



**Transport
Research
Knowledge
Centre**

**ECONOMIC ASPECTS
OF SUSTAINABLE
MOBILITY
THEMATIC
RESEARCH SUMMARY**

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for Mobility
and Transport



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Thematic Research
Summary:

Economic Aspects of Sustainable Mobility

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Foreword

This report has been produced as a part of the activities of the TRKC (Transport Research Knowledge Centre) project of the Sixth Framework Programme.

The role of TRKC, as its predecessor project EXTR@Web, is to collect, structure, analyse and disseminate transport research results. It covers EU-supported research, as well as research financed nationally in the European Research Area (ERA) and selected global research programmes. The main dissemination tool used by TRKC is the public web portal at www.transport-research.info.

The approach to dissemination of results of the research projects, adopted by the TRKC team, includes the following three levels of analysis:

- Project Analysis, which provides, project by project, information on research background, objectives, results, technical and policy implications;
- **Thematic Analysis**, which pools findings of research projects according to a classification scheme based on thirty themes, fixed for the life time of the TRKC project; the product of this analysis activity is the set of **Thematic Research Summaries** (TRS); the present document belongs to this set;
- Policy Analysis, which pools findings of research projects according to combinations of themes based on ad-hoc policy priorities, which are agreed with DGMOVE of the European Commission, formerly DGTREN, and the representative group of research users.

The present Thematic Research Summary deals with the theme of economic aspects of sustainable mobility. The aim is to provide the reader with a structured guide to the results of research projects carried out mainly in the European Research Area (ERA). The report is intended for policy makers at the European, national and local levels, as well as interested readers from other stakeholders and from the academic and research communities.

Disclaimer

The analysis in this report is under responsibility of the TRKC project team; it does not represent the official viewpoint of the European Commission; it has not been approved by the coordinators of the research projects reviewed.

Executive summary

This report has been produced as part of the activities of the TRKC (Transport Research Knowledge Centre) project of the EU's Sixth Framework Programme for Research and Development. The role of TRKC, as its predecessor project EXTR@Web, is to collect, structure, analyse and disseminate transport research results. TRKC provides comprehensive coverage of transport research in EU programmes as well as key research activities at national level within the European Research Area and selected global programmes.

The report is one of the thematic research summaries (TRS). The TRSs aim at providing a synthesis of research results and policy implications from completed projects. Each TRS deals with one or more themes according to the classification adopted by the TRKC project. The theme of this TRS is Economic aspects of sustainable mobility.

The first part of the report includes a brief analysis of the scope of the theme, and a policy review where the main policy developments at EU level are summarised.

The theme "economic aspects of sustainable mobility" deals with the investigation of the ways in which economic efficiency and beneficial development impacts can be pursued as well as of the ways in which they are measured and assessed.

Policy developments at EU level have traditionally been related to the opening of the markets to competition, the competitiveness of the EU industry and the securing of funds to develop the Trans-European network infrastructure. More recently, much of the transport policy debate has centred around the use of pricing as a tool to correct market distortions and combat congestion and pollution. The principle has been accepted that the undesired impacts of transport activities should be disconnected from economic growth.

The second part includes a synthesis of the main findings and policy implications from research projects and is concluded with an overview of the implications for further research. The research projects synthesised are EU-funded projects, from the Fifth and the Sixth Framework Programmes, that have results publicly available. Projects that had been reviewed in the related report produced within the predecessor project EXTR@Web are briefly summarised.

Five sub-themes are considered in the synthesis. The following are the main achievements.

In the sub-theme concerning the drivers of demand for passenger and freight transport and the factors that affect it:

- a segmentation of demand for both passenger and freight transport has been provided to fulfil policy makers' and modellers' needs; the segmentation helps at the same time identifying the drivers behind demand trends;
- expected trends in demand have been analysed using the impact pathway approach which identifies a series of cause-effect mechanisms affecting travel behaviour;
- the impacts of the e-economy on freight transport activities have been analysed with a view to discriminating between e-economy developments bringing about increase in travel and those bringing about decrease.

In the sub-theme concerning costs in relation to pricing policies:

- open methodological issues regarding the valuation of the different marginal cost categories for the different modes of transport have been highlighted; new methodologies for the valuation of marginal costs in inland waterway have been developed;
- improvements from a methodological viewpoint in the development of transport accounts at state level have been identified and recommendations for the development of transport accounts at local level provided.

In the sub-theme concerning the effects on welfare and on the economy at large of transport investment and other policies:

- various modelling tools have been used to provide an appraisal of the impacts on economy of different policy scenarios, in particular marginal social cost pricing (MSCP) and trans-European transport networks (TEN-T).
- the impacts assessed include welfare and indicators typical of macroeconomic analysis such as GDP and employment; some tools have provided evidence of how the impacts might be distributed spatially across EU regions;
- policy questions that have been addressed in the analyses relate particularly to the way pricing policies should be implemented in terms of level and differentiation of charges and to how revenues from pricing should be spent.

In the sub-theme concerning the different approaches to funding of trans-European infrastructure projects:

- a review of theoretical principles and of international practice extending beyond the EU in funding transport infrastructure has provided recommendations for new schemes for funding TEN-T projects, in particular for the scheme based on an infrastructure fund at EU level.

In the sub-theme concerning the methodologies used in cost-benefit analysis (CBA):

- a review of current European practice of CBA for transport projects has served as the basis for the provision of a set of guidelines for the use of CBA in European transnational projects where the harmonisation problem is relevant;
- the methodological aspects which are still open in CBA and the solutions available from recent scientific literature have been reviewed.

Finally, research has also identified a number of issues or topics for further investigation:

- better understanding of how decisions related to the location of firms and distribution centres as well as to logistic and transport operation are made;
- better understanding of the link between ICT (Information and Communication Technologies) adoption, at household and firm level, and land use patterns;
- better understanding of the transport impacts of e-commerce in urban regions;
- reasons for differences in cost estimations produced by different studies;
- comprehension of the relative magnitude of different marginal cost categories;
- transferability and generalisation of local estimates of externalities;
- variation of elasticities of wear and tear costs with traffic volume and infrastructure quality;
- risk elasticities and their implications for the marginal external costs of accidents;
- practical ways of determining congestion and scarcity costs for rail, water and air transport;
- monitoring of availability of data relevant to transport accounts and development of methodological improvements for production of new accounts;
- the multiplicity and variety of models and tools available for the assessment of socio-economic impacts of investment and other transport policies requires a comparative analysis of all these modelling approaches and tools ;
- need for advancements in the state of the art of the methodologies used for providing basic inputs to CBA.



Abbreviations and acronyms used

3PLP	Third Party Logistic Service Provider
BAU	Business As Usual
BCR	Benefit Cost Ratio
CBA	Cost-Benefit Analysis
CEC	Commission of the European Communities
ERA	European Research Area
ETS	Emissions Trading System
EU	European Union
DGMOVE	Directorate-General for Mobility and Transport (new EC Directorate-General from 2010)
DGTREN	Directorate-General for Energy and Transport (former EC Directorate-General up to end of 2009)
FHTF	Federal Highway Trust Fund
FP5	Fifth Framework Programme
FP6	Sixth Framework Programme
GDP	Gross Domestic Product
HGV	Heavy Goods Vehicles
ICT	Information and Communication Technologies
ITS	Intelligent Transport Systems
KA	Key Action
MSCP	Marginal Social Cost Pricing
NPV	Net Present Value
PTA	Priority Thematic Area
RNPSS	Ratio of NPV and Public Sector Support
RTD	Research and Technological Development
SCGE	Spatial Computable General Equilibrium
TEN-T	Trans-European Networks - Transport

TRKC Transport Research Knowledge Centre
TRS Thematic Research Summary

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1. Introduction

This report provides a structured review of the research relating to economic aspects of sustainable mobility, carried out in EU-funded research projects. “Economic aspects of sustainable mobility” is one of the thirty themes in the classification scheme adopted by the TRKC project, shown in the table below.

Table 1. The classification scheme adopted in TRKC

<i>Sectors</i>
<ul style="list-style-type: none"> • passenger transport • freight transport
<i>Geographic</i>
<ul style="list-style-type: none"> • urban transport • rural transport • regional transport • long-distance transport • EU accession issues
<i>Modes</i>
<ul style="list-style-type: none"> • air transport • rail transport • road transport including walking and cycling • waterborne transport • innovative modes • intermodal freight transport
<i>Sustainability policy objectives</i>
<ul style="list-style-type: none"> • economic aspects • efficiency • equity and accessibility • environmental aspects • user aspects • safety and security
<i>Tools</i>
<ul style="list-style-type: none"> • decision support tools • financing tools • information and awareness • infrastructure provision including TEN-T • integration and policy development • Intelligent Transport Systems ITS • regulation/deregulation • land-use planning • transport management • pricing and taxation • vehicle technology

This scheme was adopted to enable search facilities in the TRKC portal, and to ensure comprehensive coverage of research results and appropriate policy analysis in the Thematic Research Summaries (TRS). Definitions for each theme are found on the TRKC portal www.transport-research.info.

In the predecessor project EXTR@Web, TRSs have been produced for 28 out of the 30 themes (the reduced number of TRSs resulting from merging of some themes into a single TRS). The TRKC project has planned to produce final versions of the TRSs for all themes by June 2010. This is the final version of the TRS on Economic aspects of sustainable mobility and substitutes the first version issued in October 2008.

The TRS “Economic aspects of sustainable mobility” produced in the predecessor project EXTR@Web (EXTR@Web, 2006a) reviewed research from European projects belonging to the Fifth Framework Programme (FP5) and selected national projects. The report here adds new projects to the analysis reported on in that report. The new projects are mainly European projects from FP5 and FP6.

The research reviewed in this report does not represent the entire range of research dealing with economic aspects carried out in Europe. The report focuses on research from those projects which have made documentation on results available to the TRKC team after the issue of the EXTR@Web report in 2006. A summary of the research reported on in the previous EXTR@Web report is also included to make the reader aware of the less and more recent research which has dealt with the theme. For completeness, projects from FP6 which are on-going or which, although completed, have not yet made results publicly available, are also listed.

The report is organised as follows. Sections 2 and 3 set the scene. Section 2 includes a brief analysis of the scope of the theme. Section 3 provides an overview of the policy priorities at EU level which underpin the research objectives. The sources for this section are principally European Commission documents which have set the policy agenda such as white papers, green papers and communications. EU legislation – directives, regulations, rulings of the Court of Justice – is mentioned where relevant.

Section 4 reports on the results from research projects. The section is structured according to sub-themes to make the broad area of research which has dealt with economic aspects more manageable. For each sub-theme research objectives are presented, then research findings are synthesised. The policy implications of research results are given a special focus and are linked to the EU policy priorities of Section 3. Section 4 is concluded with an overview of topics for future research which were identified by the projects synthesised. Sources for Section 4 are documents available from the projects and reporting on their achievements, essentially the project final reports and selected deliverables.

