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EXECUTIVE SUMMARY

Aim

The principal aim of the FUNDING research project is to develop a scientifically sound approach to the funding of large transport infrastructure investments in the EU. Two different avenues are explored for the funding of these investments. The first is the creation of an EU transport infrastructure fund financed by mark-ups on transport activities. The second is the use of mark-ups on the users' costs charged by the infrastructure suppliers that make the investment.

The economics of infrastructure funds and the mark up method are first explored conceptually. The conceptual phase leads to the formulation of a limited number of principles for a European infrastructure fund and for the use of mark-ups. Application of these principles to accepted TEN-T investments gives an idea of the subsidy needs in the coming decade.

Different models are used to test the performance of the alternative infrastructure fund and mark-up scenarios: a multi-modal spatial general equilibrium model of the EU; two models that study the freight and passenger transport models; and a multi-modal pricing and investment assessment model (MOLINO II), which is applied to five important "TEN-T" infrastructure projects. This case study approach will enable the effect of infrastructure fund scenarios on a representative set of investment projects to be studied.

Economics of infrastructure funding

In work package 1, the review of the existing literature on the economics of infrastructure funding gave rise to a number of research questions to be explored. Firstly, the price setting behaviour of member states on different types of network structures was addressed.

1. In serial networks (where transit traffic uses an infrastructure that passes through two different countries) the main 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 ("double marginalisation"). This can be overcome by cooperative solutions between the two price setters or by giving the concession for the pricing of the network to a single infrastructure manager rather than to one infrastructure manager per country. The problem is not solved by requiring identical charges on transit and local users and it may even be better for the federal government not to allow any charges at all.
In parallel networks (transit can choose between links), the main problem is insufficient investment whenever there is no user pricing. The origin of the problem is the transit that shifts to the link where transport costs are lowest. This acts as an important disincentive for each member state to invest. Whenever user pricing is possible, even if it discriminates against transit traffic, user pricing will give incentives for more investments and the competition between the two parallel links will keep tolls from becoming much too high.

2. Secondly, if marginal social cost pricing is in place, this is not always sufficient to cover the cost of an infrastructure project. The cost recovery ratio with marginal social cost pricing is equal to the degree of scale economies in capacity extension (as low as 0.2 for rail, while closer to 1 for road). Internal mark-ups can be imposed, where the

users of an infrastructure project pay more Imposing user charges to increase cost recovery above this level rapidly leads to a high efficiency cost. Infrastructure charges should also not be too high to avoid the additional welfare loss of traffic switching to an underpriced substitute

3. A consistent approach to large uncertainties in transport projects was considered next as many projects fail, for example, when there are wide differences between forecast and realised demand. To model the attitude towards risk when selecting a project among several candidates, two criteria are proposed: the Value at Risk and Conditional Value at Risk. These can be implemented in the MOLINO II model.

4. Finally, we examined the federal experience of infrastructure funds in Europe and the United States. There are currently no transport infrastructure funds operating at the EU level. At the member state level, the German federal model of infrastructure procurement bears most resemblance to a potential European structure. The attributes of the transport infrastructure funds established by several EU member states are a means of managing and providing infrastructure financing independently of public budgets. They highlight a number of important issues for the set-up of any fund: the allocation of finances between modes; the division of responsibility for selection and administration of projects; and the apportionment of risk. In the case of 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.

In the US, the Federal Highway Trust Fund (FHTF) was set-up to finance the National System of Interstate Highways using highway user tax revenues. The Fund is mainly financed by dedicated taxes on motor fuel, collected by a federal agency. A number of lessons can be learnt from the US experience. Since project selection is political and the federal grant level is very high (80%), the system is very inefficient and there is a tendency for pork barrel politics. As a safeguard against this, EU funding of projects should be limited and tied to their non-local benefits. Member States should have the right to select the projects realised on their soil, so as to prevent locally harmful federal projects, which caused the largest obstacles in the US federal infrastructure program. To avoid the diversion of funds to other uses, there should be a stable, transparent formula for financing the infrastructure fund.

Scenarios

1. A set of scenarios was then developed in work package 2, which could be used to answer the above policy questions and to address the problems of the current funding framework for large European transport infrastructures. The objective was to develop a number of alternative scenarios, which would range from heavy reliance on a European fund and low mark-ups on user prices for the new infrastructure to, at the other extreme, a small role for the European fund and an important role for the internal funding of investments via mark-ups.

3. In order to answer these policy and project assessment questions, we used three dimensions to define the scenarios: how to spend the money, which comprises level of aid and form and conditionality of aid; how to raise the money for the infrastructure fund; and the organisational structure.

In terms of spending the money, three scenarios are proposed. In all cases the member state will be required to provide a matching grant for any EU level subsidy for projects on their territory and the share of transit users will be the main determinant of the size of the EU contribution. The remaining factors which affect the economic and financial viability of a project are cost recovery and the marginal cost of public funds. In the moderate scenario, it is assumed that roads and airports can recover all their costs from user charges, while rail and inland waterways receive some funding. In the high subsidy scenario, a lower level of cost recovery is expected and funding for all modes is accordingly higher. The final scenario is also concerned with distributional issues rather than with efficiency effects alone. In this case investment costs may additionally be subsidised for countries whose GNP is lower than the EU average. Further to the levels of aid outlined in the three scenarios, pricing restrictions could also need to be applied to avoid excessive charges on corridor projects or on routes with high transit traffic. It is not recommended that the Commission covers the risk on future user charges but that these are borne by the member states or private partners. Risks to private capital can be controlled to some extent by conditions on the EU aid.

We follow the US approach in proposing charges on the road transport sector to finance the transport sector infrastructure fund. In addition, we propose an annual contribution to the fund rather than "one-off" payments to the fund by member states. Although EU level transport taxes may not seem acceptable in the current political climate, such taxes represent a more feasible way of raising revenue, in our opinion, than re-allocation of or changes to the general EU budget. The specifics of the taxation methods is considered in work package 3.

In work package 2, some recommendations are made about the organisation of the proposed infrastructure fund, drawing on the US experience and political economy theory documented in Deliverable 1. For the implementation of scenarios, however, we can only take account of the impact of the fund on the decision process in terms of the scenario dimensions (i.e. the level of aid, the conditions put on it and the source of public funds) and the social welfare generated by a given investment. Financial autonomy can be partly tested by examining the effect of public provision/finance or private provision/finance.

Compute revenues and financing gaps

1. The first objective of work package 3 was to compute revenues from pricing and possible financing gaps per mode and per country 2005-2020 for the EU transport baseline scenario developed with SCENES-TREMOVE II. TREMOVE is a transport and emissions simulation model developed for the European Commission.

The first task was to construct the baseline. For this, the ASSESS Partial A forecast was implemented in TREMOVE. This includes all follow-up activities already implemented or planned to be implemented before 2010 by the EC or by member states. In particular, all TEN-projects that, following the estimation published in 2004, are planned to be finalised before 2010 (or 2020) are included in the partial implementation scenario. Other White Paper measures include driver training and road safety, liberalisation of the freight rail market and freight infrastructure charges. From the baseline, resource costs, net taxes (or subsidies), external costs and priority TEN-T investment costs have been calculated per mode. This gives an idea of the financing gaps with respect to the TEN-T investments and also the ability of a given mode to sustain additional taxation.

2. The next step was to compute the effects on revenue streams and welfare (efficiency) of additional transport sector levies and other taxes, which are used to finance the EU infrastructure fund and member state matching grants, under the different funding scenarios described above (work package 2). To do this, the public aid requirements for the moderate and high subsidy scenarios were first translated into annuities, thus smoothing out the investment costs over their delivery period. These annuities represent the revenue to be raised by direct taxes on the transport sector and other taxes in order to finance the EU infrastructure fund and the member state matching grants Since, the grants allocated under the infrastructure fund scenarios (and indeed under the present system) will fall short of the total investment costs of the TEN-Ts, it is assumed that, in line with our cost recovery arguments, the remainder of the investment costs can be recovered from the TEN-T projects themselves through tolls.

3. A detailed comparison of taxes and marginal external costs was carried out in order to gain some insights into the most efficient application of taxes on the transport sector. The analysis was differentiated by vehicle type, time period, type of infrastructure and country. When taxes are low relative to marginal external costs, then it is economically efficient to increase taxation. Similarly, high subsidies relative to marginal external costs are inefficient. The analysis indicated that peak-period taxes or taxes on the road sector would be most economically efficient. Removing all inefficiencies offered considerable scope for revenue raising in the transport sector.

Effect on revenue streams and welfare of transport sector levies

1. Four transport sector taxes were implemented in the TREMOVE model, to assess the effect of raising the required revenues for a EU infrastructure fund from the transport sector: a vehicle/km tax, differentiated by vehicle type, time period, road type and country; a vehicle/km tax, differentiated by vehicle type, time period and road type; an undifferentiated vehicle/km tax; and a fuel tax with differentiation by fuel type only.
2. Overall we see a welfare cost per euro raised that is close to one or even as low as 0.95 if one opts for a sophisticated road toll. The most differentiated road toll performs best under both subsidy scenarios, followed by the fuel tax. This is because marginal external costs can differ quite strongly between countries. The fuel tax is also not limited to road modes.

   A few caveats are in order when interpreting these results. First, we limit the welfare assessment to the transport sector and there could be important effects on other markets like the labour market. Second, we do not take into account the extra transaction costs associated with the implementation of more sophisticated tax systems. Third, the welfare cost of the fuel tax scenarios could be higher as some of the unintended effects are missing.

   The overall conclusion is that more tax revenues can be raised in the transport sector at a limited welfare cost. This welfare cost ratio needs to be compared to the welfare cost of the alternatives (raising general tax revenues outside the transport sector, for which, in the case of labour taxes, the cost could be 1.2 Euros or more per euro raised) or raising users' prices through tariffs or tolls.

Testing the EU-wide equity and efficiency effects of alternative pricing and revenue use scenarios

In order to analyse the spatial impacts of the priority projects for the regions of the European Union with the CGEurope model, each priority project of the trans-European transport projects (TEN-T) is considered individually. For each project, two policy scenarios are assessed: one without any EU subsidy and one with an EU subsidy proportional to the benefit spillovers (outside the investing countries), where the subsidy is financed by an EU-wide levy proportional to the GDP of the country.

Comparing the scenarios with and without subsidies allows the economic efficiency and the regional equity of the EU subsidy scheme to be assessed. A number of conclusions can be drawn, bearing in mind that the model does not provide a full CBA of each project. 1) Not all projects have significant benefit spillovers. 2) The rate of return of many projects is low. 3) When there are benefit spillovers, so that the project receives EU funding, the rate of return increases significantly but this is often insufficient to adopt the project. 4) The proposed EU subsidy scheme does not appear to systematically hurt poorer countries.

The methodology developed in this work package provides a useful "benefit distribution" rule for determining whether transport infrastructure projects generate European added value and should therefore be subsidised by the EU. It complements the "transit share" approach proposed in Deliverable D2

TEN-T Case Studies

The D2 subsidy and mark up rules are tested with three different types of models. First, a new European wide "corridor" model is developed to analyse 4 high speed rail (HSR) projects for passenger transport in which rail competes with air transport. Second, an existing "corridor" model is used to analyze two TEN-T freight projects: de Betuweline and the Brenner tunnel. Third a specific case study model (MOLINO-II) is developed to analyse the project economics in more detail for five TEN-T projects.

The selection process has taught us that, for the TEN-T projects we looked into, there is often no good documentation available. Despite the help of the European Commission services it was impossible to obtain a Cost Benefit Analysis (CBA) for most projects.. This constitutes in itself an important finding. Another implication is that for some projects our analysis is based on poor data and has to be considered with the necessary caveats.

The results of the passenger corridor model analysis indicate that it is only worthwhile improving the high-speed European rail network if the governments (member states and EU) are willing to subsidize the cost of the infrastructure upgrading to a large extent. The scope for funding the investment via higher mark-ups on the users for the use of the infrastructure is very limited.

The STEMM model was used to analyse the Betuweroute and Brenner Axis. In line with the MOLINO analysis for these routes and the Seine-Scheldt inland water ways upgrade, the three freight corridor projects had in general poor net economic benefits. The proposed EU subsidy rules in combination with improved pricing of competing modes would not make these projects economic. Most projects would require a subsidy of close to 100% of the initial infrastructure investment to make them financially viable. Only for the Gdansk-Vienna axis, both rail and road projects as well as their combination generate welfare gains and this holds for all pricing regimes considered. The EU role should be limited as most benefits concern national traffic and as the two projects can, when pricing of all modes is improved, largely finance the project themselves.

