REVENUE
Revenue Use from Transport Pricing

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Deliverable 6
Synthesis and Policy Conclusions

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EXECUTIVE SUMMARY

Background

While the determination of prices for the use of transport infrastructure has been the focus of much previous and some current European research, it has become obvious that how revenues from transport related taxes and charges can be used most efficiently is also highly relevant. Therefore, the REVENUE project focuses on analysing the efficiency and equity impacts of different options to use revenues from infrastructure charges, and deals also with the acceptability and feasibility of these options.

More precisely, the REVENUE project was set up with three main objectives:

- to assess current practice for transport revenue use;
- to develop guidelines for good use of the revenues from social marginal cost pricing; and
- to examine current practice and the use of the guidelines on a set of case studies.

This report summarises the results obtained within the project, including theoretical guidelines on optimal use of revenues and their comparison with current practice and spending schemes which are proposed or under discussion in the EU countries. This is demonstrated in a series of case studies focusing on interurban transport - dealing with revenue use in road, rail, airports and seaports – and urban transport. The specific aim of this Deliverable is to provide a summary and discussion of the project results and draw pertinent policy conclusions.

Policy questions analysed

- ✓ **Pricing and revenue use**: European Commission infrastructure charging policy is based on "user-pays" and "polluter-pays" principles. The key message of the policy is that transport taxes and charges, in every mode of transport, should be varied to reflect the cost of different levels of congestion and pollution, as well accident risk and infrastructure costs. A key policy aspect of a change in pricing structure, and possibly price for the use of transport infrastructure, is **what happens to the revenue raised through the new charges**. An additional empirical question is whether the revenues raised by the new charging structure will be sufficient to cover total costs of the existing infrastructure, and importantly whether it will be sufficient to allow further development of new infrastructure. In summary, EU transport policy sees an important link between pricing and financing in that pricing reform is seen as a key way of raising funds for investment. For instance, funds raised from road haulage users will can be devoted to the transport sector, and even they may be used to build rail infrastructure, where bottlenecks exist and there are environmental constraints. Whether policies on pricing and use of revenue of this nature can be justified is a key consideration for the REVENUE project.

- ✓ **Assignment of responsibilities**: Responsibility for transport policy formulation and implementation is vested with different levels of government. In Europe, local, regional, national and supranational (i.e. the EU) governments all play a role. Furthermore, the prevalence of through traffic between regions, and trans-boundary externalities such as pollution, create overlapping interests for governments in

neighbouring jurisdictions. Where such vertical or horizontal relationships between governments exist, the assignment of responsibilities becomes an important policy issue. The principle of subsidiarity, which is the agreed policy of the European Union, recognises that the location-specific nature of many transport externalities means that policy action is often better pursued at the national or local level, rather than the European level. This principle has meant that European policy development has focused much less on urban transport than on inter-urban transport. It is for reasons of subsidiarity that the Commission has proposed a Directive for HGV infrastructure charging, but has no proposals for infrastructure charging of private cars. It is important to note that, according to current empirical evidence, when the setting of charges is decentralised between governments covering different geographical areas of a single market, individual governments may have incentives to deviate from marginal social cost pricing in order to influence the distribution of revenues and costs. For instance, even if they are precluded from discriminating against foreign hauliers, countries with a high level of transit traffic may have an incentive to impose charges that are inefficiently high (Nash, Niskanen and Verhoef, 2003). This will ensure that transit traffic, which uses the country concerned, pays more than the marginal social costs. The result of this is not solely inefficient routing of international traffic, but distortions to production and distribution decisions throughout the economy. Thus there may be justification for imposing constraints on the levels of charges at the European level.

- ✓ **Efficient pricing**: For two reasons efficient charges are of central importance to the REVENUE project. First, the types and levels of user charges that are chosen affect passenger and freight transport flows, and consequently the allocative efficiency of transportation activity. Second, the system of charges determines the amount of revenue generated that can be allocated for various uses. If **first-best conditions** hold throughout the economy, charges should be set accordingly to Social Marginal Cost Pricing principles; i.e. equal to the difference between the social marginal cost of each trip or transport activity and the average private cost borne by users. Unfortunately first-best conditions are not satisfied in the real world, and the more complex problem of second-best pricing must be tackled. One reason why first-best conditions fail is inefficient pricing of substitute or complementary transport modes. A second reason is heavy reliance throughout the economy on labour taxes and Value Added Taxes. These taxes impose an excess burden because they distort economic incentives and are costly to collect and administer. Because the revenues from efficient transport user charges can be used in lieu of revenues from more distortionary sources, a case can be made for deviating from SMCP in the transport sector to boost revenues. Finally, a third source of distortions are flaws in the way transport policies are formulated and in the way transport infrastructure and services are provided. Politicians and other decision makers may pursue their own interests. And unregulated private-sector agents with market power create distortions by setting prices above competitive levels.