The sub-themes covered in Section 4 are:

- sub-theme 1: drivers of demand for passenger and freight transport;
- sub-theme 2: costs in relation to pricing;
- sub-theme 3: socio-economic impacts of transport investment and policies;
- sub-theme 4: funding of infrastructure;
- sub-theme 5: cost-benefit analysis methodology.

The **Annex 1** includes the list of the research projects that have been reviewed in the report. Links to the projects' websites are included. In several cases these websites make the project documentation available to the public. This may include final reports and project deliverables.

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Topics which have also been subject of research are:

- pricing of transport infrastructures and services so that users pay the full costs and adapt their choices accordingly;
- links between transport and issues of location, urban and regional development, and economic growth;
- participation of the private sector in the financing and management of public infrastructures.

Also, economic aspects are dealt with in two strongly related areas of research:

- development of scenarios, which identify the social, economic, political, and technological factors likely to shape mobility and the transport business in the future;
- assessment of policies for sustainable mobility, which extends the assessment of the impacts and of the implementation aspects to regulatory and economic policies in addition to infrastructure provision.

The above summary of topics describes the principal breakdown of aspects which are relevant to the theme, whereas the organisation according to sub-themes adopted in Section 4 of this report reflects the priorities of the research projects synthesised there.

3. Policy context

The priorities of the EU policy relevant to the theme have been focused on the:

- opening up to competition of the markets of the different modes;
- support for the competitiveness of the European transport industry;
- financing of the infrastructures;
- elimination of the distortions in competition with the encouragement of the diversion of road traffic to more sustainable modes by infrastructure charging and taxation;
- disconnecting economic and transport growth.

3.1 Market opening

In the road sector, the 2001 White Paper “European Transport Policy for 2010: Time to Decide” (CEC, 2001a) had remarked that price competition is fierce for haulage companies and enlargement is expected to exacerbate this. Maintaining profitability is difficult under the pressure exerted on prices by consignors and industry especially in periods of diesel price increases. Support was therefore advocated to encourage owner-operators to group together to provide logistics-related activities and advanced information and management systems.

In the rail sector, the three directives of the 2001 (Directive 2001/12/EC, 2001/13/EC, 2001/14/EC), referred to as “first railway package”, have opened the main rail axes to European rail companies for freight international traffic and have defined the organisation of the railway sector with particular regard to the role of the infrastructure manager who has to open the access to the network for a multiplicity of operators in a non-discriminatory way. The package follows the 1991 Directive on the separation of accounts between infrastructure management and transport service provision.

A 2004 directive within the second railway package (Directive 2004/51) opened to competition the international and national rail freight market. A 2007 directive within the third railway package (Directive 2007/58) opened to competition the market of international passenger services.

The 2001 White Paper had stressed the need for combating in particular the decline of rail in new Member States, where it retains a higher share of the freight market compared to the EU15, by reforming the rail sector before road transport completely gains the upper hand.

The definitive transition of the air sector to an open and competitive market had been set with the three Regulations 2407, 2408, and 2409 of 1992. The 2001 White Paper had stressed the need for a more efficient use of airport capacity to cope with the traffic growth, also due to the enlargement. In this context the definition of a new regulatory framework on slot allocation at airports was proposed to allow also greater access to the market using market mechanisms. Also, the White Paper had suggested keeping the privatisation of airports under control with specific reference to the implications on transport capacity.

In the waterborne sector, the Commission has recently taken initiatives in favour of a more pronounced opening up of the market of the port services (CEC, 2002a), as well as of the reform of the Regulation 4056 of 1986 which grants liner conferences an antitrust exemption (CEC, 2003a).

In the sector of public transport services the 2001 White Paper had suggested that transport services of general economic interest should be governed by a series of general principles, notably: (i) use of the tendering procedure within a clear legal framework defined at Community level, (ii) granting of exceptions or exclusive rights where necessary, (iii) awarding financial compensation to operators responsible for performing public service tasks.

The orientation stated in the White Paper has been followed up by an amendment to the proposal for a new Regulation (to replace 1191/69 which does not say how the contracts should be awarded) concerning public service requirements and the award of public service contracts (CEC, 2002b). The proposal would require the majority of urban public transport services to be opened to competition with some exemptions including contracts for low-value routes or networks. A ruling of the European Court of Justice of July 2003 on subsidies for public transport services (the Altmark case) could speed up the Commission's proposal to come into force. The Court ruled that subsidies can be paid without breaking competition rules but only if they support clearly-defined public service obligations.

These developments have been followed by the Regulation 1370/2007 which has a twofold aim:

- to determine how competent authorities may act in the field of public transport to
- guarantee the provision of services of general interest;
- to lay down the conditions under which competent authorities, when contracting for
- public service obligations, compensate operators for the costs incurred or grant
- exclusive rights.

The most adequate tools to support the investments in transport infrastructure projects were analysed in a Communication in 2003 (CEC, 2003c). In particular, the Communication addressed the Community financing sources, the pros and cons of private-public partnerships, and the conditions and solutions needed to attract private capitals.

The Directive 1999/62 on the charging of heavy goods vehicles for the use of certain infrastructures (the Eurovignette Directive) recognised the “user pays” principle by allowing Member States to levy distance-based charges (tolls) to recover the cost of construction, maintenance and operation of infrastructure. The reform of the Eurovignette Directive had been proposed in the 2001 White Paper. The subsequent proposal of the Commission for a new Directive amending the Eurovignette Directive (CEC, 2003d) allowed the Member States to apply mark-ups to tolls in particularly sensitive areas to cross-finance the investment costs of other transport infrastructures – railways – of a high European interest in the same corridor or area. Following this, the EU has finalised the approval of a new directive in 2006 on freight vehicles (Directive 2006/38). The Directive makes provision for Member States to be able to increase tolls with a “mark-up” on roads in particularly sensitive mountainous regions. The income from these mark-ups must be used to fund alternative transport infrastructure in that corridor or zone.

In July 2008 the European Commission has issued a proposal for amending the Eurovignette Directives (CEC, 2008a). This proposal is a key part of the strategy on the internalisation of external costs which is jointly proposed (CEC, 2008b). The proposed revision (CEC, 2008a) earmarks the part of the tolls based on external costs to various measures contributing to sustainable transport and to the development of alternative infrastructure.

In the rail sector the directive 2001/14/EC on infrastructure charging states that the charge for infrastructure use shall be set at the cost that is directly incurred as a result of operating the train service, but also it can include congestion, environmental and maintenance components. A mark-up to ensure full cost recovery can be included if the market can bear it.

3.4 Market distortions

In the 2001 White Paper, charging for infrastructure is recognised as one instrument, together with fuel tax, for integrating infrastructure costs and external costs, and thus replacing existing transport system taxes. The White Paper stressed that while transport may be too heavily taxed it is above all badly and unequally taxed as users are all treated alike, irrespective of the infrastructure damage, bottlenecks and pollution they cause. The consequence is a considerable distortion of competition both between transport operators

and between modes of transport. Infrastructure charging, based on the “user pays” and “polluter pays” principles, is advocated as a particularly effective means of managing congestion and reducing other environmental impacts, and fuel tax as a means of controlling carbon dioxide emissions.

The principles of infrastructure charging had been discussed in the Green Paper “Towards Fair and Efficient Pricing in Transport” (CEC, 1995), in the White Paper “Fair Payment for Infrastructure Use: a Phased Approach to a Common Transport Infrastructure Charging Framework in the EU” (CEC, 1998), and in the series of reports of the High Level Group produced in 1998 and 1999.

As a follow up of the infrastructure charging debate, the Directive 2001/14 on rail infrastructure charging has required marginal social costs to be used as the basis of charging, whilst permitting supplementary charges where necessary for cost-recovery purposes.

In the road sector, the proposal of the Commission (CEC, 2003d) for a new Directive amending the Eurovignette Directive 1999/62 aimed to change the framework for tolls and vignettes for goods vehicles over 3.5 tonnes, with the introduction of a higher differentiation including: distance travelled, accident and environmental costs, congestion levels by time period, local population density, vehicle emission classes. In addition, the proposal provided the methodologies for the calculation of the different toll components.

The road charging Directive finally approved in 2006 (Directive 2006/38) represents the first step towards taking account of external costs: it will allow a greater variation in tolls to reflect congestion, and toll variations to reflect the pollution caused by vehicles. The new Directive also establishes the principles for calculating tolls and limits frequent user discounts, to ensure that they are fair, proportionate, transparent and non-discriminatory. These improvements will reduce obstacles to the free movement of goods and guarantee fair competition between road haulage operators.

As a follow up of the White Paper proposal of a harmonised taxation of fuel used for commercial purposes, the Commission has proposed (CEC, 2002c) to amend Directives 92/81 and 92/82 which had imposed less taxation on diesel for reasons of economic needs of road hauliers. Further to the White Paper support for the use of alternative fuels, fiscal promotion of bio-fuels has been included in a proposed Directive (CEC, 2001b). The proposal then has been incorporated in the Directive 2003/96 on taxation of energy sources providing Member States with the option of applying a reduced rate of excise duty to pure or blended bio-fuels, when used as motor fuels.

In the air sector, the 2001 White Paper had proposed to re-consider the tax exemption for kerosene on intra-Community flights as this exemption provides no incentive for airlines to

use the most efficient aircraft and also creates situations where the competition between air transport and other modes is unfair. However, this proposal up to now has met opposition by the operators within the sector.

In 2006 the Commission was asked by the Parliament to prepare a communication which will provide a general framework for the internalisation of external costs. The preparatory work has led to the issue of a handbook on the estimation of external costs in the transport sector based on a review of best practice (INFRAS et al. 2007). This handbook is intended to serve as the basis for future calculations of infrastructure charges. The communication on the strategy for internalisation of external costs has been issued in July 2008 (CEC, 2008b). The strategy sets out how external costs can be internalised in all modes of transport. Social marginal cost charging is set as principle for internalisation as this will provide the users with the right signals. It is recognised that the EU has already started to internalise external costs. This is accomplished by existing rules on minimum tax levels for motor fuel, although most maritime and aviation uses are exempt. In addition, the Commission has proposed to include aviation in the EU Emissions Trading System (ETS) and to incorporate a CO₂ component in registration and annual circulation taxes for cars.

In the road sector the strategy proposes an amendment to the directives on infrastructure charging for heavy goods vehicles (Directives 1999/62 and 2006/38). This proposal is outlined in a separate document (CEC, 2008a). According to the existing directives toll rates may be varied according to vehicle emission standards or congestion levels but under a constraint of revenue neutrality. Except for Germany and Czech Republic this option has not been exerted because of the complexity for infrastructure operators to adjust their charging structure to the demand response in a way that keeps revenues constant. Thus the existing directives do not enable Member States to apply optimal pricing. This means that sufficient incentives cannot be put in place for operators to modernise their fleet with cleaner vehicles and to adapt their route planning and logistics towards more sustainable practices.

