for the member states of the present European Union. The accessibility of the candidate countries as a whole is not much less than in the present European Union as a whole. However, there remain large differences in accessibility both in the European Union and among the candidate countries. It can be seen that the network scenarios tend to be implemented incrementally and so slowly build up their impact over time, whereas the pricing scenarios work like a shock and then follow the general trend of the reference scenario.

The comparison of the two diagrams seems to indicate that the effects of the network scenarios are stronger in the candidate countries, whereas the pricing scenarios more strongly affect the member states of the present European Union. This effect will be discussed again in the section on cohesion effects.

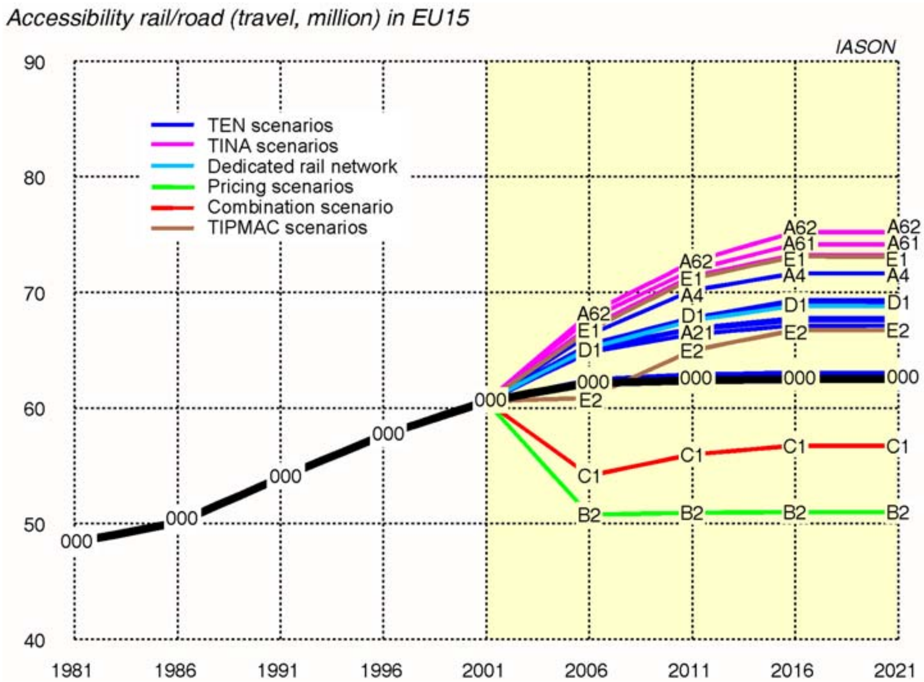

FIGURE 21: ACCESSIBILITY RAIL/ROAD (TRAVEL, MILLION) IN THE EUROPEAN UNION

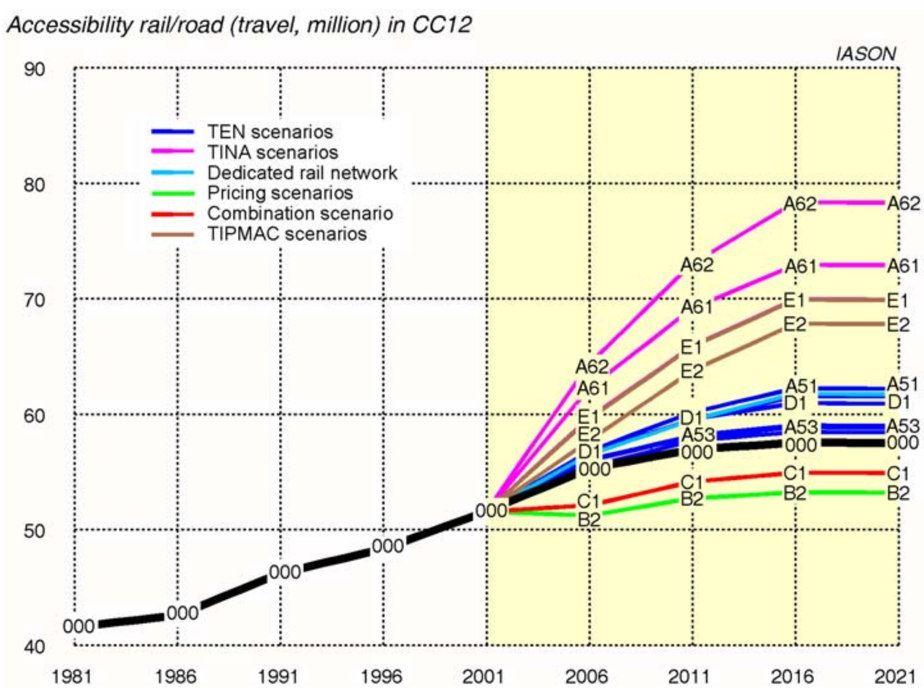

FIGURE 22: ACCESSIBILITY RAIL/ROAD (TRAVEL, MILLION) IN THE CANDIDATE COUNTRIES

C.3.2.3 GDP per capita

The major policy-relevant output of the SASI model is regional GDP per capita, i.e. GDP totalled over all six sectors used in SASI divided by population.

Figures 23 to 29 show the changes in GDP per capita caused by the policies in the same set of policies as shown in Figures 14 to 18 (or more precisely, the difference between GDP per capita in the policy scenario and GDP per capita in the reference scenario in 2020). The classes of the legend and the colour code are identical in all maps to allow easy comparison. Red colour shades indicate positive differences (i.e. the GDP per capita in the policy scenario is higher), whereas blue indicates negative differences. However, in contrast to the accessibility maps, now the regional GDP per capita are standardised as percent of the EU27+2 average, so that the generative effects of the forecast GDP forecasts are neutralised and only the distributional effects are shown. This serves to demonstrate that even if the model predicts that all regions gain in GDP per capita, there are relative winners and losers.

Figures 23 and 29 demonstrate that regions that gain in accessibility also gain in GDP per capita. A comparison of Figure 23 with Figure 14 shows that if the 'classical' TEN priority projects of the Essen list are implemented as in Scenario A1, the network improvements in the cohesion countries Portugal, Spain and Italy are successful in promoting economic development in these countries as intended. Figure 24 shows that, as in Figure 15, the implementation of all TEN and TINA projects would spread the impacts over a wider area including the candidate countries in eastern Europe.

Similar observations, but with the opposite sign, can be made with respect to the impacts of transport pricing policies. Figures 25 and 26 show the effects of road pricing for lorries (Scenario B1) and pricing of all modes for both travel and goods transport (Scenario B2), respectively. Figure 25 (Scenario B1) conforms to expectation: the peripheral regions, which lose most in accessibility (see Figure 16), also lose most in GDP per capita. The reverse occurs in the case of the more comprehensive pricing scheme of Scenario B2 (Figure 26). Now the peripheral regions seem to be the (relative) winners, because the central regions suffer more under the high charges on travel.

If network scenario A1 and pricing scenario B2 are combined as in Scenario C1, the results is, as to be expected, a superposition of the effects of both policies (see Figure 27). A comparison with the accessibility map of Scenario C1 (Figure 3.13) shows that regions with high losses in accessibility also lose GDP per capita and that regions with gains or only slight losses in accessibility perform well economically.

The same relationship between accessibility and GDP per capita holds true for the two remaining scenario examples. The changes in GDP per capita resulting from the new priority projects in Scenario 51 (Figure 28) correspond well with the changes in accessibility in that scenario in Figure 3.9. A comparison with the GDP per capita in Scenario A1, in which the 'old' priority projects are implemented (see Figure 23), shows that the economic effects of the two priority lists are very similar, except that the new priority projects redress some of the disadvantages of the peripheral regions in Eastern Europe. Not surprisingly, the massive network policies in eastern Europe in Scenario A62 lead to significant additional economic growth in the candidate countries (see Figure 29).

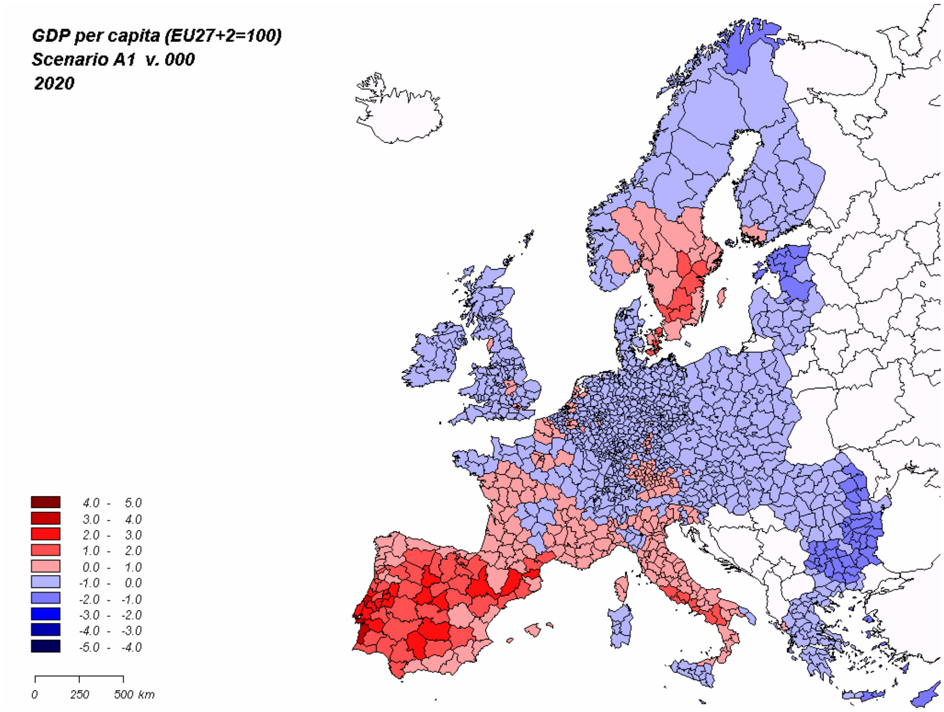

FIGURE 23: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY TEN PRIORITY PROJECTS (SCENARIO A1)

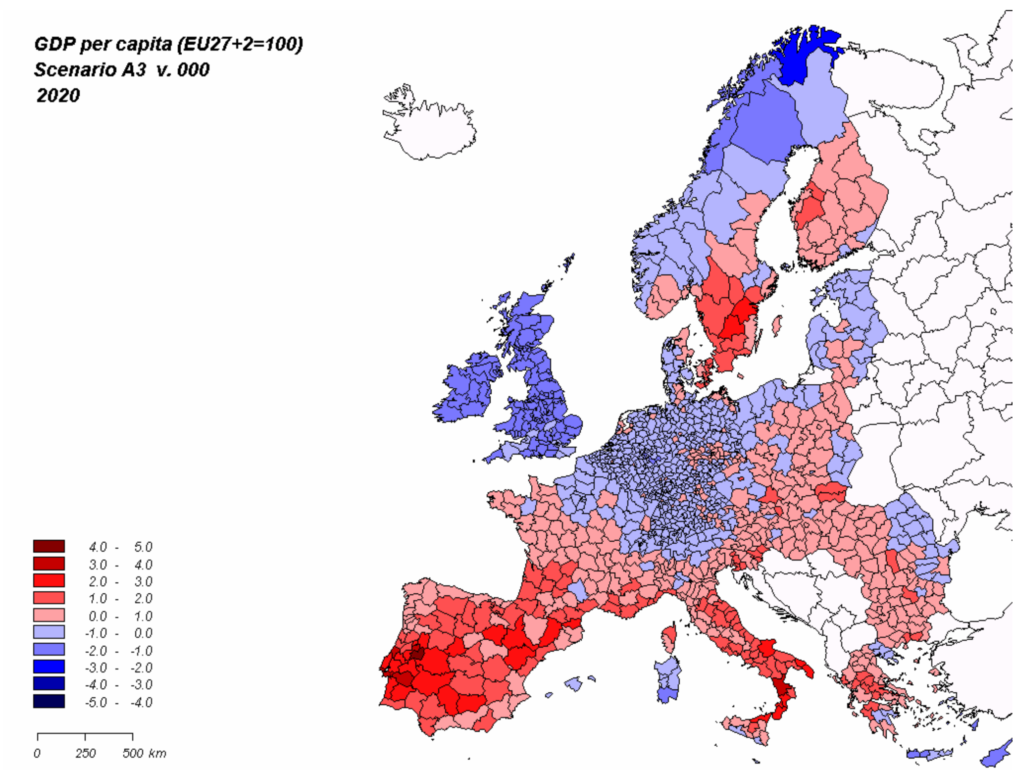

FIGURE 24: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY ALL TEN/TINA PROJECTS (SCENARIO A3)

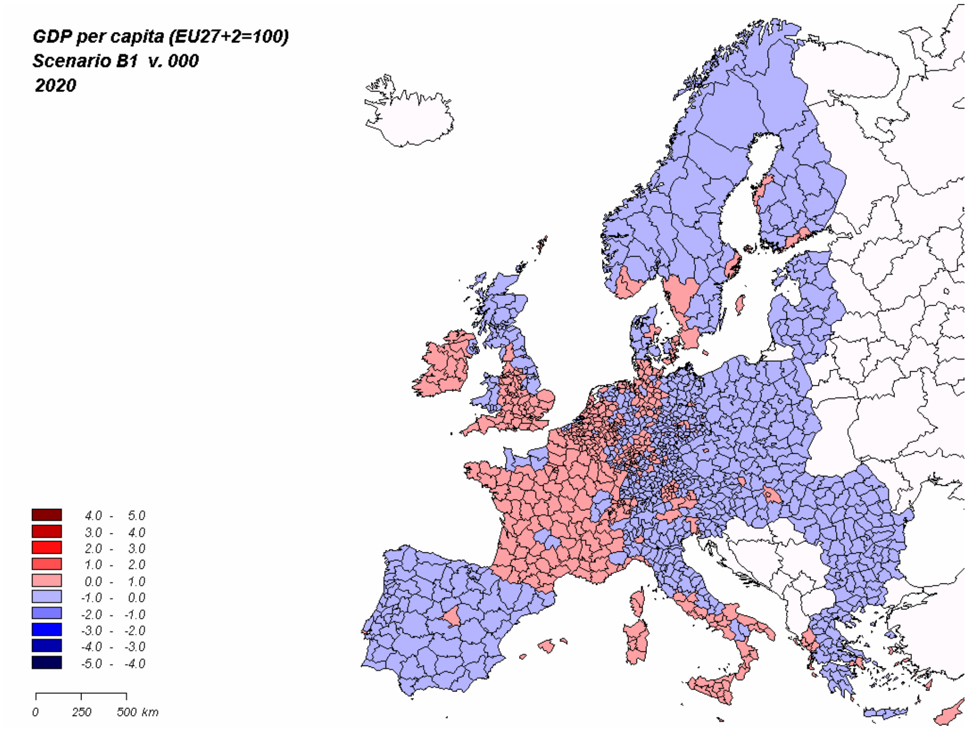

FIGURE 25: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY FREIGHT ROAD PRICING (SCENARIO B1)

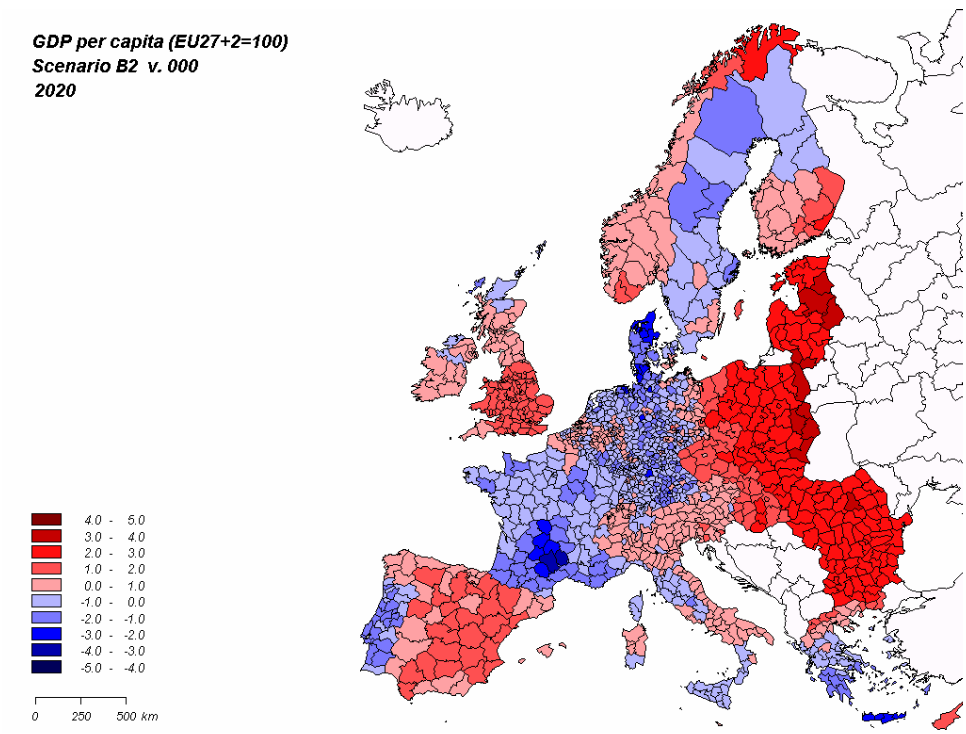

FIGURE 26: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY PRICING OF ALL MODES (SCENARIO B2)

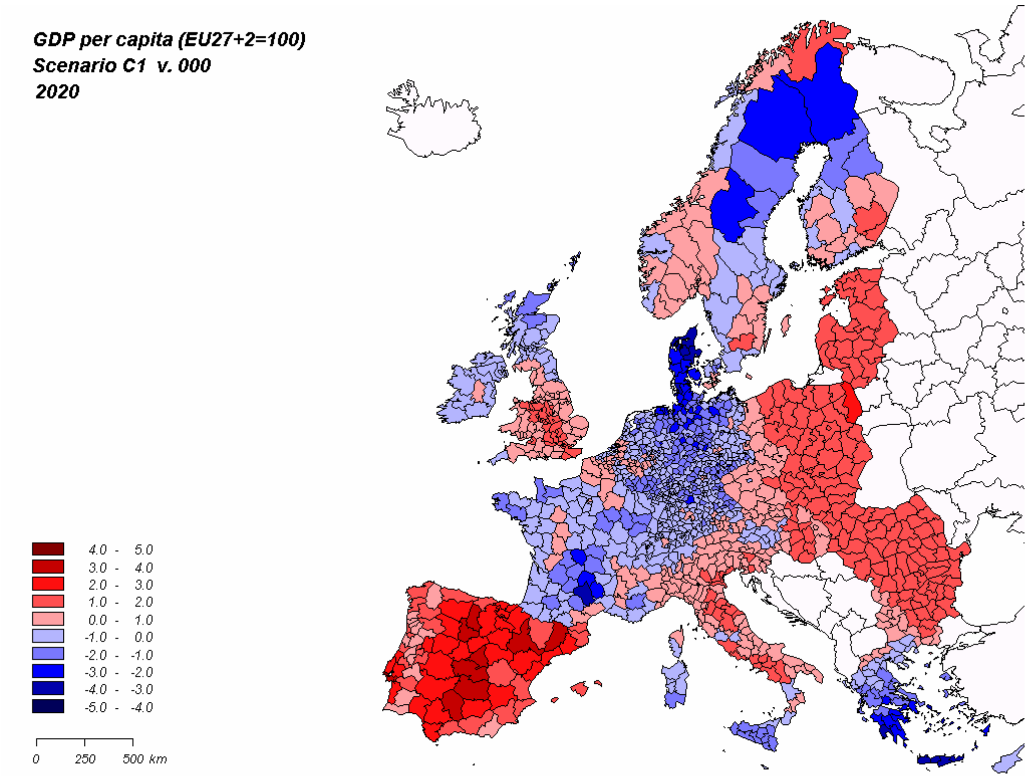

FIGURE 27: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY COMBINATION OF SCENARIOS A1+B2 (SCENARIO C1)

Table 13 and Figures 30 and 31 summarise the GDP per capita effects of all simulated policy scenarios.

Table 13 shows for each policy scenario the percentage difference in GDP per capita between the policy scenario and the reference scenario in 2020 for four groups of regions: the present European Union (EU15), Switzerland and Norway (CH+NO), the twelve candidate countries (CC12) and the total study region (EU27+2). GDP per capita shown is the total of GDP of the six sectors used in SASI divided by population, in unstandardised form.

In this unstandardised form, all network scenarios have a positive effect on GDP per capita. As with accessibility, the largest effects are associated with the more comprehensive investment programmes: all TEN projects (Scenario A1), all TEN and TINA projects (Scenario A3) and the larger version of the additional projects in CC12 (Scenario A62). Also in economic terms, high-speed rail is more effective than conventional rail, and rail is more effective than road – but again with the caveat that this result may be due to the larger proportion of rail, and in particular high-speed rail, projects among the projects of the two priority lists. In economic terms, the dedicated rail network is not so successful as its accessibility effect might suggest.

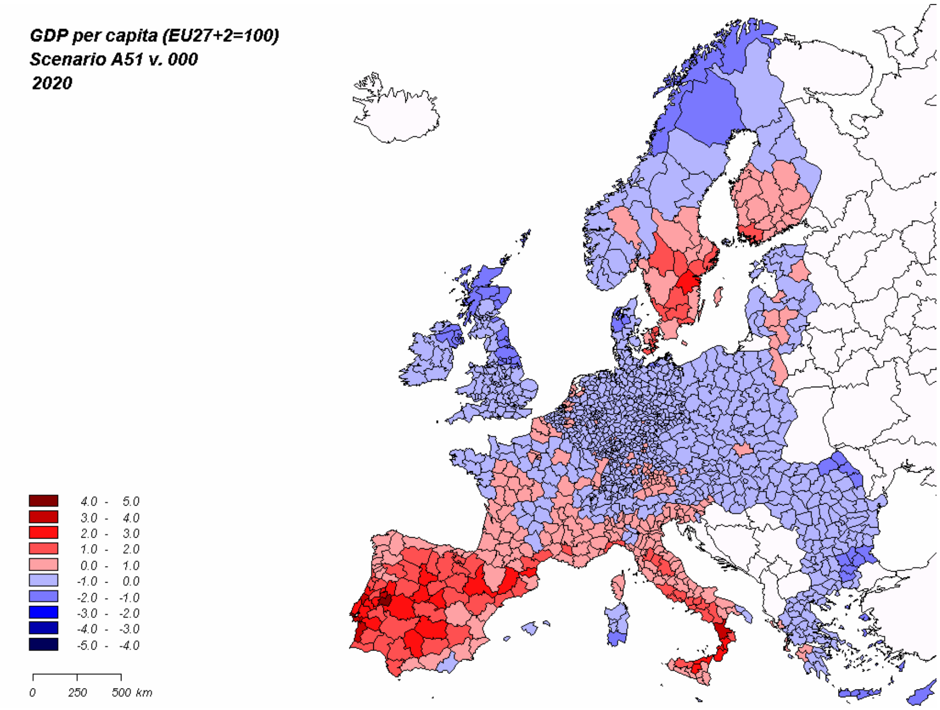

FIGURE 28: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY NEW PRIORITY PROJECTS (SCENARIO A51)

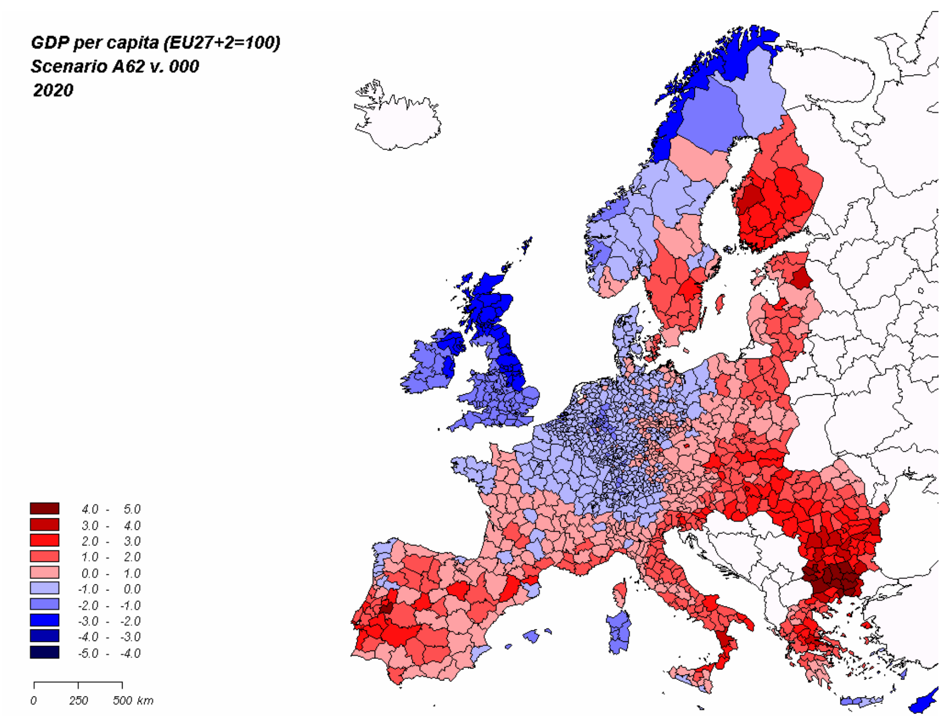

FIGURE 29: PERCENT CHANGE IN GDP PER CAPITA (E27+2=100) BY A3 + MAXIMUM PROJECTS IN EASTERN EUROPE (SCENARIO A62)

TABLE 13: SASI MODEL RESULTS: GDP PER CAPITA

Scenario		GDP per capita difference between policy scenario and reference scenario in 2020 (%)			
		EU15	CH+NO	CC12	EU27+2
A1	TEN priority projects	+1.25	+0.88	+0.32	+1.19
A21	High-speed rail priority projects	+1.07	+0.55	+0.28	+1.01
A22	Other rail priority projects	+0.14	+0.20	+0.01	+0.13
A23	Road priority projects	+0.09	+0.18	+0.03	+0.09
A24	Rail priority projects	+1.17	+0.74	+0.30	+1.11
A3	All TEN/TINA projects	+2.59	+2.14	+2.90	+2.58
A4	All TEN projects	+2.19	+1.84	+0.78	+2.11
A51	New priority projects	+1.62	+1.31	+1.02	+1.58
A52	New priority rail projects	+1.54	+1.17	+0.86	+1.49
A53	New priority road projects	+0.12	+0.20	+0.21	+0.13
A61	A3 + additional projects in CC12	+2.84	+2.30	+3.70	+2.85
A62	A3 + maximum projects in CC12	+3.10	+2.48	+5.16	+3.16
B1	SMC pricing road freight	–0.10	–0.16	–0.19	–0.11
B2	SMC pricing all modes travel/freight	–3.84	–3.38	–1.62	–3.72
C1	A1+B2	–2.38	–2.47	–1.23	–2.33
D1	Dedicated rail freight network	+1.71	+1.61	+1.06	+1.68
E1	TIPMAC business-as-usual scenario	+2.54	+2.03	+2.89	+2.52
E2	TIPMAC fast TEN + SMC	+0.33	–0.84	+2.20	+0.35

Transport pricing policies reduce not only accessibility but also GDP per capita. Remarkably, pricing of only freight transport on roads (Scenario B1), has only little economic effect despite its significant negative effect on accessibility (see Table 12). However, if all modes and both travel and goods transport are subjected to pricing as in Scenario B2, the negative effect is very strong and is in fact the strongest effect of all scenarios whether positive or negative. If both network and pricing scenarios are combined as in Scenario C1, the negative effect of pricing by far outweighs the positive impact of the network improvements.