Policy Conclusions

The policy conclusions can be best presented as response to a series of questions.

Why and when does one need transport infrastructure aid?

The problem of funding transport infrastructure depends on whether infrastructure is: to be provided publicly or privately; to be funded by user or taxpayer or in what mix; to be priced at network or at route/link level; or to be funded from earmarked taxes or from general revenue. Experience with funding arrangements is reviewed in D1 of FUNDING.

In general, transport benefits, revenues and costs accrue at the level of member states or regions within states and therefore most infrastructure decisions are properly decisions for member states (or more locally within member states). In such cases there is no justification for EU intervention in decisions or funding for such infrastructure provided EU rules regarding competition, procurement, single market etc are observed.

Involvement of the EU in infrastructure decisions is warranted where:

- There are significant spillovers between the provision of a piece of infrastructure in one country and costs and benefits in neighbouring countries. It is easy to demonstrate that in the presence of transit traffic, (a) the incentive to an individual state to provide infrastructure is distorted and (b) the incentive to price capacity efficiently is also distorted.
- A transport fund at EU level could serve as a device, together with appropriate regulation, for helping to correct for these distortions and to incentivise efficient pricing and investment. A funding contribution from the EU is warranted to pay for non-national benefits; however a funding contribution is not warranted to enable projects with poor rates of return to happen. High quality modelling and appraisal of major projects is needed to illuminate good decision-making.

How much aid should be given from an economic efficiency and from an equity point of view?

In D2, the economic factors which determine the efficient level of subsidy to infrastructure investment are brought together in a simple model. A subsidy formula is proposed which takes account of: the degree of economics of scale in capacity expansion (differs among modes); the share of transit use; the cost of public funds; and the relative GDP of the member state requiring aid. An important part of any investment has to be covered by member country subsidies and by user charges. The potential for funding projects through user price mark ups on top of the marginal social cost is limited.

What level of aid would our subsidy rules require at the level of the EU?
The proposed subsidy formula implies a maximum EU aid budget for the remaining TEN-T priority projects of the order of 4 billion Euros per year for the next 13 years. This is a maximum budget as existing TEN-T priority projects with poor benefits may not be pursued by member states that need to co-finance or infrastructure managers that need to be sure about future user charges. This budget does not yet include new projects (for example in new member states) that meet the subsidy criteria.

How to finance an EU infrastructure fund by levying extra charges in the transport sector?
Given that it is costly to gather extra tax revenues from general income taxes, an increase of taxes on road use in the EU may be the best way to generate extra revenues. This can take the form of a small additional excise on motor fuel.

What is the economic and equity impact at the regional level of building the TEN-T priority projects and financing them in the way we suggest?
1. An analysis with an EU wide regional model of the 22 priority projects selected found that the economic rate of return of most projects was low.
2. The share of the spillovers in total benefits was for 10 projects below 10% and sometimes negative (hurting other member states). For 8 projects it was below 30% and for the remaining 4 projects between 30 and 50%.
3. The proposed EU subsidy formula does, for those projects that have large spillovers, increase the rate of return for the investing member countries but does not guarantee that the project will be realized.
4. The EU subsidies do not systematically hurt the poorest countries

What is the effect of the European infrastructure aid we suggest on a selection of the 30 priority TEN-Ts?
Seven projects were analysed in more detail.
The three freight corridor projects analysed had in general poor net economic benefits. The proposed EU subsidy rules in combination with improved pricing of competing modes would not make these projects economic. Most projects would require a subsidy of close to 100% of the initial infrastructure investment to make them financially viable. The different HSR projects could survive the competition of air transport if the rail operators are charged the marginal infrastructure rather than the average infrastructure cost. The HSR projects could be economically worthwhile if infrastructure managers receive an EU and member state subsidy covering a large fraction of the investment cost and if there is coordination of pricing and operation.

What are the appropriate modelling tools to assess the effects of a subsidy scheme?
There is no generally accepted cost benefit guide for assessing transport infrastructure projects in the EU. This means that there is a large risk of a positive bias in project assessments. There is also no obligation to have a publicly available cost benefit assessment for the TEN-Ts.

Under these conditions there is a clear need for models that can help to form a second opinion on projects that apply for EU funding. Four different models of varying complexity and regional focus have been assessed and found useful in aiding EU and member state decision making.

1 INTRODUCTION

1.1 Objectives and structure of the FUNDING project

The main objective of the FUNDING project is to develop a scientifically sound approach to the funding of large transport infrastructure investments in the EU. Two different avenues are explored for the funding of these investments. The first is the creation of an EU transport infrastructure fund financed by mark-ups on transport activities. The second is the use of mark-ups on the costs charged by the infrastructure suppliers that make the investment. The overall structure of the research is outlined in Figure 1.

In WP1, the economics of infrastructure funds and the mark up method are first explored conceptually. For the infrastructure fund we examine three questions: how to spend the resources of the infrastructure fund (what type of projects, subsidies or loans), how to finance the operation of the fund (contributions out of general budget or earmarked taxes on transport) and what decision rules to use for the fund (political body versus agency, accountability issues). These questions are explored using economic theory (political economy, risk pooling, and network spillovers) but we also draw upon experience with infrastructure funds and mark-ups in EU, US and World Bank.

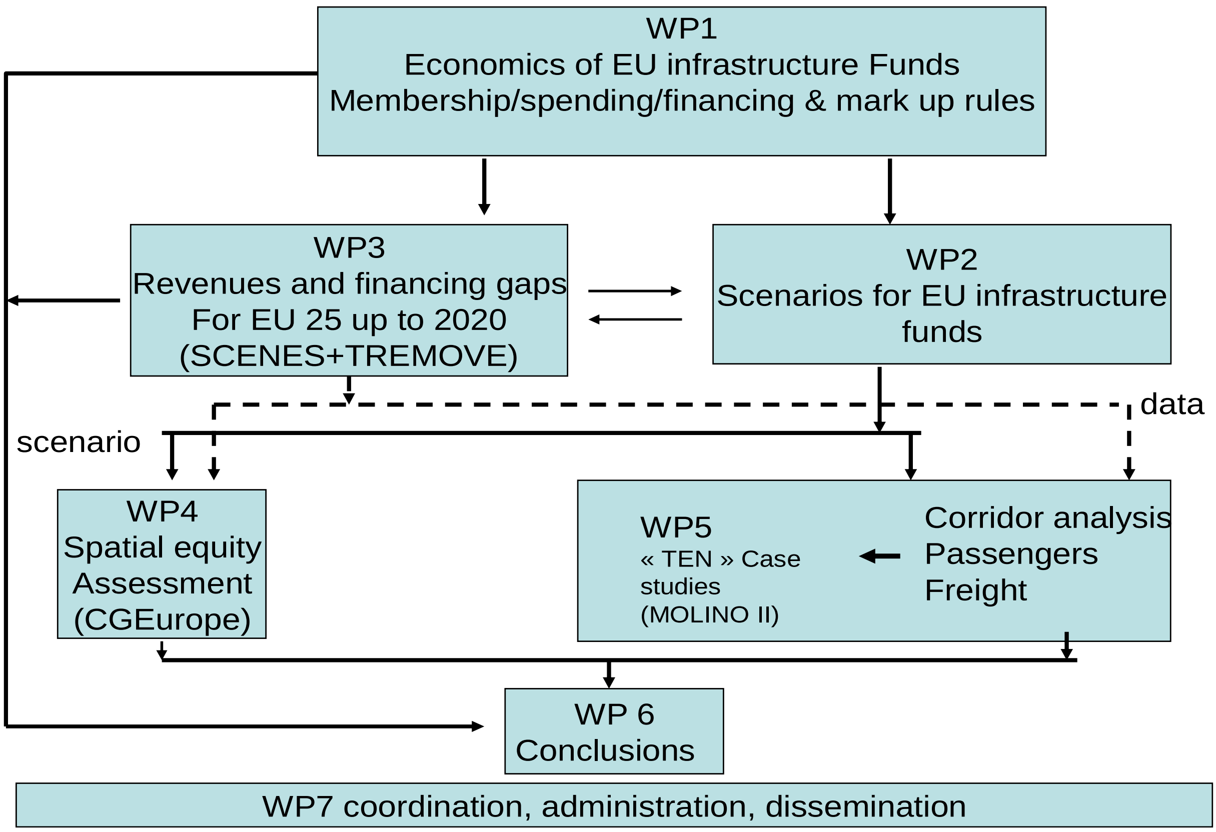

Figure 1 Overall structure of FUNDING project

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 (WP2). These scenarios are adjusted in function of the financing gaps that are calculated for the

horizon 2020 by mode and country given the accepted TEN-T investments (WP3). The financing gap is computed using the SCENES – TREMOVE baseline 1995-2020. WP3 generates revenues from different mark-up rules and will therefore not only allow the order of magnitudes for an infrastructure fund scenario to be adjusted but will also provide information about the efficiency costs of different ways of generating revenues. As WP3 is based on one accepted baseline scenario for the EU it is also used as much as possible as baseline for the other modelling work packages. WP3 cannot evaluate the effect of scenarios on investments as the TREMOVE and SCENES model have exogenous investments.
The performance of the alternative infrastructure fund and mark-up scenarios in terms of investments and pricing is tested using two different but complementary modelling approaches. Each of the modelling approaches tests the same set of scenarios defined in WP2 but examines a different dimension.
The first model (WP4) is a spatial general equilibrium model of the EU that checks the spatial equity effects of infrastructure aid and mark-ups for more than 1300 regions in the EU. It does this by translating the infrastructure and mark-up scenarios into lower transport costs between regions and simulating the trade and welfare effects of this cost reduction. The model is in line with the TREMOVE-SCENES baseline used in WP3 and tests scenarios developed in WP2. The main contribution of the model is the spatial equity dimension. The main missing dimensions are the endogenous investment behaviour and the non-competitive behaviour in the transport sector. These will be addressed specifically in WP5.
The second approach (WP5) is a case study approach. We take five important “TEN” infrastructure projects and use for each of them the same multi-modal pricing and investment assessment model. For every project, this model is calibrated on the basis of the available information that has led to the selection of the “TEN” project. The assessment model (MOLINO II) represents the transport flows, pricing, financing and investment decisions related to the project itself. It is complemented with corridor analysis information provided by corridor models for freight and passengers. The case study approach enables the effect of infrastructure fund scenarios on each of the investment projects to be examined in terms of financial structure the pricing decisions and on welfare. The corridor models are calibrated on the TREMOVE-SCENES baseline used in WP3.
The different tests lead in principle to consistent and tested guidelines for financing infrastructures via a European transport infrastructure fund and mark-up rules (WP6).

1.2 Policy context

The trans-European transport network (TEN-T) encompasses the major planned transport infrastructure in Europe. The concept of a trans-European transport network was formally recognised in the Maastricht Treaty (1992) and the current priority list consists of 30 axes to be launched before 2010. Investment in transport infrastructure does not, however, end with the TEN-T as the European Commission is also currently consulting on the extension of this network to neighbouring countries and regions.

To date, the selection and funding of such infrastructure projects has predominantly been the responsibility of the individual member states, although most of them contain (often multiple) cross-border sections. The main existing European Community sources of funding for the TEN-Ts are the TEN-T budget line itself, the Cohesion Fund and the European Regional Development Fund (ERDF). Although, not the only cause of delays in the implementation of the TEN-Ts, under the current funding procedures, by the end of 2003 only three of the 30 priority projects had been completed, only a quarter of cross-border funding had been found and 20 years would be needed to complete the priority axes at the current rate of investment[1].

There are currently no real transport infrastructure funds operating at the EU level. At the member state level, the German federal model of infrastructure procurement bears most resemblance to a potential European structure. Several countries also have recent experience with national transport infrastructure funds (such as ASFINAG in Austria and AFTIF in France) from which useful lessons can be drawn for the formation of a European fund. The private sector is, in addition, together with the EIB, a potentially important source of finance for the TEN-Ts.