The proposal for amending the existing directives (CEC, 2008a) enables Member States to integrate in tolls an amount which reflects the cost of air pollution and noise pollution caused by traffic. During peak periods it also allows tolls to be calculated on the basis of the cost of congestion imposed upon other vehicles. The current scope of the existing directives is extended beyond the TEN-T to avoid inconsistent pricing schemes between major corridors and other inter-urban roads.

The strategy for internalisation addresses other modes too (CEC, 2008b). The directive 2001/14 allows internalisation of external costs in the rail sector. In the case where this would lead to an increase in revenues for the infrastructure manager internalisation is allowed only if there is an equivalent increase for competing modes. The proposed revision of the directives 1999/62 and 2006/38 on heavy goods vehicles will make it possible to internalise costs in road transport and therefore in rail transport.

For inland waterways the strategy announces the internalisation of all external costs in the sector following the NAIADES Communication, and, for maritime, where internalisation has yet to begin, it commits the Commission to acting in 2009 if the International Maritime Organisation (IMO) has not agreed concrete measures to reduce greenhouse gas emissions by then. Commission action may include integrating the maritime sector into the EU's ETS. The strategy will be developed in line with the new European Integrated Maritime Policy. At the same time the strategy announces a cross-cutting internalisation measure for later in 2008: the revision of the Energy Taxation Directive. This will ensure that energy taxation better complements the EU ETS and better reflects the EU's climate change, energy and air quality goals.

3.5 Disconnecting economic and transport growth

The economic importance of the transport sector stems from the benefits and costs that it produces. Transport is a contributor to the creation of GDP and employs a significant number of persons: in the transport services sector the value created is 7% of the EU GDP and the number of persons employed is 5% of all persons employed in the EU (CEC, 2006). However, transport at the same time produces disadvantages in terms of external costs (congestion, environmental impacts, accidents). The external costs of road traffic congestion alone amount to 1% of Community GDP, environmental costs of all transport to 1,1% of GDP (CEC, 2006).

Economic growth is strongly correlated with the development of the transport sector. Data at EU level show that GDP growth and growth in transport demand have always developed in parallel although with slightly different rates. This is not surprising: on the one hand, transport demand is a derived demand because it is linked to production and consumption activities, on the other hand, transport demand needs to be met in order to prevent that an insufficient provision of infrastructures and transport services acts as a constraint to economic growth.

For these reasons the EU transport policy has recognised efficient transport systems as an essential element to the competitiveness of the European business, economic growth, and employment. At the same time, the concerns about the expected increase in transport demand and the attendant consequences on congestion and environment have led to the principle, stated in the 2001 White Paper, that economic growth needs to be disconnected ("decoupled") from transport growth. The White Paper endorses an interpretation of the principle in terms of need for limiting the growth of transport demand.

The mid term review of the White Paper (CEC, 2006) has recognised that economic growth has been less than expected. On this basis the interpretation of the 2001 White

Paper of the principle of disconnecting transport from economic growth is no longer valid. Mobility is essential to competitiveness of European economy. The principle has therefore been reformulated in the following terms: economic growth needs to be disconnected from the negative side effects of mobility.

The future transport policy will need to optimise each transport mode's own potential to meet the objectives of clean and efficient transport systems. Shifts to more environmentally friendly modes must be achieved where appropriate, in particular on long-distance, in urban areas and on congested corridors. Co-modality, i.e. the efficient use of different modes on their own and in combination will result in an optimal and sustainable utilisation of resources.

4. Research findings

4.1 Introduction

The research which is synthesised in this report deals with five sub-themes.

The first sub-theme relates to transport demand and the factors which affect it. The analysis of the demand for transport services is the key to the assessment of the transport intensity of the economy and of the costs which are paid by society due to transport activities. On the other hand demand is also linked with the economy because production and consumption activities are main determinants of demand itself.

The second sub-theme is concerned with the estimation of costs in relation to pricing. Pricing is expected to have an increasing role in the transport policy agenda. Estimation of costs is the key to charge setting according to the principle advocated by economic theory that users should pay the full costs of their travel activities. A related topic is the development of an accounting system for the transport sector. This is important for monitoring policy impacts.

The third sub-theme deals with the socio-economic impacts of transport policies. Research has been developing modelling tools which provide policy makers with the appraisal of the impacts of policies. Research has been investigating ways to estimate the effects on welfare as well as on economy at large considering at the same time the impacts within the transport markets and in other markets. Implications for reforming current pricing and taxation policies are derived from research in this sub-theme. Indications for earmarking revenues from infrastructure charging are another policy-relevant product.

The fourth sub-theme is concerned with the funding of transport infrastructure projects with particular regard to large European infrastructure projects like TEN-T and to fund raising approaches based on levies on the transport sector. The sub-theme links two areas which rank high in the today and future transport policy agenda: pricing policies and infrastructure financing.

The fifth sub-theme deals with the methodological aspects of cost-benefit analysis which is to date the dominant approach for appraising transport infrastructure and policies from an economic viewpoint.

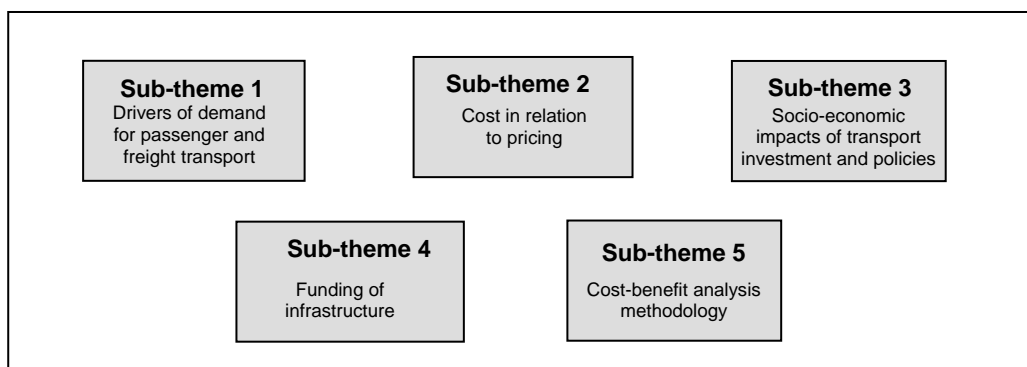


Table 2 shows the EU-funded projects which have dealt with each sub-theme. The Table includes:

- completed projects which are synthesised in this TRS and for which the following sub-sections report on research objectives, research results, policy implications and implications for further research;
- projects which had been synthesised in the EXTR@web TRS and which are briefly summarised in the background of the following sub-sections.

Table 2. EU-funded projects relevant to the theme

Sub-theme	Contributing projects
Drivers of demand for passenger and freight transport	<u>Projects covered in this report:</u> THINK UP; FORESIGHT FOR TRANSPORT; POET. <u>Projects covered in EXTR@Web report:</u> PRO-TRANS; SULOGRTRA.
Costs in relation to pricing	<u>Projects covered in this report:</u> CATRIN; IMPRINT-NET; GRACE. <u>Projects covered in EXTR@Web report:</u> DESIRE ; IMPRINT-EUROPE ; MC-ICAM ; RECORDIT ; UNITE.
Socio-economic impacts of transport investment and policies	<u>Projects covered in this report:</u> DIFFERENT; GRACE, REVENUE; SPECTRUM; TIPMAC. <u>Projects covered in EXTR@Web report:</u> IASON; TRANSECON.
Funding of infrastructure	<u>Projects covered in this report:</u> FUNDING.
Cost-benefit analysis methodology	<u>Projects covered in this report:</u> HEATCO; EVA-TREN; ROSEBUD.

4.2 Sub-theme 1: drivers of demand for freight and passenger transport

4.2.1 Background

The sub-theme deals with the analysis of the factors which affect demand for transport. Analysis of the attendant trends is part of the sub-theme. Both demand for freight and passenger transport is considered.

The review on the subject found in the report written within the predecessor project EXTR@Web (EXTR@Web, 2006a) looks into projects which have dealt with freight transport only. Research reviewed in that report has provided insights on:

- worldwide trends in the management of the supply chain and logistics and consequences on transport activities,
- current status in the sector of third party logistic service providers (3PLP) in Europe,
- link between transport activity and GDP in different industry sectors in Finland.

4.2.2 Research objectives

A first strand of research relates to the understanding of the drivers and factors which shape demand for transport. Two approaches have been followed.

One approach identifies different segments of demand, each one characterised by its trends. A proper choice of segments allows making explicit and taking into account drivers and factors subject to major changes. Research has provided insight on how this segmentation should be organised fulfilling at the same time policy makers' and modellers' needs (THINK UP, 2003). Another approach examines demand by investigating impact pathways. The impact pathway can be described as a succession of interrelated variables ending with impact indicators which include among the others transport demand. The examination of impact pathways has provided insight on the drivers of both freight and passenger demand (FORESIGHT FOR TRANSPORT, 2004). Each impact pathway has been elaborated with an expert consultation exercise. Particular attention has been given to the initial or generating factors of the impact pathway: these factors describe developments in the external non-transport environment, such as economy, demography, attitudes, or developments at the level of transport policy.

A second strand of research has been aimed at investigating the consequences on transport demand of the transformations which society and economy are currently undergoing due to the introduction of ICT (Information and communication technologies). Telecommunication technologies and its applications such as teleworking and e-commerce have potential impacts on demand for physical transport in both passenger and

freight sectors. Also, telecommunication technologies and its applications such as tracking and tracing offer improvements in the efficiency of transport systems. Research has investigated (POET, 2005) the interaction between e-economy developments, choices made by individuals and firms, and the functioning of the transport system. The expected impacts on passenger and freight transport activities have been estimated using a combination of survey and modelling tools.

4.2.3 Research results

4.2.3.1 Freight

Research on market segmentation (THINK UP, 2003) has provided a proposal for the segmentation process and identified key variables for this. The first is the product type: bulk flows and general cargo. The second is, in the general cargo, the logistic/transport organisation, for which lead time and shipment size can be used as proxy variables. The third is the shipper profile distinguishing between the two categories of producer and distributor which in turn allows for distinction between interplant and distribution transport. Fourth, spatial differentiation: international, national and regional which is the key to attribution of policy makers' competence. The combination of shipment size and spatial differentiation makes it possible to bring consolidation/deconsolidation of flows into the analysis. Fifth, load unit transport which is considered as a separate segment.

Research on impact pathways (FORESIGHT FOR TRANSPORT, 2004) has highlighted a few mechanisms which determine growth for overall demand for transport in the freight sector. One pathway is that between economic growth and freight transport demand which has trade as key intermediate variable. Obviously the link is far more complex as economic growth impacts on trade through the economic structure, in turn trade impacts on transport demand through logistic organisation. Another pathway relates to the effects of EU enlargement in terms of increased trade and attendant traffic flows between West and East.

Other impact pathways give explanations for future transport demand in certain modes. It is noted that the European transport policy priorities are likely to be re-oriented from internal market regulation to correction of distortions in market competition. If pricing measures targeting road will be implemented a shift of demand from road to rail will take place. On the other hand, European West-East trade flows will be dominated by the road mode if current prioritisation of new Member States of road transport is maintained.