- ✓ **Cost recovering**: The key theoretical result, due to Mohring and Harwitz (1962), is the **cost recovery theorem** that revenues from efficient user charges just suffice to pay for the long-run costs of building, operating and maintaining infrastructure. If the conditions of the Theorem hold, each transport mode will be self-financing. Neither surpluses nor deficits will arise and there will be no *prima facie* case for cross-subsidisation within modes or between modes, or for net transfers between the

transport sector and the rest of the economy. However, while the Cost Recovery Theorem is a useful benchmark result, the conditions that underlie full cost recovering according to the theorem are too strong to be found frequently in reality.[1] In any case, the theorem shows that the cost recovery will be a function mainly of the characteristics of the cost functions for operation and investment, and this conclusion opens up a set of empirical questions about economies of scale in transport, which have been addressed in the literature. Most of the available evidence relates either to constructing new roads or railways of different capacities, or to comparing existing transport systems on a cross section basis. The implications of adding capacity to existing systems may be rather different, particularly in built up areas where expansion may require substantial property demolition and environmental externalities. In this case the cost of incremental capacity may be substantially above that of the inherited capacity (even if that is valued at replacement cost). This is why first best charging on congested roads (and railways where the only way to expand capacity is to build new infrastructure) in urban areas in particular may yield substantial surpluses.

- ✓ **Raising additional revenue**: Whether or not SMCP pricing allows full cost recovery is largely an empirical issue. This implies that SMCP pricing may in principle give rise to either surplus revenue or revenue deficits compared to infrastructure costs. This is an important point, particularly in the latter case, as from a policy perspective there may be a political desire to **raise price above marginal social cost to ensure full cost recovery where this is possible**. The most common mechanisms for charging above marginal cost pricing are average cost pricing, multi-part tariffs and Ramsey-Boiteux pricing. Multi-part tariffs and Ramsey-Boiteux pricing are both pricing systems that try to implement marginal social cost pricing with minimum efficiency cost deviations to attain a given balanced budget or revenue objective (of course multi-part tariffs and Ramsey-Boiteux pricing may be combined in a single price structure; they are not necessarily alternatives). Such methods are, on efficiency grounds, clearly superior to average cost pricing, since average cost pricing fails to minimise the cost of deviations from optimal pricing. On the other hand average cost pricing may be simpler and cheaper to implement.

- ✓ **Equity and acceptability**: Though the terms **equity and acceptability** are sometimes used interchangeably, the two concepts are distinct. Equity relates to how individuals or other agents fair relative to each other. Acceptability concerns approval or disapproval. A head tax on identical households may be considered equitable but unacceptable. Conversely, a policy that confers small benefits on most people while concentrating the costs on a few may be considered acceptable (by the majority) but inequitable. Acceptance, by the public, of a policy is important for implementation of that policy. This is because within a political process that is democratic and representative, only policies that are not opposed by a majority of relevant actors are likely to be implemented. Research suggests that public acceptability may well require transparency of the institutional mechanisms of fee

[1] The conditions are as follows: i) first-best conditions apply and user charges are set according to SMCP principles; ii) capacity is perfectly divisible and can be expanded at constant marginal cost; iii) user costs are homogeneous of degree zero in capacity and usage; and iv) capacity is at its long-run optimal level

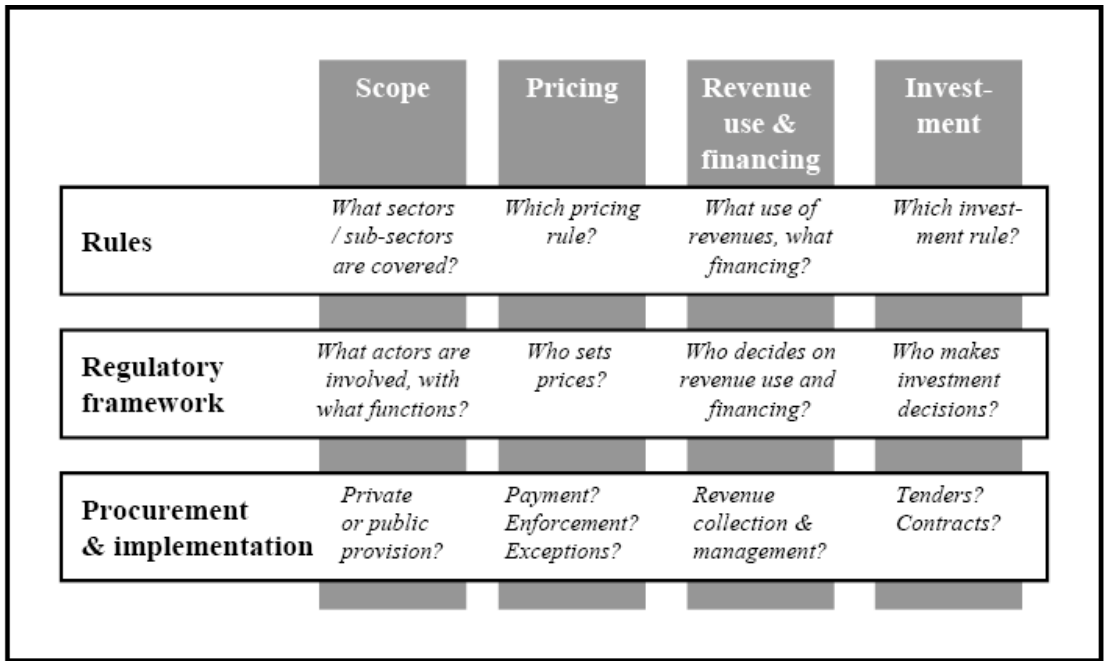
setting, subsidy distribution, collection of surplus revenues and spending of revenue, either in case of publicly owned or private infrastructure.