The main example of federal funding of transport infrastructure projects is the US. The Federal Highway Trust Fund (FHTF) was set-up to finance the National System of Interstate Highways using highway user tax revenues. The original system was completed by 1992. The Fund is mainly financed by dedicated taxes on motor fuel, collected by a federal agency. The federal matching grants, on average 80% of the total costs, are paid out by the agency based on technical criteria of the projects. This leaves the actual project selection to the states. While the federal set-up in the US differs from the EU system, some important lessons can be drawn with regard to how an EU fund should be organised.

The correct pricing of transport infrastructure use has been the subject of other studies financed under the 6th Framework Programme (GRACE for example). It is relevant for FUNDING since, in addition to any EU fund, direct user charges are expected to be applied to partially recover investment costs. Current EU policy allows for tolls on HGVs (Eurovignette) and rail infrastructure charging but does not extend as far as full marginal social cost (MSC) pricing on all modes.

1.3 Organisation of this deliverable

Deliverable 7 provides an overall summary of the FUNDING project. In the following chapters, we present the main findings of Deliverables 1 to 6, which correspond to work packages 1 to 6, briefly described in Section 1.1 above. A separate chapter is used for each deliverable. A full list of deliverables, together with publications and supplementary reports can be found at the end of this document.

[1] European Commission proposal for a regulation on financial aid for the TENs (COM 2004/0475)

2 Economics of European Infrastructure Funds

The main objective of Deliverable 1 is to review the different elements that matter for the construction and assessment of alternative scenarios for the funding of TEN-T projects. We will draw upon existing economic theory (public goods and political economy, transport economics and financial economics) as well as upon experience in EU and abroad with similar financing structures.

The review leads to the following sets of research questions:

A. What price setting behaviour can we expect from member states that can build infrastructure that is used also by transit and can or cannot set user prices – and does the structure of the international network in which they operate matter?
B. What is the cost recovery ratio of transportation projects in the presence of marginal social cost pricing and what is the efficiency loss of increasing this cost recovery ratio within the project versus the costs of public subsidies?
C. Is there a consistent way to address the large uncertainties in demand and cost estimation for transportation projects?
D. How have federal countries solved these problems up to now?
    a. In the EU and some European countries with a federal structure
        i. In the EU: what is the origin and performance of the current structure of EU level funds?
        ii. In Germany where the federal level also intervenes heavily in the construction of transportation infrastructure?
    b. In the USA where there is a long tradition with the Federal Highway Fund?

Price setting and investment behaviour of member states (regions) in transport corridors

Even the analysis of a simple parallel or serial network as the one shown in Figure 2 is sufficient to show that large inefficiencies in pricing and investment can exist in federal countries where member states (or the firms to which they subcontract) decide independently on pricing and investment.

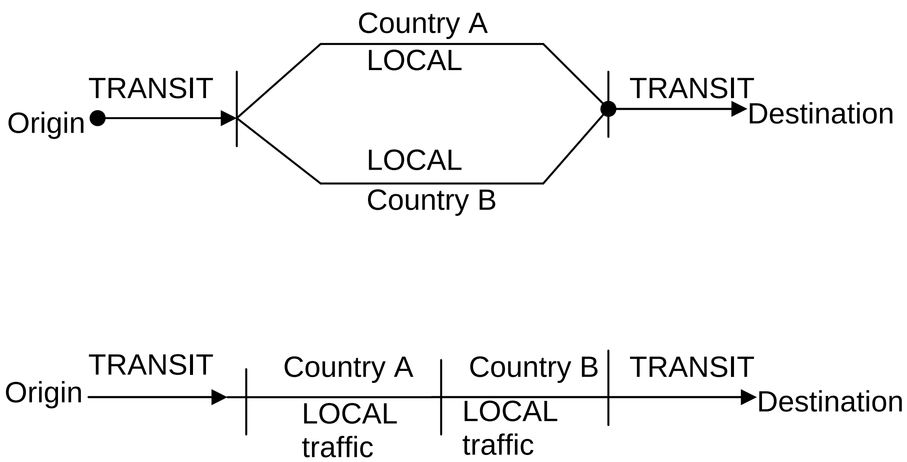

Figure 2 parallel (upper part) versus serial (lower part) competition

In Figure 2, we distinguish between parallel and serial network structures as very simple descriptions of real-world toll and capacity competition problems. The first case (top of

Figure 2) arises when different parallel links can be used to make a particular trip; each link is used by both local traffic and transit traffic (through traffic) and is operated by a different authority (say, a member state). Moreover, transit traffic has a choice between the different parallel links, so that governments compete for transit tax revenues. The second prototype network arises when transit has to use a route that sequentially runs through the territory of different governments. The existence of this ‘transport corridor’ leads to a different type of user charge or tax competition: transit no longer has any route choice, but the same transit traffic may sequentially be taxed by each of the governments operating the serial links. Note that in the two network types, origins and destinations of transit are assumed to lie outside the network. We assume that member state governments are interested in maximizing a (local) social welfare function that reflects three concerns, viz. (i) the travel conditions of its local users and the associated welfare, (ii) total tax revenues on the link it controls and (iii) investment costs associated with capacity provision

In serial networks (where transit traffic uses an infrastructure that passes through two different countries) the main 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 (“double marginalisation”). This can be overcome by cooperative solutions between the two price setters or by giving the concession for the pricing of the network to a single infrastructure manager rather than to one infrastructure manager per country. Contrary to common belief, the requirement to charge transit the same tolls as local users is not at all sufficient to avoid user prices that are too high. The excessive pricing problem can be so severe that it may be better for the federation not to allow any user charging at all, even if that leaves congestion unpriced.

In parallel networks, the main problem is insufficient investment whenever there is no user pricing. The origin of the problem is the transit that shifts to the link where transport costs are lowest. This acts as an important disincentive for each member state to invest. Whenever user pricing is possible, even if it discriminates against transit traffic, user pricing will give incentives for more investments and the competition between the two parallel links will keep tolls from becoming much too high.

These lessons have been drawn from a simple network setting and using many simplifying assumptions. This implies that the network structure and the strategic behaviour of member states (or the operators they control) need to be integrated in the cost benefit assessment of the investment project.

<u>Mark up rules to fund investments internally and to finance the operation of a fund</u>

Marginal social cost (msc) pricing is not always sufficient to cover the cost of an infrastructure project. There are three ways to cope with this problem. Either the users 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. Here we examine the economic efficiency cost of decreasing the financial deficit of a transport project by using internal mark-ups. These will later be compared with the two other ways to fund the deficit. The use of mark-ups in the rest of the transport sector will be analysed in D3 using TREMOVE II that covers the whole

transport sector. For the cost of general budget money one can rely on estimates of the marginal cost of public funds.
Using a simple model of one transport market it can be shown that

- the cost recovery ratio[2] is equal to the degree of scale economies in capacity extension – for rail this may be as low as 0.2 while for roads this may be closer to 1
- the cost recovery ratio can be increased by higher user prices but the maximum cost recovery may remain well below 1
    - the efficiency cost of increasing the cost recovery beyond the degree of scale economies becomes quickly very high
    - this implies that one has to be careful to advance minimum cost recovery rates that are not in line with the economies of scale of the project

If there is an underpriced existing substitute for this project (typically road or air traffic are substitutes for a rail project), there will be an additional welfare loss when the cost recovery ratio is increased since part of the users that decided not to use the overpriced mode anymore will switch to the underpriced mode (road, air) and increase the existing inefficiency. In the case of rail TEN-Ts, the substitution mode is often interurban road or air and it is important to know whether prices for these modes are too low or not. Prices that are too low are a clear justification for lower cost recovery requirements in rail or IWW.

Car and truck use is mostly underpriced in urban areas and in the peak. This is less the case for interurban traffic because cars and trucks are becoming much cleaner than in the past, there is an important fuel tax, congestion is limited and congestion pricing is making its way on the most acute segments. As regards air travel, there is indeed an air pollution cost that is not internalised but some of the air traffic prices have also an important monopolistic margin driving prices above marginal cost so that again underpricing has to be shown on a case by case basis.

Risk in transport infrastructure projects

We have observed a large number of failures of large projects. The Suez Canal and Euro Tunnel provide only two among numerous well known examples. There are various sources of uncertainty which may affect the costs and the benefits of large scale projects. They correspond to, roughly speaking, demand uncertainty, supply uncertainty as well as to various macroeconomic shocks. Risk and uncertainty are not well taken into account in current cost-benefit analyses. However, risk and uncertainty affect the major ingredients of the cost-benefit analysis during the whole process of construction, operation and maintenance of a project.

The introduction of risk in the standard cost-benefit analysis used in transportation is analysed in this text. Typically, the value of a project is measured by the Net Present Value (*NPV*), which measures the discounted value of the investment. In practice, both supply and demand are random: this variability is due to microeconomic as well as to macroeconomic factors.

[2] The ratio between user charges for infrastructure and the capacity costs of this infrastructure.

If one is only interested in the expected Net Present Value, one can look for rules of thumb to adapt the investment rules in function of the risks. As an uncertain future demand is one of the main issues for the timing and capacity choice of the TEN-T investment projects we analysed whether a systematic overinvestment could be justified. It is shown that this could be justified when demand is relatively inelastic but this cannot serve as general principle.

When the decision-maker is sensitive to the randomness of the Net Present Value (typically, decision-makers are risk averse), the decision rule has to integrate a priori the whole distribution of *NPV*. We argue that the standard average and Mean-Variance models, widely used in finance, are not adequate for the evaluation and comparison of projects. The reason is that these criteria do not take into account the default risk which is of prime importance both for the private and public sectors.

To model the attitude towards risk when selecting a project among several candidates, we borrow two criteria developed in finance which are used to optimize portfolio. Indeed, the investor often wishes to maximize the expected return under the constraint that the probability of a negative (or lower than a given level) return is small enough. The two proposed criteria are the Value at Risk and the Conditional Value at Risk. We show that they can be used to compare projects. The idea is that a "good" project is such that poor returns occur with low enough probability. For a given probability, the Value at Risk is equal to the corresponding quantile, while the Conditional Value at Risk corresponds to the average Net Present Value of the worst outcomes (below the corresponding quantile). It is shown how these criteria can be computed in practice and how they can be implemented in MOLINO II, the model used to assess the individual case studies.

European Experience with infrastructure funds

There are currently no transport infrastructure funds operating at the EU level and the main existing European Community sources of funding for the TEN-Ts are the TEN-T budget line itself, the Cohesion Fund and the European Regional Development Fund (ERDF). At the member state level, the German federal model of infrastructure procurement bears most resemblance to a potential European structure and has therefore been analysed in more detail. Several countries also have experience of national transport infrastructure funds from which useful lessons can be drawn for the formation of a European fund. The private sector is, in addition, a potentially important source of finance for the TEN-Ts.

The main federal planning instrument in Germany is the federal infrastructure master plan. This contains 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. The division of powers between federal and state level in the road sector has raised several issues of criticism, including delayed planning processes, inefficiencies in the planning, and an excessive number of projects that have to be decided and financed at the federal level. This experience suggest clear rules are necessary to determine whether transport infrastructure is eligible for EU funding, and the involvement should be restricted to projects that clearly fulfil transport functions benefiting European objectives in order to avoid over-subsidisation and excessive involvement in regional transport infrastructure investments. There also 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 Several EU member states have established transport infrastructure funds via financing agencies as a means of managing and providing infrastructure financing independent of public budgets. Prominent examples of such agencies have been established in Germany, Austria and France. Of these, only the Austrian ASFINAG has been in existence for more than a couple of years. Between them, the three agencies have a number of attributes, which could be considered for a European infrastructure fund. The German VFIG and French AFTIF have been set-up with a view to financing multi-modal projects and facilitating PPP involvement. The VFIG is financed by HGV and IWW tolls, which has led to a debate on the public acceptability of user charging when cross-financing of modes is allowed. ASFINAG, which is only responsible for motorways, obtains capital from the capital market, with the loans being guaranteed by the Austrian state. The refunding of the investments is done via user charges which are set by the federal government. The agency is, however, involved in the selection of projects for investment, in contrast to VFIG and AFTIF. The organisation of a European infrastructure fund clearly needs to be considered carefully. The set-up 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 will also be a need not only for financial but also for organisational co-ordination of cross-border infrastructure procurement.

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. Empirical evidence from Great Britain suggests that private sector involvement is of greatest benefit for the management rather than the financing of road procurement. The experience from the fully privately financed M1/M15 project in Hungary indicates that private involvement in infrastructure provision requires support in the form of long-term commitment of the public partner. Despite being finished on-time and within budget, the concession company was renationalised after low demand led to high tolls, which were unpopular.