The research strand on the e-economy (POET, 2005) has found that ongoing developments work in opposite directions. Developments increasing the efficiency of transport include optimal planning of delivery tours and e-markets for return loads: these

enable increased reliability of shipment timing and better vehicle utilisation. Developments decreasing the efficiency of transport include just-in-time management and fast consumer response systems: these bring about more trips the number of tonnes being unchanged. The analysis based on surveys and models suggests that the latter effect will be stronger than the former: as a result it is foreseen that the number of road vehicle-kilometres will increase because of the e-economy developments.

4.2.3.2 Passenger

Research on market segmentation has provided a proposal for segmentation of demand for passenger transport (THINK UP, 2003). At the first level there are the functional trip segments which derive from a combination of distance and spatial character of the trip. At lower levels, in descending order, mode of transport, trip purpose, age group, socio-demographic and socio-economic variables. The latter two include household size, car ownership, occupation. Other variables can be combined with the ones above: trip regularity, time of the trip, and subjective factors such as the travellers' level of information.

It has been noted that passenger demand has become increasingly volatile especially in the tourism segment. This is proved by the increasing number and shorter duration of leisure trips by households. Factors for growing volatility include increased income, more flexible working time and increasing number of well-off and mobile elderly people. This trend has been reinforced on the supply side by last-minute offers and internet reservation capability. Another observed phenomenon is the generation of more complex trip chains with in particular the combination of business and leisure trips.

Research on impact pathways has identified a series of cause-effect mechanisms which impact on demand for passenger transport (FORESIGHT for TRANSPORT, 2004); these include:

- ageing and the labour market: as we can expect a higher rate of persons aged more than sixty to remain active in labour market we can expect ageing to generate higher transport demand for daily mobility as far as labour supply growth is not fully absorbed by teleworking;
- ageing and leisure patterns: contemporary older cohorts are more interested in travelling in their leisure time, which will result in an increase of demand for collective forms of transport by road and rail;
- valorisation of time and speed and daily travel: in view of contemporary attitude towards time and speed we can expect transport users to prioritise high-speed modes of transport, which can contribute to a continuing increase of the motorisation rate.

Research on the transport consequences of e-economy developments (POET, 2005) shows that increasing uptake of telecommunication technologies by households is likely to contribute to a reduction in passenger-kilometres, due particularly to teleworking and e-

commerce, and, to a lesser extent, to e-learning and e-government. A substitution between passenger travel and freight travel can take place as a consequence of e-commerce (fewer shopping trips and more home delivery) but evidence on the net effect is not conclusive.

4.2.4 Policy implications

4.2.4.1 Freight

Research has highlighted a few trends which bring about increased distance travelled and more international transport flows (THINK UP, 2003). These include the move towards centralised distribution structures with pan-European warehouses being preferred to national warehouses, macro-policies and related policies at firm level such as European integration and internationally oriented procurement. Also a phenomenon of concentration and specialisation of production plants has been observed which has similar effects in terms of transport flows. The implication is that European policy should aim at creating the conditions needed for serving these transport flows by the maritime and rail modes in lieu of the road-only mode.

The effects of more vehicle-kilometre which should be brought about by the developments of the e-economy according to research in POET (2005) should be countered by transport and environmental policy measures, not by promoting a slower adoption of communication technologies by firms. The latter policy would harm the competitive position of European firms.

The implications are relevant to the EU policy priority related to the disconnection of transport and economic growth.

4.2.4.2 Passenger

Research has emphasised the role that subjective factors play in travel decisions (THINK UP, 2003). Travellers' perceptions and images of modes are predominantly disadvantageous towards rail and at urban level public transport modes in general. Often travellers' level of information on public transport services is remarkably low. Complex fare systems have deterrent effects on the usage of public services. The implication is that it is important to combine classic transport policy measures with soft measures. Especially the marketing and public relations departments of transport service providers have an important role in contributing to change perceptions and images of modes and in providing sufficient and reliable information on both services and fares.

The reduction in passenger-kilometres which is expected from the uptake of ICT applications by households according to research in POET (2005) suggests the adoption of policies to encourage such uptake. As e-commerce is one of the main drivers, one policy approach is to improve the security of on-line transactions. More generally, to realise the full potential of travel reduction of ICT applications it is important that new technologies are accepted and used by society. The e-Europe action plan should not focus just on the capability-price combination of ICT applications, and include consideration of institutional and behavioural factors that play a role in their acceptance.

The implications are relevant to the EU policy priority related to the disconnection of transport and economic growth.

4.3 Sub-theme 2: costs in relation to pricing

4.3.1 Background

In the EU consensus has been achieved on the need for adopting the principle and practice of cost-based charges. As a consequence research has been oriented towards the estimation of social external costs because these are a fundamental input to the price setting process. Extensive research has been carried out on this topic both at European and national level.

The research reviewed in the report on economic aspects produced within EXTR@Web (EXTR@Web, 2006a) has shown that disagreements and uncertainties still exist which prevent from having charges estimated in the various countries according to a common basis. Methodologies and tools are available to calculate external cost values with acceptable accuracy levels, although the maturity of the methodologies still varies between modes and cost categories.

Another area of research is the development of accounts for the transport sector. The EXTR@Web report (EXTR@Web, 2006a) reported on research carried out by the UNITE project of FP5 which developed transport accounts for all EU15 countries, plus Hungary and Switzerland. These accounts provide information about the total social costs (infrastructure costs, supplier operating costs, delay costs due to congestion, accident costs, environmental costs) and revenues of transport for road, rail, other public transport, air, inland waterway and maritime transport, disaggregated by network types, transport means and user groups. Since transport accounts show the total or average social costs rather than the marginal costs they should not be viewed as an instrument for determining

charge levels or charge structures. The major aim of transport accounts is to serve as a monitoring tool.

4.3.2 Research objectives

On the side of cost valuation research has dealt with marginal costs with the intention to provide inputs to charge setting. Research has been aimed at providing insights on the state of advancement in cost valuation (IMPRINT-NET, 2006a; CATRIN, 2009). A series of workshops has aimed at reaching consensus on the determination of marginal social costs in interurban road (IMPRINT-NET, 2006b), rail (IMPRINT-NET, 2006c), maritime transport (IMPRINT-NET, 2006d), and inland waterways (IMPRINT-NET, 2006e). A specific aim here has been to concentrate on most controversial issues. Other research has carried out case studies in order to address gaps in the level of knowledge of marginal social costs for road and rail (GRACE, 2006a), and for air and waterborne transport (GRACE 2006b).

On the side of transport accounts research was motivated by the recognition that both methodological and data improvements are needed in order to enable the use of transport accounts for monitoring pricing policies. This was in particular a result of the UNITE project. On this basis research has aimed at identifying methodological improvements of transport accounts to enable the intended use (GRACE, 2007). Within the same research strand, additional objectives have been to provide recommendations for implementation of transport accounts in new Member States, and to develop and test accounts at regional level.

4.3.3 Research results

4.3.3.1 Estimation of marginal costs

Research on the state of the art in cost valuation (IMPRINT-NET, 2006a) highlighted two under-researched cost categories where there are still open methodological questions: infrastructure costs, and scarcity costs in the rail and air sectors.

At the margin higher use of transport infrastructure results in increase in wear and tear damage which implies associated costs of extra-maintenance work and an anticipation of renewal activity. Studies exist on infrastructure costs for road and rail, while much less work has been done for air and waterborne transport. Informed judgements tends however to say that wear and tear costs for these modes are close to zero. For road and rail studies have provided conflicting evidence as to whether marginal wear and tear cost is increasing or decreasing with traffic (IMPRINT-NET, 2006a).

The analysis of case studies has shown that marginal costs for road and rail vary considerably between and within countries because of many factors such as infrastructure quality and traffic density. More specifically, average costs are very variable (due to differences in infrastructure quality and traffic density across countries), while the usage elasticities have been estimated to be much less variable (they differ by traffic density but in a much more predictable manner) both across and within case study countries (CATRIN, 2009).

In the rail sector scarcity costs are opportunity costs which arise where the presence of a train prevents another train from operating, or requires it to take an inferior path. These costs need to be kept distinct from congestion costs which only arise when a train actually operates. Different approaches have been proposed for measurement. Auctioning is deemed to have theoretical merits according to the working group in IMPRINT-NET but this approach faces difficulties on practical grounds (IMPRINT-NET, 2006 c). Furthermore, by estimating, through engineering tools, the damage levels on the infrastructure caused by different rail vehicles, it has been found that damages caused by different vehicles, and, consequently, costs would be better allocated by differentiating charges by vehicle type (CATRIN, 2009).

Problems of scarce capacity also arise for allocating slots at congested airports. A number of approaches that could be used to allocate slots at airports based on a reflection of their value as a scarce resource have been proposed. There is however the problem that these approaches are not used in practice (IMPRINT-NET, 2006a). Research has also shown that difficulties in practically disentangling scarcity and congestion lead to cope with delays without differentiating between these two different concepts. Consequently, congestion at airports is generally addressed by imposing peak and off-peak charges (generally only related to scarcity). Such practices also lead to ignore the evaluation of congestion in terms of opportunity costs (i.e. the value of time and resources lost due to delays). Furthermore, the analysis of case studies has shown that airport charges are always closer to the estimates of the long-run approach rather than to those of the short-run approach. This has been ascribed to the fact that, historically, the airports have proved to be financially robust firms (CATRIN, 2009).

Research has remarked that for marginal costs of congestion in road transport it is important to take account of the adjustment in the volume of traffic which will follow the introduction of pricing: this implies taking into account all the behavioural responses of the users, including time of day and car occupancy. For environmental costs it has been noted that an operational framework for monetary valuation of marginal costs is available. Relevant emissions to be considered are those from vehicle operation and fuel provision, the latter increasing in importance with decreasing emissions from vehicle use. Values of green-house gas emissions are often based on estimation of the costs needed to reach a socially accepted target. For this reason it is expected that global warming will become relatively more important if tougher targets than Kyoto are agreed (IMPRINT-NET, 2006b).

In the maritime sectors two issues have been highlighted, the difficulty of accounting for human life in addition to physical damage to goods and ships in accident costs, and whether the emissions of oil spill and sludge should be regarded as an externality (IMPRINT-NET, 2006d). The review of current knowledge on marginal costs of maritime infrastructure has also highlighted that the use of fairways¹ in general has a very low marginal cost even though in the literature there is almost no support to such a claim. The cost of pilotage is, to a large extent, independent of vessel type and size, as long as it does not require more than one pilot. The comparison between the expected marginal cost and the price structure has shown that the category of ships with lowest charges are approximately charged equal to marginal cost while the bigger ships pay a mark-up, basically to improve cost recovery (CATRIN, 2009).

Finally, research has pointed out that the ice-breaking service necessary for winter navigation is an often forgotten part of the maritime infrastructure. None of the EU Member States charges for icebreaking in open water, even though the analysis of case studies has shown that this operation is characterised by considerable marginal costs (in the Baltic these costs are estimated to be about € 30 million per year), and current charging regimes are theoretically non-optimal (CATRIN, 2009).