- ✓ **Role of the private sector**: The private sector can be harnessed to provide transport infrastructure in many ways ranging from a simple maintenance contract to a comprehensive Design-Finance-Build-Own-Operate concession. Private sector involvement has several potential advantages *vis à vis* wholly public schemes, but potential drawbacks. In any event, for the private sector to be involved, full cost recovery on their part is imperative, either through user charges alone or a mixture of user charges and government subsidy. Private sector pricing constraints may result in the private sector either receiving insufficient revenue to cover full costs (thereby requiring a public subsidy) or receiving a significant revenue surplus (e.g. if marginal social cost pricing leads to a very high cost recovery). In the latter case governments will generally wish to find a way of recovering such surpluses, rather than allowing the private sector to retain large profits resulting from scarcity of infrastructure capacity. In both situations it will be necessary to make financial arrangements to deal with the surpluses or deficits.

- ✓ **Earmarking of revenue for transport spending**: Current EU policy does allow revenue raised from one mode to be spent on infrastructure associated with another mode and also for revenue raised in one region to be spent in another region (e.g. the proposed HGV directive (CEC, 2003)). Such a hypothecation policy, however, is only one option regarding the use of revenue. Other options would include using revenue for general taxation purposes (e.g. reducing labour taxes or social transfers) or more restrictive options such as directing revenue towards projects within the region or the mode from which it was raised. Each type of revenue use has important implications for efficiency, equity and acceptability. With regard to **efficiency**, as there is no guarantee that transport projects will be the most efficient projects, standard theory informs us that hypothecation of funds to transport budgets may result in a loss of efficiency, in that it may require that a set of projects be undertaken which does not maximise social welfare. However, in a system with various levels of government (European, national, regional), governments at the lower levels may take no account of the effects of their decisions on the rest of the system outside their area. For instance, governments may select projects that favour local rather than transit traffic. To the extent that detailed investment decisions are sensibly left to national or regional government, earmarking funds to be invested in the Trans European Network may offset this inefficiency. As it concerns **equity**, there is no reason to suppose in general that earmarking will improve equity, although there may be specific cases where it would (for instance earmarking revenue from bus infrastructure charges to be used on bus priority measures rather than on measures that benefit rail passengers). Equity arguments for earmarking more often take the form of saying that those who pay should get corresponding benefits for their money. This would again only be fair in general if the existing distribution of income were fair. Finally, the prospect of a pricing reform being implemented will be enhanced if it enjoys public **acceptability**; that is, a majority of the population support it. Earmarking of surplus revenues to the transport budget is one method for ameliorating the harmful impacts of pricing reform that raises prices for certain users. For example earmarked revenue can be used to develop transport projects that improve accessibility by alternative modes (e.g. Norwegian toll rings and London's congestion pricing scheme).

Approach

In the REVENUE project, transport charging and use of revenue are examined together as two parts of a so called **regulation scheme**, which encompasses a specific combination of pricing, revenue use and investment rules (see Proost S. et al., 2004). The figure below depicts the elements of a regulation scheme.



As depicted in the figure, a regulation scheme is more effectively featured answering to a sequence of **basic questions** about what are the rules, who are the actors of the regulatory framework, and how actions are implemented. These basic questions cover the "scope", the "pricing mechanism", the "revenue allocation mechanism" and the "investment" activities.

Different tools and methodological approaches, including the use of quantitative models and qualitative analysis, have been used in the assessment of the regulation schemes. More in detail, the assessment of efficiency and equity impacts in the interurban regulation schemes was mainly undertaken using the MOLINO model. MOLINO is a partial equilibrium model for the analysis of investment and pricing policies. This model studies transport problems that be can described in terms of two alternative transport links. The links may refer to one mode, for example a tolled stretch of motorway versus a non-tolled link or to two competing modes. This is the case in several interurban case studies where road versus rail transport is the problem examined. For each link studied a regulation scheme is defined providing input data for the basis scenario. This status quo scenario is then compared with the alternative regulation schemes. The complete description of MOLINO model can be consulted in Proost et al. (2005).

The ASTRA system-dynamics model is applied in parallel to MOLINO in order to analyse further the long-term effects of pricing and investment measures. As the

ASTRA model allows the consideration of several distance bands per mode and transport market therefore cover aspects not considered in single link approaches like MOLINO. Moreover, ASTRA consists of a macro-economic module containing different business sectors, a state module and international trade relationships. Using this structure the substitution between and the contribution of transport to the rest of the economy can be presented more realistically than with the substitution elasticity concept followed by Molino. The ASTRA model, however, does not compute market equilibria and consequently can not deliver neo-classical welfare measures as MOLINO does. In practice, only in the German case study the MOLINO and ASTRA models were both used for the assessment.