Survey of US experience

In the US, the Federal Highway Trust Fund (FHTF) was set-up to finance the National System of Interstate Highways using highway user tax revenues. The original system was completed by 1992. The Fund is mainly financed by dedicated taxes on motor fuel, collected by a federal agency. A great part of the FHTF funds has since been used to finance other transportation related projects than interstate highways. The federal matching grants for individual projects, on average 80% of the total costs, are based on technical criteria of the projects. 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, which are increasingly widely defined. 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 outcome of the formula has been very stable even though the formula and its computation rules have changed and become increasingly complex. 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 practise 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 practise of pork barrel has increased the total transportation budget and made the transportation expenditures less efficient.

We can learn from the US experience that:

1) The very high share of federal aid (larger than the share of local benefits) together with the distribution of votes between representatives of individual states has given rise to common pool (or pork barrel) politics: politicians use their power to attract projects to their district but do not want the overall federal budget to become larger – empirical results suggest that the selection of projects is very inefficient.

2) The financing of the Fund was guaranteed by the use of dedicated gasoline taxes. The initial highway fund objectives have been altered to allow funding of a wide range of other transportation related projects to the extent that the Fund money is not expected to be able to cover its initial purpose: to maintain the interstate highways.

3) Although there is a federal agency to supervise the use of funds of the subsidy program, the agency supervises only the technical eligibility rules of the projects, and the collection and disbursement of funds. The selection and implementation of the programs' projects is done by the states, while the selection of the demonstration projects is done by the Congress representatives. The states have been largely able to substitute the federal money for the state transportation money, in effect directing the federal money for other purposes than maintaining the interstate highways.

4) The current legislation aims to return to each state at least 90% of their gasoline tax contributions. This legislation developed after a long history of stable receiver-donor state status, which was an outcome of the Congress' vote distribution giving relative advantage to rural, less populous states like Alaska. The return-to-origin features make the federal-aid highway program function as a cash transfer, a general purpose grant program. While this feature provides relief from the donor-receiver dilemma, it loses in efficiency to the federal administration totally withdrawing from the collection and distribution of the funds.

The differences between the US and EU systems that need to be taken into account can be characterised as follows:
1) the US federal government redistributes directly between individual citizens, whereas the EU has mainly a system of intergovernmental transfers;
2) the US federal government is directly appointed by and accountable to individual voters, whereas political appointments and accountability are only indirect in the EU;
3) the US federal government controls a wider set of policy instruments than the EU.

When any recommendations from the US federal highway funding are applied to the EU infrastructure funding, they should be subject to these three differences.

In this light, the EU infrastructure funding program needs to pay particular attention to:

1. Limiting the share of the EU level in the financing of transport investments and tie this share 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. To safeguard this principle, each member state should have an option to withdraw from the Fund with remuneration of its past contributions, if its contributions exceed the non-local benefits its inhabitants receive from those contributions.

2. Setting a consistent standard evaluation procedure for estimating the benefits of infrastructure investments for each transportation mode. This would make the benefits of infrastructure investments in different transportation modes transparently comparable and safeguard against favouring any particular mode. Transparency is another major safeguard against pork barrel politics, which tends to favour investments that require high sunk costs.

3. Defining the technical infrastructure standards for each mode of transport funded by the EU Fund. This would safeguard against technical incompatibility between national standards and therefore promote realization of non-local benefits from the EU funded infrastructure.

4. Maintaining the member states' right to choose the EU funded infrastructure projects that are realized on their soil. This would safeguard against locally harmful federal projects, which caused the largest obstacles in the US federal infrastructure program.

5. Looking for a stable, transparent funding formula for its Fund but avoid that the money could be spend on other projects than what the Fund was established for. The effective safeguards against both alteration of fund collecting principles and diversion of funds to other uses are the above mentioned cost-benefit transparency across different transportation mode investments combined with the member state's option to withdraw from the Fund with remuneration.

6. There is an increasing interest in private partners as long as the private partner will carry their share of the risks of revenue. Both the presence of private partners and the political unattractiveness of gasoline tax hikes increase the attractiveness of tolls as a revenue source. The share of tolls versus taxes should therefore be one of the case study design dimensions. In the implementation of the options, attention should be paid in safeguarding against the private party evading risks through bankruptcy or other kind on non-existence, and the public party evading risks through non-accountability to its commitments.

3 Scenarios for EU Infrastructure Fund and Mark-ups

In this chapter, the object is to define a set of scenarios which can be used to answer policy question arising from Chapter 2 and to address the problems of the current funding framework for large European transport infrastructures.

A number of alternative scenarios are developed, which range between heavy reliance on a European fund and low mark-ups on the new infrastructure and, at the other extreme, a small role for the European fund and an important role for the internal funding of investments via mark-ups.

3.1 How much aid should be given: the appropriate balance with user charges

If a fund is established to provide federal subsidies to transport infrastructure projects, then clear rules are required to determine the amount of aid a given project can receive. In Table 3.1 below, we present three scenarios for different levels of federal aid. Note that in both the moderate and high subsidy cases, this EU aid is matched by a public subsidy from the member state and the level of aid is differentiated by mode. In Table 3.1 investment costs are denoted by *I*, share of foreign users by *X*, the equity weighting by *s* and the marginal cost of public funds by Γ.

Mode	Source of aid	Moderate subsidy	High subsidy	Equity scenario
rail and inland waterways	EU	(1-0.7 Γ) X I‡	(1-0.3 Γ) X I	(1-0.7 Γ) X I +(1-0.7 Γ) Is
	MS	(1-0.7 Γ) (1-X) I	(1-0.3 Γ) (1-X) I	(1-0.7 Γ) (1-X) I
road and airports	EU	0	(1-0.8 Γ) X I	
	MS	0	(1-0.8 Γ) (1-X) I	

Table 3.1 Recommended proportion of investment funded by public aid (grant), split between EU and member state (MS) and differentiated by mode

‡Total investment cost = I, share of foreign use = X, marginal cost of public funds = Γ

The scenarios of Table 3.1 are based on three main ideas that result from the economic theory contributions of Deliverable 1.

First in the presence of marginal social cost pricing, the infrastructure manager can recover a share 1-ε of the capacity costs. The parameter ε is the scale elasticity of capacity costs: it gives the % increase in total capacity costs for a given % increase in total capacity[3]. This parameter is typically low for infrastructures with strong economies of scale like rail and IWW (we chose ε=0.3 for these) but is close to 1 for

[3] The degree of returns to scale in the costs of capacity is the percentage increase in total capacity costs when capacity is increased by a given percentage. If ε, equals 0.3 say, this means that a doubling of capacity would increase total cost by $2^{0.3}$=23%. The estimation of the degree of returns to scale can sometimes be difficult.

road and airport[4] infrastructure. In the first line of Table 3.1 we propose two variants: one where we take a high estimate for ε (close to 0.7), representing relatively modest returns to scale, so that, if Γ equals one, only 30% needs to come from public funds (moderate subsidy); and a variant where ε is around 0.3, such that 70% of the investment costs needs to come from public money (high subsidy). These contributions will be reduced if the cost of raising public money is greater than one.

The second key idea is that national infrastructure can only claim EU subsidies according to the share of transit (through) traffic on its territory. Subsidies for through traffic are necessary in order to give incentives to construct enough capacity for through traffic too. On the other hand if a much larger share of local investments would be paid by EU funds, there would be a strong political pressure for EU subsidies as this would have, in this case; a strong pure aid element leading to pork-barrel politics (as exemplified by the federal systems in the US and Germany (see Deliverable 1, Chapters 6 and 7)).

The third key idea is that public funds are in general costly as they require taxes that distort in general labour markets. The higher the costs of public money, represented by the marginal cost of public funds, the smaller should be the share of public subsidies and the higher the share of user fees.

For the equity scenario, using the moderate subsidy scheme as a basis, an additional EU subsidy is added for the poorest countries. The subsidy rate, *s*, depends on relative income.

So the moderate aid scenario does not provide any public aid for capacity expansion in roads or airports and provides a maximum of 20% in the high aid scenario. Again this value will be adjusted as a function of the marginal cost of public funds. In the case of roads one should not forget that the present fuel taxes are already an important user charge and at airports, airline charges. Note that there is no distributional subsidy for roads and airports as they can finance their infrastructure by user charges and it is efficient to do so.

The internal cost recovery ratio can be increased by charging higher user charges than the ones proposed in Table 3.1 but at a high efficiency cost. If there is an underpriced existing substitute for this project (typically road or air traffic are substitutes for a rail project), there will be an additional welfare loss when the cost recovery ratio is increased since part of the users that decided not to use the overpriced mode anymore will switch to the underpriced mode (road, air) and increase the existing inefficiency. In the case of rail TEN-Ts, the substitution mode is often interurban road or air and it is important to know whether prices for these modes are too low or not. Prices that are too low are a clear justification for lower cost recovery requirements in rail or IWW.

Car and truck use is mostly underpriced in urban areas and in the peak. This is less the case for interurban traffic because cars and trucks are becoming much cleaner than in the past, there is an important fuel tax, congestion is limited and congestion pricing is

[4] For road and airports, there is more evidence that the degree of returns to scale is close to 1 (i.e. constant returns to scale). It would appear that airports enjoy increasing returns-to-scale up to approximately 3 million passengers per year, beyond which they reach constant returns-to-scale

making its way on the most acute segments. As regards air travel, there is indeed an air pollution cost that is not internalised but some of the air traffic prices have also an important monopolistic margin so that again underpricing has to be shown on a case by case basis.

3.2 Conditions for obtaining EU infrastructure aid

There are three conditions that need to be linked to the infrastructure aid scenario. The first is co-funding by the region or member state in proportion to its share of traffic.

The second condition is the correct pricing of the users of the infrastructure. Indeed the presence of many foreign users implies that there is the potential for misuse of user pricing. Deliverable 1 (Chapter 3) has shown that the pricing inefficiency generated by uncontrolled pricing by member states or by the private of public operators they control, will be larger when the share of transit is large and when the investment is part of a corridor or a serial network. As the level of EU aid is larger for projects with many transit users, one may need to link pricing restrictions to the investment cost subsidy.
In addition, in the case of corridor projects (where one infrastructure project runs through different member countries), member states have a tendency to set excessively high prices. The main problem is that every member country (or regional government) will try to use its monopoly power to extract revenue from transit. The double marginalization problem can be avoided by ensuring that corridor projects are carried out by one company operating in several member states.

The third condition is that the subsidy contains sufficient guarantees for an efficient procurement procedure. This could require that the European Commission uses fixed cost estimates by type of infrastructure project so that the incentive for cost minimization is with the member country and the infrastructure owner. This could also involve bundling investment and operation [5](see EIB, 2005).

3.3 Form of the public aid

We suggest that the public aid is given under the form of a grant or a financial equivalent. Future user charges are an important part of the funding of the investments. These user charges are uncertain because of many factors: demand may not be realised or there may be operational problems. In order to advance the realisation of TEN-Ts, the EU may be tempted to cover the risk on future user charges by guaranteeing private loans or give loans to particular projects itself. As the EU is no better informed of the risks than the other parties involved, member states and operators may be tempted to present inferior projects with a high probability of lower than expected user payments.

It may be preferable that the EU does not take on the risk on future user charges so that these risks are born either by the member states or by the private partners involved. The experience in the US (FHTF) and in Europe points to the large risk of federal funds

[5] European Investment Bank (2005): *Innovative financing of infrastructure – the role of public-private partnerships.* EIB Papers, Vols 1 & 2

being misused to favour local interests. Private partners can be involved via PPP constructions. This requires a case by case discussion[6]

3.4 The organisation of the EU fund

Clearly it is possible to distinguish between the fund and the bodies that administer it. Indeed there are a number of candidates in the EU: the European Commission, the EIB, a specialised executive agency, etc. However, the simplest case, in line with current experience, is that a single agency administers the fund and we only discuss the rules and tasks relating to this simple set-up.

The political and financial autonomy of the fund are two important related questions. Most existing funds are not politically autonomous. Political autonomy not only has an impact on project selection but the ability of the fund to offer long term support can also be important for attracting private capital. Financial autonomy is crucial if money is to be borrowed on the capital markets or if money for the funds is raised from user charges and transport sector taxes.