Congestion and scarcity costs of inland waterways have been found to be an area of gap in current research (IMPRINT-NET, 2006e). Congestion in inland waterways arises from bottlenecks. These include waiting at locks or at bridges that are not high enough for the stack of containers. Scarcity is linked with the drop in water level.

Research has also dealt with the risk for insufficient cost recovery if marginal cost pricing is used, focusing on the possibility of establishing clubs for organising infrastructure activities. The idea consists in whether infrastructure users should be asked to establish a club to decide on how much infrastructure to provide and how to charge for it in order to ensure an efficient provision and use of it. Cooperative game theory has been used to overcome some of the obstacles for club members to cooperate. However, the huge number of potential club members in the case of the road sector would prevent the practical implementation of the club concept, while it might be successfully used in the case of the provision of ports, airports and railways (CATRIN, 2009).

Research carried out within the case studies of the GRACE project provided a number of insights on cost valuation in different modes of transport.

Case studies have been conducted to identify reasons why road congestion costs show a remarkable variability. Reasons found include differences in: definition and measurement of optimal tolls; structural factors of the city such as degree of congestion, availability of

¹ Navigable paths of water in a channel, harbour or river.

alternative modes, unused road capacity; values of time and resources; models use to estimate system performance. Case studies carried out in urban areas concluded that wind speed and population density are the key factors for valuation of environmental costs. Comparisons between Alpine regions and flat regions have concluded that most externalities from road and rail transport are higher in Alpine regions by a factor between 1 and 5. These include local air pollution, noise costs, number of accidents, infrastructure maintenance costs (GRACE, 2005a).

A simulation tool has been developed (GRACE, 2005b) for the estimation of marginal costs in case of a vessel calling at and leaving a port. Marginal costs taken into account include: infrastructure costs as consequence of using locks; crew costs in the vessel; operating and maintenance costs of the vessel, tugboats and pilotage boats; accident costs for cargo and persons; noise costs and air pollution costs. It has been found that marginal costs per vessel call increase with vessel size. Marginal infrastructure costs are only a small fraction of total marginal costs and fully depend on lock use. The tool can deal with congestion and scarcity costs although in the case studies these cost items were not relevant due to port overcapacity.

A methodology has been developed to estimate congestion and scarcity costs on inland waterways. Three elements have been considered: congestion at locks, congestion at bridges and scarcity on waterways. Case studies at certain locks have shown that congestion costs are not negligible in inland waterways (GRACE, 2005b).

The case studies for ports and inland waterways of the GRACE project have served to test new methodologies for cost valuation. The numerical results should only be used in their own specific context. The problem of estimating environmental costs from oil spills for European maritime trajectories has also been tackled in the GRACE project (GRACE, 2005b).

4.3.3.2 Transport accounts

Research on improvements to the methodologies used for developing the transport accounts (GRACE, 2007):

- has provided quantitative ranges for estimates of variable infrastructure costs which can be used as proxy for marginal costs;
- has developed a method to split the accident cost into the internal component, i.e. already internalised in user's decisions, and the external component;
- has provided improved methods for estimating noise costs from air transport and air pollution costs for maritime shipping;
- has investigated categories of port services and charges paid within ports.

Within the same research strand barriers to implementation of transport accounts in new Member States have been investigated. The barriers found include lack of problem perception and fear for undesirable results. The problem of developing transport accounts at regional level rather than at national level has been addressed. A conceptual approach and a methodology for transport accounts at urban level have been provided. Feasibility tests in terms of data availability have been conducted for Rome and Amsterdam. Different types of accounts for the Alpine region in Switzerland have been developed each type depending on the perspective taken and the way trans-boundary effects are considered (GRACE, 2007).

4.3.4 Policy implications

4.3.4.1 Estimation of marginal costs

The use of appropriate methodologies for cost valuation makes it possible to charge according to the costs that are in actuality generated. In the rail sector research has suggested estimating wear and tear costs according to engineering models. These models consider how different types of rolling stock impact on different types and elements of the infrastructure. They are to be preferred to econometric models for charge setting because they enable a more accurate differentiation of charges by type of train (IMPRINT-NET, 2006c).

For environmental externalities the damage cost approach should rank higher than the avoidance cost approach. However, research in the air sector has found that current valuation practice at airports for noise and air pollution are often based on avoidance costs rather than on the damage approach leading to an inappropriate estimation of the social impact. The improvement of assessment methodologies has the potential to correct this (IMPRINT-NET, 2006f).

Research recommends estimating usage elasticities rather than specific marginal costs in the rail sector. The latter can be calculated by multiplying usage elasticities by country specific average cost estimates. In fact, even though some variations in usage elasticities within countries can be found, they follow a more systematic pattern which permits to make recommendations for usage elasticities based on traffic density of the network (CATRIN, 2009).

The methodology developed in the GRACE project (GRACE, 2005b) for cost valuation in inland navigation could be the basis of a unified European approach to congestion pricing for inland waterways.

These implications are relevant to the EU policy priority related to the correction of distortions in transport markets, in particular to infrastructure charging policies.

4.3.4.2 Transport accounts

Transport accounts, for which the GRACE project has developed methodological improvements (GRACE, 2007), are a tool meant to enable:

- strategic monitoring of trends in level and structure of costs and revenues, and progress in implementing policy measures;
- assessment of progress towards sustainable transport by provision of accident and environmental costs;
- implementation of pricing policy by use of variable costs as proxy for marginal costs and by avoidance of overcharging;
- assessment of financial viability for modes which are not self-financing, by information on deficit/surplus;
- assessment of equity between modes, vehicle classes, regions, and along cross-border corridors.

Based on the analysis by GRACE, strategies to foster the implementation of transport accounts in new Member States should include: dissemination targeted at policy makers, explanation of use and policy implications, appointing organisations responsible for developing the accounts, providing funds.

These implications are relevant to different EU policy priorities: the funding of infrastructure, the correction of distortions in the transport markets, and the disconnection of transport and economic growth.

4.4 Sub-theme 3: socio-economic impacts of transport investments and policies

4.4.1 Background

The sub-theme deals with the estimation of the impacts of transport investments and policies. The impacts of concern are not just the effects on the transport system but extend to those in the economic, the environmental and the social systems. The estimated indicators include changes in welfare, possibly incorporating externalities, as well as quantities typical of macroeconomic analysis such as GDP and employment. Distribution of impacts across regions and sectors are also of relevance.

Research reported on in the EXTR@Web report (EXTR@Web, 2006a) has focused on analysis of indirect, second-round, or induced benefits and costs that occur through feedback effects between the transport sector and other economic sectors. The spatial effects of transport policies have been investigated within the IASON project which has estimated the impacts on GDP of TEN-T scenarios and the distribution of these impacts across countries. It was found that economic development might be significant for peripheral regions of Europe.

4.4.2 Research objectives

One strand of research has aimed at combining transport modelling with macroeconomic modelling to study the indirect macroeconomic impacts of transport infrastructure investments and transport pricing policies in the EU (TIPMAC, 2003). This research was motivated by the need for demonstrating the feasibility and capabilities of advanced tools where models of the transport system providing detailed representation of transport networks are combined with state of the art macroeconomic models.

Another strand of research has looked in particular at the socio-economic impacts of pricing policies using a range of tools with different capabilities. Research in GRACE has estimated the welfare and regional employment effects of European scenarios of pricing reform, as well as the effects on the Swiss economy of the implementation of a regionally differentiated transport pricing reflecting the high costs of the sensitive Alpine area (GRACE, 2008a). Research in REVENUE has aimed at estimating the impacts on the transport, environmental and economic systems of different ways of spending revenues from road infrastructure charges in Germany (REVENUE, 2006). Research in DIFFERENT (DIFFERENT, 2008) has investigated welfare effects and general political effects of differentiated charging measures.

A further strand of research has been concerned with the development of a framework for the analysis, at the urban and interurban level, of combinations of economic instruments, regulatory measures and physical measures which permit to meet the objectives (such as equity and sustainability) set by transport and other relevant policies (SPECTRUM, 2005a).

4.4.3 Research results

Research in TIPMAC (TIPMAC, 2003) has used two modelling tools to investigate the impacts of TEN-T and pricing scenarios. One tool is the combination of the SCENES transport network model with E3ME macro-econometric model. TIPMAC has been the first study that combines disaggregated macroeconomic modelling with a detailed transport network and demand analysis. Another tool is the ASTRA model which is based on system dynamics.

Three scenarios have been evaluated in TIPMAC: one is marginal social cost pricing (MSCP) on all modes together with a slow implementation of the TEN-T core projects, the other two consider fast implementation of TEN-T projects. In the second scenario the additional funds needed for the anticipated investment flows for TEN-T is made available by increased taxation on fuel, in the third scenario revenues from MSCP are used. All MSCP scenarios are revenue-neutral, with revenues from MSCP being offset by reductions in personal income tax. These scenarios are compared with a business as usual (BAU) scenario where past trends continue with a variety of national approaches to transport taxation, charges and investment.

Key results for the three scenarios assessed in TIPMAC are as follows.

- The adoption of SMCP has significant macroeconomic impacts in terms of change in GDP and employment compared with the BAU scenario; this is true for both scenarios with slow and fast implementation of TEN-T projects; GDP would be increased on BAU scenario by a range of 2-3% in 2020, which is significant given the rather small share of transport, around 10% (CEC, 2001a), in the overall economy.
- The differences in the impacts of the SMCP without and with fast implementation of TEN-T projects are not significant.
- The scenario with fast implementation of TEN-T projects funded by fuel tax has relatively small macroeconomic impacts.
- The implication from the above is that the macroeconomic impacts are dominated by the revenue recycling, the magnitude of the response to income tax reductions being a key factor in model results.
- Effects in terms of changes in CO₂ emissions from the BAU scenario are very small for all scenarios.

In GRACE (GRACE, 2008a) three European scenarios for pricing reform for road transport have been considered: only fuel taxes, a km-based charge, and km-based charges differentiated by time and space. In each scenario the other modes are priced so that variable costs and marginal external environmental costs are covered.

The use of the TREMOVE model has provided an assessment of the transport impacts and of welfare change in each scenario. Welfare is obtained by adding the net change in transport revenues to consumer and producer surplus. Different weights are assigned to the transport revenue component of welfare depending on how the revenue is used. Higher weights are assigned in the case where labour taxes are reduced than in the case where general taxation is reduced because of the higher distortions due to taxes in labour markets. The application of the TREMOVE model has shown the following results:

- road pricing based on fuel taxes only gives a tiny welfare gain if we discount the recycling effect of tax revenues to alleviate labour market distortions;
- with a km-based charge there are significant welfare gains, irrespective of the way transport revenues are used; transport volumes decrease by 11%;

- the impacts in terms of welfare of the spatial and temporal differentiation of km-based are not significantly different from the undifferentiated case; the differentiated case shows higher congestion relief benefits and less transport revenues.