The following chart shows which tools have been used in the interurban case studies.

Assessment criteria	Tools	Case studies							
		Interurban road financing	German HGV toll	Transport investment funds in Switzerland		France road funds	Zurich airport	Port of Rotterdam	Road haulier´s acceptability of road charges
				Road/rail	Bern				
Efficiency	MOLINO	X	X			X		X	
	ASTRA		X						
	MOLINOinGAMS			X					
	Other model						X		
	Qualitative/quantitative analysis				X				
Equity	MOLINO	X	X			X		X	
	MOLINOinGAMS			X					
	Qualitative/quantitative analysis				X		X		
Technical and organisational feasibility	Qualitative/quantitative analysis	X		X	X		X	X	
Acceptability	Qualitative/quantitative analysis			X	X	X	X	X	X

The assessment of the REVENUE urban regulation schemes was carried out abandoning the MOLINO approach - widely used for the interurban case studies - in favour of other urban models with more detailed representations of the respective urban road networks than the MOLINO model can accommodate.

The **Oslo case study** used the FINMOD model. This is a model for the investigation of optimum policies for public transport at an aggregate level for regions or smaller local areas. As an aggregate model it does not handle single routes, but uses aggregate measures of public transport supply. The **Warsaw case study** has been done using the Warsaw Computer Traffic Model, which works under the VISUM platform, enables the production of traffic forecast at a regional and local scale for individual and public transport traffic (including rail, light rail, metro, tram and buses). In the **Edinburgh case study** the MARS[2] (Metropolitan Activity Relocation Simulator) model has been applied. This is a strategic, interactive land-use and transport interaction model. Finally, in the **cross boundary acceptability case study**, the approach for the assessment of technical and organizational feasibility and acceptability was qualitative, based on a set of in-depth interviews with stakeholders and the analysis of the secondary information related with the public consultation process.

[2] For a more technical description of the MARS model see Pfaffenbichler and Shepherd (2003).

The following table shows which tools have been used in the urban case studies.

Assessment criteria	Tools	Case studies			
		Oslo	Warsaw	Edinburgh	Cross-boundary acceptability
Efficiency	FINMOD	X			
	WCTM (Warsaw Computer Traffic Model) and standard algorithms for a numerical method of calculation		X		
	MARS			X	
Equity	FINMOD	X			
	MARS			X	
Technical and organisational feasibility	Qualitative/quantitative analysis		X		X
Acceptability	Qualitative/quantitative analysis	X	X		X

By design, the REVENUE studies share some common features, but they also differ in many ways: the modes of transport involved, the institutional settings including rules on revenue use, the nature of the questions that were addressed and so on. Conclusions on some of the questions also differ. These differences raise the issue whether general policy insights can be gleaned from the studies that carry over to other jurisdictions, transport modes, institutional environments and so on. There are clearly limits on the transferability of detailed findings such as the economic merits of a particular type of investment, or the degree of public support for a given policy package. Results at this level are sensitive to case-study-specific factors such as congestion levels, the marginal cost of public funds, public trust in local governments and so on. The value of the case studies lies more in illustrating how pricing and revenue-use policy packages can be analysed and the range of results that are possible.

Main results and conclusions

The main results and conclusions of the REVENUE project are summarised below, pointing to the most relevant questions that were addressed in the studies - the merits of earmarking, acceptability of charging and revenue use policies, the institutional arrangements and assignment of responsibilities for charging and revenue allocation - before making some final comments.

Although widely practiced, **earmarking remains controversial**. It was seen that the circumstances in which complete earmarking of revenue for use within the mode on which it is raised could be theoretically justified were likely to be rare, and the case for earmarking is therefore more likely to rest on pragmatic grounds. The case studies identify circumstances in which revenues are best allocated to particular uses in which case earmarking the revenues for them is justified. This may entail returning the money to the facilities on which the charges are levied, or it may call for cross-subsidisation of other facilities or other modes. The case studies also report survey and other evidence

that earmarking enhances acceptability. Earmarking may increase efficiency too if it deters politicians from making self-interested decisions that are socially wasteful. But earmarking can harm efficiency by preventing money from going to the most economically worthwhile uses. A clear example of this is the requirement in Britain that all revenue from urban congestion charges must be devoted to transport. In the case of Edinburgh, efficient charges would produce more revenue than can efficiently be used in the transport sector, and the opportunity to use this revenue to reduce other distorting taxes is prevented by this requirement. In some circumstances earmarking may in fact channel revenues to both economically efficient and publicly acceptable uses. Yet, even well-targeted earmarking schemes will be undermined if funds from other sources are reduced in an offsetting way.