Figures 30 and 31 present the same information in graphical form. Figure 30 shows the development of GDP per capita between 1981 and 2021 in the present European Union (EU15) and Figure 31 the same for the twelve candidate countries (CC12). Each line in the diagram represents the development of GDP per capita in one scenario, the heavy black line the reference scenario. As noted before, all scenarios are identical until the year 2001. The lines are colour-coded to indicate the scenario groups.

A comparison of Figures 30 and 31 with the same diagrams for accessibility (Figures 21 and 22) demonstrates that relatively large changes in accessibility translate into only very small changes in economic performance (note the difference in scale of the two pairs of diagrams). In fact the changes in GDP per capita caused by transport policy are tiny in relation to the changes caused by other driving forces, such as innovation, productivity gains or globalisation. For instance it is assumed for all SASI scenarios that total GDP in the study area grows by 70 percent until 2021, or by 2.66 percent annually. Even the economic effect of the implementation of all TEN and TINA projects would amount to less than one year's growth or increase the annual growth rate by a mere 0.08 percent.

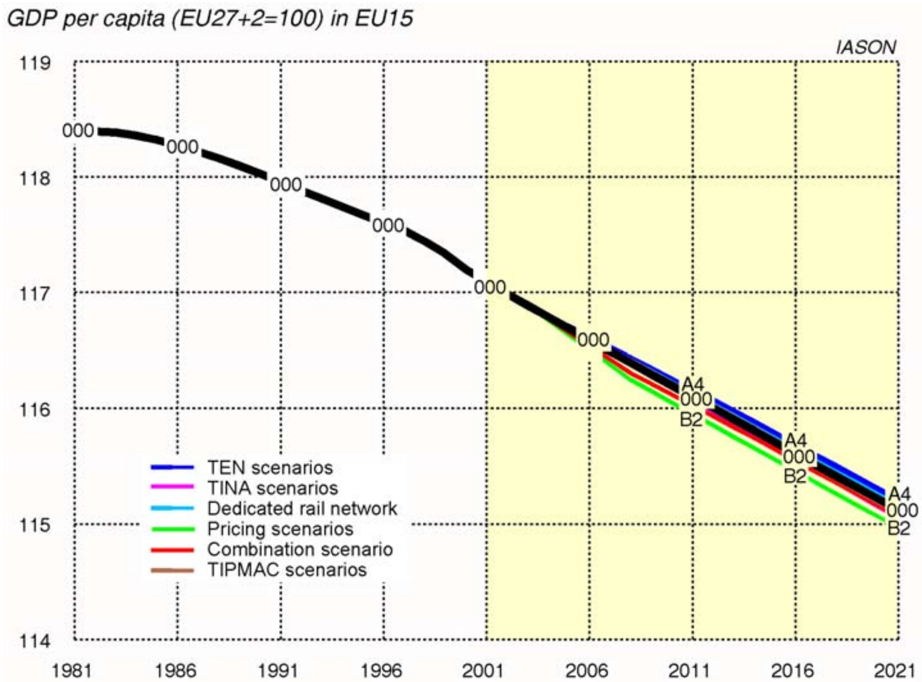

FIGURE 30: GDP PER CAPITA (EU27+2=100) IN THE EUROPEAN UNION

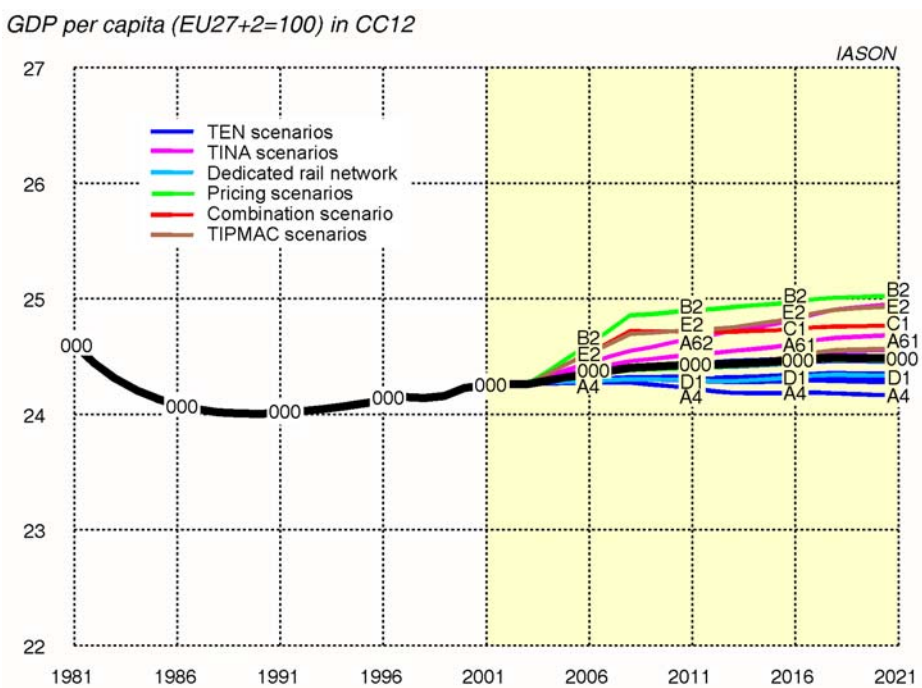

FIGURE 31: GDP PER CAPITA (EU27+2=100) IN THE CANDIDATE COUNTRIES

A further look at Figures 30 and 31 shows that the average GDP per capita in the candidate countries is less than one fifth of that in the member states of the present European Union, and that this vast gap in is narrowing, though very slowly. Transport policy seems to contribute only very little to this convergence, and if it does it does so by improving accessibility in the candidate countries rather than reducing accessibility in the European core. The comprehensive pricing scenario B2 and the massive transport infrastructure programme of Scenario 62 accomplish most in closing the gap, whereas the dedicated rail freight network (Scenario D1) and the implementation of all TEN projects (Scenario A4) tend to increase it. This leads to the issue of cohesion.

C.3.2.4 Cohesion

Strengthening cohesion between the regions in the European Union and reducing the economic and social disparities between them is one of the main goals of the European Union. Transport policy is one of the major policy instruments of the European Union to serve this goal in conjunction with the goal to increase the economic competitiveness of regions. With the enlargement of the European Union and the accession of ten of the twelve candidate countries, cohesion issues become of growing importance.

There are many possible ways to measure the cohesion effects of transport policy measures. Five indicators of territorial cohesion were applied to the results of the scenario simulations. The five indicators are:

- *Coefficient of variation*. This indicator is the standard deviation of region indicator values expressed in percent of their European average. The coefficient of variation ranges between zero (no variation) and one (extreme polarisation).

- *Gini coefficient*. The Gini coefficient measures the area between the accumulated distribution of sorted indicator values and the straight line representing an equal distribution. Like the coefficient of variation, the Gini coefficient ranges between zero (equal distribution) and one (extreme polarisation).

- *Geometric/arithmetic mean*. This indicator compares two methods of averaging among observations: geometric (multiplicative) and arithmetic (additive) averaging. If all observations are equal, the geometric and arithmetic mean are identical, i.e. their ratio is one. If the observations are very heterogeneous, the geometric mean and hence the ratio between the geometric and the arithmetic mean go towards zero.

- *Correlation between relative change and level*. This indicator proposed by Johannes Bröcker examines the relationship between the percentage change of an indicator and its magnitude by calculating the correlation coefficient between them. If for instance the correlation between the changes in GDP per capita of the region and the levels of GDP per capita in the regions is positive, the more affluent regions gain more than the poorer regions and that disparities in income are increased. If the correlation is negative, the poorer regions gain more than the rich regions and disparities decrease.

- *Correlation between absolute change and level*. This indicator also proposed by Johannes Bröcker is constructed as the previous one except that absolute changes are considered.

The distinction between the last two indicators is demonstrated by calculating them for the three scenarios A1, B2 and C1.

Figures 32 to 34 show for each scenario four scatter diagrams. Each dot in the scatter diagram represents a predicted value for one of the 1,321 NUTS-3 regions of the study area in 2021. The dots are colour-coded to allow to identify the regions by country or group of countries. The horizontal axis of each scatter diagram represents the values of one of two variables, accessibility and GDP per capita in the reference scenario in 2020. The vertical axes represent the change of these variables caused by the policy examined, i.e. the difference between the variable in the policy scenario and the reference scenario. The upper row of scatter diagrams refer to accessibility, the lower row to GDP per capita. In each row the left-hand diagram refers to relative (percentage) change, whereas the right-hand diagram refers to absolute change. In each diagram, the correlation coefficient is indicated and the regression line representing the cloud of dots is drawn. The slope of the regression line corresponds to the sign of the correlation coefficient.

It can be seen that in the network scenario A1 (Figure 32) the correlation between relative change and level of accessibility is negative, i.e. the regression line slopes downward. This indicates, as the cloud of dots testifies, that the largest gains in accessibility tend to be in the more peripheral regions, in particular in Portugal and Spain and in the Nordic countries. However, one should be careful. The right-hand diagram indicates that in absolute terms the more central, already highly accessibly regions gain more. This is reflected in the lower two diagrams. The regression line in the left-hand diagram (relative change) has a positive slope because the regions in the candidate countries (the red dots) remain poor. The anti-cohesion effect of Scenario A1 is becoming even more obvious in the right-hand diagram (absolute change).

Figure 33 shows the same four diagrams for the comprehensive pricing scenario B2. Here accessibility declines less in relative terms in the more central regions (which would classify the scenario as anti-cohesion). However, in absolute terms the scenario is strongly pro-cohesion because the more central regions suffer much larger losses in accessibility than the peripheral regions. In economic terms, the scenario is pro-cohesion in both relative and absolute terms.

The superposition of both scenarios in Scenario C1 is shown in Figure 34. Now the negative slope of the regression line in the top-left diagram (relative change of accessibility) and the positive slope of the corresponding diagram in Scenario B2 combine to a slightly negative slope in Scenario C1 making the scenario fully pro-cohesion.

The four correlation coefficients demonstrated for the three scenarios were calculated for all scenarios for each year of the simulation. The results are shown in Figures 35 to 37. The colour code is the same as in Figures 21 to 24. The diagrams are interpreted as follows: lines above the heavy black line represent positive correlation coefficients, i.e. belong to scenarios which are anti-cohesion. Lines below the black line represent negative correlation, i.e. belong to pro-cohesion scenarios. The distance from the black line indicates the intensity of the relationship between change and level.