The regional impacts on real income and employment from the three scenarios have been assessed using an extended version of CGEurope, a spatial computable general equilibrium (SCGE) model, which has been used also in the European projects IASON, FUNDING and TRANSTOOLS. The model extensions adopted in GRACE relate to imperfect labour markets (i.e. if unemployment rises there is fall in wages), mobile capital (i.e. capital stock is mobile inter-regionally), and a distribution mechanism for the transport revenues (i.e. in each country proportionally to regional GDP).

This model has indicated a small negative impact on real income, in the range of 0.1% of GDP, which however does not take into account the possible environmental, congestion and accident benefits. Also there is a small negative effect on employment. The reason is attributed to the ultimately distorting nature of transport taxes and charges which come down to an increase in the prices on the market of tradable goods and add to the existing distortions (the model assumes imperfect markets for tradable goods, characterised by monopolistic competition, and for labour). The spatial pattern is characterised by a concentration of losing regions in the periphery of the EU27. The regions with strong market potential and a lot of traffic (mostly located in Western-Central Europe) even gain.

In GRACE the economic impacts of pricing policies within Switzerland have been assessed using SwissTRANS, a multi-sector computable general equilibrium (CGE) model of Switzerland (GRACE, 2008a). The study has investigated the effects of MSCP and of average cost pricing. Also a policy whereby internalisation charges are on top of the existing taxation has been considered because, although not theoretically justified, it often appears in the political debate. Key results have been:

- a change from the current pricing regime in transport towards MSCP is beneficial for both the Alpine region and the rest of Switzerland though the impact is rather limited in terms of welfare;
- a politically-feasible transport pricing policy aiming at charging users for external costs without lowering existing taxation may be welfare improving as long as the recycling of transport tax revenues is used to reduce distortions of existing taxes; substantial additional revenues can be generated in this case;
- average cost pricing for rail and road can lead to inefficient policies in terms of welfare;
- due to the geographical position of Switzerland, road transit represents a significant share of total traffic demand; it is therefore by far the main positive contributor to welfare gains in any scenario as domestic households benefit from foreign additional revenues without bearing the tax burden.

meet them in the urban and interurban contexts. This framework consists of five components (SPECTRUM, 2005a): transport and other social objectives, transport context, indicators and measurement, assessment framework and classification of instruments. Three main kinds of operational mechanisms for transport instruments have been considered:

- economic instruments aimed at modifying transport market actors' behaviour by distributing or withdrawing wealth;
- regulatory instruments aimed at modifying transport market actors' behaviour through a system of restrictions, standards and controls;
- physical instruments aimed at modifying transport market actors' behaviour through a change in the quantity and/or quality of the available transport infrastructure capacity, equipment and vehicles.

This framework has been used to analyse urban (SPECTRUM, 2005c) and interurban (SPECTRUM, 2005b) case studies relating to both passenger and freight transport and all modes in order to assess the performance of the implementation of a range of transport instruments singly or in packages. The developed framework permitted to define the high level objectives against which the performances of single instruments and instrument packages could be measured, using a specific objective function calculated numerically for each instrument or package of instruments (SPECTRUM, 2005b; SPECTRUM, 2005c).

At the urban level the main findings have been (SPECTRUM, 2005a):

- some of the best performing packages involved distance charging and fuel taxation, even though there are problems concerning the public acceptability of such measures, especially with short term implementations;
- in some cases, instrument combinations generated disbenefits when assessed in a short term time horizon in a road sector case study, but generated positive benefits when assessed over a long term time horizon (such as 30 years) in a multimodal case study;
- synergy resulted from the combination of cordon pricing and traffic signal optimisation (in York), and the combination of distance-based road pricing and bus lanes (in Leeds);
- the assessment of benefits from combinations including public transport fare changes was highly dependent upon the value assigned to the Marginal Cost of Public Funds.

At the interurban level the key results have been (SPECTRUM, 2005a):

- In general, case studies have highlighted the importance of the social costs associated with externalities and the significant impacts on welfare obtained by internalising the externalities through economic instruments. In the airport case study the economic instruments appeared to be a valid or even optimal capacity allocation mechanism and a market based way to internalise problematic externalities at airports. In particular, this case study demonstrated the relevance of introducing specific noise charges to

address noise problems. The rail case study recommended that rail operators should be charged for the infrastructure capacity they use in accordance with the social opportunity cost of that capacity. In particular, simulation exercises have shown that if auctioning could be arranged with appropriate subsidies in place, it would give the best outcome in terms of social welfare. For the road case study, it has been found that motorway tolls would have a relatively small welfare effect compared to fuel taxes.

- The multimodal case studies confirm the findings from the unimodal case studies clearly indicating that internalisation of externalities is the most significant instrument in terms of generating (positive) changes in welfare. Furthermore, EC initiatives concerning fair and efficient pricing are likely to improve welfare even if implemented on their own. The planned investment programme for the Trans European Network priority projects should be implemented as a part of a package with fair and efficient pricing.

4.4.4 Policy implications

Research in this sub-theme provides evidence of policy relevance, as it helps to formulate judgements on the desirability of investment and other transport policies. However it is not possible in general to derive simple recipes. The socio-economic impacts which are estimated vary not only because of the differences in the policy scenarios assessed but also in view of the modelling tool used, the mechanisms that are modelled, the economic indicators that are measured.

According to the assessments in TIPMAC (TIPMAC, 2003) the implementation of SMCP with revenue neutrality and corresponding reduction in income tax is beneficial in terms of GDP and employment; viceversa a policy based on increased fuel tax to fund accelerated development of TEN-T projects does not bring about significant macroeconomic effects; the large scale of the revenues from SMCP makes the accompanying fiscal policy very significant. The more rapid construction of TEN-T does not bring about a large aggregate effect on industrial activity. No significant effects are brought about on CO₂ emissions from implementation of SMCP.

According to the assessments in GRACE (GRACE, 2008a) a km-based road charge brings about higher welfare gains than fuel taxes only, when all non-road modes pay the variable costs and the external marginal environmental costs. The way the extra transport revenues are used are important for welfare as the selection of the pricing policy, with reduction of labour taxation providing higher benefits than reduction of general taxation. There is some evidence that a reform of pricing from present policy to MSCP may affect negatively in terms of real income and employment the peripheral regions of the EU27. The GRACE project has also provided evidence that cost recovery policies may be inefficient based on the result of a model which has assessed average cost pricing for road and rail transport in Switzerland.

Research in REVENUE (REVENUE, 2006) has provided evidence of possible negative effects on GDP, although of small entity, of road pricing policies for HGV. The effect on GDP is significantly affected by the way transport revenues are spent and is subject to change over time. Research in REVENUE has also suggested that in the long run financing of additional investments via average cost-based user charges can be superior in terms of welfare over the sole application of the state-financed basic investment programme. These results hold for the case assessed of introduction of HGV tolls on German motorways.

The analysis of urban case studies concerning the differentiation of charging has concluded that the “best” solution involves the differentiation according to the characteristics of individual links and their traffic demand at any given point in time. However, in spite of its technical feasibility, this solution implies a degree of differentiation which might be too complex for people and, consequently, undermine its acceptability. As a second best approach, this analysis suggests introducing different charges on roads according to their different roles and characteristics. Finally, many of the theoretically obtainable benefits can be achieved by introducing time-varying tolls. In particular, significant benefits can be obtained by implementing a simple peak/off-peak differentiation, but much greater benefits can be obtained by applying a dynamic differentiation. However, as it has already been pointed out in the previous paragraph, more complex charging schemes imply significant increases in costs because of the expensive technology they require. In contrast, differentiation by type of vehicle is relatively cheap and, consequently, easier to implement (DIFFERENT, 2008)

As for the rail mode, infrastructure charges should be differentiated, in line with efficiency objective and the short term marginal cost principle, according to the drivers of the costs such as the weight of the train, speed, the age of the track, maintenance programmes of the track, traffic levels (which affect congestion and scarcity costs) (DIFFERENT, 2008).

The analysis of transport instruments performances in SPECTRUM in terms of efficiency and feasibility has concluded that, in the urban context, economic instruments performed best when implemented in combination with other instruments (particularly those aimed at improving public transport) and quite less well when implemented singly. In the interurban context, marginal cost pricing measures perform very well. Furthermore, it has been pointed out that there is practically no policy instrument providing efficiency gains without costs to a particular stakeholder or group (SPECTRUM, 2005a).

These implications are relevant to three EU policy priorities (in decreasing order of relevance): disconnection of transport and economic growth, correction of market distortions using pricing policies, and funding of infrastructure.

4.5 Sub-theme 4: funding of infrastructure

4.5.1 Background

The difficulty of mobilising capital is one of the main obstacles to carry out infrastructure projects. Transport infrastructure funding in Europe takes place against a backcloth of a multitude of different institutional setups and at different levels of decision making.

At the national level there is a wide variety of approaches to the procurement of infrastructure including infrastructure funding agencies and private sector involvement. A related report by the EXTR@Web project on “pricing, taxation and financing tools” (EXTR@Web, 2006b) had reviewed national research projects dealing with the institutional and financial reforms on funding transport systems, including road infrastructures.

At the European level the Member States are the movers of nearly all strategic transport infrastructure investment, with the EU institutions holding both a political influence and the capability to contribute via the funding mechanisms at its disposal. Recent European research, reviewed in EXTR@Web (2006b), has addressed the funding of European infrastructure projects but only indirectly. Insights on the optimal use, from a welfare viewpoint, of the revenues from social marginal cost pricing schemes have been provided. Options for use have included earmarking to infrastructure investment.

4.5.2 Research objectives

Research has aimed at developing a scientifically sound approach to the funding of large transport infrastructure investments in the EU, most particularly the TEN-T projects. Different mechanisms are explored for the funding of these investments. The one which has received highest attention is the creation of an EU transport infrastructure fund financed by pricing mark-ups on transport activities.

The economics of infrastructure funds and the mark-up method are first explored conceptually (FUNDING, 2007). The conceptual phase leads to the formulation of a limited number of alternative scenarios for a European infrastructure fund and for the use of mark-ups (FUNDING, 2007). Modelling is used to assess taxation scenarios which could be used to finance the infrastructure fund (FUNDING, 2007).

4.5.3 Research results

The conceptual investigation of the economics of infrastructure fund has first addressed pricing and investment decision on parallel and serial networks, with and without regulatory intervention (FUNDING, 2007). In parallel networks, where parallel links fall into different countries, transit traffic shifts to the link where cost is lower. This acts as disincentive for a country to invest. User pricing will give incentives with competition between the parallel links preventing tolls from becoming too high. In serial networks with adjacent links falling into different countries the problem is the potential for excessively high user prices because each country charges a monopoly margin without taking into account the revenue reduction for the other country.

Another issue which has been explored conceptually is the relationship between cost structure, pricing and subsidies (FUNDING, 2007). A marginal social cost pricing (MSCP) is not always sufficient to cover the cost of an infrastructure project. There are three ways to cope with this problem. Either the user of the infrastructure project pay more (internal mark-up), the infrastructure is financed by letting the whole transport sector (even those who do not use the specific infrastructure) contribute (external mark-up), or non transport money from the general budget is used.