[6] See the documentation of the British and EIB experience in EIB (2005).

4 Computing Revenues from Pricing and Possible Financing Gaps

In Deliverable 3 we study the possibilities of financing an infrastructure fund through additional levies on the transport sector. We proceed in a number of steps. Firstly, revenues from pricing and taxation are computed per mode and per country over the period 2005-2020 for the EU transport baseline scenario. This first objective allows us to assess the current situation as regards revenue raised from taxation on the transport sector and how this compares both with existing costs and with the expected investment costs of the priority TEN-T axes. Next, in order to determine how the public aid requirements for the Deliverable 2 moderate and high subsidy scenarios (see above Chapter 3 of this text) could be financed by mark-ups on the transport sector, we calculate how much money we need to raise in the transport sector in each case. A detailed comparison of taxes and marginal external costs is then carried out in order to gain some insights into the most efficient reform of taxes in the transport sector. The analysis is differentiated by vehicle type, time period, type of infrastructure and country. This leads to the development of possible taxation scenarios which could be used to finance the infrastructure fund under both the moderate and high subsidy schemes. Note that the equity scheme is not considered explicitly in this report as the amount of tax revenue required to finance it does not differ significantly from the moderate subsidy scheme.

The TREMOVE FUNDING scenarios consist of:

- ‘Subsidy and toll’ scenario, which represents the case of moderate subsidies for infrastructure combined with the implementation of an additional road toll differentiated by vehicle type
- ‘Subsidy and detailed toll’ scenario, which represents the case of moderate subsidies for infrastructure combined with the implementation of an additional road toll differentiated by vehicle type, time period and geographical area
- ‘Subsidy and detailed country-specific toll’ scenario, which represents the case of moderate subsidies for infrastructure combined with the implementation of an additional road toll differentiated by vehicle type, time period, geographical area and country
- ‘Subsidy and fuel tax’ scenario, which represents the case of moderate subsidies for infrastructure combined with the implementation of an additional fuel tax differentiated by type of fuel and applied to all modes

The resulting eight transport tax revenue scenarios are evaluated with the TREMOVE model, which is used to compute their effects on revenue streams and welfare (efficiency). These are compared to the ‘Do nothing’ (N) scenario, which is identical to the TREMOVE baseline and corresponds to the present infrastructure funding system.

The principal results are summarised in Table 4.1. The total tax revenue needs (first line in Table 4.1) were derived from applying the subsidy scenarios derived above to the priority list of TEN-Ts. These scenarios include an important share of users’ contributions and result in rather modest public subsidy requirements for the TEN-T investments. The tax revenue needs indicated in the first line of the table include the contribution of the EU and of the member state.

	Moderate subsidy scenario	High subsidy scenario
Total extra tax revenue needed per year (billion Euro)	3.84	15.13
Welfare cost ratio of raising 1 EURO in the transport sector in 2010		
Simple road toll	1,016	1,019
Road toll differentiated by vehicle type, time and location	0,996	1,015
Road toll differentiated by vehicle type, time, location and country	0,949	0,964
Additional fuel tax	0,997	1,001

Table 4.1 Tax revenue needs and cost of raising extra tax revenues in the transport sector

Table 4.1also reports the welfare cost of raising extra tax revenues in the transport sector via the different tax scenarios. The welfare cost is defined by the ratio:

$$\frac{\text{additional tax revenues} + \text{welfare loss of raising revenue}}{\text{additional tax revenues}}$$

Overall we see a cost per euro raised that is close to one or even as low as 0.95 if one opts for a sophisticated road toll. The most differentiated road toll performs best under both subsidy scenarios, followed by the fuel tax. This is because marginal external costs can differ quite strongly between countries. The fuel tax is also not limited to road modes.

A few caveats are in order when interpreting these results. Firstly, we limit the welfare assessment to the transport sector and there could be important effects on other markets like the labour market (e.g. the effect of commuting costs on labour supply). Secondly, we do not take into account the extra transaction costs associated with the implementation of more sophisticated tax systems. Finally, the welfare cost of the fuel tax scenarios could be higher as some of the unintended effects (such as substitution by more fuel efficient cars) are missing.

The overall conclusion is that more tax revenues can be raised in the transport sector at a limited welfare cost. This welfare cost ratio needs to be compared to the welfare cost of the alternatives (raising general tax revenues outside the transport sector, for which, in the case of labour taxes, the cost could be 1.2 or more[7]) or raising users' pricing through tariffs or tolls.

[7] The MCPF depends on the country's tax structure and on the tax used to collect extra revenues. On the basis of Kleven H.& Kreiner C.(2003)["The marginal cost of public funds in OECD countries: hours of work versus labour force participation" CESifo Working paper n°935] a value of 1.2 appears to be a conservative lower bound for EU countries.

5 Testing the European-wide spatial equity and efficiency impacts of the transport priority TEN-T

In this chapter, we explore the regional economic impacts of 22 priority projects of the Trans-European Transport Networks and examine the efficiency and equity effects of a European infrastructure fund scenario. For the assessment, we use the CGEurope model, which is designed to model the economic welfare effects of developments in transport infrastructure on the European scale with large regional detail. For each individual project, we compute the overall net benefit of the project for the EU as a whole and the regional distribution of the benefits. Next, it is assessed whether the countries responsible for the investments have sufficient local benefits to take on the projects and whether an EU subsidy equal to the benefit spillovers in other countries (EU value added) will change the incentives for the investment. As the EU subsidy is paid for by a levy on all EU countries, the net benefit computation, together with the subsidy and the financing of the subsidy is the information used to assess the equity effect of the proposed EU subsidy scheme.
The model used in this deliverable has the advantage of covering the whole of the EU and has a large spatial detail. It is as such not the best model to assess an individual transport project but is suited to assess the regional distribution of the benefits of transport projects and the subsidy schemes proposed.

The CGEurope model

CGEurope is a multiregional spatial computable general equilibrium model, in which transport costs explicitly appear as firms' expenditures for transport and business travel. It works with the assumption of the market forms of monopolistic competition in each region for the markets of tradable goods and perfect competition for local goods and for factor markets. The production functions are linear homogeneous nested CD-CES functions. As a response to transport infrastructure investments, prices as well as quantities react to changes in transport cost and times resulting in changes in income and welfare in each region.
The main indicator for the regional consequences is the welfare change of regional households as measured by the household’s utility function, which is transformed to the so-called Hick’s measures of variation, which measures the welfare change as the monetary equivalent. The focus of the CGEurope model is on evaluating welfare effects in a comparative static equilibrium analysis, that means by comparing cases “with” and “without”, leaving everything else unchanged. It studies welfare gains and losses for the representative household of each region given the spatial distribution of factors of production.

The evaluation of the situation with and without is done by the definition of scenarios, in which travel times and costs before and after the implementation of certain transport policies are computed by deriving these costs for each region pair by shortest route algorithm. Based on these transport costs and times and actual national trade flows, interregional trade flows are calibrated. As the CGEurope model is a model with a consistent microeconomic foundation of preference-based consumer behaviour, the equivalent variation of household welfare can be derived for each policy scenario. This measure is calculated for whole Europe on NUTS-2 level for 22 of the TEN priority projects separately. Model tests have indeed shown that this project by project assessment is a good first approximation because the interaction between projects is limited.

Policy scenarios

In order to analyse the spatial impacts of the priority projects for the regions of the European Union with the CGEurope model, each priority project of the trans-European transport projects (TEN-T) is considered individually. For each project, two policy scenarios are assessed: one without any EU subsidy and one with an EU subsidy proportional to the benefit spillovers (outside the investing countries), where the subsidy is financed by a levy proportional to the GDP of the country.

Comparing the scenarios with and without subsidies allows the economic efficiency and the regional equity of the EU subsidy scheme to be assessed.

Welfare effects and European Added Value or regional benefit spillovers

The main output of CGEurope is the equivalent variation by NUTS-2 region and scenario. The equivalent variation of a policy is the amount of money that must be added to the household's benchmark income (everything else held constant at benchmark levels), in order to bring the household the same utility as under the policy change. It is not the same as the income increase generated by the policy change, because, following the freight transport cost changes, other variables (e.g. prices and number of product varieties) also change.

Priority rail project	No
High speed train combined transport North-South, incl Messina bridge	1
High speed rail Paris-Cologne-Amsterdam-London	2
High speed rail south: Madrid-Barcelon-Montpellier/Madrid-Dax	3
High speed rail Paris-Karlsruhe / Luxembourg / Saarbruecken	4
Betuwe line Rotterdam-Rhein/Ruhr	5
High-speed rail Lyon-Venice-Trieste/Koper-Ljubljana-Budapest	6
Greek motorways (Via Egnatia, Pathe), motorways in Bulgaria and Romania	7
Multimodal link Portugal-Spain-Central Europe	8
Nordic triangle	12
Ireland / UK / Benelux road link	13
West coast main line	14
High capacity rail across the Pyrenees, freight line Sines-Badajoz	16
High speed train, combined transport East-West	17
Fixed link Fehmarn Belt	20
Rail Athina-Kulata-Sofia-Budapest-Vienna-Praha-Nuernberg	22
Rail Gdansk-Warsaw-Katowice-Brno/Zilinia	23
Rail Lyon/Geneva-Basel-Duisburg-Rotterdam-Antwerp	24
Motorway Gdansk-Katowice-Brno-Vienna	25
Multi-modal link Ireland/UK/continental Europe	26
Rail Baltica	27
Eurocaprail Brussels-Luxembourg-Strasbourg	28
Intermodal corridor Ioannian Sea/Adria	29

Table 5.1 Priority projects in FUNDING WP4 scenarios

This measure is calculated for each region in the general equilibrium when we deal with changes of freight transport costs and their impact on households' demand. On top of this, we add the benefits for the passengers that originate from the respective region. The direct cost savings approximate these benefits for the passengers. The direct cost savings are the difference of the price of a trip in the reference situation minus the price in the policy scenario multiplied by the numbers of passengers doing that trip in the reference situation.

Assessment of the regional efficiency and equity impacts of the TEN priority projects

This analysis is strongly simplified when it comes to the analysis of individual projects, as it is not a full CBA of the project, but has the advantage of analysing all projects in a consistent way. The results help us answer the following questions:

1. How do different member countries share the benefits and costs of the TEN projects? Is there an important spillover of benefits to other member countries?
2. What is the rate of return of each project for the country making the investment in the absence of EU subsidies?
3. If the EU were to provide a subsidy equal to the sum of spillover benefits to the other countries, how would this affect the incentives for the investing countries?
4. What would be the equity effect of such a subsidy, would these EU subsidies benefit mostly the poorer EU countries?

Table 5.2 below summarizes the answers to these questions for 22 priority projects.

Firstly it shows that the EU-wide annual rate of return (third column of Table 5.2) for all projects is positive, but for most projects it is low and lies below the benchmark rate of 5% on the invested sum per year. The rates vary from nearly zero for the Betuwe Line and the intermodal corridor Ioannian Sea/Adria up to 23.5% for the multimodal link Ireland/UK/continental Europe. In general, the newer projects, which have been added in the last revision of the TEN, have a higher rate of return, than the projects of the old list of 20 projects. However, one has to keep in mind that CGEurope does not represent a full CBA of each project, because it does not take account of most external effects like noise, accidents, and pollution. Changes in congestion are not explicitly modelled in the transport network database, but are taken account of through travel times and link speeds. The gains for local transport are also not included. So one cannot directly draw the conclusion that these projects are not beneficial. Nevertheless, regarding the direct and indirect economic effects as they are modelled in CGEurope, most projects perform rather poorly.

Secondly, we see that in many cases the share of the non investing (“other”) countries in the benefits of the project (see column 5 in Table 5.2) is rather low, which is surprising given the fact that they were selected under the criterion that they are cross-border and benefiting the EU. Among the projects on the list, four projects even have a negative impact in other countries, namely projects no. 13, 16, 26 and 27. On the other hand, some projects have a low internal rate of return, but provide a relatively high share of the benefits in other countries. These are projects no. 2, 5 and 17. In addition, we have four projects that have a high internal rate of return of over 5% and a high share of benefits in other countries, which are projects no. 8, 20, 23, and 25

Thirdly we find that, for some projects, the provision of the EU subsidy increases the internal rate of return to the investors significantly and may induce them to take better into account the European value added of these projects (see Table 5.2, column 8). But in none of the cases is the EU subsidy sufficient to increase the return of an unprofitable project over the threshold of 5%.