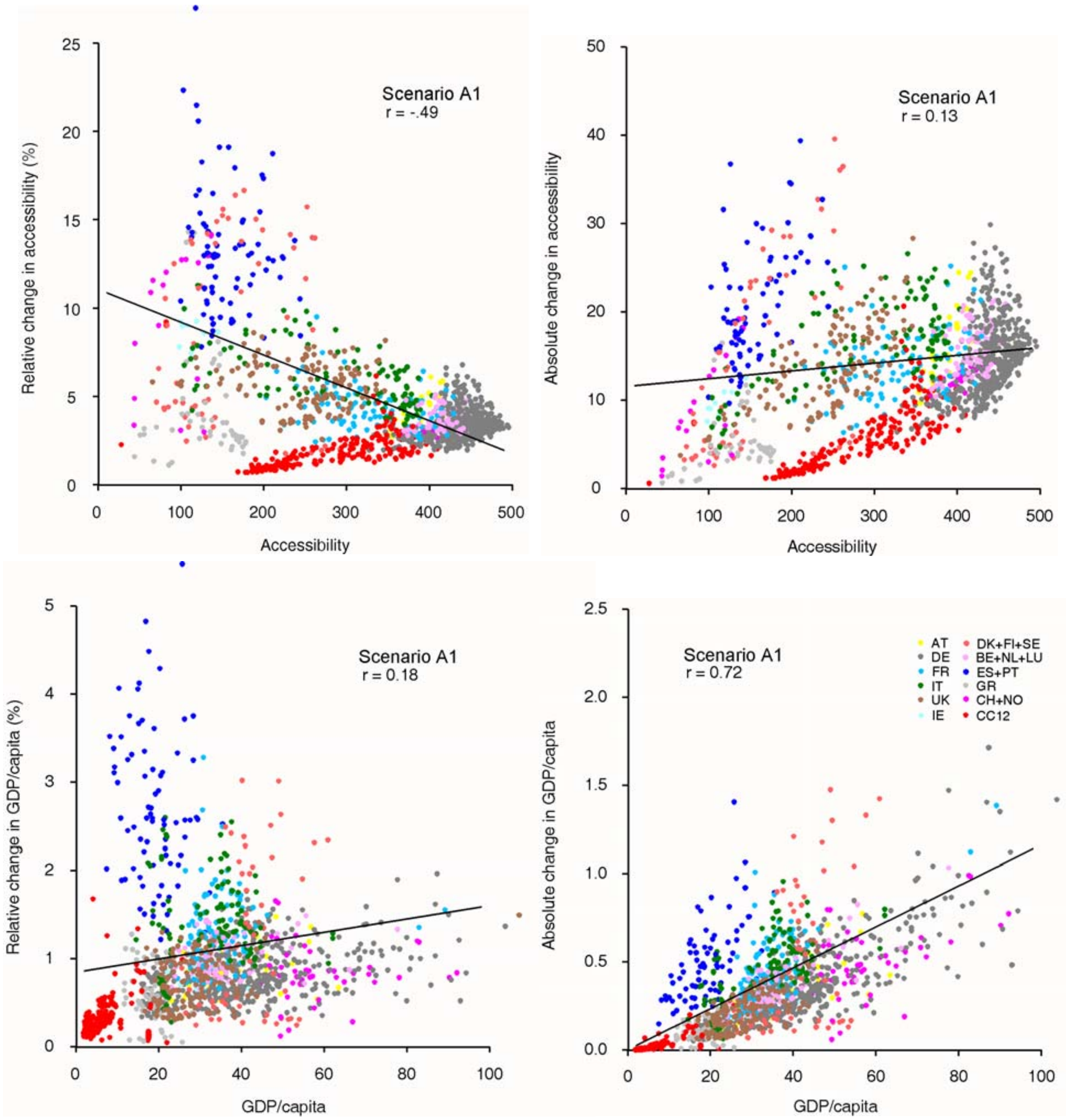

FIGURE 32: CHANGE V. LEVEL: ACCESSIBILITY (TOP), GDP PER CAPITA (BOTTOM), SCENARIO A1

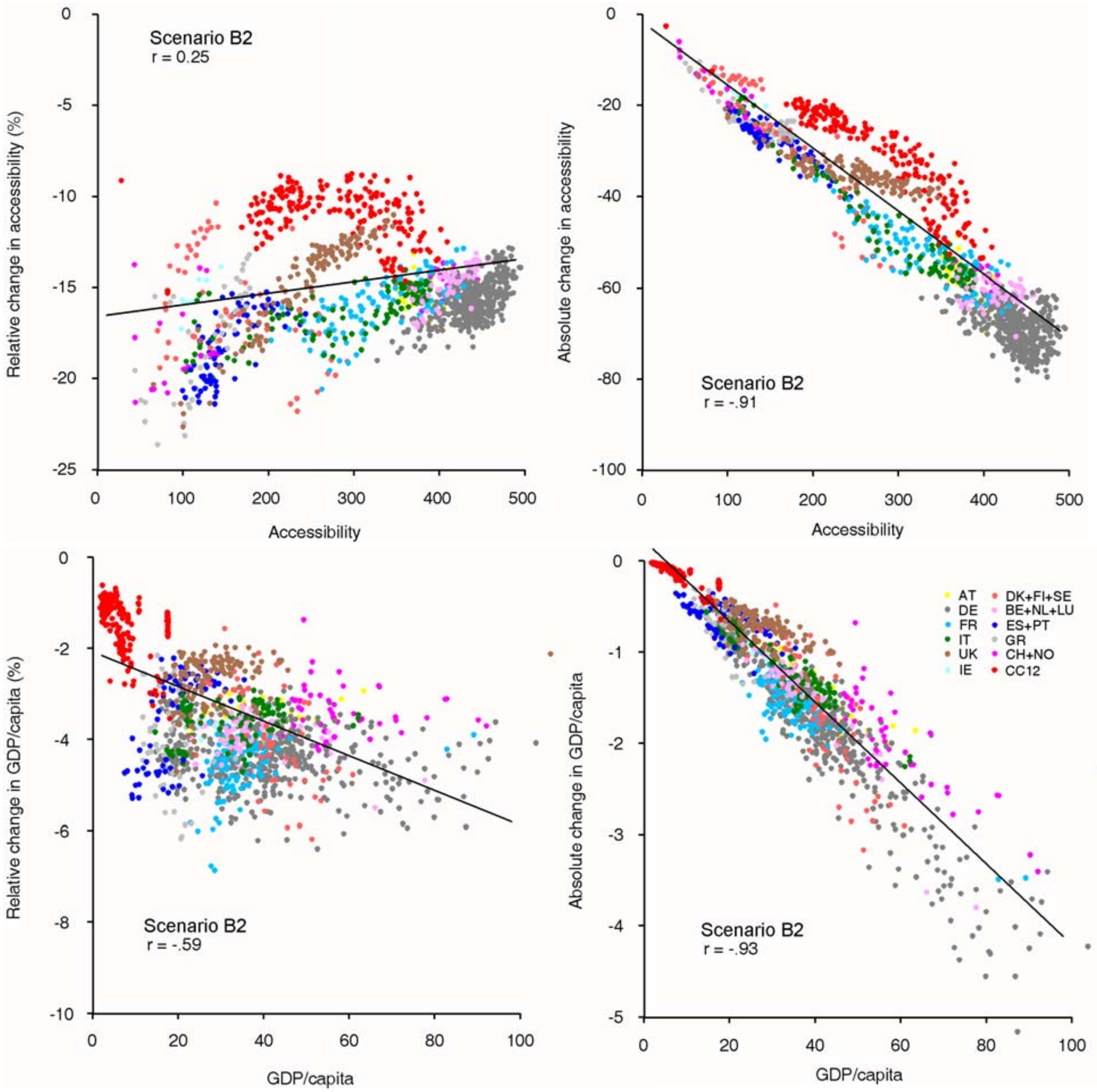

FIGURE 33: CHANGE V. LEVEL: ACCESSIBILITY (TOP), GDP PER CAPITA (BOTTOM), SCENARIO B2

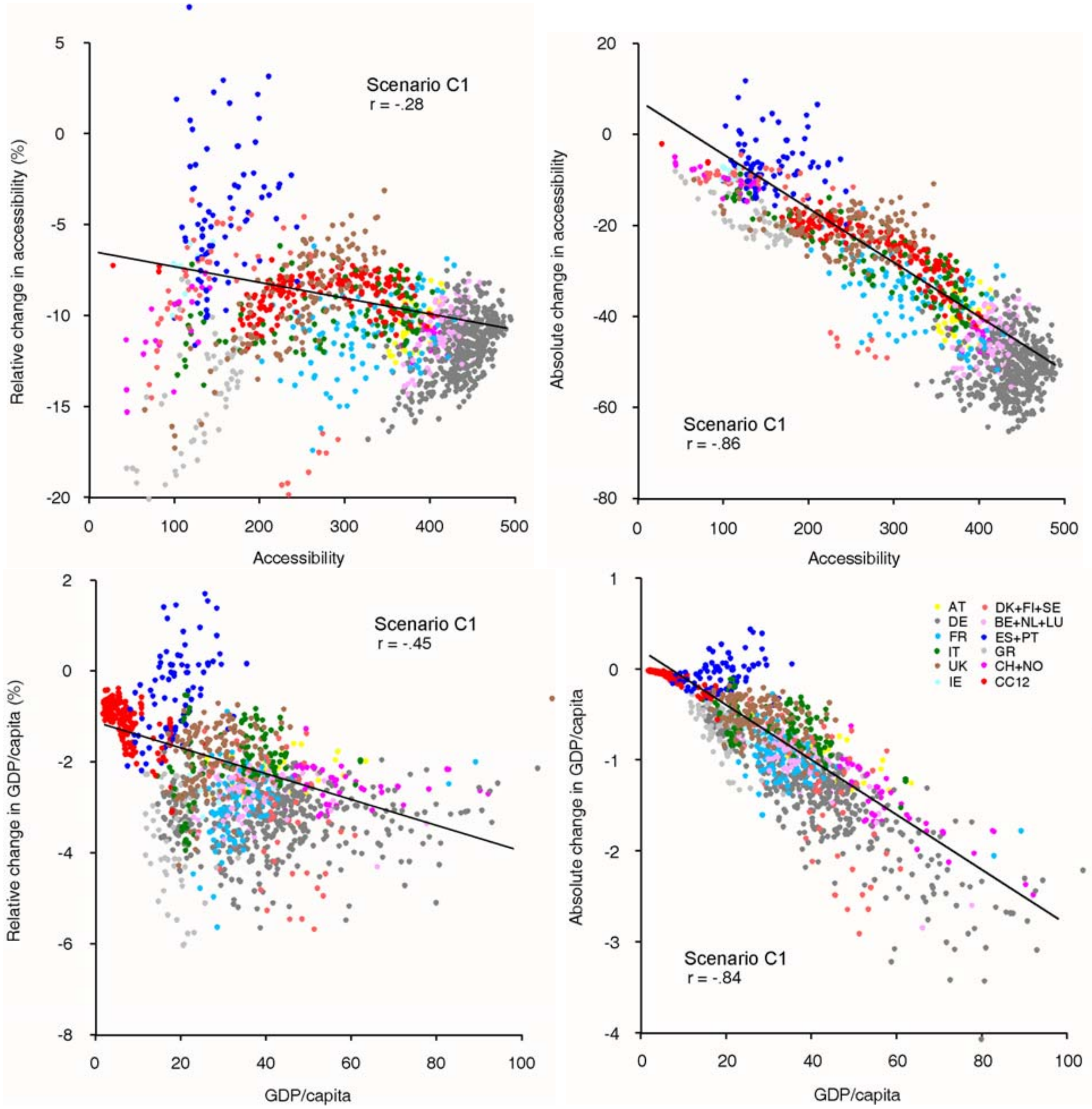

FIGURE 34: CHANGE V. LEVEL: ACCESSIBILITY (TOP), GDP PER CAPITA (BOTTOM), SCENARIO C1

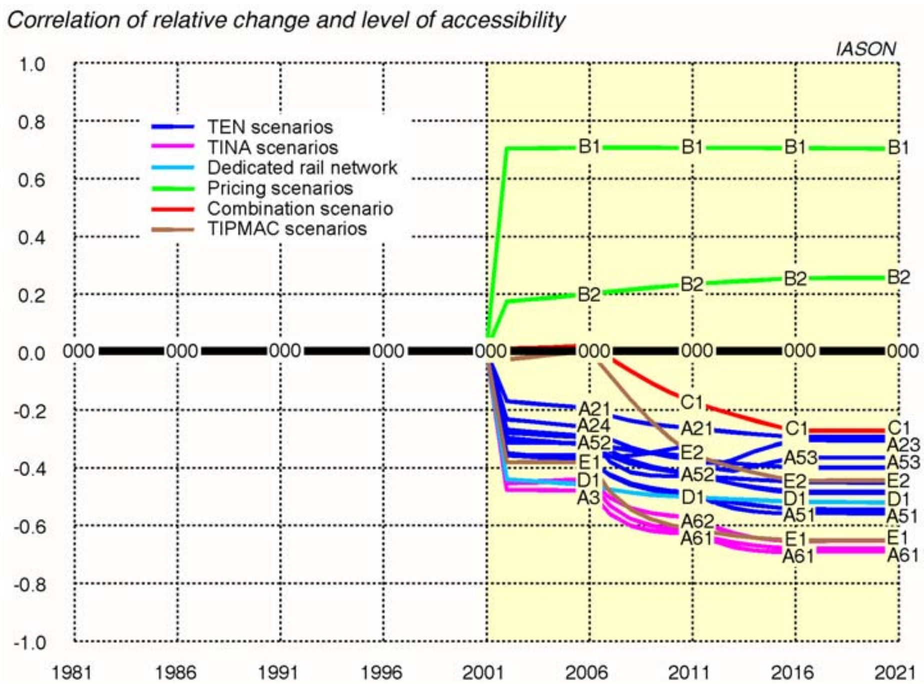

FIGURE 35: CORRELATION OF RELATIVE CHANGE AND LEVEL OF ACCESSIBILITY

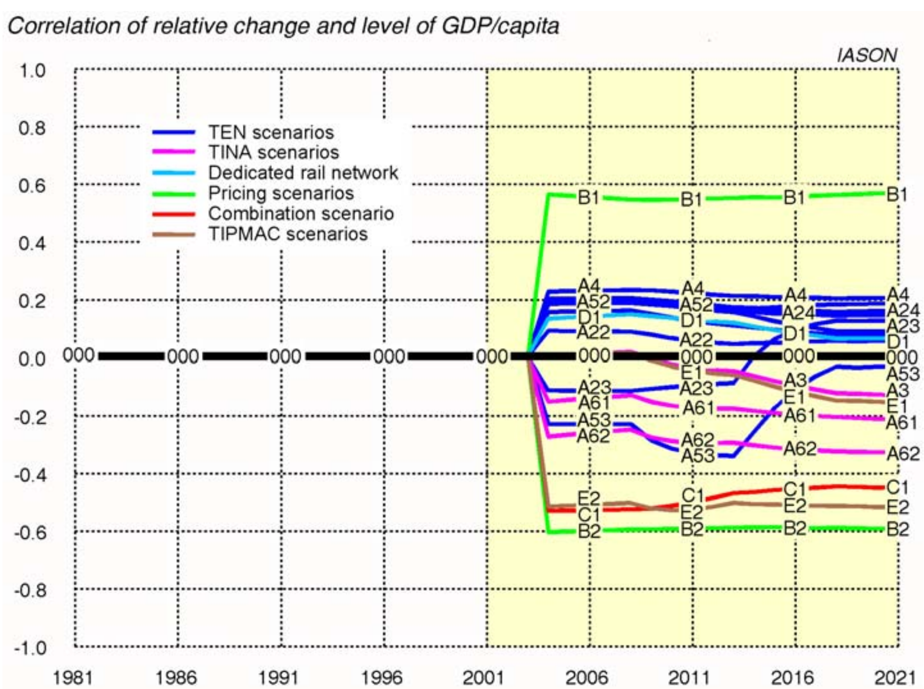

FIGURE 36: CORRELATION OF RELATIVE CHANGE AND LEVEL OF GDP PER CAPITA

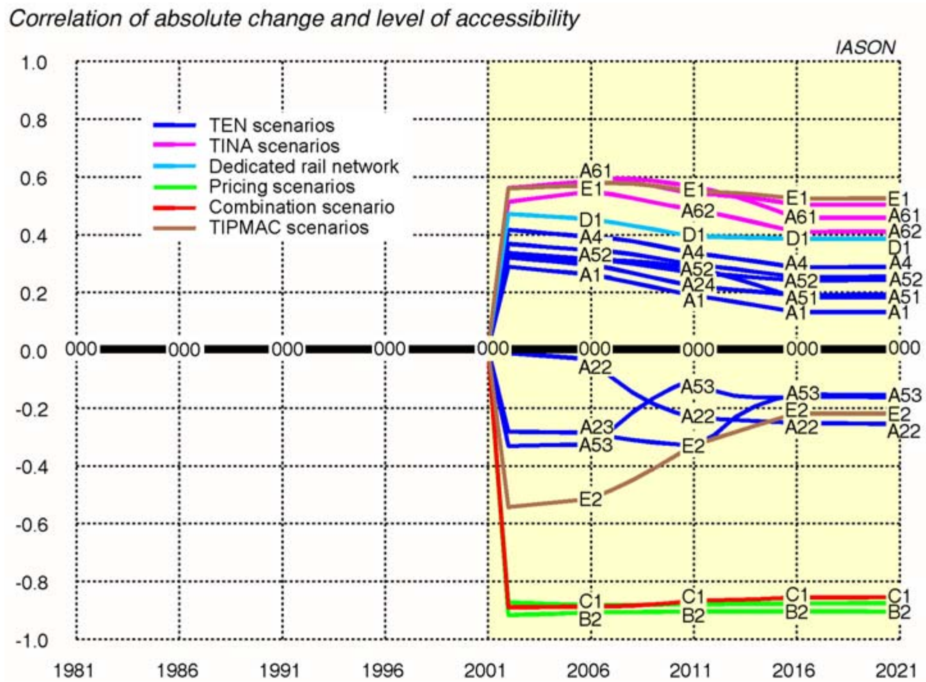

FIGURE 37: CORRELATION OF ABSOLUTE CHANGE AND LEVEL OF ACCESSIBILITY

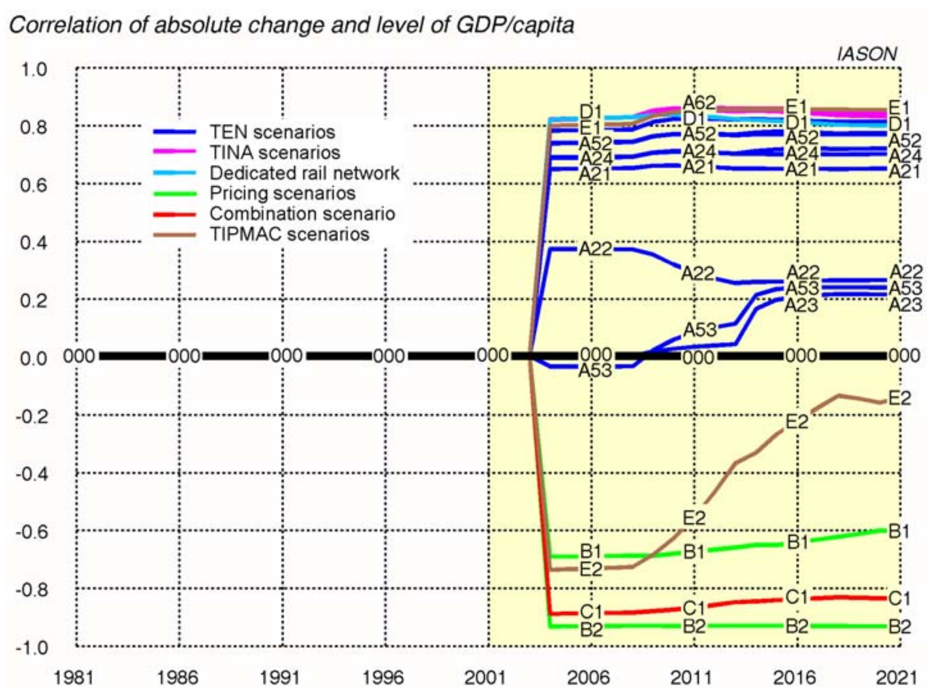

FIGURE 38: CORRELATION OF ABSOLUTE CHANGE AND LEVEL OF GDP PER CAPITA

Tables 3.4 and 3.5 summarise the information gained from the five cohesion indicators for accessibility and GDP per capita. The two tables show that with respect to accessibility, almost all policy examined contribute to cohesion, except the two pricing scenarios B1 and B2 – if one applies one of the first four indicators, coefficient of variation, Gini coefficient, geometric/arithmetic mean or relative correlation. However, if one consults also the fifth indicator, absolute correlation, the picture is more complex as more often than not the sign of the indicator is reversed. In terms of GDP per capita, the choice of indicator is even more critical as now even the relative correlation indicator signals polarisation where the coefficient of variation and the Gini coefficient signal cohesion.

It is therefore not easy to assess whether a transport policy supports economic cohesion. Of the policy scenarios examined here, most network scenarios are pro-cohesion except the two road-only scenarios. The scenario assuming road pricing for lorries (Scenario B1) is clearly anti-cohesion, whereas the comprehensive transport pricing scenario B2 is strongly pro-cohesion. However, it is not clear whether these effects are caused by the fact that the two pricing schemes were only applied to the present European Union.

The lesson to be learned from this exercise is that the choice of cohesion indicator is critical in assessing the socio-economic impacts of transport policies and that classifications relying on only one indicator should be avoided.

C.3.2.5 Conclusions

The results of the regional spatial economic model SASI show that the socio-economic macro trends have a much stronger impact on regional development than transport policy. If one considers that under normal economic circumstances the long-term growth of regional economies is in the range between two and three percent per year, an additional regional economic growth of less than one or two percent as is observed in Western Europe over twenty years is almost negligible.

Large increases in regional accessibility translate into only very small increases in regional economic activity. For regions in the European core with all the benefits of a central geographical location *plus* an already highly developed transport and telecommunications infrastructure, additional gains in accessibility through even larger airports or even more motorways or high-speed rail lines may will bring only little additional incentives for economic growth. For regions at the European periphery or in the accession countries, however, which suffer from the remote geographical location *plus* an underdeveloped transport infrastructure, a gain in accessibility through a new motorway or rail line may bring significant progress in economic development. But, to make things even more complex, also the opposite may happen if the new connection opens a formerly isolated region to the competition of more efficient or cheaper suppliers in other regions.

High-speed rail projects seem to be more effective in terms of promoting regional economic activity than conventional rail projects, and rail projects seem to be more effective than road projects. All transport pricing scenarios have negative economic effects but these can be mitigated by their combination with network scenarios with positive economic effects, although the net effect depends on the magnitude of the two components.

The network scenarios reduce disparities in accessibility, but reduce disparities in GDP per capita only if also the TINA projects are implemented.

Many infrastructure investment programmes of the past have been anti-cohesion, i.e. have contributed to widening the spatial disparities between central and peripheral regions in Europe. This is even true for the 'old' list of TEN priority projects. The 'new' list of priority projects is a clear advance in this respect. However, there is room for improvement, as some of the scenarios have shown. The simulations have demonstrated that rapid upgrading and extending of the rail and road infrastructure in Eastern Europe would contribute to the economic and social integration of the accession countries after the enlargement of the European Union.

C.3.3 Indirect effects analysis with CGEurope

C.3.3.1 Results for the 1997 calibration

Calibrating the model means to assign concrete numbers to each parameter and exogenous variable such that the equilibrium solution exactly reproduces the observed data or resembles them as closely as possible. Unfortunately, however, this cannot provide all required parameters. In particular, fixing elasticities of substitution has to rely largely on literature surveys[14]. In order to perform simulations numerical values are assigned to the parameters of the CGEurope model in a calibration procedure[15]. First the model is calibrated for 1997 thereafter it is calibrated for 2020 and recalibrated for the policies/projects to be assessed. Thereafter, a series for experiments is performed taking the year 2020 instead of 1997 as a reference, i.e. we compare a hypothetical world of 2020, that has the respective projects of the scenario installed, with another hypothetical world without these projects. The world "without" is constructed by recalibrating the model for 2020. In this recalibration all parameters remain the same as for 1997 with two exceptions: the regional factor stock parameter and the trade impediments. The recalibration proceeds as follows; we introduce assumptions about the increase of regional GDPs from 1997 to 2020 and about the decrease of impediments. Then the calibration is redone for 2020 just in the same way as for 1997 with one modification: there is no adjustment to observed international trade flows. Instead estimates of these flows are an outcome of the calibration, resulting from the predicted impediments. To put it differently: for 1997 we know international trade flows and infer on impediments, while for 2020 we know impediments and infer on international trade flows. Below the out come of the calibration for the IASON scenarios (A through E) is explained.

A1

This scenario covers the projects of the Essen list, including the extensions proposed in 2001. These projects are all located within the EU15 area; hence the impact is mainly visible in EU15 countries, even though there are also some smaller gains in the accession countries due to their interaction with E15 countries. The welfare gain amounts to around one tenth of one percent of GDP per annum. Taking the EU15 impact only, this amounts to about 9.3 billion Euro for the year 2000. Given the estimated investment cost of 235 billion Euro, the rate of return would be roughly 4 %. Note that this is exclusive of private passenger travel.

A look at the map in Figure 41 (page 84) clearly shows the shadows of individual projects. Some of them have a strong impact such as the Nordic triangle plus the Øresund and Fehmarnbelt fixed links, the projects on the Iberian peninsula, the Irish road and rail projects, the road link and West cost main line in Britain and the Greek motorways.

In some cases gains generated by a certain link spread over a large area in the prolongation of the respective link. Cases in point are the Italian West coast south of Naples plus Sicily participating in the gains from the North-South high speed train (No. 1 from the Essen list), the French West coast participating in the gains from the multimodal link Portugal-Spain-Central Europe (No. 8) or North-East Germany and North-West Poland participating from the gains at the Northern end of the North-South high speed train.

[14] See IASON D2

[15] See IASON D6 for a full explanation.

A2

Figure 42 (page 84) shows the impact of rail projects (high speed and conventional) only (scenario A2.4). Again the individual projects already described show up on the map. The projects in this scenario are the union of those in scenarios A2.1 (high speed) and A2.2 (conventional). Therefore the effects are almost identical to the sum of the effects from these two scenarios. This is clearly shown by the scatter-plot in Figure 39, correlating the effects of scenario A2.4 against the sum of effects from scenarios A2.1 and A2.2.

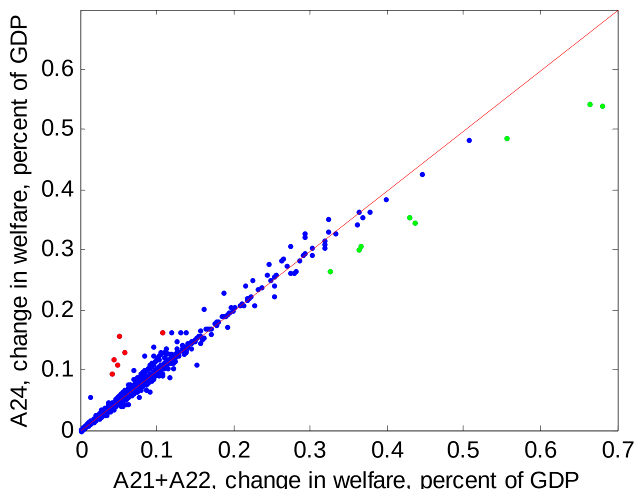

FIGURE 39: ADDITIVITY OF RAIL PROJECTS

The red line marks equality. Obviously there is virtually no superadditivity or subadditivity of the two kinds of rail projects, with a few exceptions of slight supperadditivity in the North of Portugal (red dots) and slight subadditivity for some regions in Western Spain and central Portugal (green dots).

A similar conclusion applies to a comparison of scenario A1 with the sum of A2.3 (all rail projects) and A2.4 (all road projects). The comparison is illustrated by the scatter-plot in Figure 40. It is again obvious that there is virtually no superadditivity or subadditivity. Only for regions with comparatively large effects there is a tendency towards subadditivity. Typically, these are the regions close to parallel road and rail projects.

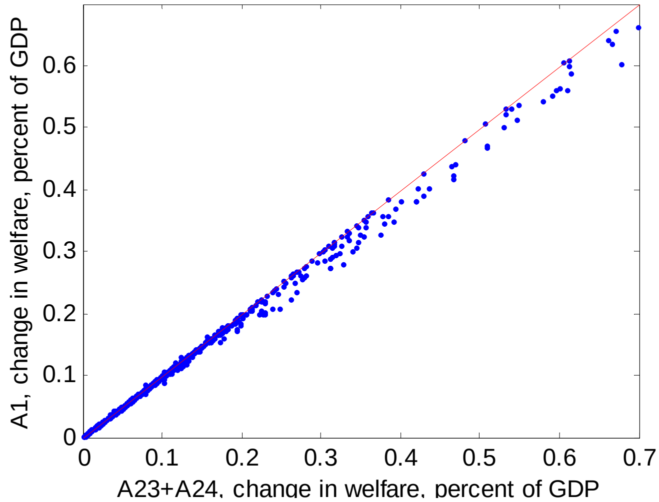

FIGURE 40: ADDITIVITY OF ROAD AND RAIL PROJECTS

A3/E1 and A4

A3 is the most comprehensive scenario containing projects that cover more or less the whole area of EU27 except Switzerland. E1 is almost the same as this scenario. Most regions are positively affected. Only a few gain almost nothing like Paris, East-England and some central regions in Germany and agglomerations in Italy. Accession countries gain almost the double of what EU15 countries gain, in relative terms. Note, however, that in per capita terms gains are still smaller in accession countries because of the lower level of per capita GDP.

A4 is just the EU15 part of A3. Hence, the pattern is the same as that of A3 within EU15, while there are smaller, though still significant gains in accession countries. They are due the better access to Western markets. This effect is more pronounced in the 2020 calibration than in the 1997 calibration due to the higher level of integration in 2020.

A5

For the A5 scenarios most of what has already been said for the A1 and the A2 scenarios can be said, too, because the projects of the old list of priority projects are also part of the new list. Compared to the A1 scenario, the additional projects of the list of priority projects show additional positive impacts in Eastern Europe, especially in Poland, the Czech Republic, Hungary and Western Romania. Furthermore, the additional projects in England and Ireland and the Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen cause even higher positive impacts in England, Ireland and the Benelux than could be seen in the A1 scenario.

A6

The two A6 scenarios represent two alternative network development scenarios for the Eastern European countries combined with the full list of TEN projects. In both scenarios the highest impacts can be observed in the Eastern

European countries in both cases of the minimum and the maximum implementation of the possible TINA networks. The additional road projects in the maximum implementation make the main difference between both scenarios, causing especially higher impacts in Romania, Bulgaria, Estonia, Latvia and Lithuania.

B and C

An interesting spatial pattern emerges from SMCP pricing that leads to a general increase in travel cost and transportation cost. Note that, in order to isolate the spatial effect of the pricing itself, we assume no redistribution of revenues. Revenues are "burned". Exactly the same spatial pattern would emerge, if a lump-sum redistribution proportional to GDP instead of burning was assumed. Only the level would be different, the weighted average of effects would be close to zero. In fact it would be slightly negative, because the welfare loss exceeds the revenue slightly. Note, however, that this is only the case because the intended welfare gain resulting from internalisation of externalities is not included in our model. Neither do travel times react on a reduction of travel flows induced by higher out-of-pocket costs, nor is an improved environment felt by the households as a utility gain in our model. We explain this in order to emphasise that the overall negative welfare impact of the pricing scenarios must not be misinterpreted as a statement against efficiency gains from SMCP. Our experiments just isolate the effects form the cost side.

The spatial pattern is an overlay of two centre-periphery patterns, a national and a European one. Within each country, regions with a high market potential suffer from the smallest losses, those in the national periphery lose most. This is most clearly observable in large countries like UK, France, Germany, Spain, Italy and Poland, but even in smaller countries such as Greece (see the light colour around Athens on the map in Figure 46) or Denmark. These national patterns are overlaid by a similar, though less pronounced pattern on a European scale, so that regions suffer most that are far from national as well as from European markets, such as Portugal, Scotland, Southern Italy or Northern Norway and Finland.

It should also be noted that SMC pricing is enforcing spatial inequality, because the aggregated welfare loss is the larger, the bigger is the assumed inequality aversion. This is because peripheral regions tend to be poorer than central ones. The impact of the inequality aversion parameter is however small, which means that even though the spatial distribution is contradicting the cohesion objective, the degree of increasing inequality is too small to be regarded as a real problem.

Scenario C is a combination of scenarios A1 and B2. Hence, because of additivity holding also in this case, the spatial pattern is approximately the sum of those generated by these two scenarios and needs not extra discussion.

D

This scenario generates considerable gains in some regions at the European geographical periphery in Southern Portugal, Spain and Italy, in Ireland and Scandinavia. Large parts of Germany (except the North-East) and of France remain unaffected.

E

E1 is similar to A3, as already noted. Finally, E2 resembles a combination of E1 with a weaker form of SMC pricing as in B2. As the pricing in B2 applies to EU15 countries only, the positive TEN investment effects show up in the accession countries, with the same pattern as in E2. In EU15 the negative impact of pricing dominates, with the centre-periphery structure described above. Positive effects appear within EU15 only in some regions with strong infrastructure effects in Portugal, Spain, Sicily and Greece.