The so-called cost recovery theorem, based on a few simplifying assumptions, states that the ratio between optimal user charges and the capacity cost is equal to the degree of scale economies in capacity expansion, which may be as low as 0.2 while for road can be close to 1. An internal mark-up (price above MSCP) to finance the investment project will lead to a welfare loss due to overpricing of the infrastructure use. If, in addition, there is an underpriced existing substitute for this project (typically road or air traffic for a rail project), there will be an additional welfare loss since part of the users that decided not to use the overpriced mode anymore will switch to the underpriced mode and increase the existing inefficiency.

Surveys of European and US experience of infrastructure funds have been carried out (FUNDING, 2007). At the EU level the main existing European Community sources of funding for the TEN-T are the TEN budget line itself, the Cohesion Fund and the European Regional Development Fund (ERDF). At the national level the German federal model of infrastructure procurement bears more resemblance to a potential European structure for an infrastructure fund and has therefore been analysed in detail. The main federal planning instrument in Germany is the federal infrastructure master plan. This includes a list of priority projects for investments ranked according to the results of a project appraisal. A quota system is then applied for the distribution of investments between the states. The federal government is responsible for providing federal motorways and trunk roads while the states administer them.

Several EU countries have established transport infrastructure funds via financing agencies as a means of managing and providing infrastructure financing independent of public budgets. Prominent examples have been set up in Austria (ASFINAG), in Germany (VFIG) and in France (AFTIF). While ASFINAG is responsible only for motorways, VFIG and AFTIF have been set up with a view to financing multi-modal projects. ASFINAG obtains capital from the market with the loans being guaranteed by the Austrian State. The refunding of the investments is done via the user charges which are set by federal government. The agency is, however, involved in the selection of projects for investment, in contrast to VFIG and AFTIF who are not.

Also a review of the infrastructure funding system in the US has been carried out (FUNDING, 2007). In the US, the Federal Highway Trust Fund (FHTF) was set-up to finance the National System of Interstate Highways. The Fund is mainly financed by dedicated taxes on motorfuel, collected by a federal agency. A great part of the FHTF funds has since been used to finance other transport-related projects than interstate highways. The federal agency does not choose the funded projects: it only confirms that the project can receive federal funding if it complies with the criteria. This leaves the actual project selection to the states.

About every five years the Congress approves a new set of legislation defining the appropriation formulas for the disbursement of the funds. The formula takes into account factors like the state's length of road network, the number of motor vehicles in the state and the annual contributions of the state to the FHTF. The Congress does not decide on the project selection of the FHTF funds. However, the Congress representatives have developed a practice of requiring an increasing number of "earmarks" or "demonstration projects", i.e. additional projects from other federal funds that they require as a condition for their approving vote for the legislation package. This increasing practice of pork barrel has increased the total transport budget and made the transport expenditures less efficient.

Based on the results reported on above different scenarios have been developed for funding the TEN-T projects (FUNDING, 2007). A first scenario has moderate subsidy, a second scenario has high subsidy. A third scenario is as the moderate scenario but with in addition an equity component as countries with relatively low GDP receive an extra subsidy. Subsidy comes from EU and Member States. The EU contribution would be financed by an infrastructure fund while the Member States are required to provide a matching grant. The remaining investment costs are covered by user charges.

The magnitude of the subsidy is differentiated by transport mode in the light of the cost recovery theorem, being different the returns to scale in capacity costs. As the main reason to have the EU involved in subsidising investment costs is the spill over of benefits when there are many foreign users, it is suggested making the EU subsidy share

proportional to the share of foreign users. The EU infrastructure fund would be financed with extra charge on all traffic flows and contributions from Member States. In the high subsidy scenario an important share has to come from extra charge on the road sector as this sector has the largest market share.

Subsequent research (FUNDING, 2007) has assessed the welfare costs of financing the total EU and Member State subsidies for TEN-T projects by raising money from the transport sector. Different taxation scenarios which can be used to finance the infrastructure fund under the moderate and high subsidy scenarios above have been developed. These include additional road tolls, flat or differentiated in various ways (by vehicle type, time period, geographical area and country), and an additional fuel tax for all modes.

The TREMOVE model has been used to quantify welfare for the different scenarios. Welfare results from summing up consumer and producer surplus, external costs, and tax revenues for the government. First the total extra tax revenues needs have been estimated for the moderate and high subsidy scenarios. Then the welfare cost of 1 Euro levied via additional transport taxation has been estimated for 2010 and 2020. The welfare cost is defined as the ratio of additional tax revenues plus welfare loss to additional tax revenues. The result is that this cost is close to 1 in both scenarios with all different types of taxation considered. For the most differentiated road toll we have the best performance with a welfare cost slightly lower than 1 indicating a welfare gain.

4.5.4 Policy implications

Research on the economics of infrastructure funding (FUNDING, 2007) has suggested solutions for cases of serial networks crossing two or more countries: the excessive charge problem can be overcome by cooperative solutions between two price setters or by attributing the concession for the pricing to one only infrastructure manager.

The survey of European experience on infrastructure funding (FUNDING, 2007) has highlighted issues which need to be tackled when introducing new schemes for funding TEN-T projects. In particular a few recommendations for the set up of an infrastructure fund at European level have been proposed.

- Clear rules are necessary to determine whether transport infrastructure is eligible for funding, and the involvement should be restricted to projects that clearly fulfil trans-boundary transport functions benefiting EU objectives in order to avoid over-subsidisation and excessive involvement in regional transport infrastructure investments.

- There needs to be a clear division of responsibilities between the European and the Member State level with control mechanisms installed over the whole procurement process to protect the interests of the financing actors.
- An infrastructure fund promises more flexibility and higher stability of the investment budget than funding from general budgets. Currently there is no autonomous funding mechanism for cross-border infrastructures of European interest.
- A future funding organisation is likely to contain elements of grant contributions from government as well as funding from user charges and private sector involvement in financing and project delivery. The clear assignment of the powers and responsibilities of the parties within the model is crucial to efficient delivery.
- There is a need not only for financial but also for organisational co-ordination of cross-border infrastructure procurement. First steps towards this have been taken by the introduction of European co-ordinators for the TEN-T priority axes.
- The setup of an infrastructure fund needs to consider carefully whether a multimodal approach is taken, revenues from user charges are earmarked and directly transferred to the fund, and whether the fund can borrow money from the capital market.
- In the case of the private participation, rules are necessary to determine who bears the risk of cost overruns; experience shows that privately owned companies (and in particular railway network companies) need planning security and this issue must be considered in the financing rules of a fund.
- Private involvement in infrastructure provision requires support in the form of long-term commitment of the public partner.
- Assuming that the larger airports can recover their costs through user charges, privatisation of airports may require close monitoring and regulation of charges to prevent abuse of monopoly powers. Subsidising airports at the local and regional levels needs to be closely monitored to prevent market distortions.

The main implication which could be derived from the survey of the interstate highway funding system in the US (FUNDING, 2007) is that the share of the EU level in the financing of transport investments should be limited and tied to the non-local benefits: this is the major safeguard against pork barrel politics and could avoid that Member States claim every year their share of the budget.

4.6 Sub-theme 5: cost-benefit analysis methodology

4.6.1 Background

Assessment of the value for money of investments and policy measures is commonly carried out according to the Cost-Benefit Analysis (CBA) approach. The vast literature on

the South and East regions. The appraisal framework for rail seems less standardised than for road and only few of the European countries surveyed have formulated principles for the appraisal of air, inland waterway and sea transport projects. Main challenges to the development of harmonised guidelines have been identified in lack of consensus on which elements to include in the CBA (especially environmental effects), lack of consensus on approaches to valuation, and the significant range of values used, as an example for safety.

Standard CBA restricts to consider the welfare change for transport users and providers. Additional terms to account for environmental and accident externalities are commonly considered in the calculation of the net value of a project. The assessment of the economic impacts in markets other than transport is a grey area of CBA. The problem here is essentially the need for avoiding double counting. HEATCO has carried out a review of the theoretical insights on this specific aspect of CBA provided by past research (HEATCO, 2005). Contributions had come in particular from the European project IASON, which had largely built on the UK study on transport and the economy by SACTRA (SACTRA, 1999).

While the wider economic impacts can be substantial as transport impacts propagate over time through the economy, these are not necessarily welfare effects that are additional to the transport impacts. It is possible to conclude that additional economic impacts, with a value that is not captured in the calculation of direct transport benefits and costs, arise due to market imperfections. An example is when a local market changes from monopoly to competition due to new entrants which meet better accessibility enabled by transport investment. In such circumstances considering wider economic impacts in the assessment could lead to an increase, or a reduction, in the net value of a project compared with conventional appraisal.

Research within HEATCO has identified in noise and travel time savings the effects where improved economic unit values are needed (HEATCO, 2006b). Contingent valuation surveys conducted in six European countries have provided new values for noise annoyance from road and rail and for travel time savings in the case of commuters.

The following principles have been put at the core of the guidelines proposed for CBA on EU-level projects (HEATCO, 2006a):

- to estimate costs and benefits a “do minimum scenario” needs to be compared with a “do something” scenario;
- net present value (NPV) is recommended as a criterion to judge whether a project is convenient; depending on the question to be addressed benefit-cost ratio (BCR) and ratio of NPV and public sector support (RNPSS) can also be used;
- the default appraisal period should be 40 years with residual effects being included;
- sensitivity analysis or scenario technique are used to assess (non-probabilistic) uncertainty; Monte Carlo simulation analysis can be undertaken;

- risk premium-free rate or weighted average of the rates currently used in national transport project appraisal in the countries where the project is located should be adopted for discounting; weights should be according to finance contribution from each country;
- at minimum a “winners and losers” table should be developed to make allowance for intra-generational equity issues;
- if impacts cannot be expressed in market prices non-market techniques should be used for valuation;
- if impacts cannot be expressed in monetary terms they should be presented in qualitative or quantitative terms in addition to evidence on monetised impacts;
- where resources are available for estimating indirect effects these should be assessed by using a Spatial Computable General Equilibrium (SCGE) model;
- instead of using a shadow price for public funds, a cut-off value for RNPSS of 1.5 should be adopted;
- producer surplus of transport providers should be computed in NPV;
- the unit of account should be prices at factor cost; monetary values should be converted to € in a base year using purchase power parity corrected exchange rates;
- results should be presented with sensitivity analysis and impacts expressed in physical terms in addition to monetised results.

In the cases of time and congestion, externalities related to accidents, local air pollution and noise, the recommendation is to use local values according to state-of-the-art methodologies described in the guidelines; where these are not available the recommendation is to use the country-specific fall-back values, obtained from meta-analyses, indicated in the guidelines (HEATCO, 2006a).

Research aimed at improving current assessment methodologies for large projects has highlighted open issues in CBA and discussed ways in which conventional CBA practice can be modified to cope with them based on solutions proposed in the literature (EVA-TREN, 2008). Issues include the following.