There is now abundant evidence from various countries that **acceptability is a *sine qua non* of transport policy reform**. Acceptability appears to have been a major consideration in the design of the pricing and revenue use policy packages (both implemented and proposed) that were examined in the case studies. There is ample evidence in the case studies that earmarking may help achieve acceptability. However, stakeholders must be convinced that charges will be imposed fairly and evolve (or remain fixed as the case may be) as promised. And if revenues are earmarked, there must be assurance that moneys will be allocated as intended and without offsetting reductions from other sources. For instance, the Edinburgh study remarked on how a lack of legal obligation for the City of Edinburgh Council (CEC) to share revenues undermined the confidence of residents outside the city.

Institutional arrangements are very important. Assignment of responsibilities for user charging and revenue use decision-making depends on various considerations. One is local knowledge about congestion, the merits of alternative infrastructure investments and so on, which favours assignment of responsibility to local governments. By contrast, spill over problems between regions related to inter-regional traffic, pollution, etc., call either for centralised government control or coordination between neighbouring regional governments. The Edinburgh case study illustrates the dangers of delegating decision-making to an authority below the level at which the impacts will be felt, and correspondingly the need to develop proposals on a consensus basis between authorities. In Oslo, consent of all affected authorities was required and the negotiation between neighbouring authorities worked more smoothly. It has become popular to delegate transport infrastructure financing and operation to the private sector – this is common for ports and airports, as well as significant parts of the motorway system (only in rail transport is it rare). The primary motivation is to lower costs but it is naturally associated with earmarking of revenues. In other cases responsibilities have been devolved to independent bodies. The **Swiss** railway investment fund FINÖV and the **French** funding agency AFITF are two examples mentioned in the case studies.

As a final comment, we may say that on balance **transport charging appears to be both efficient and politically feasible only if accompanied by an acceptable revenue-use plan and an effective information/marketing campaign**.

We have seen that the theoretical case for earmarking revenue for use either in the transport sector as a whole or in the mode or region in which the revenue is raised rests on assumptions that are unlikely to be often realised in practice. Moreover, where earmarking is practiced it risks forcing the authority in question to use money

inefficiently or (as in Edinburgh) to hold charges inefficiently low. Thus if governments could be relied upon to act efficiently earmarking would be at best pointless and at worst damaging.

However, earmarking may play a part in achieving an acceptable, fair and even efficient outcome. Moreover it must be remembered that the application of a systems dynamic model to Germany produced a stronger case for earmarking than the other studies, which used static models. This may be a result of particular circumstances or assumptions, or it may reflect the fact that long term dynamic behaviour brings into play factors not considered or modelled in other case studies. **It is therefore necessary to take a pragmatic approach, treating each proposal for earmarking on its merits**.

What is also clear from the REVENUE case studies is that **whilst in general a move to marginal social cost pricing will improve efficiency, there is often a case for charging more than this for the use of transport infrastructure**, where SMCP pricing will leave a need to meet deficits on existing infrastructure or investment needs from distorting taxes elsewhere in the economy.

Thus in conclusion we see a need for earmarking, but consider it necessary to design schemes carefully to ensure an acceptable trade-off between efficiency, equity and acceptability. We see an argument for multimodal infrastructure funds which permit cross financing and take detailed decision taking away from politics to more independent bodies. And we see a case for mark-ups over and above marginal social cost provided that these are designed to minimise distortions and to fund deficits or investment projects that are the result of efficient and equitable decisions on pricing and investment.

1 INTRODUCTION

The REVENUE project was set up with three main objectives:

- to assess current practice for transport revenue use;
- to develop guidelines for good use of the revenues from social marginal cost pricing; and
- to examine current practice and the use of the guidelines on a set of case studies.

These objectives have been achieved through a series of steps:

- **Setting the stage (workpackage 1)**: this work package identifies a set of policy and research questions to be addressed. As such this work package provides an overview and background to REVENUE and justifies the rationale for addressing the research questions identified.

- **Theoretical framework (workpackage 2)**: this work package develops a theoretically sound framework for integrating the efficient use of transport infrastructure in the short run, and the efficient provision of infrastructure in the longer run. Central issues are how revenues should be used and how deficits are covered when investment needs are high.

- **Case studies specification (workpackage 3)**: this workpackage provides the specs for an as far as possible harmonised implementation of the interurban and urban case studies, which include:
  - a review of pricing and revenue allocation/financing schemes currently introduced across Europe;
  - a set of research questions for the case studies;
  - a unified methodology for the case studies with regard to data collection procedures and analysis;
  - an evaluation scheme to be applied in the different case studies**.**

- **Interurban and urban case studies (workpackages 4 and 5)**: based on the specifications produced in the previous workpackage, these workpackages deals separately with 7 interurban case studies – road financing in Finland, HGV tolls in Germany, Railway investment fund in Switzerland, French multimodal fund, Zurich airport, Ports of Rotterdam and Antwerp, Acceptability of HGV charges – and 4 urban case studies – Oslo, Warsaw, Edinburgh, Berne.[3] The case studies results show to what extent the schemes are efficient, equitable, technically, organisationally and politically feasible and acceptable/accepted;

- **Conclusions and recommendations (workpackage 6)**: this final work package draws together and summarises the findings of the previous work packages and identifies the project's overall conclusions and policy recommendations. The primary objective is to identify the most effective options for utilising revenues

[3] For practical reason, the urban case of Berne has been implemented as a separate part in the same Swiss case study which includes the railway investment fund as interurban case. The Edinburgh case is split in two sub-cases, one on the planned congestion pricing scheme and the other focusing on cross-boundary acceptability problems.

arising from pricing of the existing transport system for funding transport investments and subsidies/deficits or for reduction of other taxes, taking account of the need to achieve an efficient, equitable and acceptable outcome. The policy conclusions relate to the trade-offs between economic efficiency, public acceptability and equity associated with the use of revenues from transport pricing for spending on transport infrastructure and operations. They also highlight any legal or institutional constraints.