Lastly, as far as the equity issues are concerned, some of the 22 projects benefit mostly the richer countries and other projects benefit mostly the poorer countries. Some projects qualify for an important EU subsidy because they have important spillover benefits. Do the projects that qualify for these high subsidies benefit mostly the poorer or the richer countries when account is taken of who receives the benefits and the subsidies and who pays for the investment costs and the financing of the subsidies? Of the 6 projects that qualify for large subsidies (2,7,8,17,20,25), four have a negative correlation (see Table 5.2, last column) between net benefits and per capita GDP (thus favouring poorer regions relatively more), but two have a positive correlation. Drawing conclusions on this basis is difficult but it cannot be argued that the proposed EU subsidy scheme systematically hurts the poorer countries.

The methodology developed in this work package provides a useful “benefit distribution” rule for determining whether transport infrastructure projects generate European added value and should therefore be subsidised by the EU. It complements the “transit share” approach proposed in Deliverable D2.

The spatial effects of increased mark ups on the TEN-Ts are not modelled, since the redistribution of benefits from user charge revenues will clearly depend on the national tax system of the member states and the regional redistribution rules imposed (the CGE model has many regions in each country). Such detailed modelling of taxation and redistribution is beyond the scope of CGEurope and merits a study in its own right. We rather exploit the full potential of the model to assess the distribution of benefits from the priority TEN-T projects on a case-by-case basis.

Project #	Name of the project	EFFICIENCY: EU-wide yearly rate of return, %	Share of total welfare effect on investing countries, %	Share of total welfare effect on other EU-27 countries, %	Maximum subsidy size, mln. euro per year	Yearly rate of return for the investing countries without a subsidy, %	Yearly rate of return for the investing countries with a subsidy, %	EQUITY: Correlation between the predicted regional welfare effects and GDP per capita, %
1	HSR combined transport North-South	1,46	97	3	24,47	1,41	1,46	-9,55
2	HSR Paris-Cologne-Amsterdam-London	1,96	55	46	216,51	1,05	1,96	4,00
3	HSR south: Madrid-Barcelon-Montpellier/Madrid-Dax	4,05	96	6	66,58	3,78	4,05	-4,43
4	High speed rail Paris-Karlsruhe / Luxembourg / Saarbruecken	4,72	97	4	8,26	4,57	4,72	6,36
5	Betuwe line Rotterdam-Rhein/Ruhr	0,01	62	42	0,22	0,01	0,01	3,50
6	HSR Lyon-Venice-Trieste/Koper-Ljubljana-Budapest	1,35	91	8	41,37	1,24	1,35	-19,83
7	Greek motorways (Via Egnatia, Pathe), motorways in Bulgaria and Romania	4,27	73	20	121,80	3,35	4,27	-12,07
8	Multimodal link Portugal-Spain-Central Europe	6,61	79	25	204,63	5,02	6,61	-13,51
12	Nordic triangle	1,90	91	5	14,71	1,80	1,90	13,97
13	Ireland / UK / Benelux road link	8,76	131	-15	0,00	9,89	9,89	18,69
14	West coast main line	1,13	93	7	14,80	1,04	1,13	17,60
16	HSR across the Pyrenees, freight line Sines-Badajoz	7,34	103	-1	0,00	7,44	7,44	-8,85
17	HSR combined transport East-West	4,68	51	50	244,41	2,37	4,68	-8,31
20	Fixed link Fehmarn Belt	9,94	56	39	229,67	5,76	9,94	2,68
22	Rail Athina-Kulata-Sofia-Budapest-Vienna-Praha-Nuernberg	7,94	80	18	83,46	6,52	7,94	-27,82
23	Rail Gdansk-Warsaw-Katowice-Brno/Zilinia	6,99	71	25	83,93	5,21	6,99	-32,47
24	Rail Lyon/Geneva-Basel-Duisburg-Rotterdam-Antwerp	2,74	97	2	8,72	2,68	2,74	7,42
25	Motorway Gdansk-Katowice-Brno-Vienna	8,91	73	26	167,27	6,60	8,91	-26,69
26	Multi-modal link Ireland/UK/continental Europe	23,49	123	-11	0,00	25,83	25,83	15,17
27	Rail Baltica	16,60	101	-6	0,00	17,57	17,57	-11,25
28	Eurocaprail Brussels-Luxembourg-Strasbourg	8,53	84	14	9,26	7,30	8,53	5,72
29	Intermodal corridor Ioannian Sea/Adria	0,04	86	15	0,07	0,04	0,04	-7,94
	TOTAL	3,49	86	14	1340,60	2,99	3,49	-11,84

Table 5.2 Summary of internal rates of return and distribution of welfare effects

6 Case Studies: How Do The Infrastructure Fund Scenarios Affect Existing Ten-T Projects?

The objective of Deliverable 5 is to test the effects of new EU subsidy rules as well as the possibilities to finance projects by internal mark-ups on a selection of "TEN" infrastructure projects. The subsidy rules that are proposed make the EU grant a function of the degree of economics of scale, the share of transit traffic and the co-financing by the member states.
The subsidy and mark up rules are tested with three different types of models. First, a new European wide "corridor" model is developed to analyse 4 HSR projects for passenger transport in which rail competes with air transport. Second, an existing "corridor" model is used to analyze two TEN-T freight projects: the Betuweline and the Brenner tunnel. Third a specific case study model (MOLINO-II) is developed to analyse the project economics in more detail for five TEN-T projects.

Table 6.1 gives the selected TEN-T projects and the models that have been used to analyse them. The selection process has taught us that, for the TEN-T projects we looked into, there is often no good documentation available. Despite the help of the European Commission services it was impossible to obtain a Cost Benefit Analysis (CBA) for most projects. This constitutes in itself an important finding: some of the publicly funded projects have not passed a published cost benefit test. Another implication is that for some projects our analysis is based on poor data and has to be considered with the necessary caveats.

Case study	Corridor model	Case study model MOLINO
TEN-T 1: HSR Germany, Austria and Italy	Full corridor with Passenger model	
	Full corridor with Freight model	Freight part with MOLINO
TEN-T 3: HSR France and Spain	Full corridor with Passenger model	Madrid-Barcelona-Montpellier MOLINO
TEN-T 6: HSR Italy, Slovenia and Hungary	Full corridor with Passenger model	
TEN-T 17: HSR France, Germany and Austria	Full corridor with Passenger model	
TEN-T 5: Betuwe line	Freight	MOLINO
TEN-T 23 + TEN-T 25: Gdansk - Vienna		MOLINO
Seine – Escaut		MOLINO

Table 6.1 Selected case studies and modelling framework

The analysis of HSR projects with the passenger corridor model

The corridor passenger model used computes the equilibrium on the European long distance network for rail and air travel that results from the competition between one European rail operator and 5 airlines. A distinction is made between 3 hub-spoke airlines and 2 low cost airlines. Only one European rail operator is distinguished for three reasons: this maximizes the profitability of the rail project (avoiding double marginalization), there is de facto often an institutionalized cooperation across countries (Eurostar, Thalys) and finally it is not clear what are the objectives of the different existing rail operators.

In the equilibrium the rail operator maximizes profits and competes in prices and frequencies with his airline competitors. A distinction is made between business and leisure trips. The model represents the equilibrium for different configurations of the European HSR: with or without the 4 TEN-T projects considered and also for different infrastructure charges imposed on the rail operators: covering the marginal cost only or covering the average cost that includes the investment costs of the HSR extensions. The main results are summarized in Table 6.2.

Infrastructure Type	*basic*	*basic*	*with TENs*	*with TENs*
Rail Access Charge (€/km)	***2***	***10***	***2***	***10***
Consumer Surplus	*83,485,405*	*33,364,426*	*113,082,572*	*46,028,103*
Producer Surplus	*64,108,178*	*57,264,677*	*78,613,071*	*55,108,986*
Environmental Charge	*21,015,200*	*21,660,113*	*22,285,323*	*22,095,678*
Air Taxes	*25,863,247*	*29,479,614*	*25,682,687*	*28,370,283*
Rail Taxes	*7,106,673*	*0*	*14,746,893*	*0*
Government Surplus	*64,782,145*	*61,367,672*	*75,257,882*	*60,559,153*
Externalities: Europe	*-42,437,503*	*-44,584,257*	*-42,711,291*	*-44,748,975*
Externalities: International	*-4,348,313*	*-4,269,366*	*-4,309,195*	*-4,285,381*
Fixed cost of TENs	*0*	*0*	*-13,423,589*	*-13,423,589*
Infrastructure Manager Surplus	*0*	*33,490*	*-13,423,589*	*-13,390,997*
Social Welfare	*165,589,912*	*103,176,642*	*206,509,450*	*99,270,889*

Table 6.2 Welfare assessment of 4 HSR TEN-T projects with the passenger corridor model

Table 6.2compares 4 different cases: without (cases 1 and 2) and with the investments (cases 3 and 4) and with marginal cost pricing by the infrastructure manager (case 1 and 3 where an access charge of 2 €/km is charged to the operator) or with average cost pricing by the rail infrastructure manager (10 €/km is charged).

It is only worthwhile improving the high-speed European rail network if the governments (member states and EU) are willing to subsidize the cost of the infrastructure upgrading to a large extent. The social welfare strictly decreases if the high-speed rail operator is charged more than the marginal social costs (€2 per kilometre access charges); in other terms the scope for funding the investment via higher mark-ups on the users is limited. This can be seen by comparing cases 3 with 1 and cases 4 and 3.

The least appropriate scenario tested would be to upgrade the TEN-T projects and not subsidize this investment so that the rail operators are charged a reasonably high access charge (in the region of €10 per kilometre, close to covering the average costs) leading to an inefficient use of the infrastructure. Charging the rail operator according to marginal cost of maintenance would be worthwhile and may qualify for an EU subsidy scheme given the very high levels of transit passengers on these routes.

The analysis of projects with the corridor Freight model

The STEMM model was developed in the ‘Strategic European Multimodal Modelling’ (STEMM) European collaborative research project under the Fourth Framework Research Programme (EU Commission, 2000). The model provides information on mode and multimodal route choice at a spatially disaggregated level, and can be used to analyse the impact of policy changes on the demand for freight transport in particular regions. Traffic is allocated to route/mode alternatives in relation to the modelled ‘utility’ of each alternative. STEMM considers the improvement in the overall situation of a shipper when there are additional alternatives using concept of ‘composite costs’. The model is used here to study the funding of the Betuwe route and of the Brenner tunnel. We concentrate on the results for the Betuweroute for which data quality is probably better.

The **Betuweroute** is a dedicated freight railway line across the Netherlands to Germany providing easier and more environment-friendly transport options into the port of Rotterdam. The line has been designed to move up to 74 million tonnes of freight a year, although initially it is expected to only attract half this amount. The line opened on June 16th 2007.

Table 6.3 reports the results of 4 alternatives. Each time the project is built but financed by a different combination of subsidies and increased user charges. All results reported are differences with the case where the Betuweline is not constructed. Prices for transporting a container are varied between 48 and 78 Euro, where 48 is the marginal cost and 63 the base level. None of the alternative user charge scenarios generates an increase in welfare: the welfare loss is almost equal to the cost of investment. It is also no surprise then that user charges on the Betuweline can in the best case only cover 5 to 10% of the investment.