C.3.3.2 Maps for baseyear(1997) Simulation Results

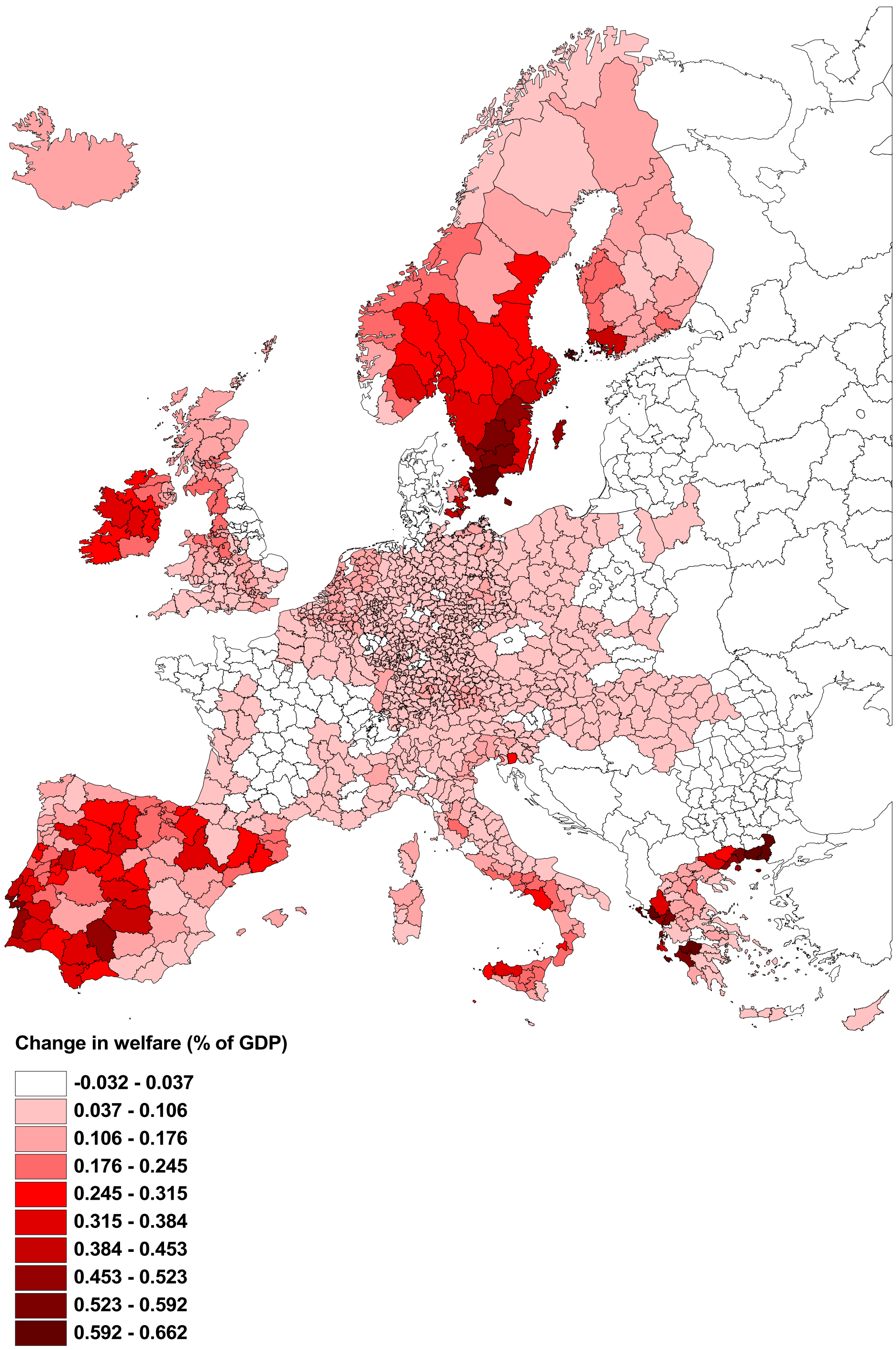

FIGURE 41: SCENARIO A1: FAST IMPLEMENTATION OF ALL TEN PRIORITY PROJECTS TOGETHER

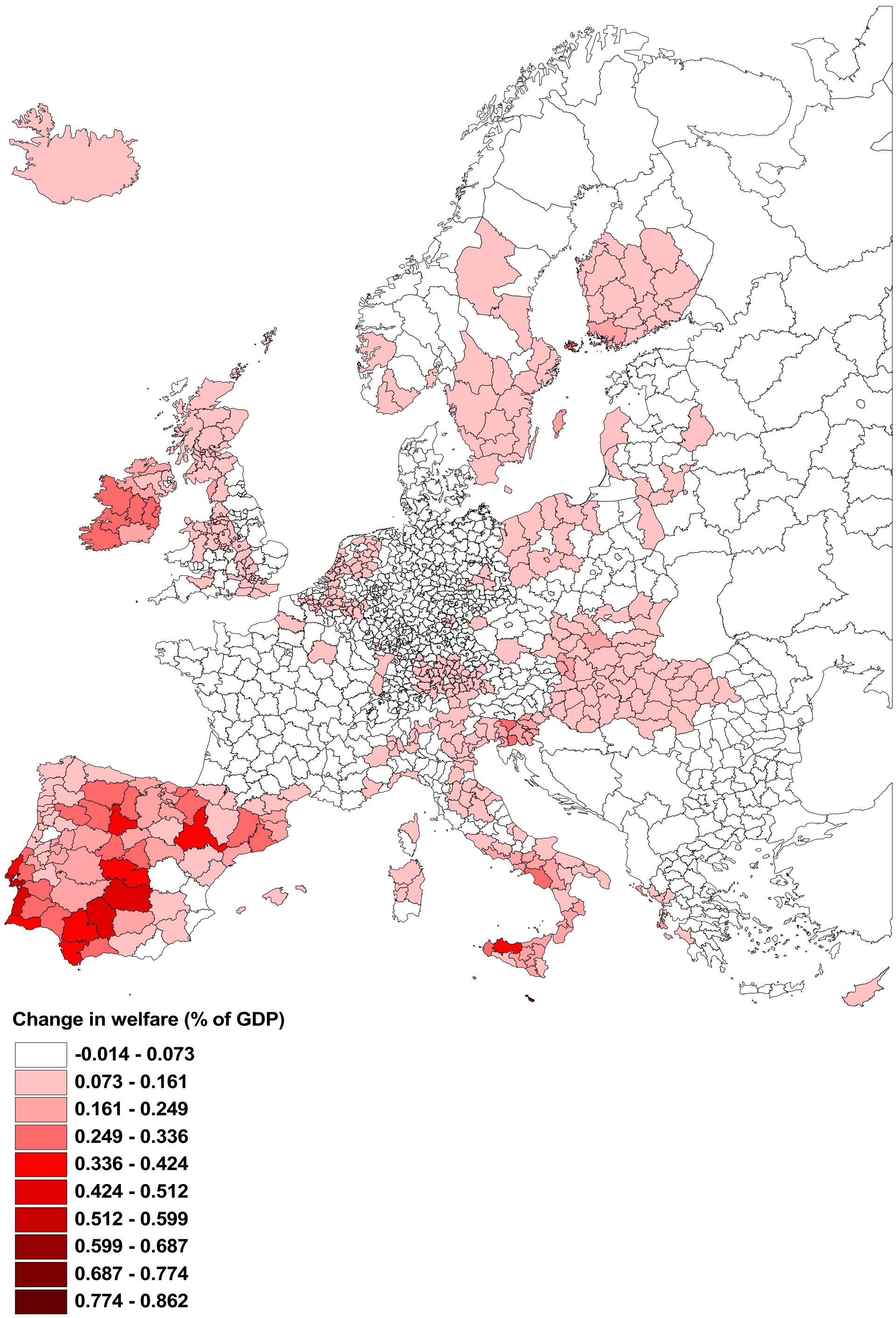

FIGURE 42: SCENARIO A2.4: IMPLEMENTATION OF ALL RAIL (HIGH SPEED AND CONVENTIONAL) PRIORITY PROJECTS

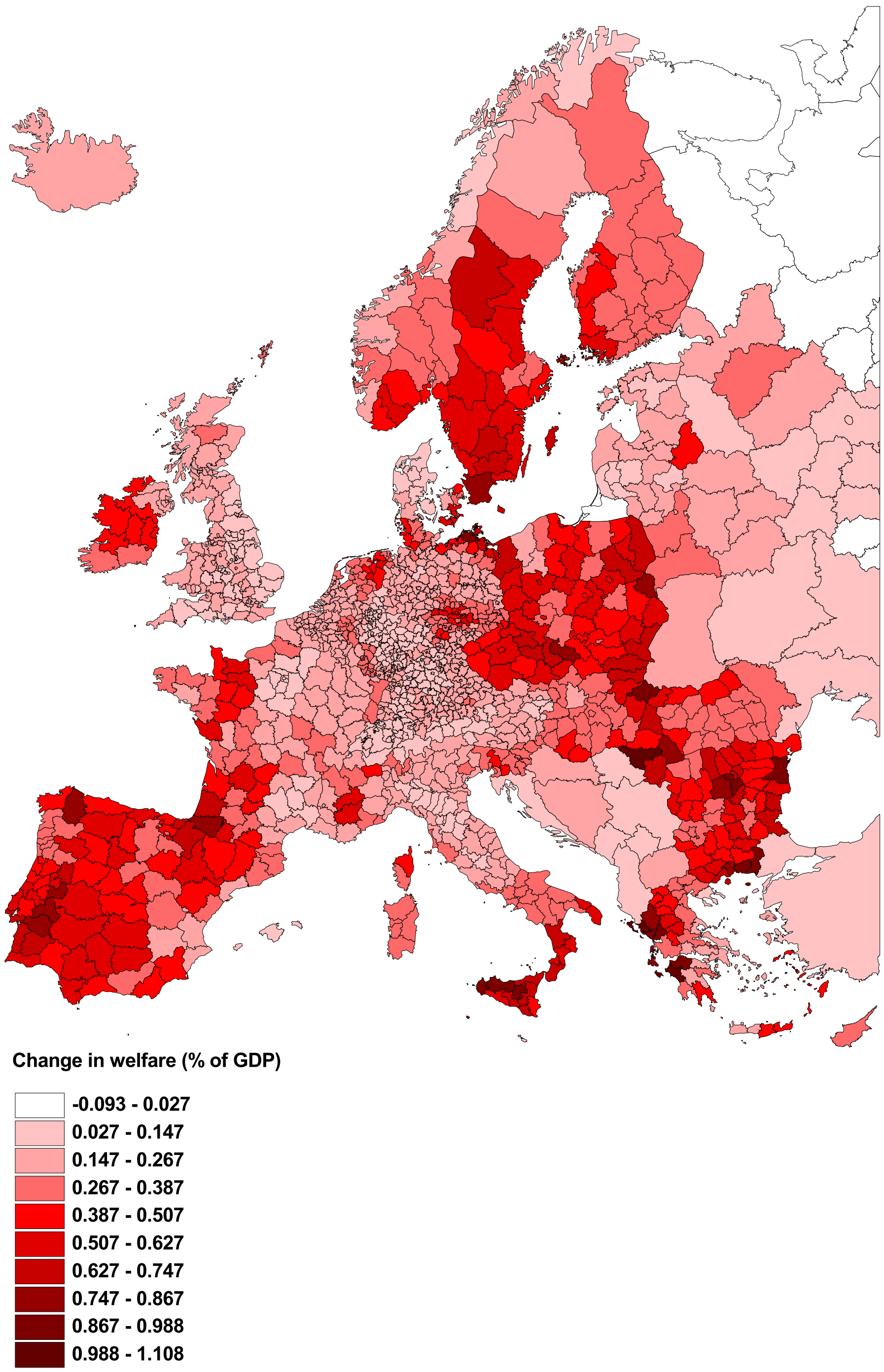

FIGURE 43: SCENARIO A3: FAST IMPLEMENTATION OF ALL TEN AND TINA PROJECTS AND NETWORK

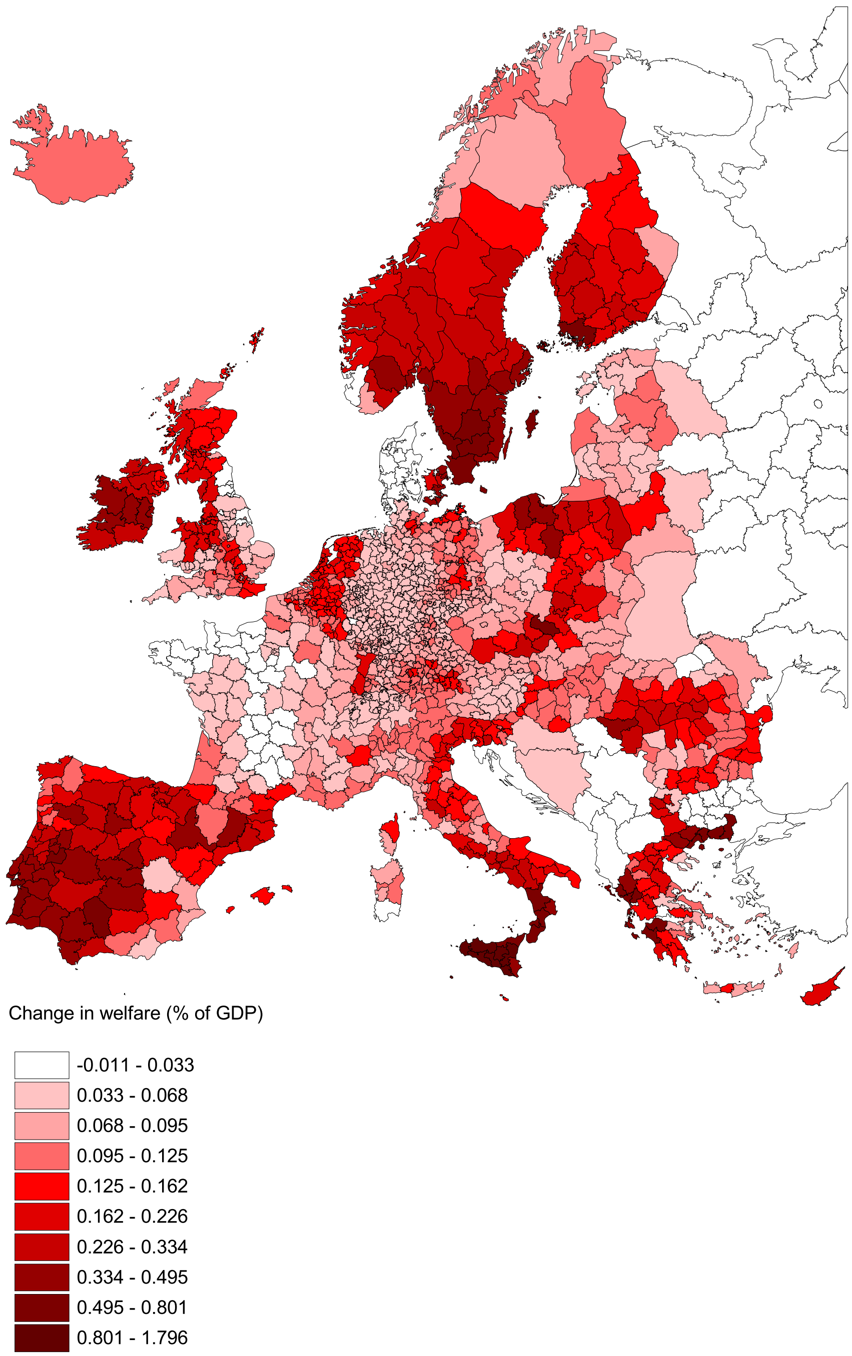

FIGURE 44: SCENARIO A51: IMPLEMENTATION OF NEW LIST OF PRIORITY PROJECTS FOR ROAD AND RAIL

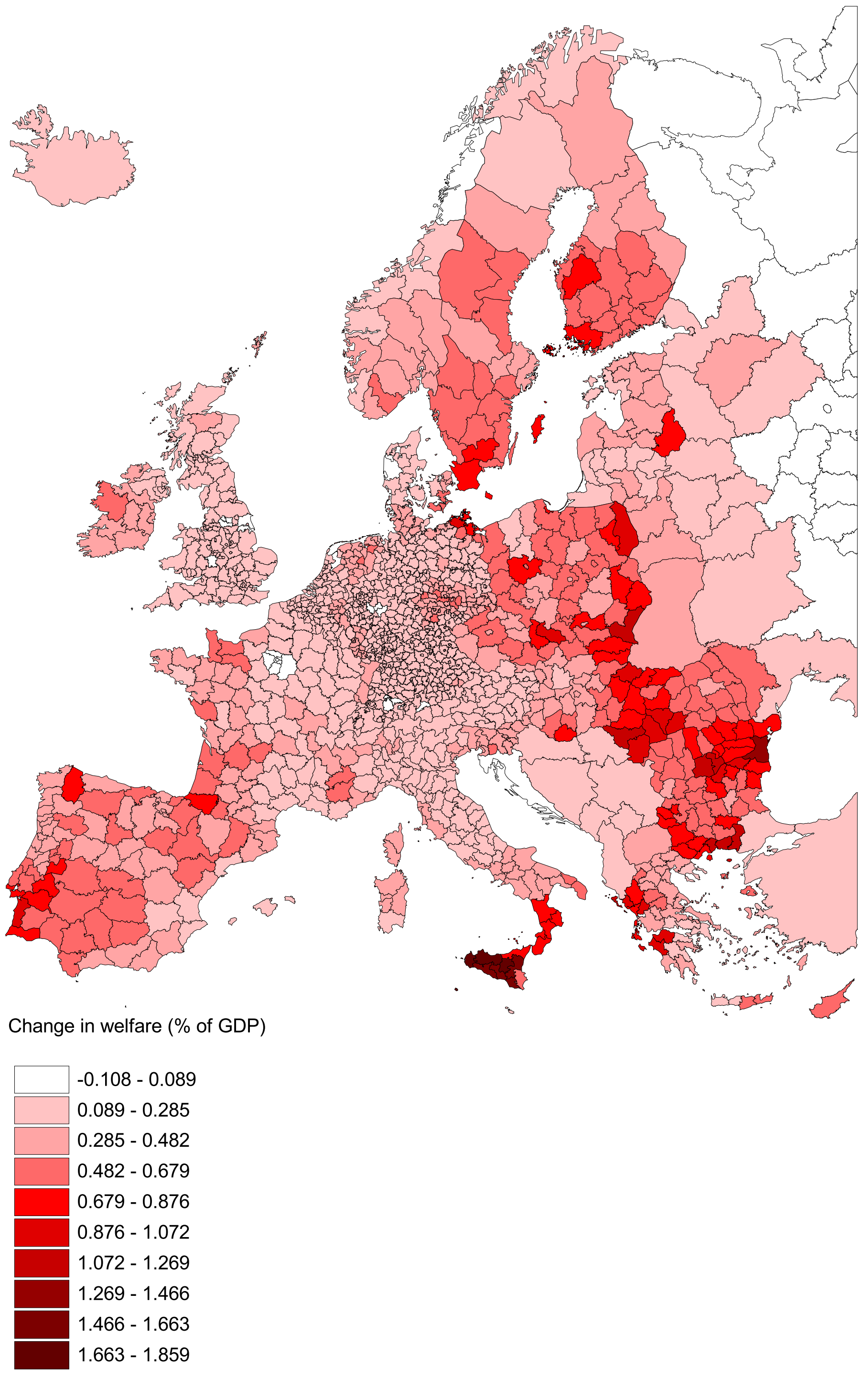

FIGURE 45: SCENARIO A62: IMPLEMENTATION OF ALL TEN PROJECTS AND MAXIMUM ROAD/RAIL NETWORK DEVELOPMENT FOR ACCESSION COUNTRIES