REVENUE Deliverable 6 summarises the findings of the previous project's work packages 1-5, and then identifies the overall conclusions and policy recommendations of the project.

Following this introduction, **Chapter 2** introduces the key issues of the project, based on REVENUE Deliverable 1.

Chapter 3 describes both the theoretical issues and the methodological framework adopted for the case studies, based on REVENUE Deliverables 2 and 3.

Chapter 4 provides an overview of current practice in pricing and revenue use in Europe, based on REVENUE Deliverable 3. This chapter assessed the current practice of transport pricing and revenue allocation schemes in Europe. The general picture that arises from our analysis is that **second-best pricing** is in place in many countries, usually multi-part tariffs for motorway use, railway infrastructure charging and airport fees, and fully distributed cost schemes used for heavy goods vehicles and aircraft navigational charges. Some countries use elements of social marginal cost pricing. **Target-oriented pricing schemes** (particularly average cost pricing) is mostly used in bridge and tunnel tolls, public transportation, and inland waterways and maritime transport. Regarding the allocation schemes, it was observed that intramodal **earmarking** is common in all modes, but intermodal earmarking involves almost always the **road mode**, where some of the revenue is earmarked for use in e.g. railway infrastructure construction or re-allocated geographically. Fuel tax earmarking takes place in some countries but mostly fuel tax goes to the general budget. Urban public transport often receives funding through road traffic revenue earmarking schemes, but sometimes also from non-transport activity. Most of these intermodal earmarking schemes are combined with second-best pricing schemes (multipart-tariffs and, to a lesser extent, fully distributed costs). Management of large networks is often done by public companies, whereas smaller networks and more specific tasks are more and more carried out by private enterprises, often using performance contracts. Public-private partnerships are gaining popularity as governments want more control over budgets.

Chapter 5 describes the interurban case studies, based on REVENUE Deliverable 4, while **Chapter 6** describes the urban case studies, based on REVENUE Deliverable 5. The case studies assess a range of scenarios encompassing existing policies, official proposals, policies currently under discussion, and policies or scenarios developed by the case-study authors that may be welfare-superior and/or more acceptable to policy makers, the public and other stakeholders. Each scenario is defined by a pricing regime, rules for allocating revenues between sectors and/or modes, and expenditure plans that may include infrastructure investments. As far as pricing regimes the studies are similar in that all feature pricing in the *status quo*, a Social Marginal Cost Pricing (SMCP) regime and at least one intermediate regime. All studies feature alternative revenue

earmarking schemes. Earmarking is either a legislative requirement in the jurisdiction under consideration or perceived to be an acceptability constraint on revenue use.
Almost all interurban case studies use partial-equilibrium models to assess the impacts of alternative pricing *cum* revenue use policy packages. More in detail, the majority of interurban case studies use the MOLINO model which was developed for the REVENUE project.[4] The Swiss study uses a variant of the MOLINO model that allows for a time lag between commencement of an investment project and the time it is completed and brought into operation.[5] The Oslo, Warsaw and Edinburgh urban case studies used other models with more detailed representations of the respective urban road networks than the MOLINO model can accommodate.

Chapter 7 finally illustrates the policy conclusions and recommendations of the project. In a nutshell, key conclusions are as follows:

- If governments could be relied upon to act efficiently, and acceptability and equity were not at issue, then earmarking would be at best pointless and at worst damaging.

- The case for earmarking is that it improves acceptability and in some cases also equity and efficiency.

- If earmarking is seen as necessary for more efficient pricing to be implemented then it must be checked that the package of pricing and investment is better than doing nothing. Earmarking may affect the most efficient level of charge.

- In some circumstances, earmarking revenue for use on modes other than the mode on which it is raised may be both economically justified and acceptable; this is more likely on urban networks or in the presence of severe capacity and environmental bottlenecks such as the Alps.

- Where impacts of pricing and investment decisions spill over between authorities, it is in the interests of efficiency, equity and acceptability that proposals are developed on a consensus basis between the authorities, if necessary with reference to a higher authority to ensure this.

[4] In addition to MOLINO, the German study uses the systems dynamics macroeconomic model ASTRA to assess the long-run macroeconomic impacts of pricing and investment schemes.
[5] The time lag affects the present values of the project's benefits and costs.