Price (€) per container on Betuweroute	BASE 2020 with Betuwe 63				BASE + Betuwe + lower cost 48				BASE + Betuwe + higher cost 70.5				BASE + Betuwe + highest cost 78			
	Road	Train	Betuwe	IWW	Road	Train	Betuwe	IWW	Road	Train	Betuwe	IWW	Road	Train	Betuwe	IWW
TEUs (mill pa)	-0.2	0.2	0.3	-0.1	-0.4	0.4	0.6	-0.4	-0.1	0.1	0.2	-0.1	-0.1	0.1	0.1	-0.1
TEU kms (mill pa)	-19.2	24.9	45.0	-102.6	-42.6	78.2	95.5	-181.1	-14.8	25.1	34.9	-96.6	-12.5	40.2	13.6	-98.2
Revenue (Million € pa)	**-3.6**	**2.4**	**6.5**		**-8.0**	**7.5**	**0.0**		**-2.8**	**2.4**	**7.1**		**-2.3**	**3.9**	**4.6**	
Infrastructure costs	-0.7	0.2	0.2	0.0	-1.5	0.6	0.5	0.0	-0.5	0.2	0.2	0.0	-0.4	0.3	0.1	0.0
Noise costs	-0.4	0.0	0.0	0.0	-0.9	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	-0.2	0.0	0.0	0.0
External env.costs	-2.8	2.1	3.7	0.0	-6.2	6.4	7.9	0.0	-2.1	2.1	2.9	0.0	-1.8	3.3	1.1	0.0
Accident costs	-0.3	0.0	0.0	-0.2	-0.6	0.0	0.0	-0.4	-0.2	0.0	0.0	-0.2	-0.2	0.0	0.0	-0.2
Congestion costs	-16.5				-36.7				-12.7				-10.8			
External costs (Million € pa)	**-14.6**				**-30.7**				**-10.7**				**-8.8**			
Change in Consumer surplus (Million € pa)	0	0	0		0	0	5.6		0	0	-0.8		0	0	-0.6	
Annualised cost of Betuwe (Million € pa)	**117.1**				**117.1**				**117.1**				**117.1**			
Net Change in welfare (Million € pa)	**-97.3**				**-83.9**				**-99.8**				**-102.8**			

Table 6.3 Welfare effects of higher prices on the Betuwe rail line

The Brenner axis case study presents very similar results. As was found for the Betuweroute, the existence of viable alternative routes to the Brenner tunnel leads to relatively high elasticity of freight traffic demand with respect to user charges levied on the Brenner route. This is even more problematic in the Brenner case, because major improvements in freight capacity and journey time are also going ahead on the alternative routes. Tunnel schemes such as the Brenner base tunnel are extremely expensive, and mark-ups over marginal cost need to be relatively high if investment costs are to be recovered in a realistic period of time.

The analysis of 4 individual projects with the MOLINO model

The model MOLINO-II is designed to make cost benefit analyses and to test the impact of different pricing and investment rules on transport infrastructure. In principle every problem can be studied with a specific transport model. However, it may, for the EU or for an investor in general, be easier and more consistent to use the same simple model to assess very different projects.

The core of the model is a representation of the transport market with several alternatives. These alternatives can be different modes or parallel routes for the same mode in a given network context. Each alternative can be used for freight and passenger transport. The demand module for passenger transport features an aggregate nested CES utility function with three levels: choice between transport and consumption of a composite commodity, choice between peak and off-peak periods, and choice between the two transport alternatives. Elasticities of substitution at each level are parametrically given. Passengers can be segmented into classes that differ with respect to their travel preferences, incomes and costs of travel time. The core of MOLINO-II is completed with a financial fund module and with welfare functions that include external costs and public finance variables. Compared to the corridor passenger and freight model, MOLINO has a simpler network, analyses each time only one project but allows a wider range of pricing policies and a financial analysis.

For the analysis of the **Betuwe line**, MOLINO was used to assess the effects of different pricing scenarios on the economic and financial viability of this project. One scenario involved full marginal social cost pricing for all the modes. Full marginal social cost pricing performs indeed better than current pricing but it did not turn the Betuweline into a good investment project. The Betuweline has only a small market share and the net discounted cash flow is negative and close to the investment cost. In conclusion the project is economically not justified and can only survive financially with a subsidy that covers close to 100% of the initial investment sum. The MOLINO model corroborates fully the analysis with the freight corridor model.

The **Gdansk–Vienna/Bratislava corridor** is a roughly 900 km long North-South corridor, linking the Baltic Sea port of Gdansk to the Central European capital cities Vienna and Bratislava. Within the TEN-T priority projects a road project (PP25) and a rail project (PP23) are planned in this corridor. The case study area was limited to the Polish part of the corridor. The overall investment on the whole corridor is 7,800 millions Euros for PP25 (road) and 5,500 million Euros for PP23 (rail).

Scenario	Infrastructure	No TEN-T project		Road project only			Rail project only			Road and rail project		
	Pricing	Existing (baseline)	MSC toll	Existing	MSC toll	Max. cost recovery	Existing	MSC toll	Max. cost recovery	Existing	MSC toll	Max. cost recovery
	Code	A0	A1	B0	B1	B2	C0	C1	C2	D0	D1	D2
Passenger transport users' surplus												
Domestic		1.507.500	-10.300	1.200	-9.200	0	700	-9.600	0	1.900	-8.500	0
Inbound/outgoing		157.000	-1.000	100	-900	0	0	-1.000	0	100	-900	0
Transit		37.300	-200	0	-200	0	0	-200	0	0	-200	0
Freight transport users' costs												
Domestic		557.500	-8.500	300	-8.300	0	300	-8.200	0	600	-7.900	0
Import/export		259.300	-2.700	100	-2.700	0	0	-2.700	0	100	-2.600	0
Transit		24.100	-300	0	-300	0	0	-300	0	0	-300	0
Passenger transport users' surplus minus freight transport users' costs												
Domestic		898.800	-20.600	1.600	-19.300	0	1.000	-19.600	0	2.600	-18.200	0
Foreign		-37.900	-2.400	100	-2.300	0	100	-2.300	0	200	-2.200	0
Domestic+foreign		860.900	-23.000	1.700	-21.600	0	1.100	-22.000	0	2.800	-20.400	0
Toll revenues												
Road (PP25)		0	19.000	0	19.100	1.700	0	19.000	0	0	19.100	1.700
Rail (PP24)		2.900	2.200	0	2.200	0	100	2.300	1.000	100	2.300	1.000
Infrastructure costs												
Investment - road (PP25)		0	0	-2.200	-2.200	-2.200	0	0	0	-2.200	-2.200	-2.200
Investment - rail (PP23)		0	0	0	0	0	-1.400	-1.400	-1.400	-1.400	-1.400	-1.400
Salvage value - road (PP25		0	0	1.200	1.200	1.200	0	0	0	1.200	1.200	1.200
Salvage value - rail (PP23)		0	0	0	0	0	800	800	800	800	800	800
Operation costs - road (PP2		1.200	300	-100	200	-100	0	300	0	-100	200	-100
Operation costs - rail (PP23		500	0	0	0	0	0	0	0	0	0	0
Tax revenues												
Poland (national governmen		3.800	-600	0	-600	0	0	-600	0	0	-600	0
Users' surplus after allocation of tax revenues & profits												
Domestic		903.800	200	500	700	600	400	600	400	900	1.000	900
Foreign		-37.900	-2.400	100	-2.300	0	100	-2.300	0	200	-2.200	0
Total		866.000	-2.200	600	-1.700	600	500	-1.700	400	1.100	-1.200	900
External costs (excl. congestion)												
External cost		27.000	4.200	-300	4.000	0	0	4.200	0	-300	4.000	0
Total welfare												
Domestic		876.900	4.400	200	4.700	600	400	4.800	400	600	5.100	900
Foreign		-37.900	-2.400	100	-2.300	0	100	-2.300	0	200	-2.200	0
Total		839.000	2.000	300	2.400	600	500	2.500	400	800	2.800	900

Scenario	Infrastructure	No TEN-T project		Road project only			Rail project only			Road and rail project		
	Pricing	Existing (baseline)	MSC toll	Existing	MSC toll	Max. cost recovery	Existing	MSC toll	Max. cost recovery	Existing	MSC toll	Max. cost recovery
	Code	A0	A1	B0	B1	B2	C0	C1	C2	D0	D1	D2
Passenger transport users' surplus												
Domestic		1.507.500	-10.300	1.200	-9.200	0	700	-9.600	0	1.900	-8.500	0
Inbound/outgoing		157.000	-1.000	100	-900	0	0	-1.000	0	100	-900	0
Transit		37.300	-200	0	-200	0	0	-200	0	0	-200	0
Freight transport users' costs												
Domestic		557.500	-8.500	300	-8.300	0	300	-8.200	0	600	-7.900	0
Import/export		259.300	-2.700	100	-2.700	0	0	-2.700	0	100	-2.600	0
Transit		24.100	-300	0	-300	0	0	-300	0	0	-300	0
Passenger transport users' surplus minus freight transport users' costs												
Domestic		898.800	-20.600	1.600	-19.300	0	1.000	-19.600	0	2.600	-18.200	0
Foreign		-37.900	-2.400	100	-2.300	0	100	-2.300	0	200	-2.200	0
Domestic+foreign		860.900	-23.000	1.700	-21.600	0	1.100	-22.000	0	2.800	-20.400	0
Toll revenues												
Road (PP25)		0	19.000	0	19.100	1.700	0	19.000	0	0	19.100	1.700
Rail (PP24)		2.900	2.200	0	2.200	0	100	2.300	1.000	100	2.300	1.000
Infrastructure costs												
Investment - road (PP25)		0	0	-2.200	-2.200	-2.200	0	0	0	-2.200	-2.200	-2.200
Investment - rail (PP23)		0	0	0	0	0	-1.400	-1.400	-1.400	-1.400	-1.400	-1.400
Salvage value - road (PP25		0	0	1.200	1.200	1.200	0	0	0	1.200	1.200	1.200
Salvage value - rail (PP23)		0	0	0	0	0	800	800	800	800	800	800
Operation costs - road (PP2		1.200	300	-100	200	-100	0	300	0	-100	200	-100
Operation costs - rail (PP23		500	0	0	0	0	0	0	0	0	0	0
Tax revenues												
Poland (national governmen		3.800	-600	0	-600	0	0	-600	0	0	-600	0
Users' surplus after allocation of tax revenues & profits												
Domestic		903.800	200	500	700	600	400	600	400	900	1.000	900
Foreign		-37.900	-2.400	100	-2.300	0	100	-2.300	0	200	-2.200	0
Total		866.000	-2.200	600	-1.700	600	500	-1.700	400	1.100	-1.200	900
External costs (excl. congestion)												
External cost		27.000	4.200	-300	4.000	0	0	4.200	0	-300	4.000	0
Total welfare												
Domestic		876.900	4.400	200	4.700	600	400	4.800	400	600	5.100	900
Foreign		-37.900	-2.400	100	-2.300	0	100	-2.300	0	200	-2.200	0
Total		839.000	2.000	300	2.400	600	500	2.500	400	800	2.800	900

Table 6.4 Welfare effects of different combinations of pricing for the Gdansk- Vienna TEN projects

Table 6.4 reports the main results of four different investment scenarios. The first column gives the values for the baseline scenario in which no new road or rail investment is made. In the three other scenarios, one constructs either, only the new road, only the new rail, or both. For each investment project, three pricing scenarios are considered: current pricing, marginal social cost pricing and maximum cost recovery. Current pricing means no road pricing and average cost rail access charges. The maximum cost recovery scenario means that the operator can completely skim the generalised cost savings of the users that are due to the investment. This means that traffic levels do not change but the operator increases his profits strongly and he absorbs all the gains in consumer surplus[8].

Contrary to the Betuweline and the Brenner tunnel project, both rail and road projects as well as their combination generate welfare gains and this holds for the three pricing regimes. By far the best welfare result is achieved with marginal social cost pricing. Marginal social cost pricing would also generate much larger revenues for the rail and road operators. Another characteristic of this project is the low share of the transit users. The economic performance of this project is good but the revenues with the current pricing are insufficient to finance the investment. The maximum cost recovery scenario generates revenues that are sufficient to finance the investments of rail and road (after taking into account the salvage values). It is only when current pricing stays in place that there is a potential need for an EU infrastructure grant. The role should be limited as most benefits concern national traffic and as the two projects can, when pricing of all modes is improved, largely finance the project themselves.

The **Brenner tunnel** (important part of the TEN-T project N°1 (Rail-Axis Berlin – Palermo) was also analysed with MOLINO II. The tunnel will be dedicated to rail transport only and will cost at least 4.5 Billion EUR. Table 6.5 reports the welfare effects (without investment costs) of constructing the Brenner tunnel for different types of pricing and corresponding subsidy regimes, if only freight traffic is taken into account.

Comparing the net benefits after 9 years of operation with the investment cost of 4500 Million Euro, even the best pricing scenario (MSC pricing) only generates net benefits of less than 5% of the total investment. In economic terms this is a very poor project and this confirms the analysis with the freight corridor model. Applying our subsidy rule, we take into account that 50% of traffic is transit traffic, so that the EU subsidy would be less than 35% of the investment costs. The countries that need to make the investment are probably never interested to start this project and they are right if economic efficiency is their main objective.