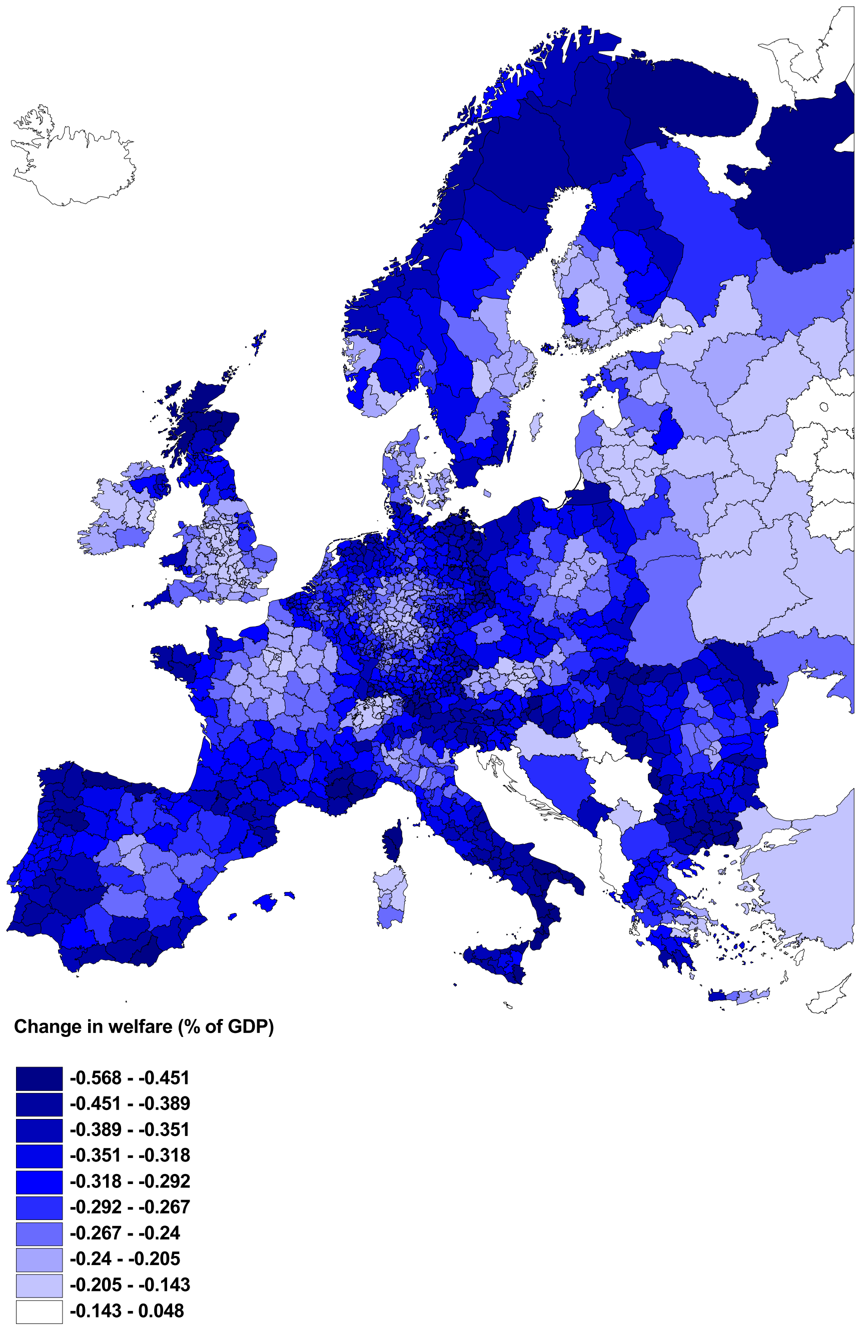

FIGURE 46: SCENARIO B1: SMCP APPLIED TO ROAD FREIGHT

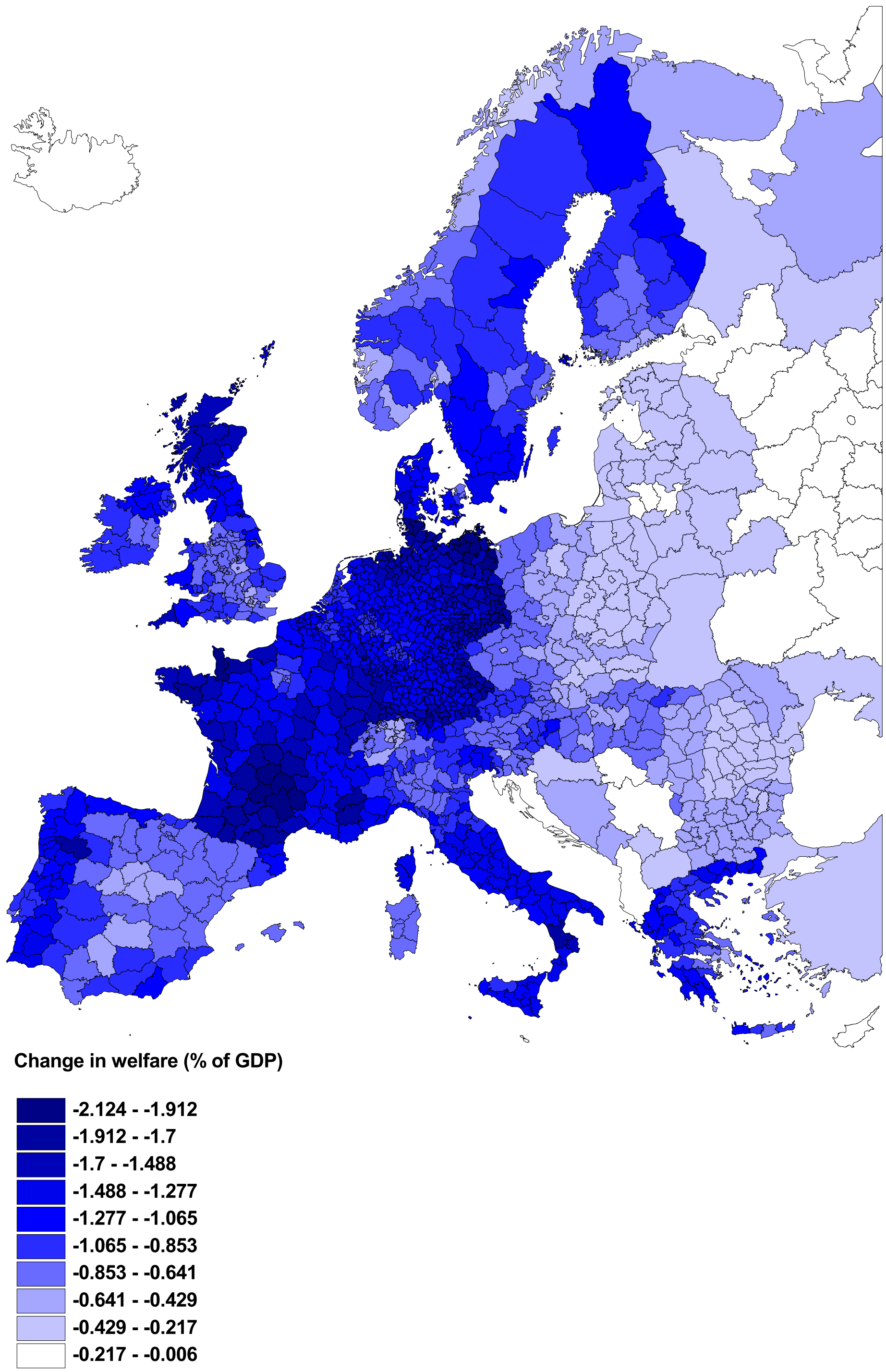

FIGURE 47: SCENARIO B2: SMCP APPLIED TO ALL MODES

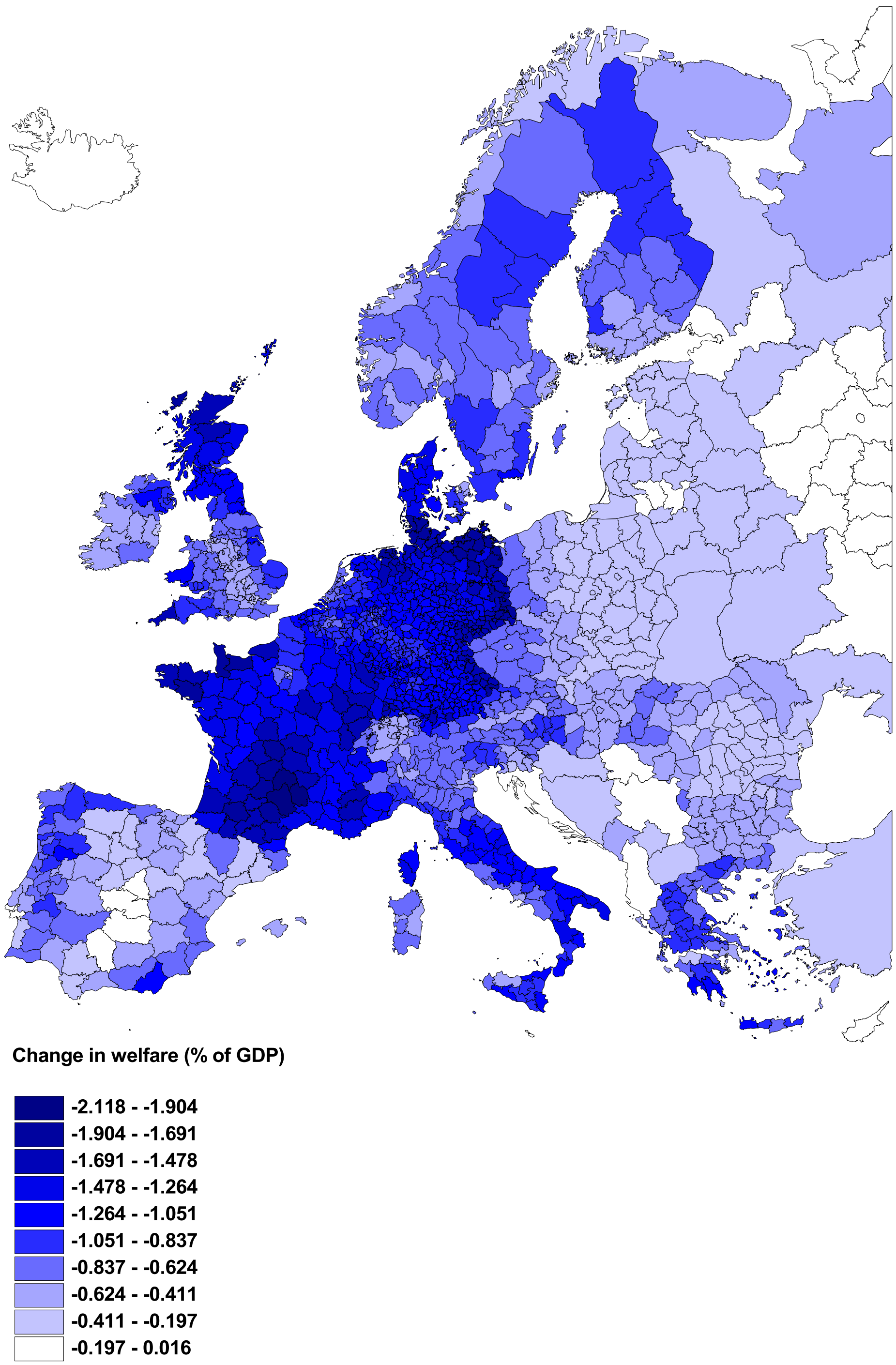

FIGURE 48: SCENARIO C1: SMCP APPLIED TO ALL MODES AND FAST IMPLEMENTATION OF ALL TEN PRIORITY PROJECTS

C.3.3.3 Results for the 2020 calibration

For accession countries relative effects are uniformly larger in absolute terms for 2020 than for 1997. In most infrastructure scenarios effects are larger for 2020 than for 1997 by a factor between 2 and 3. The losses in the pricing scenarios are larger by a factor around 1.5. The reason is the higher degree of economic integration between accession countries as well as between these countries and the EU15 countries. This leads to an increase of trade until 2020 that is larger than the increase in GDP. Hence, the cost savings or cost increases amount to a larger share in GDP.

Note that the cost savings or cost increases per unit of good are assumed to remain constant in relation to GDP between 1997 and 2020. For infrastructure effects this means implicitly to assume no productivity gain in transport. If we introduce productivity gains in transport, the ratio of costs per unit to GDP will decline, and all effects would have to be downscaled. Assuming for example a productivity increase of 1 % per annum for transport between 1997 and 2020 would mean that effects would have to be reduced by about 20 %. For the pricing scenarios the implicit assumption is that fares grow by the same rate as GDP.

Outside accession countries, the estimated relative effects for 2020 are virtually the same as for 1997.

C.3.3.4 Results on cohesion effects

Going through the scenarios in detail, we can distinguish between inequality enforcing and reducing initiatives – always keeping in mind that the distributional impact is moderate. We only refer to results from 1997; those for 2020 reveal similar patterns, in fact identical as afar as the EU15 is concerned.

- A1 enhances equality within EU15, but increases inequality for EU27, because the priority projects are located in EU15.
- A3 is equality enhancing in EU15 as well, and also equality enhancing in CC12, though to a lesser degree. It is clearly equality increasing for the whole EU27, because relative effects of the initiatives in accession countries are larger then those in EU15. The same pattern holds for E1, which is almost the same as A3, as already mentioned.
- A4 enhances equality within EU15. The increase of inequality for EU27 is again just due to the fact that the scenario does not include the TINA projects in the accession countries.
- A51 enhances equality within EU15 and EU27, but increases inequality in the accession countries, because the projects additional to the A1 scenario are mainly located in the better-off countries of the CC12.
- A61 and A62 are equality enhancing for all groups of countries.
- B1, SMC pricing for road freight, is inequality increasing for all groups of countries; the welfare loss is the larger, the stronger the inequality aversion.
- B2, SMC pricing for all modes, is also slightly inequality increasing within EU15. The reduction of inequality for EU27 is again just due to the fact, that the measures do not apply within accession countries.
- C is close to neutral within both, EU15 and CC12 (in fact slightly equalising). The strongly equalising effect for EU27 is also due to the different definition of the scenario fro the two subgroups.
- D, like all other infrastructure scenarios, enforces equality in EU15. It increases inequality within CC12 and for the whole EU27, because relative gains are much smaller in accession countries than in EU15.

- E2 enforces equality within both groups of countries, EU15 and CC12. The strongly equalising effect for EU27 as a whole has already been characterised above as a rather artificial result due to the design of the scenario.

These observations can be summarised as follows: within both groups of countries, EU15 and CC12, the infrastructure scenarios are uniformly favouring regional income equality, that is they are in line with the cohesion objective. To the contrary, the pricing policies are uniformly enforcing inequality within both groups. Equality or inequality effects on the EU27 level are less interesting because they are usually caused by the fact, that certain policies only apply to EU15 countries. We repeat however, that altogether the distributional impacts, be they in the desirable direction of more income equality or not, are small in the light of a welfare index within a plausible range of inequality aversion.

C.3.3.5 Results on indirect effects

Beyond the spatial distribution issue discussed already at length, another main question to be answered by the IASON project is whether there are indirect effects to be considered in cost-benefit analysis (CBA) that are not covered by traditional methods, and for which we need more advanced tools like CGE models for. The notion of "indirect effects" is vague. This is discussed in Deliverable 5 at length. Any impact of a transport initiative other than the cost changes for the users of the transport system can be called indirect effects. In this sense almost any economic impact of transport initiatives is indirect.

A narrower notion is to consider only those effects, that are relevant in a welfare sense but not covered in a traditional CBA (where traditional CBA is meant to include technological externalities). This is what the SACTRA (1999) report calls "wider economic effects". They stem from quantity changes on imperfect markets where prices deviate from marginal social cost (or wages deviate from marginal reservation wages) and from changes in competitive regimes. The latter are called "pro-competitive effects", if a transport initiative reduces the price-cost margin. In principle, these wider economic effects can be positive, requiring upward correction of traditional CBA, or negative, requiring downwards correction of traditional CBA.

Figure 49-51 show for all scenarios the estimated welfare effects from CGEuropeII against the direct cost changes for all deliveries from a region, that is regional exports plus intraregional flows. The red line again marks identity. One could also plot them against cost changes for deliveries to a region with similar conclusions. The cost changes are given as percentages of regional GDP, just like welfare effects are measured as percentages of regional GDP. The experiments are done with the model version without private passenger travel, because for private passenger travel no indirect effects are to be expected anyway.

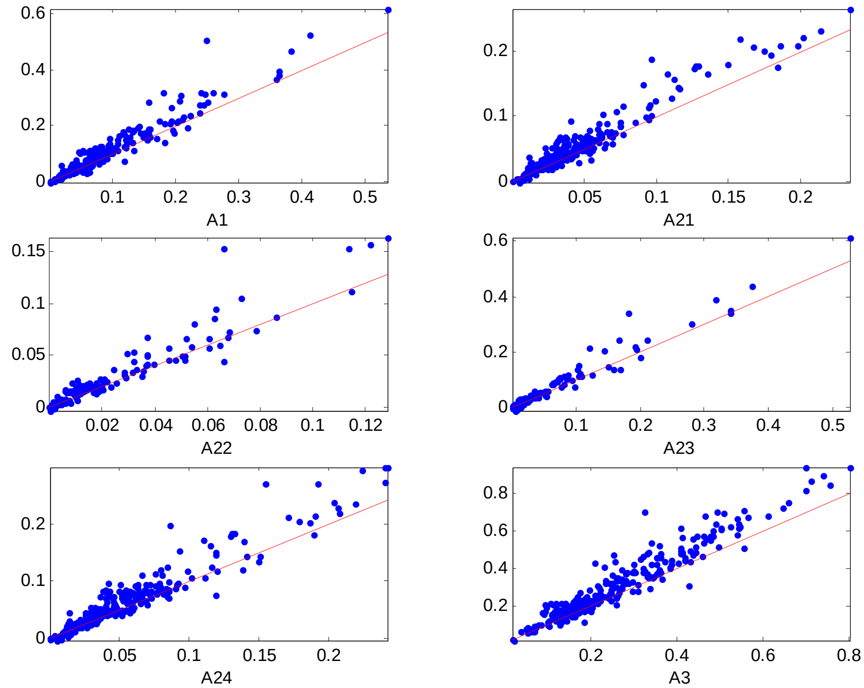

FIGURE 49: CGEUROPEII (EXCLUDING PRIVATE PASSENGER TRAVEL): RELATION BETWEEN DIRECT COST SAVINGS FOR DELIVERIES FROM A REGION (HORIZONTAL) AND WELFARE EFFECTS (VERTICAL)

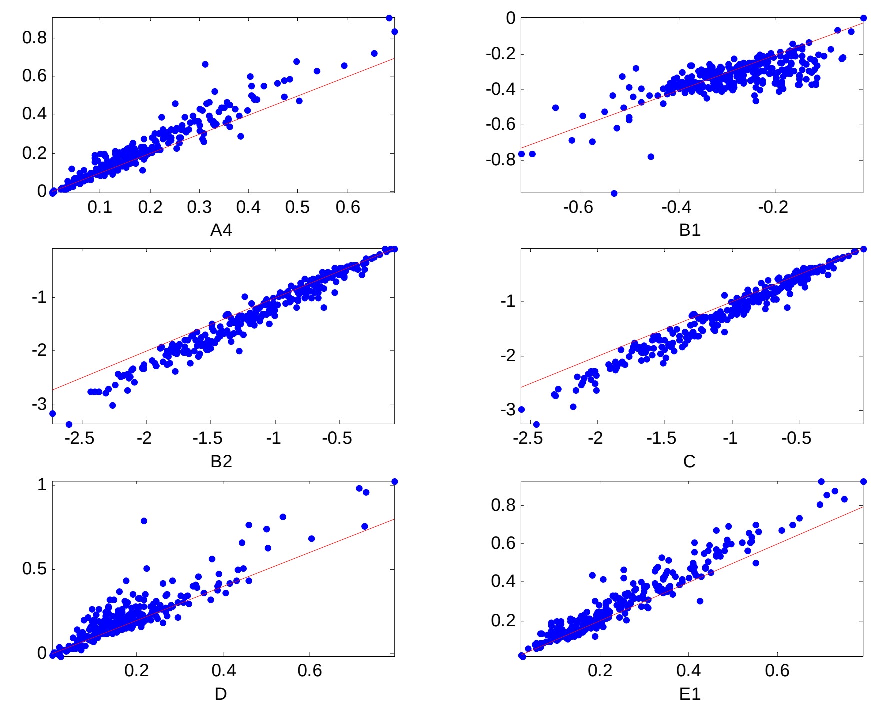

FIGURE 50: CGEUROPEII (EXCLUDING PRIVATE PASSENGER TRAVEL): RELATION BETWEEN DIRECT SAVINGS FOR DELIVERIES FROM A REGION (HORIZONTAL) AND WELFARE EFFECTS (VERTICAL)

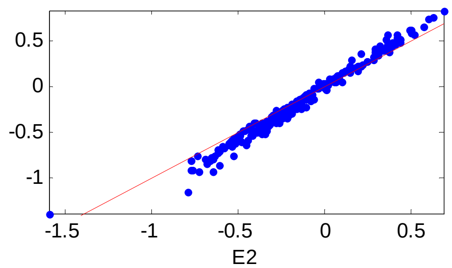

FIGURE 51: CGEUROPEII (EXCLUDING PRIVATE PASSENGER TRAVEL): RELATION BETWEEN DIRECT COST SAVINGS FOR DELIVERIES FROM A REGION (HORIZONTAL) AND WELFARE EFFECTS (VERTICAL)

Two conclusions emerge from these plots: first, the direct cost savings per region fairly well approximate regional welfare effects; second, welfare effects tend to be a little bigger in absolute value than direct cost savings. Note that negative cost savings indicate cost increase, corresponding to welfare losses. This can also be seen in Table 14. Welfare effects closely correlate with cost savings over regions. Only for B1 the correlation is not close to perfect. The excess of welfare effects over direct cost savings is the indirect or wider economic effect, which is consistently positive. Note that wider economic effects amplify direct cost savings for both, positive as well as negative effects.

The ratio of welfare effects to direct cost savings can be regarded as the "total benefit multiplier" (TBM), that is the factor by which direct effects have to be multiplied in order to obtain the total welfare effect. The average multiplier can be estimated by the slope of a regression line through the origin, if we regress the welfare effect against the direct cost saving. The respective estimates are shown in the second to last column in Table 14. Except for B1, which seems to be always a special case, the multiplier lies consistently between 1.15 and 1.21, in most cases it equals 1.17.

This TBM is rather small, as compared to what some policymakers seem to suspect (or hope) to be the outcome of imperfect competition models. It should be noted, however, that this multiplier estimate is less robust than the estimate of the spatial distribution of effects. It strongly depends on the price mark-up, which itself depends on the assumed elasticities, that are fairly uncertain. Our parameters imply mark-ups of 2 %, 10 %, and 14 % for agriculture, manufacturing, and services, respectively. Slightly larger mark-up estimates are found in econometric studies in the literature (Röger, 1995) which, if applied in the model, would yield correspondingly larger, though not dramatically larger total benefit multipliers. Higher mark-ups, however, imply lower elasticities in interregional trade, which are implausible because they make it difficult to explain distance sensitivity of trade flows without assuming extremely large transport cost.

One should keep in mind, that the model does not cover all indirect effects that could stem from market imperfections. In particular, indirect effects resulting from a change of employment with a non equilibrated labour market are not taken into consideration. Such effects could lead to considerable indirect effects. Bröcker and Schneider (2002) for example find welfare gains from Eastern expansion of the EU for Austrian regions, that are three times larger in a fixed wage that in a flexible wage scenario. It is doubtful, however, whether decisions upon transport initiatives should be based on such labour market effects. It would in fact mean to try to misuse transport policy for solving problems, that have their roots in the labour markets rather than the transport market. Another indirect effect is the pro-competitive effect already mentioned, that is not considered in our model either, due to the constant mark-up that characterises Dixit-Stiglitz competition.

TABLE 14: CGEUROPEII (EXCLUDING PRIVATE PASSENGER TRAVEL): COMPARISON OF ESTIMATED WELFARE EFFECTS VERSUS DIRECT COST SAVINGS

	direct cost change percent of GDP weighted average	welfare effect percent of GDP weighted average	welfare effect/ direct cost change	slope of a regression through origin (TBM)	correlation
A1	0.07	0.09	1.20	1.17	0.96
A21	0.04	0.05	1.18	1.17	0.97
A22	0.01	0.01	1.24	1.18	0.96
A23	0.02	0.03	1.20	1.15	0.98
A24	0.05	0.06	1.19	1.17	0.96
A3	0.19	0.23	1.17	1.17	0.96
A4	0.17	0.20	1.19	1.19	0.96
B1	-0.24	-0.29	1.20	1.06	0.73
B2	-1.19	-1.31	1.10	1.14	0.98
C	-1.06	-1.17	1.10	1.15	0.98
D	0.17	0.22	1.24	1.21	0.90
E1	0.18	0.21	1.17	1.17	0.97
E2	-0.25	-0.29	1.16	1.17	0.99

In an earlier paper we have studied the relation between the trade elasticity and the total benefit multiplier in CGEuropeI (Bröcker, 2001). The assumed elasticity of substitution in trade is larger in CGEuropeI than in CGEuropeII, and hence the TBM is even smaller in CGEuropeI than the one presented here. With an elasticity equal to 6, which is assumed in CGEuropeII, following standard assumptions in the literature, the TBM in CGEuropeI would be almost exactly the same (TBM ≈ 1.17) as the estimate given here (see Figure 5 in Bröcker, 2001).

C.3.3.6 Conclusions

The results of the general equilibrium model CGEurope show that:

- All infrastructure scenarios considered are in line with the objective of more cohesion. Regions with lower GDP per capita in the reference scenario profit more from the proposed investment in infrastructure.
- Pricing policies are not favourable for the poorer regions. CGEurope shows a characteristic spatial pattern of pricing scenarios, i.e. disfavouring the peripheral regions.
- CGEurope shows that spatial distribution effects are very moderate. Correcting welfare measures for equality gains (increase in welfare) or equality losses (decrease in welfare) alters the quantitative results only slightly.
- Indirect effects are not very large; the total benefit multiplier (TBM) is approximately 1.3. This means that total welfare effects as measured by direct effects are underestimated by 20%, on the average, although for specific regions higher multipliers can be found. Thus, as an average over many regions, the spatial distribution of welfare changes is quite well approximated by cost savings.

- Effects of transport initiatives tend to be additive, i.e. little evidence was found with respect to sub- or superadditivity of transport projects. Although the analysis was performed on a very specific and limited set of projects, our evaluations of the TEN programme yielded results comparable to the added results of individual projects.
- The results from the multisector model (CGEurope II) are not very different from the original model. Possibly this is due to the relatively modest extension from 2 to 6 sectors, which is insufficient to uncover benefits of increased opportunities of exchange between sectors.

From the results of CGEurope it can be concluded that it is not always necessary to apply a spatial equilibrium model for extended analyses. From the model exercises it appears that classical transport CBA forms a reasonable approximation. Especially cost savings give a good approximation of the total and distributive effects. If a choice should be made between a spatial equilibrium model or a good transport model, the latter should be preferred, if changes in transport costs are relatively small. However, it should be noted that combining both would give the best results.

It should also be noted that these conclusion are based on analyses for a limited number of transport initiatives. The calculations show that market imperfections have more impact on the spatial distributions and total benefits than the scenarios. Market imperfections are modelled as a moderate degree of monopoly power. CGEurope can or should be extended in this respect. Especially, in this context, labour migration should be better modelled. Several extensions of incorporating market imperfections can be considered; since calibration and data availability can be restrictive and the results of the multi-sector model are not very different from the earlier version of the CGE model. If the analysis is meant to deliver a quick and global overview of impacts it seems more appropriate to experiment with a smaller version of CGEurope.

C.3.4 Analysis of indirect network effects with NEAC and CGEurope

The network effects analysis discussed in Deliverable 7 of IASON. For this analyses two models are combined, a transport model which measures the direct network effects and an economic model which captures the total network effects. The difference can be attributed to the indirect network effects. For further information, we refer to D7; only the conclusion of this analysis is presented here.

The methodology to assess network effects works well. When applied, attention needs to be paid to the way the models are combined. Any time a combination of models is applied, the user needs to be careful using the right variables as an interface between the models. The combination of a transport network model (like NEAC) and a macro-economic model (like CGEurope) show that there are indirect network effects (changes in volume and performance). The total network effects (that is the final changes in volume and performance) are thus different than those that stem directly from a transport network model. For large infrastructure projects it is recommended to use a combination of models, in order to get the full network effects.

Additivity of network effects seems to occur when applying a transport network model like NEAC at a network wide level. The effects of two projects can then be added in order to get an idea of the total network effects. As most transport network models act in the same way (both passenger and freight), this conclusion will probably be true for most models. At the level of OD-relations however, sub- or super-additivity occurs. The amount of volume at OD level does not add up when combining the effects of two projects.

Additivity seems to occur in CGE at EU level. The relative changes in GDP per project EU wide could be added to get a first impression of the final relative changes EU wide. However, when looking at specific NUTSII zones, sub- or super additivity occurs. The network effects for the entire network remain small. Looking at the entire network, it seems that the effects of transport projects can be added up to get a first impression of the final effects for the whole network. At lower levels one needs to take care. The combination of CGE with a transport model results in sub- or super additivity on OD-level.

Though not always large, the indirect network effects cannot be neglected. Especially on OD-level they can be substantial. The relative changes in indirect network effects differ from mode to mode. In the projects that have been examined rail shows relatively small changes in volume, while those for road and inland waterways are relatively larger.

The cross border effects show that the effects can be significant, especially on country to country level. Looking at the entire network, the cross border effects are similar to those for the whole network. At local level they can be substantial. In these cases further research is needed with more detailed models. Cross border effects due to cultural and language differences are difficult to assess. They are usually incorporated in models as dummy variables.

C.3.5 Indirect effect analysis with E3ME/SCENES and ASTRA

The linkage of a transport model (SCENES) with a macro economic model (E3ME) combines the benefits of a transport model, which has a detailed underlying network, with the benefits of the macro economic model, which measures the economic effect of changes in transport patterns to economic sectors and captures the effect of the way of investment (see TIPMAC deliverables D2 and D4).ASTRA is a system dynamics macro economic model. It can provide the same set of output as the SCENES/E3ME model. This enables to compare the results of the different models for the same policy measures. This cross check improves the reliability and credibility of the results.

This section describes the consolidated results of the macro economic analysis which is performed in the TIPMAC project; we refer to TIPMAC Deliverable 7 for more detailed information about the results. For the macro economic analysis two models were used, the combined SCENES/E3ME model and the ASTRA model.

Common scenarios were defined to provide common model input assumptions. All scenarios are revenue neutral, with the Social marginal cost pricing (SMCP) charges in the SMCP and SMCP+TEN-T scenarios being offset by reductions in personal income tax. The Business as Usual projections were undertaken to provide a basis for comparison of different policies. Over the period of the projections, 1995 to 2020, GDP increases by 82% and employment increases by 31% in E3ME with slightly lower values for ASTRA. In both models the lower growth of employment than of GDP implies continuing significant increases in labour productivity.