2 KEY ISSUES OF CONCERN

In recent years, transport pricing research has provided major contributions to the shaping and formulation of EU policies. Following the 1995 Green Paper and the subsequent White Paper (1998), pricing principles have been established and cost valuation methodologies have been tested, leading to basic policy recommendations. These are reflected in the revision of the Common Transport Policy (2001) and in several EU Directives and proposals thereof (e.g. on rail – 2001, on HGVs – 2003). As part of the process, it has clearly emerged that the impact of pricing policies will heavily depend (in terms of effectiveness, efficiency, equity, acceptability) on the use that will be made of the revenues generated by transport pricing schemes. The REVENUE project has been designed to address this specific issue, thus providing further input to the formulation and development of EU policies in the area of infrastructure charging.

Most EU research on the economics of transport pricing has concluded that the **most efficient use of revenue** requires that governments be free to use the revenue in whatever way provides the greatest benefit. By contrast, research on **acceptability** tends to suggest that earmarking this income for specific uses (usually within the transport sector) would make pricing reform more acceptable, as those paying the charges would know how the income was to be used, and how it would benefit them. Earmarking is a process of linking specific sources of income to specific uses. Although earmarking may be seen both as economically inefficient and undemocratic, when institutional arrangements which combine different levels of government, government agencies and public private partnerships are taken into account, there may be good arguments for it.

2.1 An overall picture of the revenue collection and allocation mechanisms

Indeed, within the European transport sector there are a number of actors who are typically involved in or affected by transport projects or transport pricing and investment programmes. These are set out below:

- **Users:** the users of the transport system include public transport passengers and private vehicle drivers and passengers as well as businesses distributing freight.

- **Service Providers:** service providers include freight and logistic companies (road, rail, air and sea), public transport providers (e.g. bus company, train operating company, shipping company and airline).

- **Infrastructure Managers and Owners:** often transport infrastructure is owned by the government, but in some countries it can be privately owned (e.g. two thirds of the road network in Sweden and Finland is privately owned and managed, airports are often under private ownership and, in Great Britain, the railway infrastructure is privately owned). In many situations transport networks can also be operated and maintained by a private contractor as part of a concession. This can typically form part of a Public Private Partnership (PPP) agreement between a private company and a public body.

- **Government:** there are many tiers of government from local governments, who typically may have responsibility for local networks, to regional governments,

national governments and the European Commission. To understand government policy it is necessary to understand the government decision process that involves voters, interest groups, political parties, executives and government agencies.

Generally, governments are responsible for setting the policy and regulatory framework within which infrastructure managers set prices, whilst service providers and ultimately users are affected by pricing decisions. However there are interactions and conflicts between each set of actors as each may pursue a different set of objectives. Individuals and service providers impose costs on one another (e.g. congestion costs and pollution costs), whilst service providers compete with each other for business. Governments local or national tend to pursue goals that maximise the benefit that their populace will receive, potentially to the cost of people living in other regions or countries.

2.1.1 Public finance flows

It is important to understand the complexity of the transport revenue collection and allocation mechanisms, starting from an overall picture of the financial flows between the different actors. This is provided in the scheme on the following page.

The scheme illustrates the overall public finance mechanism, not only transport financing. It pinpoints the main fiscal flows — which are represented as flows of taxes paid by the taxpayers and charges paid by the users of public services to the different levels of government: local, regional, national.

Depending on EU member states fiscal laws, taxes and charges are paid by the households and business sectors (taxes) and by the users of the public services (charges) – included in the "society" box - respectively to the local, regional and national governments.[6] In principle, revenues are pooled at municipal, regional and national levels in order to finance government activities and public investments which cannot be realised by single individuals or private companies on the market (as it is the case for pure public goods), and which is more efficient to realise by pooling public revenues at the appropriate spatial scale.

For the sake of simplicity, in the scheme we make the assumption that on average in the EU 70% of taxes and charges go to the national governments, 10% to the regional government and 20% to the municipal level.[7]