- Risks and uncertainties. A very crucial point for every project assessment is how to deal with future scenarios. Assumptions on costs, benefits and impacts have to be made before they are realized. This means introducing uncertainties and risks and dealing with them.
- Marginal opportunity costs of public funds. If a state uses money of public funds to finance an investment project it causes a loss in collective richness, due to alternative use of that money.
- Equity and distributive issues. CBA produces a single indicator as output (NPV or BCR). These indicators are aggregate measures, supposing that benefits (and costs) will be redistributed to all individuals of society. They do not state who will profit and who will lose.

- Option value theory. Option values are based on the consideration that for those projects, which have a long-term time horizon and imply a large investment in a quite uncertain context, the gain and loss opportunity should be taken into account instead of including the values only.

The introduction of risk in CBA is seen as an improvement with a potential to avoid project failures as occurred in the Euro Tunnel case. Risk is distinct from uncertainty as it can be analysed in terms of probability distribution while uncertainty can't. The attitude of the public decision maker towards risk has been discussed (EVA-TREN, 2007). Research in the area of infrastructure funding (FUNDING, 2007) has proposed solutions to introduce risk in CBA when the decision maker is risk averse. The solutions are based on the assumption that the decision maker wishes to maximise the expected return under the constraint that the probability of a lower than a given level return is small enough. Given a probability distribution of the NPV, it is proposed to use as a criterion for CBA the Value at Risk which is equal to the corresponding NPV quantile, and the Conditional Value at Risk which is the average NPV of the worst outcomes below the corresponding quantile.

Research in the area of CBA for road safety measures has produced a manual for the assessment (ROSEBUD, 2006a). CBA is here considered in conjunction with cost-effectiveness analysis as key methodologies for assessment of the efficiency of safety measures. The manual provides an overview of which methodological principles are important, which knowledge and data are needed and available, which barriers may hinder the process. A code of conduct in the assessment of safety measures useful for both decision makers and analysis is included.

4.6.4 Policy implications

The guidelines for CBA produced within HEATCO (HEATCO, 2006a) are intended for use by decision makers in case of TEN-T projects. They might also be used for other trans-national projects to ensure consistency across borders and the application of state of the art methods. Although it was not in the intentions of the project, these guidelines in the long run might help achieve a more harmonised approach also for national appraisal methods. The manual for assessment of safety measures (ROSEBUD, 2006a) supports the road safety policy of the EU by helping decision makers select the measures taking into account at the same time effectiveness and costs.

These implications are of relevance to the policy areas of infrastructure development, and in particular TEN-T, and of safety, which are both of concern at the EU level.

4.7 Implications for further research

For the first sub-theme, which deals with the drivers of demand for passenger and freight transport, the projects reviewed could identify the following implications for further research.

- In the domain of freight transport there is a multiplicity of actors which make decisions related to the location of firms and distribution centres as well as to logistic and transport operation. These decisions impinge on kilometres travelled. How these decisions are made is a topic which needs further research according to the THINK UP project.
- In the domain of passenger transport research in the POET project on the transport consequences of e-economy developments has shown that the final outcome in terms of intensity of travel depends on the impacts of the e-economy on relocation. Households may tend to locate further away from workplaces due to tele-working but location impacts might occur also at the level of workplaces. Research is needed to better understand the link between ICT adoption, at household and firm level, and land use patterns.
- The uptake of e-commerce is relevant to both passenger and freight travel and may have a range of effects in different directions. A better understanding of the transport impacts of e-commerce in urban regions is a priority for further research according to the POET project.

For the second sub-theme, which looks at the valuation of costs and at transport accounts for use in pricing policies, the following areas for further research could be identified. As far as valuation of costs is concerned the IMPRINT-NET project identified the following:

- Reasons for differences in cost estimations produced by different studies.
- Comprehension of the relative magnitude of different marginal cost categories.
- Transferability and generalisation of local estimates of externalities.
- For interurban road transport more comprehensive measurement of marginal social costs, especially wear and tear costs and reliability.
- For maritime transport understanding of the relative importance of different local pollution externalities.

Research also recommends (and put forward a proposal) to run a European large scale pavement test programme to come up with new knowledge on pavement performance and the relationship between road infrastructure damage in different forms and vehicle characteristics as well as material properties and climatic conditions. This programme will provide consistent data and performance indicators for further economic research (CATRIN, 2009).

The GRACE project has identified the following key issues for further research (GRACE, 2008b):

- the treatment of renewals in estimating marginal wear and tear costs;
- variation of elasticities of wear and tear costs with traffic volume and infrastructure quality;
- risk elasticities and their implications for the marginal external costs of accidents;
- practical ways of determining congestion and scarcity costs for rail, water and air transport;
- optimal pricing given road users misperception of costs.

As far as transport accounts are concerned the GRACE project identified the following:

- monitoring of availability of data relevant to transport accounts and development of methodological improvements for production of new accounts in addition or replacement of those developed in the UNITE project.

The main implication from research in the third sub-theme, which deals with socio-economic impacts of investment and other transport policies – in particular pricing, originates from the multiplicity and variety of models and tools available for the assessment. Modelling the impacts on the economy is an area where a lot of research is still underway. Activities aimed at the development of a European platform are by now well developed (see the TRANSTOOLS project of FP6). These have opted for a particular modelling approach. In order to increase the robustness of model results for the assessment of European policies the suggestion made by the author of this report is to carry out a comparative analysis of the modelling approaches and tools available.

In the fifth sub-theme, which deals with CBA methodology, the HEATCO project has highlighted the need for advancements in the state of the art of the methodologies used for providing basic inputs to CBA, namely the estimation of future traffic volume, the ascertainment and assessment of induced traffic, the design of transport models.

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THINK UP (2003) Final Report. THINK UP (Thematic network to understand mobility prediction) Project. FP5 Competitive and Sustainable Growth Programme.

TIPMAC (2003) Final technical Report and Final Publishable Report. TIPMAC(Transport infrastructure and policy: a macroeconomic analysis for the EU) Project. FP5 Competitive and Sustainable Growth Programme.

Annex: List of projects by sub-theme

Sub-theme 1: drivers of demand for passenger and freight transport				
Project acronym	Project title	Programme	Project website	Coverage
FORESIGHT FOR TRANSPORT	A foresight exercise to help forward thinking in transport and sectoral integration	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.iccr-international.org/foresight/	This report
POET	Prediction of e-economy impacts on transport	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	http://www.poet-eu.org	This report
PROTRANS	Role of third party logistics service providers and their impact on transport	FP5 – Growth, KA2 Sustainable Mobility and Intermodality		EXTR@Web report
SULOGTRA	Effects on transport of trends in logistics and supply chain management	FP5 – Growth, KA2 Sustainable Mobility and Intermodality		EXTR@Web report
THINK UP	Thematic network to understand mobility prediction	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.netr.fr/think-up	This report



Sub-theme 2: costs in relation to pricing				
Project acronym	Project title	Programme	Project website	Coverage
CATRIN	Cost allocation of transport infrastructure costs	FP6-SUSTDEV-2 - Sustainable Surface Transport	http://www.catrin-eu.org	This report
DESIRE	Designs for inter-urban road pricing schemes in Europe	FP5 – Growth, KA2 Sustainable Mobility and Intermodality		EXTR@Web report
GRACE	Generalisation of research on accounts and cost estimation	FP6-SUSTDEV-2 - Sustainable Surface Transport	http://www.grace-eu.org/	This report
IMPRINT-NET	Implementing pricing reforms in transport - networking	FP6-SUSTDEV-2 - Sustainable Surface Transport	http://www.imprint-net.org/	This report
IMPRINT-EUROPE	Implementing pricing reform in transport – effective use of research on pricing in Europe	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.imprint-eu.org	EXTR@Web report
MC-ICAM	Implementation of marginal cost pricing in transport – integrated conceptual and applied model analysis	FP5 – Growth, KA2 Sustainable Mobility and Intermodality		EXTR@Web report
RECORDIT	Real cost reduction of door-to-door intermodal transport	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.recordit.org	EXTR@Web report

Sub-theme 2: costs in relation to pricing				
Project acronym	Project title	Programme	Project website	Coverage
UNITE	Unification of accounts and marginal costs for transport efficiency	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.its.leeds.ac.uk/projects/unite/	EXTR@Web report

Sub-theme 3: socio-economic impacts of transport investment and policies				
Project acronym	Project title	Programme	Project website	Coverage
DIFFERENT	User reaction and efficient differentiation of charges and tolls	FP6-SUSTDEV-2 - Sustainable Surface Transport	www.different-project.eu	This report
GRACE	Generalisation of research on accounts and cost estimation	FP6-SUSTDEV-2 - Sustainable Surface Transport	http://www.grace-eu.org	This report
IASON	Integrated assessment of spatial economic and network effects of transport investment and policies	FP5 – Growth, KA2 Sustainable Mobility and Intermodality		EXTR@Web report
REVENUE	Revenue use from transport pricing	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.revenue-eu.org	This report
SPECTRUM	Study of Policies regarding Economic instruments, Complementing Transport Regulation and the Undertaking of physical Measures	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.its.leeds.ac.uk/projects/spectrum	This report

Sub-theme 3: socio-economic impacts of transport investment and policies

Project acronym	Project title	Programme	Project website	Coverage
TIPMAC	Transport infrastructure and policy: a macroeconomic analysis for the EU	FP5 – Growth, KA2 Sustainable Mobility and Intermodality		This report
TRANSECON	Urban transport and socio-economic development	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	www.transecon.org	EXTR@Web report

Sub-theme 4: funding of infrastructure

Project acronym	Project title	Programme	Project website	Coverage
FUNDING	Funding infrastructure: guidelines for Europe	FP6-SUSTDEV-2 - Sustainable Surface Transport	http://www.econ.kuleuven.be/funding/	This report

Sub-theme 5: cost-benefit analysis methodology

Project acronym	Project title	Programme	Project website	Coverage
EVA-TREN	Improved decision-aid methods and tools to support evaluation of investment for transport and energy networks in Europe	FP6-INTEGRATING - Specific research and demonstration programme aimed at integrating and strengthening the European Research Area	http://www.eva-tren.eu/home.htm	This report

HEATCO	Developing harmonised European approaches for transport costing and project assessment	FP6-INTEGRATING - Specific research and demonstration programme aimed at integrating and strengthening the European Research Area	heatco.ier.uni-stuttgart.de	This report
ROSEBUD	Road safety and environmental benefit-cost and cost-effectiveness analysis and use in decision making	FP5 – Growth, KA2 Sustainable Mobility and Intermodality	http://partnet.vtt.fi/rosebud/	This report

Note. The projects listed in the Annex are those that have had the focus on the theme “economic aspects of sustainable mobility”, as well as those who have addressed “economic aspects of sustainable mobility” as secondary topics to some extent. On the TRKC portal (www.transport-research.info) it is possible to use the “advanced search” functionality – with the option “economic aspects of sustainable mobility” – and find all research projects, EU-funded and national, which have treated, to a variable extent, aspects that can be related to the theme.