The adoption of SMCP for transportation has very significant macroeconomic impacts, as well as impacts on the transport sector. The large scale of the revenues makes the accompanying fiscal policy very relevant to the impacts. Given the very large scale of these changes, the E3ME/SCENES model system shows very considerable dynamic macroeconomic impacts in the SMCP scenarios, with considerable increases in GDP and employment from the BAU in the SMCP scenarios. The ASTRA model also gives increases in GDP from the BAU. The results should be considered in the context of the BAU underlying assumed GDP growth. BAU growth from 1995 to 2020 is 82+%, so that scenario changes in 2020 of 2-3% compared to BAU are small in modelling terms. This means that ASTRA and SCENES/E3ME have produced fundamentally similar results, both for GDP changes from the BAU and for employment changes from the BAU. Differences can be observed in that E3ME in general generates a more positive picture than ASTRA as in the latter model besides countries that are better off by a policy also losers could be identified.

The Fuel Tax + TEN-T scenario has relatively small macroeconomic impacts. The differences between the SMCP scenarios with and without the fast completion of the TEN-Ts are small for both models. This indicates that the medium to long-term impact of a more rapid completion of the TEN-T projects than the BAU case is small. Given that the rapid TEN-T programme leads to a completion of the expanded infrastructure between 2 and 10 years before the BAU, this is a relatively small alteration to policy. The results of the Fuel tax + TEN-T scenario for the ASTRA and SCENES/E3ME models confirm this assessment. *The macroeconomic impacts are therefore dominated by the revenue recycling.* The SCENES/E3ME model shows strong increases for both GDP and employment in response to the reductions in income tax. ASTRA has a slight response to this reduction and therefore shows small macroeconomic impacts to these policies.

The results for changes in employment by country from the BAU are generally very similar to those for GDP.

- ASTRA has negligible responses for all countries i.e. the conclusion is that there is no employment change from BAU. For the SMCP and SMCP +TEN-T scenarios, ASTRA also has small impacts, only 0.1% increase and -0.2 (decrease) from the BAU respectively. Thus ASTRA shows no net significant change from the BAU employment.
- The SCENES/E3ME model confirms the general conclusions of ASTRA for the fuel tax +TEN-T scenario. Most countries have a negligible change from the BAU. Only Denmark, Portugal and Sweden have large employment changes. However, for the SMCP and SMCP +TEN-T scenarios, there are much larger changes – 3.3% increase and 3.5% increase from the BAU respectively. The overall change in CO2 emissions from the BAU across the EU15 is very small (< +/-1%, with significantly larger changes on country level) for all the scenarios considered.

The other way of dividing the EU economy is by industrial sector. The overall pattern of results across sectors reflects the average across countries within both models.

- Both models have negligible effects for the fuel tax +TEN-T scenario.
- The SCENES/E3ME model has significant increases in output of the year 2020 for the SMCP and SMCP+TEN-T scenarios compared to BAU (3.2% and 3.0%), and also increases in employment that are proportionally larger than those for output (4.2% and 4.1%).
- ASTRA has small decreases in output (-0.8% and -1.1%) and increased impacts on employment (-1.6% and -1.7%) for the SMCP and SMCP+TEN-T scenarios.
- There is no effective difference for either model between the SMCP and SMCP+TEN-T scenarios.
- Together with the negligible response of both models to the fuel tax + TEN-T scenario, this shows that there is no large aggregate effect on industrial activity from the more rapid construction of the TEN-T infrastructure projects.

The results for transport demand have also been briefly compared. The overall results have a similar pattern to the macroeconomic results in that the SMCP and SMCP + TEN-T scenarios generate much larger changes than the Fuel Tax + TEN-T scenario. Also, the stronger response to the adoption of SMCP of the SCENES/E3ME model than ASTRA is shown as larger decreases in transport activity. In general, there are considerable differences between the two models concerning the reactions within the transport system, which may explain part of the differences found.

C.3.6 Lessons from the model experiments

All four models can be compared for the TIPMAC TEN-SMCP scenarios. The results are shown in table 15. The general observation is that the models generate different results. In summary, E3ME draws the most optimistic picture with growth for nearly all countries, followed by ASTRA showing a heterogeneous picture with winners and losers. CGEurope foresees a slight negative impact consistently for all countries, while SASI describes the most pessimistic development, again consistently all countries are loosing.

TABLE 15: CROSS-MODEL COMPARISON OF ECONOMIC EFFECTS (EU15) FOR TIPMAC SCENARIOS MEASURED AS DISCOUNTED GDP[16]

[Mio*EURO]	TEN-SMCPtoBAU			
	SASI	CGEurope	E3ME	ASTRA
EU15	-2,209,184	-414,013	2,078,342	-108,078
Key explaining factors for differences between results of various models	- mobility of capital (SASI) - equilibration of production and consumption across regions (CGE) - closure of finance loop (recycling SMCP revenues, macro models) - endogenous technological change (ASTRA)			

One major mechanism is related to the issue of testing fully-fledged policies or partial policies. A fully-fledged policy analysis would consider also changes occurring to an economic actor outside the transport system due to the policy and not only changes to actors within the transport system e.g. in case of investment policies the way to finance the investment would be part of the policy having similar importance as the infrastructure implementation itself. Or in case of transport pricing policies the usage of revenues has to be considered of similar importance as the transport cost increase due to the pricing policy. With respect to this mechanism the four models could be distinguished into a group of models that implement partial policies i.e. consider only the direct transport side of a policy to which the CGEurope and the SASI model would belong[17]. The second group would implement fully-fledged policies closing the monetary cycle by considering the transport side of the policy and its counterpart impacts e.g. in government or consumer budgets. E3ME and ASTRA would belong to this group. This difference explains the first observation that for CGEurope and SASI all impacts turn out to be negative and show dis-benefits, while for E3ME and ASTRA winners and losers could be identified. The first two models enfolding their strength in very detailed regional analysis obviously could not react other than with negative results as they do not dispose of any mechanism, neither economic e.g. refunding of revenues nor transport related e.g. relieve of congestion, that could mitigate the transport cost increase. The mechanism is that taking the transport cost alone provides a dis-benefit, however the effects as shown can be interpreted as the pure result of transport policy (i.e. to observe the most important result for which the policy was designed). Especially for assessing pricing policies it is important to include possible refunding of revenues. Generally, it is possible to extend CGE models to incorporate this refunding as well (through household income).

The comparison between CGEurope and SASI shows that there are similarities as well as differences between the results of the two models. In general, the models agree with respect to the spatial distribution of the effects of the policies and whether they contribute to greater economic cohesion or greater polarisation between the regions in Europe. The differences lie in the predicted sign and magnitude of the total effects, with the SASI model in general forecasting larger positive or negative impacts. Possible reasons for these differences in magnitude are discussed earlier. The summary here concentrates on the aspects in which the two models agree.

SASI and CGEurope were compared for the IASON scenario's TENtoREF and the TEN-SMCPtoREF. These results are presented in table 16. Concerning the comparison between SASI and CGEurope we concluded in IASON D6 that the spatial pattern of results between SASI and CGEurope are coherent due to the rather similar structure of the function for equivalent variation in CGEurope and the GDP function in SASI concerning their dependency to transport cost changes. The main general result from IASON D6 is that the overall effects of transport infrastructure investments and other transport policies are small compared with those of socio-economic and technical macro trends, such as globalisation, increasing competition between cities and regions, ageing of the population, shifting

[16] For a more detailed explanation of SASI and CGEurope results we refer to IASON D6, for E3ME and ASTRA to TIPMAC D4, D5 and D7.

[17] These models present more the "pure" result of the transport policy in terms of changes in the transport system.

labour force participation and increases in labour productivity. These trends have a much stronger impact on regional socio-economic development than transport policies. If one considers that under normal economic circumstances the long-term growth of regional economies is in the range between two and three percent per year, additional regional economic growth of less than one or two percent over twenty years is almost negligible.

TABLE 16: CROSS-MODEL COMPARISON ECONOMIC EFFECTS (EU15)

[Mio*EURO]	TENtoREF		TEN-SMCPtoREF	
	SASI	**CGEurope**	**SASI**	**CGEurope**
	1,004,416	**94,201**	**-2,668,128**	**-767,283**
Key explaining factors for differences	- mobility of capital (SASI) - equilibration of production and consumption across regions (CGE)			

The second main result of comparing CGEurope and SASI is that even large increases in regional accessibility translate into only very small increases in regional economic activity. However, this statement needs to be qualified, as the magnitude of the effect seems to depend strongly on the already existing level of accessibility. For regions in the European core with all the benefits of a central geographical location plus an already highly developed transport and telecommunications infrastructure, additional gains in accessibility through even larger airports or even more motorways or high-speed rail lines will bring only little additional incentives for economic growth. For regions at the European periphery or in the accession countries, however, which suffer from the remote geographical location *plus* an underdeveloped transport infrastructure, a gain in accessibility through a new motorway or rail line may bring significant progress in economic development. But, to make things even more complex, also the opposite may happen if the new connection opens a formerly isolated region to the competition of more efficient or cheaper suppliers in other regions. Not surprisingly, large comprehensive programme's have more substantial effects than isolated projects.

Looking at the results in tables 15 and 16 it is obvious that each model puts emphasis on different mechanisms to generate the specific results. Two further mechanisms provide significant differences between the four models: changes in sectoral patterns due to modal-shifts and transport time changes causing changes of endogenous technical progress. The former influence could be observed in both models E3ME and ASTRA, while the latter mechanism is unique to ASTRA. E3ME and ASTRA include a sectoral differentiation into 41 sectors and 25 sectors, respectively. Transport, either as private consumption for fuel, vehicles, bus-, rail- or air services or as investment into vehicles or transport facilities, feeds directly into at least five different sectors in these models and via the input-output tables affects any other sector of the economies in the 15 EU countries. Hence, modal-shifts due to policies that alter the structure of these direct linkages from transport to the sectoral economy directly affect the indirect economic effects in both models. An example observed in both models E3ME and ASTRA: SMCP policy increases the cost for car transport by 50-100% while for bus, train and air transport the increase is between 10 and 30%. This causes a significant modal-shift away from car to the transport service modes. That implies significantly reduced final demand for private cars affecting negatively the vehicle production sector as increased investments in buses etc. would not fully compensate. On the other hand a sharp increase of final demand for transport services could be observed that is divided onto two different sectors: inland services and air services. Since, productivity in the vehicle production sector is much higher than in the transport service sectors, especially inland services, employment is increased. This shows that incorporating a sectoral structure into a model for transport policy assessment on a larger scale is of key importance. Since the sectoral shifts described above exert positive influences in the SMCP policy they account for a further element that makes results of E3ME and ASTRA more positive than for SASI and

CGEurope, since these models have a more refined sectoral division. However this is at the cost of losing spatial detail on which SASI and CGEurope provide more adequate results (see IASON D6).

Summarizing, the total system benefit/transport benefit ratio can vary considerable, the determinants of the variability as observed, within the models, can be explained by:

- differences in modelling concerning elasticities, price-cost margins and linkage effects in the relevant markets (which may be labour and land as well as products);
- the level of spatial and sectoral disaggregation of the different models;
- the presence and interrelationships between macro variables concerning investments, savings, taxes or compensation schemes etc. (in case it is needed for the policy to be assessed);
- the way in which transport costs are included (log sum or out of pocket) incorporate feedbacks that produce non-linearities;
- the way in which markets are included (behavioural modelling or not);
- the treatment of cross-border issues like e.g. variations in market regulation, trade barriers etc..

Cohesion

One major objective of transport policy of the EU is to stimulate cohesion. This topic is analyzed using SASI and CGEurope (for a detailed description we refer to IASON6).

There are several methods and indicators to measure the contribution of a policy or policy combination to the cohesion objective: the coefficient of variation, the Gini coefficient, the ratio between the geometric and arithmetic mean and the correlation coefficients between relative and absolute change and level of the variable of interest. Furthermore, aggregated welfare measures can incorporate the spatial distribution aspect of the effects resulting from a transport initiative.

However, these methods and indicators give partly contradictory results. In particular the most frequently applied indicator of cohesion, the coefficient of variation, tends to signal convergence where in many cases in fact divergence occurs, when judged in terms of absolute rather than relative income differences between regions. The coefficient of variation, the Gini coefficient and the ratio between geometric and arithmetic mean measure *relative* differences between regions and classify a policy as pro-cohesion if economically lagging regions grow faster (in relative terms) than economically more advanced, i.e. more affluent regions. Judging the distributional impact by comparing welfare indices with inequality aversion with those without leads to a similar conclusion. However, one percent additional income for a poor person (or region) is much less in absolute terms than one percent income gain for a rich person (or region). Even if poorer regions grow faster than rich regions (in relative terms), in most cases the income gap between rich and poor regions (in absolute terms) is widening. Which concept of cohesion (or convergence or divergence) is used, is a matter of definition. It is therefore of great importance to clearly state which type of cohesion indicator is used or should be used.

Beyond these methodological difficulties, a few general observations about the cohesion effects of the examined policies can be made. In general, network policies, i.e. transport infrastructure improvements, coincide with the cohesion objective, i.e. have a tendency to favour poorer peripheral regions – in relative terms. However, in absolute terms usually the richer and more central regions gain more. The opposite holds true for the pricing scenarios. The characteristic spatial pattern of the pricing scenarios is to disfavour geographically peripheral regions, both peripheral with regard to their respective national markets as well as peripheral with respect to Europe as a whole. As peripheral regions tend to be poorer than central ones, on average, pricing disfavours poorer regions more than richer ones. However, for the whole EU27 the comprehensive pricing scenario B2 is found to be pro-cohesion, because it is only applied to the (richer) present European Union. In absolute terms, all pricing scenarios are pro-cohesion because the rich central regions lose more with respect to all three indicators considered, accessibility, GDP, and welfare (measured in monetary terms). Based on an inequality corrected welfare index, it could however also be shown that the inequality corrected gains or losses resulting from a certain scenario do not differ much from those measured without such a correction, if the assumed inequality aversion lies within a plausible range.

In summary it can be concluded that many transport policies of the past had in a sense an ambiguous impact with regard to spatial distribution: though they have contributed to cohesion, when measured in relative terms, they at the same time have also contributed to widening absolute disparities between central and peripheral regions in Europe. This is even true for the 'old' list of TEN priority projects. The 'new' list of priority projects is a clear advance in this respect. However, there is room for improvement, as some of the scenarios have shown. The simulations have demonstrated that rapid upgrading and extending of the rail and road infrastructure in Eastern Europe would contribute to the economic and social integration of the accession countries after the enlargement of the European Union.

D. RECOMMENDATIONS FOR EVALUATION PRACTICE AND RESEARCH

D.1 Recommendations for applied and fundamental research

The state of the art of appraisal of transport projects and policies is developing at a fast pace. However, the TEN-T projects and in particular the opening of Europe to the East poses formidable challenges for transport appraisal. Better transport infrastructure will link together places with quite different labour markets, standards of living and access to goods and services. In such conditions the general conclusions are:

- A wider economy model linked to a transportation model does offer a way forward in modelling the total effect, including the economic network effects
- The outputs of such models include forecast changes in GDP, employment by region and consumer surplus. Conceptually such models generate the total economy-wide benefit of a project or policy
- The relationship between the total benefit and the benefit measured in a transport-only cost-benefit analysis is understood in principle, but the size of the difference between them in practical cases is as yet poorly understood. Markets which are notoriously imperfect, such as land and labour have not yet been fully incorporated into the wider economy models.
- For major projects and policies, a good quality transport sector cost-benefit analysis is vital. This requires adequate data and modelling of the transport networks to generate the inputs to the analysis.
- From the perspective of the policy makers, the spatial pattern of gains and losses is important, and spatial economic models can help to identify these.
- Therefore a consistent approach of transport cost-benefit analysis plus spatial economic modelling may be an attractive combination providing insight into the absolute value, or social rate of return on investment and the spatial and social distribution of winners and losers.
- An appraisal that is consistent in its treatment of effects from both national and supranational perspective is capable of dealing with cross-border effects. The choice of scale and models is important to highlight these effects.

Specific conclusions emerging from the IASON-TIPMAC modelling exercises substantiate these conclusions. Despite the similarity in order of magnitude of additional effects estimates, the modelling exercises do not show any pattern that would prove a structured relationship between direct and indirect effects. In other words, it seems that direct effects and indirect effects may have very loose links, only, such that the objective to find a rule for adding a certain additional benefit to direct effects to consider indirect effects can not be fulfilled. Comparing the indirect effects across models one should first think about a reasonable distinction of policies to conclude about the suitability of models or model combinations for assessment purposes and for CBA. One suggestion would be to differentiate spatial and a-spatial transport policies with the spatial policies being mainly infrastructure policies and the a-spatial policies being pricing and regulation policies.

However, as the results from the spatial models (e.g. accessibility changes from SASI) reveal that also the a-spatial transport policies would have strong spatially differentiated impacts, which is not surprising as transport is a mean to overcome space and hence always will have spatial impacts, this is not recommended. Instead, given the results, a distinction into policies that have the potential to change structures and to redistribute significant economic flows between regions, industrial sectors or groups of consumers and policies that do not have this potential seems to be more reasonable. We might call the former structural policies and the latter ceteris-paribus policies.

For ceteris-paribus policies current transport CBA practice would be sufficient i.e. calculating the direct transport effects in terms of volume, cost and time changes with a transport network model. Based on these consumer and producer surplus provide the base for assessment that is accompanied by a consideration of environmental impacts, accident and investments by the policy.

Structural policies can be differentiated into policies that change only one of the potential fields for structural change i.e. changing only regional distributions, only sectoral distribution or only household distribution. Furthermore, a category of policies exist that change more than one of these structures.
For structural transport policies that change only one of the potential fields for structural change single models of the IASON-TIPMAC family should be appropriate. The models can be differentiated into two groups:

- Models appropriate for analysis of detailed regional and sectoral distribution, such as CGEurope and SASI;
- Models appropriate for limited spatial detail and sectoral distribution, such as: E3ME-SCENES and ASTRA.

None of the models above is suitable for analysis of social distribution between households. The point with large scale policies decided at national or European level is that these will usually change more than one of the structures such that applying a single model will not be sufficient. Instead combinations of the models should be promising e.g. if a policy is affecting regional and sectoral structures it should be assessed by models from both groups in a combined way e.g. providing national totals for GDP, employment etc. from E3ME or ASTRA to CGEurope or SASI to perform the regional analysis. Alternatively, one could upgrade each model to carry out the task on its own i.e. complete SASI and CGEurope by a sectoral analysis or E3ME and ASTRA by a more detailed regional analysis, which in any case first would require a feasibility analysis. And to complete the picture all models would need a component to analyse impacts on social distribution. An overview of these suggestions is given in the following table.

TABLE 17: USE OF MODELS FOR DIFFERENT POLICY ANALYSES

Policy	No	Expected structural effects	Model for CBA
Ceteris-paribus transport policy	1	None	4-stage transport network model
Structural transport policy with step changes in transport costs	2	Focus on regional distribution	CGEurope, SASI
	3	Focus on sectoral distribution	E3ME-SCENES, ASTRA
	4	Social distribution only	No model available
	5	Regional & Sectoral distribution	CGEurope/SASI and E3ME/ASTRA. ASTRA alone for aggregated analysis.
	6	Combinations with social distribution	No model available

The policies in the IASON-TIPMAC cluster all belong to the fifth or sixth category such that at least the combination of the models should be applied for assessment. The problem with applying different models is that these generate different appraisal indicators that might not be comparable. CGE models provide welfare indicators like equivalent variation based on welfare theory that do not have an intuitive meaning neither are comparable with statistical experience. Their great advantage is the theoretical consistency. The other models provide a great variety of indicators, including social product measures, to appraise welfare effects by a vector of indicators like income or employment. Their advantage would be the intuitive meaning and statistical availability. On the other hand these bear the risk of double counting and lack the theoretical consistency.

A final point with respect to comparative strengths of these models relates to the ability to display wider macro-economic benefits which fall outside the realm of the transport or industry sectors. The effects on the economy, for example, of re-investing income from transport pricing can be considerable, as our experiments have shown. These effects cannot be shown using CGEurope or SASI (it is assumed that the income raised does not re-enter the economy but "disappears"), but requires a macro-economic, full-loop model such as E3ME or ASTRA.

D.2 Recommendations to policy makers

In TIPMAC and IASON the approach for assessing indirect effects is through undertaking modelling exercises (with models like CGEurope, SASI, E3ME). The qualitative (ex-post) approach of TRANSECON can also be clearly related to the process of CBA (see IASON D5), but requires different techniques. We note that in the process of CBA, the qualitative approach of TRANSECON can be initiated (ex-ante) before the start of the project in order to get the right set of project alternatives and to assess which groups are affected by the initiative. Furthermore, assessment on a local level can include life quality and other variables relevant to an urban environment. It should be noted that in the IASON and TIPMAC analysis of results the external effects such as accidents, emissions, etc. have been left out of the analysis.

The project has made available a new set of interconnected instruments that now can be used to assess the spatial and economic consequences of transport policies. Besides producing broad pictures of the overall economic impact for the EU, the function of the models is in particular to point the attention of policy makers to those regions, sectors or policy packages where the indirect impacts of infrastructure and pricing policies are above average. While the wider economic impacts can be substantial as transport impacts propagate over time through the economy, these are not necessarily always welfare effects that are additional to the transport impacts. When they are, they can be of significant magnitude, and these cases can now be uncovered by models like CGEurope and E3ME (when linked to the appropriate transport modelling tools).

A variety of concrete large-scale transport initiatives was examined in this study with widely varying results. It depends very much on the nature of the transport initiative and the expected impacts what models can or should be used. If one is interested in pricing policies and refunding of the tax charges is an essential part of the (transport) policy it should be clear that models like SCENES/E3ME and ASTRA are capable to deal with this type of policy. CGEurope and SASI are not capable of dealing with this type of policy since they lack a module to incorporate taxes.

From the results form ASTRA and E3ME/SCENES it is clear that the pricing policy has a greater impact than the investment in infrastructure. The pricing policies reduce the demand for transport, hence reducing the impacts and benefits of expanding infrastructure. In ASTRA and E3ME direct effects of the pricing policies including refunding are calculated as the change in consumer surplus due to the increase in transport costs. The effect of tax refunding is incorporated in the assessment. This is not done for CGE nor SASI. Hence, comparing the magnitude of indirect effects compared to the different direct effects is impossible. Conclusions concerning comparison of the different direct/indirect effects ratio is not entirely useful. Also comparisons to results of SACTRA are difficult because of the incorporation of the tax refund in the indirect effects.

If one is interested in changes in the regional or spatial structure of the European economy models like CGEurope are an outstanding example of how to model changes in the regional distribution (and sectoral structure) of the economy. SCENES/E3ME does not produce changes in spatial patterns. CGEurope results show that measuring direct effects only per region gives a reasonable approximation of changes in the regional distribution. It is unclear whether these results can be extended to all imaginable transport initiatives. Although market imperfections seem to play a bigger part than different scenarios, it should be noted that market imperfections can be very different among regions/countries in the European Union. CGEurope in its present version only permits a moderate degree of monopoly. Financing infrastructure investment usually is not considered in CGEurope models. When the investment is small compared to total GDP the error made is not very large. Most CBA practices (UK, The Netherlands) ignore the tax burden caused by financing infrastructure.

The CGEurope model can be improved in 3 ways: 1) by improving the related transport sub-model, 2) by improving the link between the transport model and CGEurope, along the ways that are described in D4 and 3) by relaxing a number of assumptions made in the present version such as labour mobility. Also, some thought has to be spent on incorporating tax refunds of pricing policies into the model. Having improved the link between CGEurope and the transport sub-model, another aspect which can be explored is macroeconomic dynamics - models such as E3ME or ASTRA can be used to build up this aspect of the analysis. Environmental effects are also of policy importance - these can be modelled at the level of the transport network in a European transport model such as SCENES, or at an aggregate level in a macro- economy/environment model such as E3ME.

The models as reported from IASON and TIPMAC follow two major different lines of thought. First, there is the general equilibrium approach focussing on price and market mechanisms and, second there is the dynamic approach focussing on the evolution of the economic system over time. The aim of both is to consider all relevant interaction within a transport – economic system. A clear direction of research would be a) to improve the welfare theoretical basis of the dynamic approach and b) to improve the dynamic capabilities of SCGE-models. The E3ME/ASTRA and the CGEurope/SASI group of models also follow a different philosophy where it concerns the importance of the economic functioning of markets (role of prices) as brought out in the first two economics models cf. the ASTRA and E3ME approaches which treats at a higher level structural technological and behavioural changes in society. Hence, the models answer in principle different questions and answer to the same questions differently.