[8] The operator could increase his profits more by lowering his user charge if demand is strongly price elastic.

	Base Scenario without project	Scenario 1 Current pricing with project	Scenario 2 MSC pricing without project	Scenario 3 MSC pricing with project	Scenario 4 Max cost recovery pricing with project
Toll Revenues					
Operator Brenner Rail	57.4	59.9	26.5	27.6	231,2
Operator Brenner Road	635.6	627.3	834.3	823.4	635.2
Maintenance Cost					
Brenner Rail	2.7	45.1	3.1	45.5	45.0
Tax revenues (fuel taxes)					
Austria	198.5	196.6	172.4	170.8	198.4
Other countries	1,686.3	1,674.0	1,528.9	1,517.6	1,684.4
External costs					
Brenner Rail	20.3	21.2	23.2	24.2	20.3
Brenner Road	738.1	730.8	639.9	633.1	737.7
Total	6,070.1	6,045.5	5,622.5	5,602.0	6,068.2
Welfare Change	**-**	**+ 220.4**	**- 116.0**	**+ 104.8**	**+ 203.0**

Table 6.5 Discounted sum of welfare effects for 9 years of operation in Million Euro before investment costs (4500 million Euro)

The aim of the **Seine-Scheldt** project is to connect Belgium and the Netherlands, especially the ports of Rotterdam and Antwerp, to northern France and Paris via inland waterways. The main bottleneck for inland waterway transport in this region is the Canal du Nord between Compiegne and Cambrai. Navigability on that section is at the lower end of international standards, with access restricted to vessels of about 300 tons on some stretches. This canal will be replaced by a new large-gauge canal, which allows the passing of barges with a loading capacity up to 4,400 tonnes. Belgium also plans to improve navigability on the axis north of this bottleneck. We concentrate our analysis on the newly constructed canal between Compiegne and Cambrai as it is the most important investment project planned for this axis. The canal will cost at least 2.3 billion EUR and is planned to be in use in 2012.

Table 6.6 reports the main elements of the analysis. Again we find rather poor welfare benefits: in the first 9 years of operation, the net benefits are of the order of 5 to 10% of the total investment. Usually, it is argued that freight traffic should cover only a fraction of the investment costs, since a canal creates additional benefits, i.e. water management, flood protection, recreational vessels, and recreational facilities on embankments and electric power generation. This means that the net benefits only need to cover 50 to 70% of the investments. Also this lower benefit threshold is not reached. As regards the funding of the investment, it appears that an EU subsidy according to our subsidy rule would never be a sufficient incentive to start this project. Internal mark-ups would, even in the presence of MSC pricing on other modes, will also be insufficient to cover a significant part of the investment costs.

	Base Scenario : current pricing without the project	Scenario 1 Current pricing with Project	Scenario 2 MSC pricing without the project	Scenario 3 MSC pricing with Project	Scenario 4 Max cost recovery pricing with project
Toll Revenues					
Operator IWW	4.3	5.4	108.1	118.8	157.4
Operator Road	1,771.3	1,760.3	4,753.4	4,726.2	1,771.3
Operator Rail	14.8	14.7	107.4	106.7	14.8
Maintenance Costs					
IWW Picardie	3.2	11.8	3.8	12.4	11.4
External Costs					
IWW Picardie	87.9	98.1	104.4	114.7	87.9
Road Picardie	4,731.3	4,702.0	4,481.8	4,456.1	4,730.8
Rail Picardie	81.7	81.1	103.4	102.7	81.6
Sum External Costs	4,900.9	4,881.2	4,689.6	4,673.5	4,900.3
Welfare Changes	**-**	**+ 203.4**	**+ 95.5**	**+ 296.6**	**+ 166.9**

Table 6.6 Discounted sum of Welfare effects for 9 years of operation (2012-2020) in Million Euros before investment costs (2170 million Euros)

What is the effect of the European infrastructure aid we suggest on a selection of the 30 priority Ten's?

The 3 freight corridor projects analysed had in general poor net economic benefits. The proposed EU subsidy rules in combination with improved pricing of competing modes would not make these projects economic. Most projects would require a subsidy of close to 100% of the initial infrastructure investment to make them financially viable.

The different HSR projects could survive the competition of air transport if the rail infrastructure managers charge the rail operators the marginal infrastructure rather than the average infrastructure cost. The HSR projects could be economically worthwhile if infrastructure managers receive an EU and member state subsidy covering a large fraction of the investment cost.

What are the appropriate modelling tools to assess the effects of a subsidy scheme?

There is no generally accepted cost benefit guide for assessing transport infrastructure projects in the EU. This means that there is a large risk of a positive bias in project assessments. There is also no obligation to have a publicly available cost benefit assessment for the TEN-Ts. Under these conditions there is a clear need for models that can help to form a second opinion on projects that apply for EU funding. Three different models of varying complexity and regional focus have been assessed and found useful to help in the EU and member state decision making.

7 Policy Conclusions

In this chapter, we draw upon the conclusions of the preceding work packages to present a scientifically sound approach the funding of transport infrastructure through an EU level fund and direct user charges. As part of this approach, a number of modelling tools were used to test the effect of subsidising infrastructure projects. These are summarised below. The general conclusions are then formulated in terms of a series of policy questions.

7.1 Modelling tools to test the effect of subsidising infrastructure projects

The objective of our modelling efforts was not to make a fresh cost benefit analysis but to analyse how, with a minimum of data, interested parties like the EU or member states subsidising projects could assess the economics and the need and effects of subsidies. Two important elements in the assessment were to take into account the EU value added of the project (the network or corridor effect) and the role of pricing. Our experience with the four types of models used in FUNDING to assess investment subsidies is summarized in Table 7.1.

	CGEurope Model	PASSENGER CORRIDOR model	FREIGHT CORRIDOR model	MOLINO – II
Characteristics	Model for interregional trade and regional activity in EU	Model for EU long distance passenger market	Model for a freight corridor	Model for any case study that can be represented as a small network
Technical level (portability)	High level of sophistication, not portable	High level of sophistication, not portable	Existing model, traditional model technology, not portable	Medium, in principle portable
Transport effects	Aggregate level	Detailed for network considered	Detailed for network considered	limited to case study area considered
European value added	Detailed, including the macro-effects	Detailed	detailed	Yes if network considers links to other countries
Pricing variants	Pricing of commodities is endogenous,	Endogenous (Nash pricing) and exogenous	exogenous	Limited Endogenous (Nash pricing) and exogenous
Economic assessment	Yes, aggregate, focussing more on freight transport	Yes	Has to be added on top of transport effects	Yes - extensive
Financial assessment	No	No – possible ex-post	No – possible ex post	Yes
Ideal for	Checking regional implications of a large investment project	Assessing HSR or airport strategy for passengers (investment, pricing, regulations)	Assessing investment in freight corridors	Assessing pricing and investment of one particular project

Table 7.1 Role of different models in assessment of TEN-T subsidies

As is mostly the case, no model answers all the questions. The CGEurope model was an established model that had already been used to assess EU wide effects of investment and pricing strategies. The freight corridor model was an established model that is available to make project assessments of TEN projects. The two other models are to a large extent products of FUNDING. The passenger long distance model appeared necessary to cover the strategic interaction between the pricing of air and the pricing and supply of long distance rail. The model is ideally continuously available to assist the investment, frequency of service and pricing decisions in this domain. The MOLINO II model is developed more as an instrument to check existing project proposals in a unified framework.

As there is no generally accepted methodology for cost benefit analysis at EU level (cfr.discussions on RAILPAG at EIB and discussions on handbook of DG-REGIO), there is a risk of a positive bias in studies paid by the interested countries or regions. Several of the priority TEN-T studies we analysed turned out to have rather poor benefits and often there was no well documented cost benefit study and supporting modelling documentation. This points to a clear need for models that help to form a second opinion on individual projects.

7.2 General Conclusions and Recommendations

Why and when does one need transport infrastructure aid?

The problem of funding transport infrastructure depends on whether infrastructure is

- To be provided publicly or privately
- To be funded by user or taxpayer or in what mix
- To be priced at network or at route/link level
- To be funded from earmarked taxes or from general revenue

For reasons of history, law and political economy, traditions vary across the EU and by mode of transport. Experience with funding arrangements is reviewed in D1 of FUNDING.

In general, transport benefits, revenues and costs accrue at the level of member states or regions within states and therefore most infrastructure decisions are properly decisions for member states (or more locally within member states). In such cases there is no justification for EU intervention in decisions or funding for such infrastructure provided EU rules regarding competition, procurement, single market etc are observed.

Involvement of the EU in infrastructure decisions is warranted where

- There are trans-boundary environmental costs which are not computed at the national level but which need to be captured at European level, and can not be dealt with via direct environmental regulation or environmental permits and taxes (for example: air pollution of aviation)

- There are significant spillovers between the provision of a piece of infrastructure in one country and costs and benefits in neighbouring countries. It is easy to demonstrate that in the presence of transit traffic, (a) the incentive to an individual state to provide infrastructure is distorted and (b) the incentive to price capacity efficiently is also distorted.

A transport fund at EU level could serve as a device, together with appropriate regulation, for helping to correct for these distortions and to incentivise efficient pricing and investment. A funding contribution from the EU is warranted to pay for non-national benefits; however a funding contribution is not warranted to enable projects with poor rates of return to happen. High quality modelling and appraisal of major projects is needed to illuminate good decision-making.

How much aid should be given from an economic efficiency and from an equity point of view?

In D2, the economic factors which determine the efficient level of subsidy to infrastructure investment are brought together in a simple model. A subsidy formula is proposed which takes account of the following:

- the degree of economics of scale in capacity expansion (differs among modes)
- the share of transit use
- the cost of public funds
- the relative GDP of the member state requiring aid

An important part of any investment has to be covered by member country subsidies and by user charges.

The form and conditionality of the aid

It is suggested to give the aid under the form of a grant at the time of the investment. Important conditions are the co-funding by the member states, investment costs that are capped and price control on the user charges levied on transit.

What level of aid would our subsidy rules require at the level of the EU?

The proposed subsidy formula implies a maximum EU aid budget for the remaining TEN-T priority projects of the order of 4 billion Euro per year for the next 13 years. This is a maximum budget as TEN-T priority projects with poor benefits may not be pursued by member states that need to co-finance or infrastructure managers that need to be sure about future user charges. This budget does not yet include new projects (for example in new member states) that meet the subsidy criteria.

How to finance an EU infrastructure fund by levying extra charges in the transport sector?

Given that it is costly to gather extra tax revenues from general income taxes, an increase of taxes on road use in the EU may be the best way to generate extra revenues. This can take the form of a small additional excise on motor fuel.

What is the economic and equity impact at the regional level of building the TEN-T priority projects and financing them in the way we suggest?

1. An analysis with an EU wide regional model of the 22 priority projects selected found that the economic rate of return of most projects was low.
2. The share of the spillovers in total benefits was for 10 projects below 10% and sometimes negative (hurting other member states). For 8 projects it was below 30% and for the remaining 4 projects between 30 and 50%.
3. The proposed EU subsidy formula does, for those projects that have large spillovers, increase the rate of return for the investing member countries but does not guarantee that the project will be realized.
4. The EU subsidies do not systematically hurt the poorest countries

What is the effect of the European infrastructure aid we suggest on a selection of the 30 priority TEN-Ts

7 projects were analysed in more detail.

The 3 freight corridor projects analysed had in general poor net economic benefits. The proposed EU subsidy rules in combination with improved pricing of competing modes would not make these projects economic. Most projects would require a subsidy of close to 100% of the initial infrastructure investment to make them financially viable.

The different HSR projects could survive the competition of air transport if the rail operators are charged the marginal infrastructure rather than the average infrastructure cost. The HSR projects could be economically worthwhile if infrastructure managers receive an EU and member state subsidy covering a large fraction of the investment cost.

What are the appropriate modelling tools to assess the effects of a subsidy scheme?

There is no generally accepted cost benefit guide for assessing transport infrastructure projects in the EU. This means that there is a large risk of a positive bias in project assessments. There is also no obligation to have a publicly available cost benefit assessment for the TEN-Ts.

Under these conditions there is a clear need for models that can help to form a second opinion on projects that apply for EU funding. Four different models of varying complexity and regional focus have been assessed and found useful in aiding EU and member state decision making.

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