The IASON-TIPMAC results indicate that at least for large scale transport policies the earlier conclusions on the magnitude of indirect effects are to be extended. One reason for this is that earlier studies are dealing with smaller scale projects which could have an impact. Earlier studies apply to partial policies instead of fully-fledged ones. That has been identified as one source of differences of results for the analysis of indirect effects.

It is our suggestion that a European-level report on the state-of-the-art in modelling and appraisal methodology is now timely, building upon the theoretical and practical advances in IASON. Such a report could, for example, follow the pattern of OEEI in the Netherlands or the UK SACTRA report (‘Transport and the Economy’, 1999). It could both raise awareness of the methods used in IASON, and give advice on best practice in CBA. EC DG-TREN, EIB or ECMT would be the natural proponents for such a report. The new 6^{th} Framework Research project HEATCO will take a first step in the direction of creating harmonized economic valuation measures. Finally, we believe that our work has underlined the key role of transport modelling in the appraisal of public transport initiatives. Future research, therefore, should remain to be targeted at advancing the state of the art of practical transport modelling and forecasting practice at EU level.

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2	Bröcker, J., Kancs, A., Schürmann, C., Wegener, M. (2001). *Methodology for the Assessment of Spatial Economic Impacts of Transport Projects and Policies.* IASON (Integrated Appraisal of Spatial economic and Network effects of transport investments and policies) Deliverable 2. Funded by 5th Framework RTD Programme. Kiel/Dortmund: Christian-Albrechts-Universität Kiel/Institut für Raumplanung, Universität Dortmund.
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G. ANNEX 1 IASON REGIONS AND NETWORKS

This section presents the framework for the IASON Common Spatial Database to be used by both the extended SASI and the CGEurope models: the system of regions and the network database. Here only the basic principles for developing the Common Database are presented. The Common Database is presented in detail in IASON Deliverable D3.

4.1 System of Regions

The system of regions defined is based on level three of the Nomenclature of Territorial Units for Statistics (NUTS) for EU member states (Eurostat, 1999a) and equivalent regions for the candidate countries (Eurostat, 1999b). Because for Poland negotiation on NUTS 3 level regions are still pending, For the other European countries, only a limited number of regions is defined (Table 4.1). With the exception of Belarus (6 regions), Switzerland (26), Norway (19), Russia (28) and Ukraine (3), all other countries are not further subdivided (see Figure 4.1).

The 1,083 regions defined for the EU member states are the so-called 'internal' regions of the model. 162 regions located in candidate countries are designated as ‘candidate’ regions, whereas 91 regions are 'external' regions for the rest of Europe, and five regions representing the ‘rest of the world’. The five regions representing the rest of the world are only used as origins and destinations of freight flows, but economic performance indicators are not calculated for them. Altogether, 1,341 regions are defined.

4.2 Trans-European Transport Networks

The spatial dimension of the system of regions is established by their connection via networks. The economic centres of the regions are connected to the network by so-called access links. The 'strategic' road, rail and inland waterways networks defined are subsets of the pan-European network database developed by IRPUD (2001), comprising the trans-European networks specified in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996) and specified in the TEN implementation report (European Commission, 1998), the TINA networks as identified by the TINA Secretariat (1999), the Helsinki Corridors as well as selected additional links in eastern Europe and other links to guarantee connectivity of NUTS-3 level regions and centroids. The 'strategic' air network is based on the TEN and TINA airports and other important airports in the remaining countries considered and contains all flights between these airports.

The networks are used to calculate regional accessibility. For that the historical and future developments of the networks are required as input information. This development of the networks over time is reflected in intervals of five years in the database, i.e. the established network database contains information for all modes for the years 1981, 1986, 1991, 1996, 2001, 2006, 2011 and 2016. The way the historical and future dimensions of the network are established in the GIS database is described in detail in the framework of the SASI project (Fürst et al., 1999, 30).

TABLE 18: NUMBER OF REGIONS

Region	Country	Number of regions
EU member states	Österreich	35
	Belgique/Belgie	43
	Deutschland	441
	Danmark	15
	Espania	48
	Suomi/Finnland	20
	France	96
	Ellada	51
	Ireland	8
	Italia	103
	Luxembourg	1
	Nederland	40
	Portugal	28
	Sverige	21
	United Kingdom	133
Total EU member states		*1,083*
EU candidate countries	Balgarij	28
	Cyprus	1
	Cesko	14
	Eesti	5
	Magyaroszág	20
	Lietuva	10
	G.1.1.1 Latvija	5
	Malta	1
	Polska	16
	Romania	42
	G.1.1.2 Slovenija	12
	Slovensko	8
Total EU candidate countries		*162*
Rest of Europe	Shqiperia	1
	Bosna I Hercegovina	1
	Belarus	6
	Schweiz	26
	Hrvatska	1
	Island	1
	Liechtenstein	1
	Moldova	1
	Republica Makedonija	1
	Norge	19

	Rossija	28
	Türkiye	1
	Ukraina	3
	Jugoslavija	1
Total rest of Europe		91
Rest of world	North-America	1
	Latin America	1
	Africa	1
	Middle East	1
	Asia, Australia	1
Total rest of world		*5*
Total all regions		*1,341*

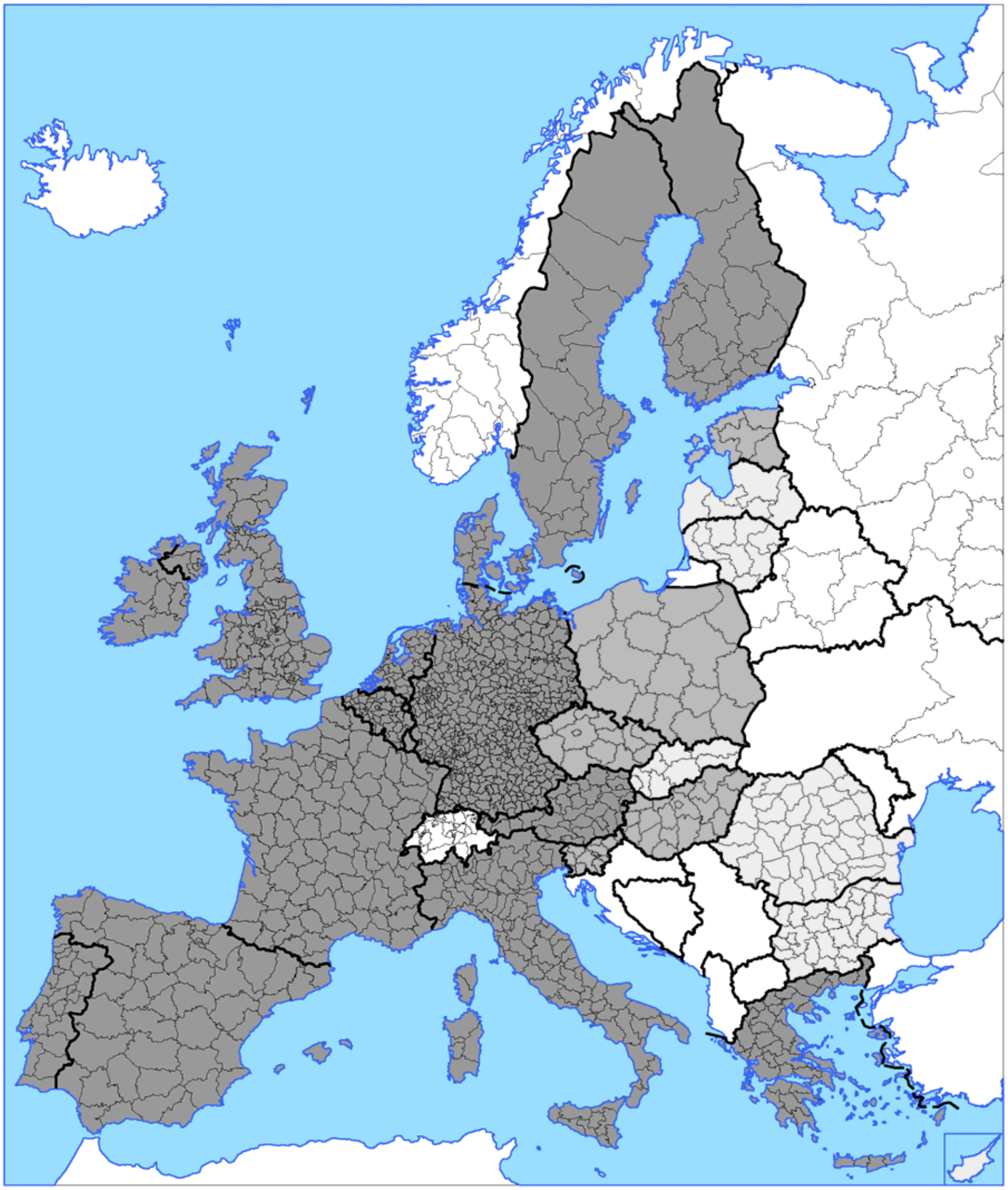

FIGURE 52: THE IASON SYSTEM OF REGIONS

Road network

The strategic road network contains all existing and planned motorways, all dual-carriageway roads and other expressways, all E-roads and main international traffic arteries identified by UN (1995), the most important national roads and car ferries, the Eurotunnel and additional motorail links (road/rail interchange points for Alps crossing), as well as additional minor or secondary roads to guarantee connectivity of NUTS-3 region centroids (Figure 4.2).

The road network database contains information on the type of road ('link category'), inclusion in the TEN and TINA programmes, time penalties in agglomeration areas due to congestion and in hilly areas due to slope gradients, ferry timetable travel times, road tolls, national speed limits and border delays.

Link categories of past networks are compiled from Shell (1981; 1992), ADAC (1987; 1991), Reise- und Verkehrsverlag (1987) and Michelin (1992a; 1992b). Link categories of future networks are taken from the TEN implementation report. National speed limits are derived from ADAC (2000), and assumptions on border waiting times are based on IRU (1998) (see also Fürst et al., 1999; Schürmann and Talaat, 2000a; 200b). Figure 4.3 gives a representation of the future road network evolution until the year 2016 according to the envisaged completion and opening years of the road projects.

Rail network

The strategic rail network contains all existing and planned high speed lines, upgraded high speed lines and the most important conventional lines as well as some rail ferry and other minor or secondary lines to guarantee connectivity of NUTS-3 region centroids (Figure 4.4).

The rail network database contains information on the type of link ('link category'), inclusion in the TEN and TINA programmes and timetable travel times.

For the past rail networks, it was first checked which railway line already existed in 1981, 1986 and 1991 and which not. For example, most of the current links existed already in 1981 with the exception of the new high-speed lines (Fürst et al., 1999, 35). In order to have the connectivity of the current high-speed lines in the 1981 network, corresponding conventional links are introduced in the 1981 strategic rail network. The new high-speed links are introduced into the strategic networks of 1986, 1991 or 1996 according to their opening year. Moreover, for the remaining lines, assumptions have been made for the general increase of the 1996 timetable travel times due to technical improvements in signalling techniques.

The TEN implementation report contains information on planned new (high speed or conventional) lines or planned upgraded lines (see Figure 4.5). This information is used to make assumptions for speed and travel time changes on a country-by-country basis with respect to the new link categories. In some cases published future travel times for railway sections are used. If no upgrading is planned for a link, a modest acceleration of ten percent is assumed which reflects improvements in signalling systems, carriage technology and railway construction.

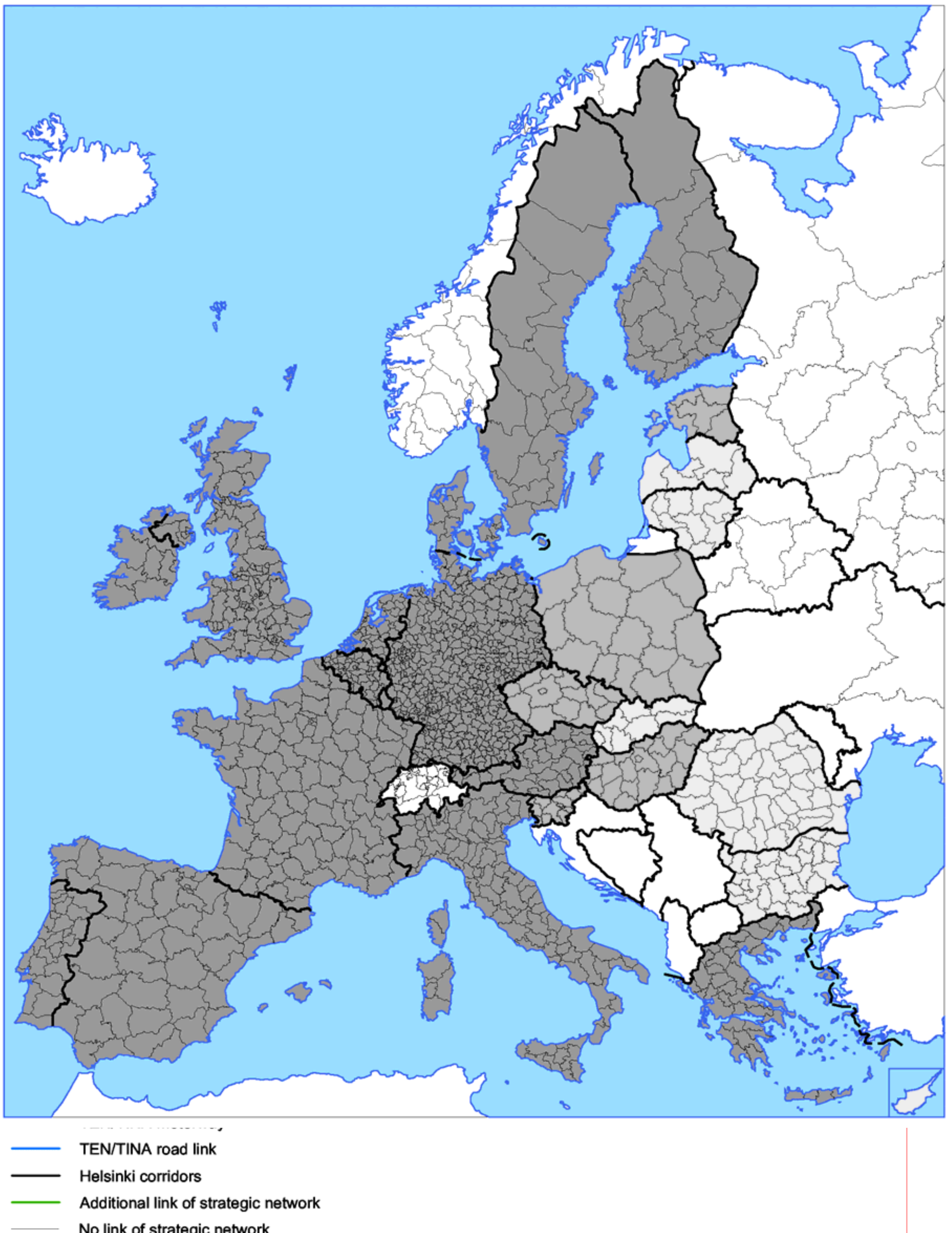

FIGURE 53: THE IASON STRATEGIC ROAD NETWORK IN 2001

H. ANNEX 2 IASON SCENARIO DEFINITION

H.1 Introduction

The policies to be examined in IASON are defined as policy scenarios, i.e. as time-sequenced programmes of implementation of network improvements and extension and other transport policies. In addition to the policy scenarios, a reference scenario is defined as benchmark for comparisons between the results of the policy scenarios. All scenarios are equal for both the SASI and CGEurope models..

H.2 Overview of Scenarios

The scenarios simulated with the SASI and CGEurope models can be classified into six categories:

Reference Scenario. Scenario 000 is the base or reference scenario serving as the benchmark for the comparisons between the results of the policy scenarios.

Network scenarios. Scenarios A1 to A62 implement different assumptions on the further development of the European transport networks, i.e. they vary in the number, selection and timing of implementation of network links.

Pricing scenarios. Scenarios B1 and B2 examine different schemes of social marginal cost (SMC) pricing. They differ in the kind of pricing regime. These scenarios do not implement any network development, i.e. the pricing scenarios are applied to the networks of the reference scenario.

Combination scenario. Scenario C1 is a combination of network scenario A1 and pricing scenario B2.

Rail freight scenario. Scenario D1 assumes the development of a dedicated rail freight network in Europe.

TIPMAC scenarios. Scenarios E1 and E2 represent combinations of network and pricing scenarios corresponding to the assumptions made in the TIPMAC project.

Table 2.1 presents a list of all scenarios, subdivided into these six categories with a brief description of their main features.

All scenarios rely on the trans-European transport network GIS database developed by the Institute of Spatial Planning of the University of Dortmund (IRPUD, 2001). The ***strategic*** road, rail and inland waterways networks used in IASON are subsets of this database, comprising the trans-European networks specified in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996), further specified in the ***TEN Implementation Report*** (European Commission, 1998) and latest revisions of the TEN guidelines provided by the European Commission (1999; 2002a), information on priority projects (European Commission, 1995), latest publications on the priority projects (European Commission, 2002b; 2003; HLG, 2003), on the TINA networks as identified and further promoted by the TINA Secretariat (1999, 2002), the Helsinki Corridors as well as selected additional links in eastern Europe and other links to guarantee connectivity of NUTS-3 level regions. The strategic air network is based on the TEN and TINA airports and other important airports in the remaining countries and contains all flights between these airports (Bröcker ***et al.***, 2002).

TABLE 19: IASON SCENARIOS

Scenario	Code
000 Reference scenario	
Reference scenario	000
A Network scenarios	
Implementation of all TEN priority projects (Essen list)	A1
Implementation of all high-speed rail priority projects (Essen list)	A21
Implementation of all conventional rail priority projects (Essen list)	A22
Implementation of all road priority projects (Essen list)	A23
Implementation of all rail priority projects (Essen list)	A24
Implementation of all TEN and TINA projects	A3
Implementation of all TEN projects	A4
Implementation of new priority projects	A51
Implementation of new priority rail projects	A52
Implementation of new priority road projects	A53
Scenario A3 plus implementation of additional projects in candidate countries	A61
Scenario A3 plus implementation of maximum projects in candidate countries	A62
B Pricing scenarios	
SMC pricing applied to road freight	B1
SMC pricing applied to all modes (travel and freight)	B2
C Combination scenario	
Scenario A1 plus Scenario B2	C1
D Rail freight scenario	
Dedicated rail freight network	D1
E TIPMAC scenarios	
TIPMAC business-as-usual scenario	E1
TIPMAC fast implementation scenario	E2

The network information is used to calculate travel times and travel costs between regions and regional accessibility for each year of the simulation. For that the historical and future development of the networks is required as input. The development of the networks over time is recorded in the database in five-year time steps, i.e. the network database contains information for the years 1981 (the historical base year of the SASI model), 1986, 1991, 1996, 2001, 2006, 2011, 2016 and 2021 (the envisaged completion year of all TEN and TINA projects). For the past, i.e. until 2001, the same network is used for all scenarios. The network scenarios differ in their assumptions about future network development, i.e. different network data for the years 2006, 2011, 2016 and 2021 are used for the different scenarios. The 2006 network data include all network changes supposed to be finished until the end of 2006, the 2011 network data all network changes supposed to be finished until the end of 2011, and so on. For the years between the five-year time steps, travel times and costs and accessibility indices are interpolated.

The type and expected year of completion of the projects were mainly taken from the ***TEN Implementation Report*** (European Commission, 1998) and the ***TINA Status Report*** (TINA Secretariat, 2002). Where no information was available in these two sources, supplementary information from national ministries or other national agencies was used. Most of the projects are composed of different sections with individual project types and completion years. The GIS network database reflects this by representing all projects by their individual sections, with specification of type of work and year of completion. Only in cases where such detailed information was not available, a common completion year for all sections of a project was assigned.

H.3 Scenario Specification

In this section the specification of the reference scenario and the 18 policy scenarios is presented in more detail.

H.3.1 The Reference Scenario

The reference scenario is the benchmark for comparing the results of the policy scenarios. For the period between 1981 and 2001, the reference scenario represents the actual development of the road, rail and air networks in Europe. For all future years the reference scenario preserves the state of the networks in the year 2001, i.e. no further network development after 2001 is foreseen. Thus, the reference scenario is not a realistic scenario but is used only as a benchmark for all other scenarios. All TEN or TINA projects that were already implemented by the end of 2001 are taken into account in this scenario, all other TEN or TINA projects are not considered.

H.3.2 The Network Scenarios

These scenarios implement different assumptions about the further development of the European transport networks. The scenarios vary by different selection and timing of TEN and TINA projects. There are twelve network scenarios, which can be further subdivided into four groups:

- TEN priority scenarios: A1, A21, A22, A23, A24
- Full TEN/TINA scenarios: A3, A4
- New priority projects scenarios: A51, A52, A53
- Alternative TINA scenarios: A61, A62

TEN priority scenarios

There are five scenarios analysing different options for the implementation of the TEN priority projects. In these five scenarios the priority projects adopted in 1996 and in 2002 in the Essen list are taken into consideration (European Communities, 1996; European Commission, 2002b). These scenarios are

A1 Implementation of all TEN priority projects
A21 Implementation of all high-speed rail priority projects
A22 Implementation of all conventional rail priority projects
A23 Implementation of all road priority projects
A24 Implementation of all rail priority projects

All other TEN not in the Essen priority list are not taken into account in this set of scenarios, nor are the TINA projects, unless they were already implemented until the end of 2001.

Table 2.2 and Figure 2.1 give an overview of all priority projects included in the network scenarios. Table 2.2 also indicates the official priority project number, the countries covered by the projects and the scenario in which the project is considered.

TABLE 20: PRIORITY PROJECTS OF THE ESSEN LIST

Priority project		Countries covered	Scenarios
Rail network			
1	High speed train combined transport North-South	DE, AT, IT	A1, A21, A24
2	High speed rail Paris-Cologne-Amsterdam-London	FR, BE, NL, DE, UK	A1, A21, A24
3	High speed rail south: Madrid-Barcelona-Montpellier/Madrid-Dax	ES, FR	A1, A21, A24
4	High speed rail Paris-Karlsruhe/Luxembourg/Saarbrücken	FR, LU, DE	A1, A21, A24
5	Betuwe line Rotterdam-Rhein/Ruhr	NL, DE	A1, A22, A24
6	High-speed rail Lyon-Venice-Trieste	FR, IT	A1, A21, A24
8	Multimodal link Portugal-Spain-Central Europe	PT, ES, FR	A1 A22, A24
9	Rail Cork-Dublin-Belfast-Larne-Stranraer	IE, UK	A1 A22, A24
11	Øresund rail/road link	DK, SE	A1 A22, A24
12	Nordic triangle	SE, FI	A1 A22, A24
14	West coast main line	UK	A1 A22, A24
16	High capacity rail across the Pyrenees	ES, FR	A1 A22, A24
17	High speed train, combined transport East-West	FR, DE, AT	A1, A21, A24
20	Fixed link Fehmarn Belt	DE, DK	A1, A22, A24
Road network			
7	Greek motorways (Via Egnatia, Pathe)	GR	A1, A23
8	Motorway Lisboa-Valladolid	PT, ES	A1, A23
11	Øresund rail/road link	DK, SE	A1, A23
12	Nordic triangle	SE, FI	A1, A23
13	Ireland / UK / Benelux road link	IE, UK, BE	A1, A23
20	Fixed link Fehmarn Belt	DE, DK	A1, A23

Four of the priority projects have not been implemented in all scenarios: the high-speed rail interoperability project on the Iberian Peninsula (Project 19), Malpensa Airport (Project 10), the Danube river improvement between Vilshofen and Straubing (Project 18) and the global navigation and positioning satellite system Galileo (Project 15).

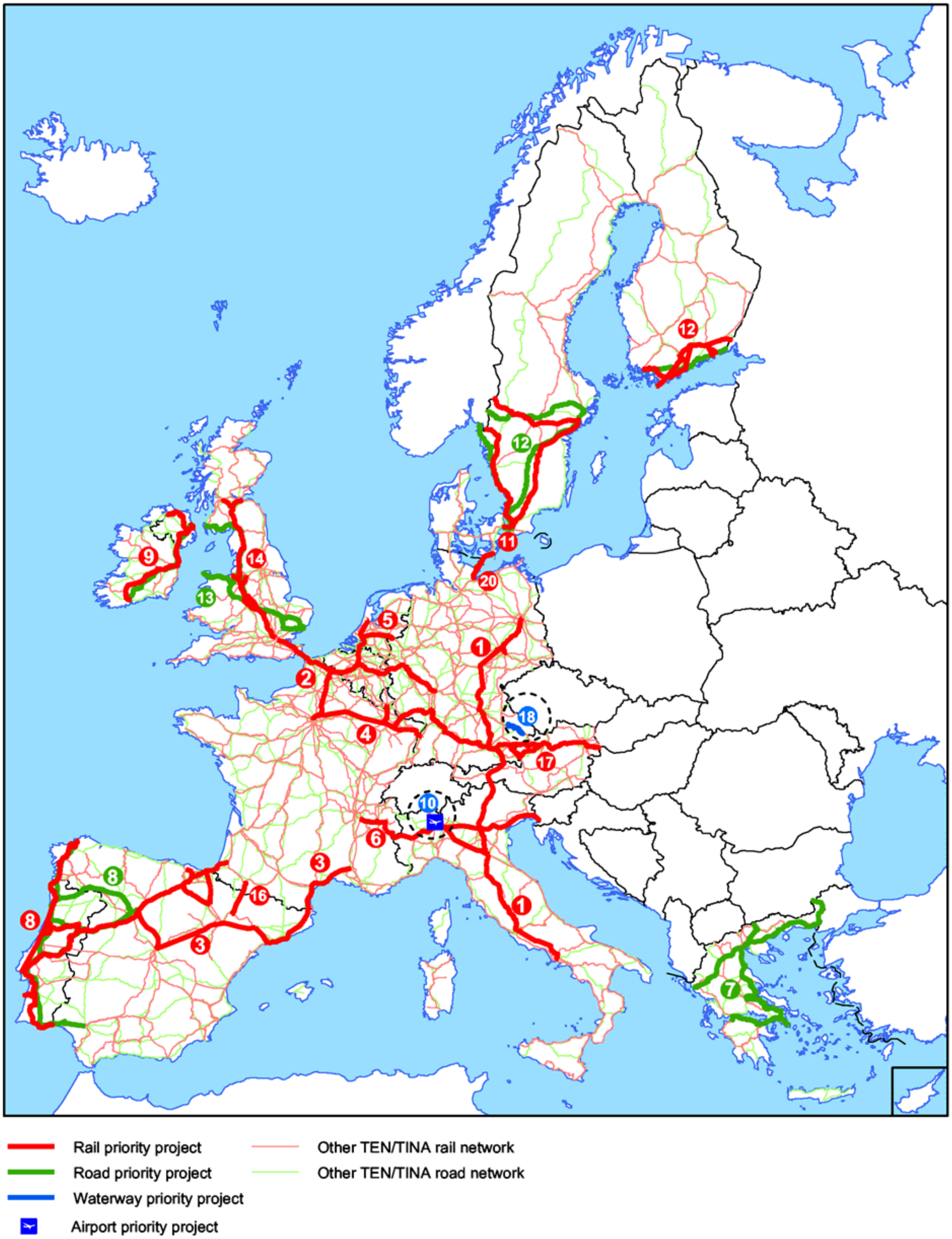

FIGURE 5.4: PRIORITY PROJECTS OF THE ESSEN LIST

Full TEN/TINA scenarios

There are two scenarios examining the impacts of the full implementation of the TEN and TINA networks:

A3 Implementation of all TEN and TINA projects
A4 Implementation of all TEN projects

Scenario A3 considers all projects included in Decision 1692/96/EC of the European Parliament and of the Council (European Communities, 1996) and reported in the ***TEN Implementation Report*** (European Commission, 1998) as well as all projects reported in the ***TINA Final Report*** and ***TINA Status Report*** (TINA Secretariat, 1999; 2002). Scenario A3 features all envisaged projects of the TEN and TINA networks. Scenario A4, however, considers only the projects of the TEN Implementation Report, i.e. does not assume any network development in the accession countries. Compared to the priority project scenarios, the two scenarios include many more projects because the priority projects are only a subset of all TEN projects.

As noted, information on the type of project (e.g. upgrading, new motorway, new conventional rail line etc.), the status of the project (e.g. planning phase, partly or fully completed etc.) and on the estimated year of completion were taken from the TEN Implementation Report and the TINA Status Report. Where this information was not available there, supplementary sources from national ministries and national agencies were used.

Altogether there are some 600 projects comprising some 2,400 individual sections implemented in Scenario A3. Figure 2.2 shows the all TEN and TINA projects considered.

New priority projects scenarios

Three scenarios assume the implementation of the most recent proposal for the further development of the priority projects. The proposals date back to the high-level group on trans-European transport networks, the so-called Van Miert group (HLG 2003) and were subsequently revised by the European Commission (European Commission, 2003). The three scenarios are:

A51 Implementation of the new priority projects
A52 Implementation of the new priority rail projects
A53 Implementation of the new priority road projects

The revised list of priority projects includes the priority projects of the Essen list plus the additions recommended by the European Commission (see Figure 2.3). The additional projects mainly cover projects in the accession countries or new corridors towards the accession countries as extensions of old priority projects. The spatial coverage of the new list of priority projects is therefore no longer limited to the member states of the present European Union but covers also the accession countries. Table 2.3 lists the projects of the new priority list.

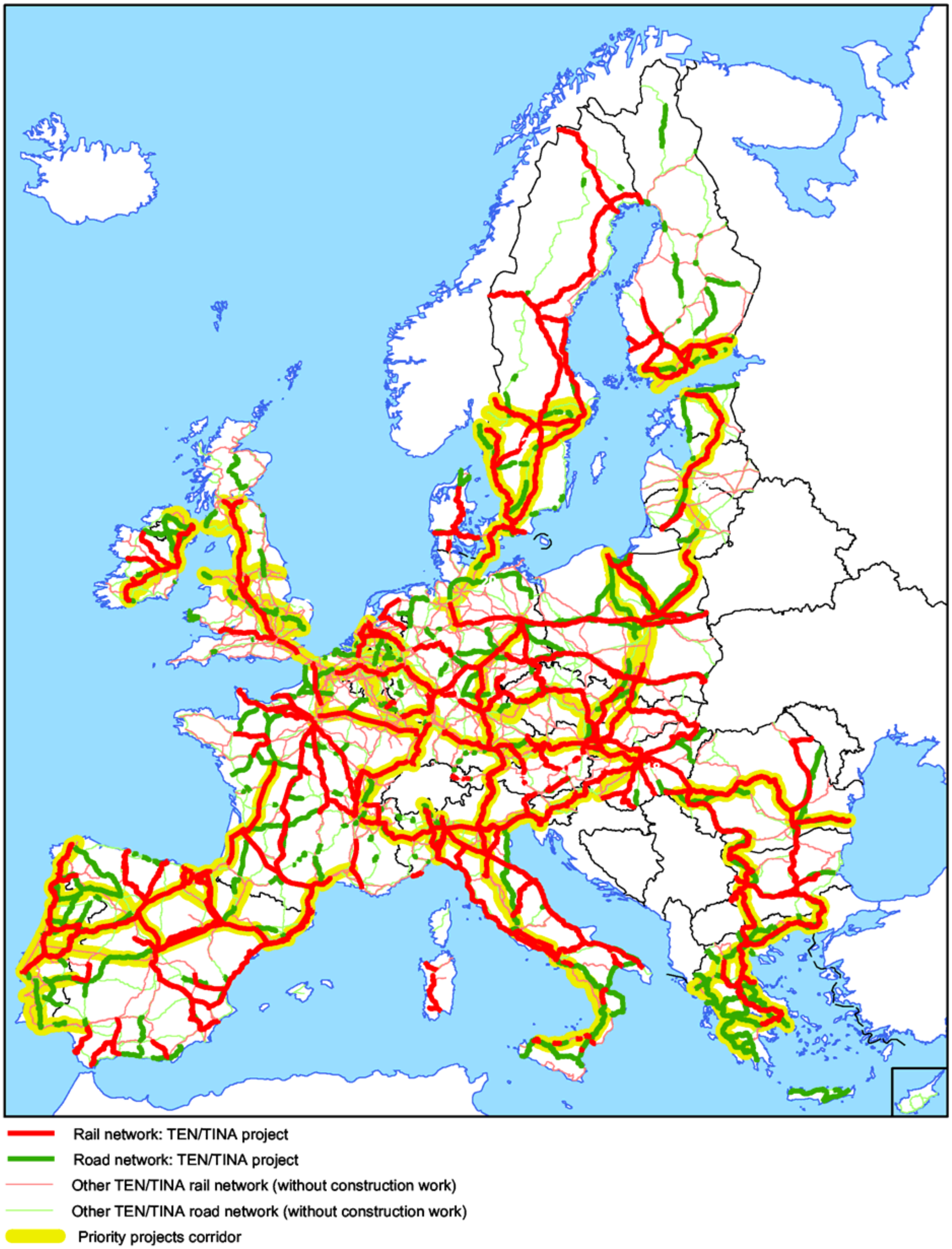

FIGURE 5.5: TEN AND TINA RAIL AND ROAD PROJECTS

TABLE 21: NEW LIST OF PRIORITY PROJECTS

Priority project		Countries covered	Scenarios
Rail network			
1	High speed train combined transport North-South, w. Messina bridge	DE, AT, IT	A51, A52
2	High speed rail Paris-Cologne-Amsterdam-London	FR, BE, NL, DE, UK	A51, A52
3	High speed rail south: Madrid-Barcelon-Montpellier/Madrid-Dax	ES, FR	A51, A52
4	High speed rail Paris-Karlsruhe/Luxembourg/Saarbruecken	FR, LU, DE	A51, A52
5	Betuwe line Rotterdam-Rhein/ruhr	NL, DE	A51, A52
6	High-speed rail Lyon-Venice-Trieste/Koper-Ljubljana-Budapest	FR, IT, SI, HU	A51, A52
8	Multimodal link Portugal-Spain-Central Europe	PT, ES, FR	A51, A52
9	Rail Cork-Dublin-Belfast-Larne-Stranraer	IE, UK	A51, A52
11	Øresund rail/road link	DK, SE	A51, A52
12	Nordic triangle	SE, FI	A51, A52
14	West coast main line	UK	A51, A52
16	High capacity rail across the Pyrenees, freight line Sines-Badajoz	ES, FR, PT	A51, A52
17	High speed train, combined transport East-West	FR, DE, AT, SK	A51, A52
20	Fixed link Fehmarn Belt	DE, DK	A51, A52
22	Rail Athina-Kulata-Sofia-Budapest-Vienna-Praha-Nuernberg	GR,BG,HU,AT,CZ,DE	A51, A52
23	Rail Gdansk-Warsaw-Katowice-Brno/Zilinia	PL. CZ, SK	A51, A52
24	Rail Lyon/Geneva-Basel-Duisburg-Rotterdam-Antwerp	FR, DE, NL, BE	A51, A52
26	Multi-modal link Ireland/UK/continental Europe	IE, UK, BE, FR	A51, A52
27	Rail Baltica	EE, LT, LV, PL	A51, A52
28	Eurocaprail Brussels-Luxembourg-Strasbourg	BE, LU, FR	A51, A52
29	Intermodal corridor Ioannian Sea/Adria	GR	A51, A52
Road network			
1	Fixed link road/rail Messina bridge	IT	A51, A53
7	Greek motorways (Via Egnatia, Pathe), motorways in BG / RO	GR, BG, RO	A51, A53
8	Motorway Lisboa-Valladolid	PT, ES	A51, A53
11	Øresund rail/road link	DK, SE	A51, A53
12	Nordic triangle	SE, FI	A51, A53
13	Ireland / UK / Benelux road link	IE, UK, BE	A51, A53
20	Fixed link Fehmarn Belt	DE, DK	A51, A53
25	Motorway Gdansk-Katowice-Brno-Vienna	PL, CZ, SK, AT	A51, A53
26	Multi-modal link Ireland/UK/continental Europe	IE, UK, BE, FR	A51, A53

It is worth mentioning that although the numbering scheme of the new list of priority projects remains the same as for the old list, some of the old projects have been extended to cover also accession countries (for example Project 7 now extends into Bulgaria and Romania). As already mentioned, Project 10 (Malpensa), Project 15 (Galileo), Project 18 (Rhine/Meuse-Main-Danube inland waterway axis) and Project 19 (high speed rail interoperability on the Iberian Peninsula) have not been implemented. Furthermore, the motorways of the sea (Project 21) have not been implemented.

Apart from this list of projects, no other network development is assumed in this type of scenarios.
For the old priority projects, information on the type of project and estimated completion year were based on the TEN Implementation Report, information on type of the project and estimated completion year of the new projects (or new parts of old projects) were taken from the TINA Status Report or from the final report of the Van Miert high-level group.

FIGURE 56 NEW PRIORITY PROJECTS

Alternative TINA scenarios

As the last group of network scenarios, two variants of the TINA outline plans for the candidate countries in eastern Europe were suggested by Tomasz Komornicki and Piotr Korcelli of the Stanisław Leszczycki Institute of Geography and Spatial Organization of the Polish Academy of Sciences (Komornicki and Korcelli, 2003). The two scenarios are modifications of Scenario A3, in which all TEN and TINA projects are implemented:

A61 A3 plus implementation of additional projects in candidate countries
A62 A3 plus implementation of maximum projects in candidate countries

Both scenarios assume the same network development as in Scenario A3 in the countries of the present European Union, i.e. the full implementation of the all TEN projects. With respect to the accession countries, both scenarios are modifications of the TINA network (TINA Secretariat, 1999; 2002). Scenario A61 represents a more realistic ('minimum') scenario, which compared to the full TINA outline plan reduces the number of transport projects implemented. Scenario A62 represents a maximum development scenario featuring more transport projects than Scenario A61 but still less than in the full TINA outline plan, in particular with respect to rail. However, both scenarios are more optimistic with respect to the general upgrading of the transport networks in the accession countries. They assume that almost all main railway lines are upgraded to high-speed rail and most major roads to motorways or dual-carriageway roads. They assume high-speed lines between Berlin and Warsaw and Vienna and Budapest that were not included in the TINA outline plans and expect that the single-track railway line Riga-Tallinn becomes a high-speed line. Whereas the TINA outline plan mainly removes existing bottlenecks, Scenario A61 improves the access of capital cities and Scenario A62 network connectivity between all regional cities (defined as cities with a population of more than 300,000). Figure 2.4 shows all projects in the accession countries included in the two scenarios in colour, whereas the parts of the network that remain unchanged are shown in black.

H.3.3 Pricing Scenarios

The pricing scenarios examine the effects of social marginal cost (SMC) pricing regimes applied to different parts of the networks and different types of vehicles:

B1 SMC pricing applied to road freight
B2 SMC pricing applied to all modes (travel and freight)

These scenarios do not assume further network development, i.e. the pricing schemes are applied to the networks of the reference scenario. The detailed specification of the pricing schemes are based on Tavasszy et al. (2003). Only transport links in the member states of the current European Union are subject to pricing measures.

It is important to note that in both the SASI model and the CGEurope model only the cost effects of the pricing schemes are taken into account, i.e. it is not considered how the revenues of the toll collection are reallocated into the economy.

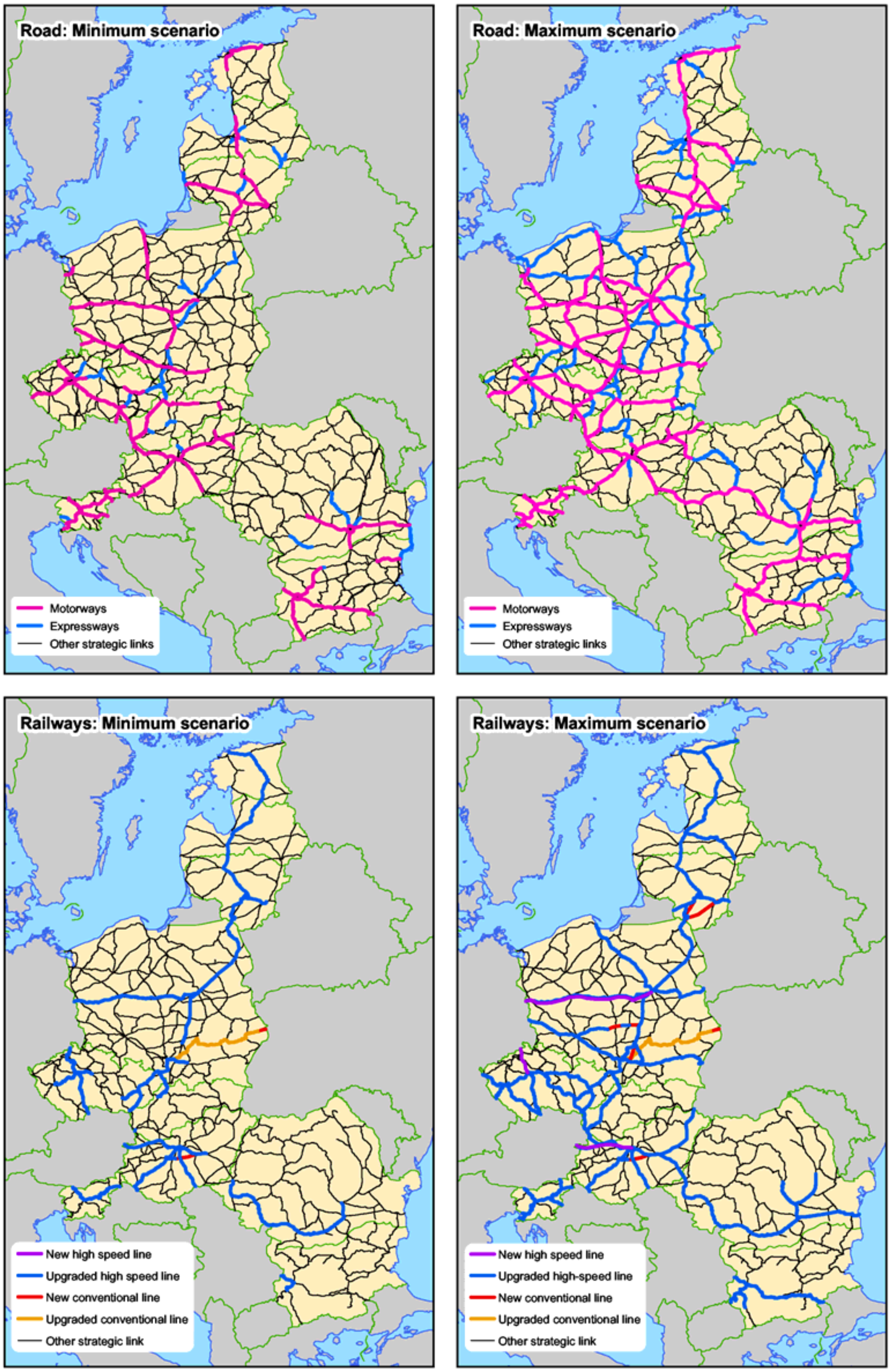

FIGURE 57: ALTERNATIVE TINA SCENARIOS A61 (LEFT) AND A62 (RIGHT): road (top) and rail (bottom)

H.3.4 Combination Scenario

This scenario is a combination of Scenario A1 (implementation of all TEN priority projects) and Scenario B2 (SMC pricing applied to all modes and to travel and freight):

C1 Scenario A1 and Scenario B2

H.3.5 Rail Freight Scenario

This scenario is a special kind of network scenario focussing on the development of the dedicated rail freight network proposed in the Eufranet project (Eufranet, 2001):

D1 Dedicated rail freight network

The dedicated rail freight network consists of corridors exclusively dedicated to rail freight transport differentiated into core and intermediate networks (see Figure 2.5). For the purpose of IASON it is assumed that all TEN and TINA projects located in or extending into these corridors are implemented, while projects outside these corridors are not implemented. Beyond this, it is assumed that travel speeds also on those sections of the core and intermediate networks that were not covered by TEN or TINA projects will increase due to improvements in signalling techniques.

As this scenario focuses on rail transport, no further network development for other modes is assumed, i.e. the road network corresponds to the road network of the reference scenario.

H.3.6 TIPMAC Scenarios

These scenarios represent certain combinations of network scenarios and SMC pricing scenarios. The assumptions about network development (type and number of projects, expected year of completion) are the assumptions made in the TIPMAC project (Borgnolo, 2002). Two TIPMAC scenarios were implemented:

E1 TIPMAC business-as-usual scenario
E2 TIPMAC fast implementation scenario

Both scenarios assume full implementation of all TEN and TINA projects and networks, similar to Scenario A3. These two scenarios differ from Scenario A3 in that they assume different years of completion not based on the TEN Implementation Report and TINA Status Report but on information compiled in TIPMAC (Borgnolo, 2002).

The two scenarios differ in their assumption on the year of completion of projects. Scenario E1 represents a rather slow implementation, which is considered as the 'business-as-usual' case, whereas Scenario E2 assumes that all projects are completed as scheduled, i.e. it more or less replicates the assumptions of Scenario A3. It is assumed that in general there is a time lag of about five years between Scenario E1 and Scenario E2 unless otherwise specified.

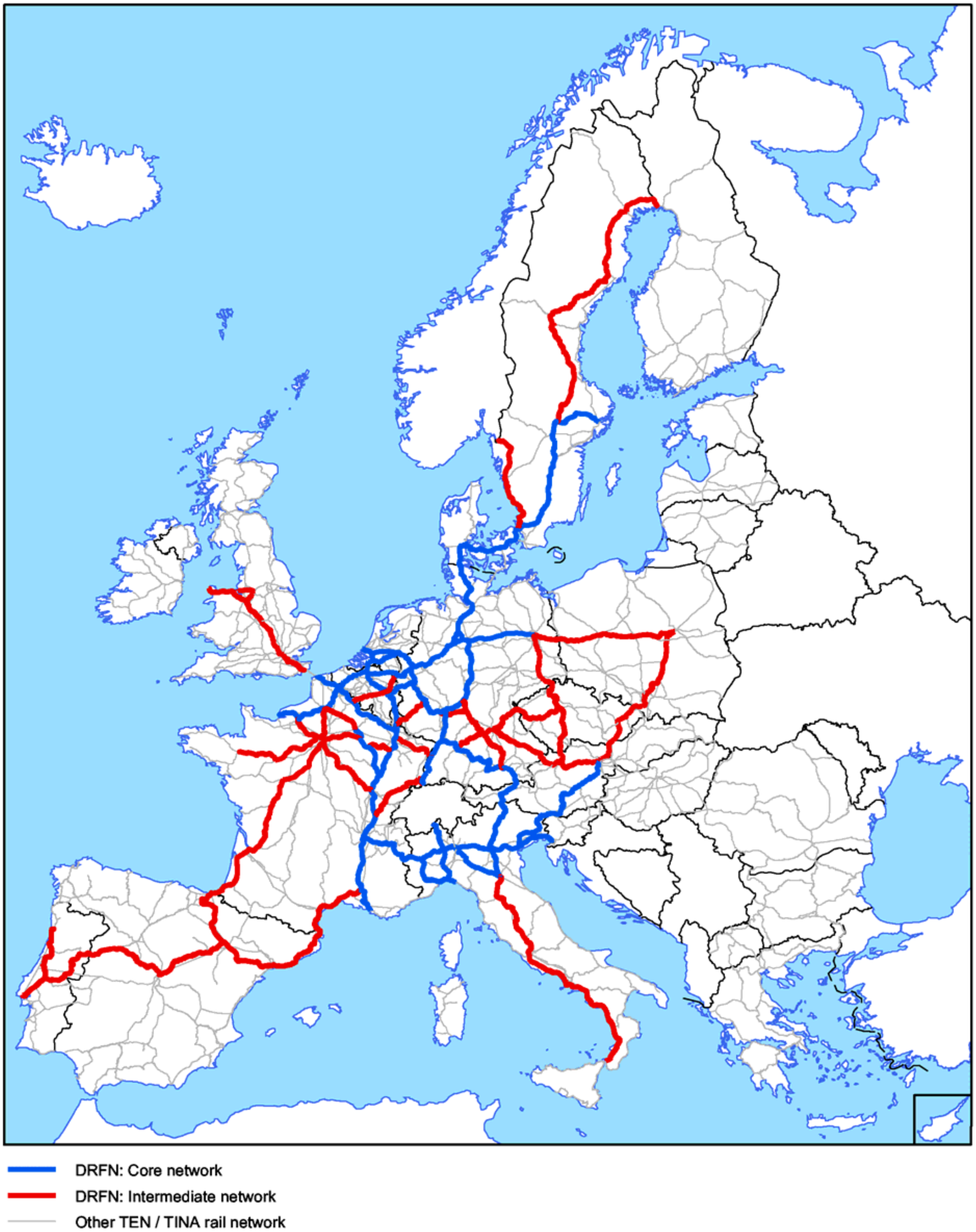

FIGURE 58: THE DEDICATED RAIL FREIGHT NETWORK