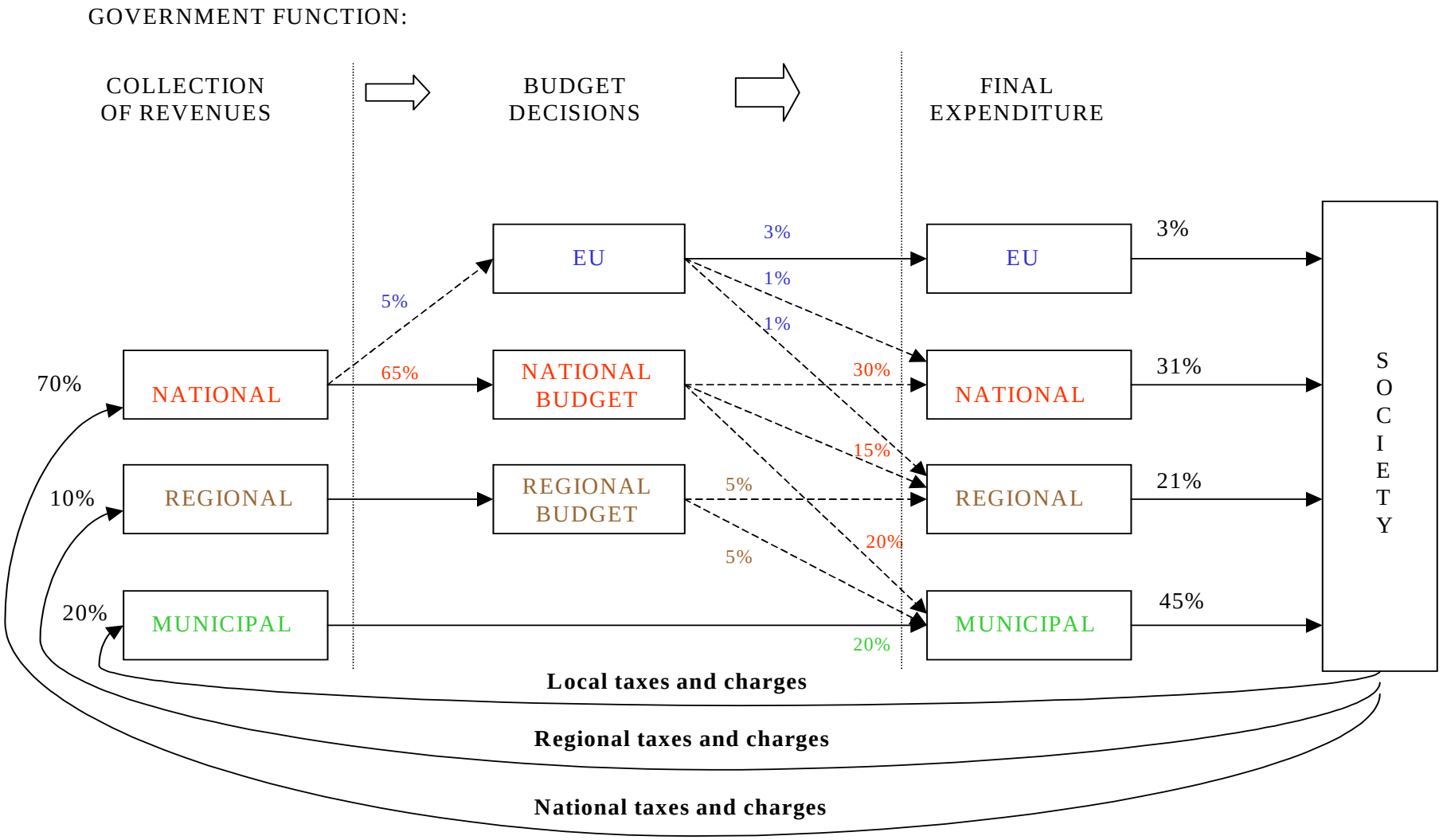
The different levels of governments are responsible for the use of these revenues, which broadly encompasses two steps: "budget allocation decisions" and the implementation of "final expenditures". As can be seen in the scheme, the budget decisions of each level of government include two main categories:

- **Expenditure decisions**, represented by horizontal lines going directly to the final expenditures realised by the same level of government;
- **Transfers of revenues (grants, subsidies)** to other level of governments, represented by oblique dotted lines linking different levels of government.

[6] The scheme is intentionally simplified, as for instance charges may go in reality to private operators to whom the government delegate the provision of the public service. A detailed overview of the current taxes and charges and revenue allocation flows for the transport sector is provided in Chapter 3 below.

[7] These figures are fictitious and they are shown purely for didactic purposes, to facilitate the understanding of the revenue flows

REVENUE - Overall picture of revenue collection and allocation mechanism



Often revenues are pooled at the higher levels of government – e.g. the national State – and then partially transferred to lower levels of government – e.g. from the State to the regional and/or municipal government. This is mainly due to the fact that tax bases at the lower levels of government may be too narrow or unevenly distributed to allow an efficient and equitable collection of the revenues: in this case the solution is provided by an higher level taxing a wider base and then redistributing a part of the revenues (net of the quota needed to finance the expenditure of the higher level of government) to the authorities at the lower levels, based on some allocation criteria.

Taking an hydraulic metaphor, it is therefore more easy to observe revenues pooled in the higher "reservoirs" to flow downward than the contrary, i.e. flows of revenues jumping from a lower to a higher level of government. This may happen when an ensemble of lower level governments decide together to transfer a share of their budget to an higher coordination "agency", as it happens for instance in Europe with the EU Member States which transfer agreed shares of their budget to the European Union institutions. A simple explanation is that is more easy for a unique authority pooling first the revenues at an higher level, and then to decide how to distribute part of the revenues to other (lower level) authorities, than for several lower authorities to coordinate their budget decisions, agreeing on a criteria to transfer part of their revenues to a higher government agency.

In the scheme we show only one "upward" transfer flow, from the national level to the EU level, and several "downward" transfer flows: from the EU to national and regional government (e.g. Structural Funds); from the national level to the regional and municipal level; from the regional level to the municipal level.[8]

Considering the shares of direct expenditures and transfers for the various levels of government (again the shares in the scheme are fictitious), the final result is a different distribution of final expenditures as compared to the distribution of revenues initially allocated to the different tiers. The final result in the scheme is the following breakdown of expenditures: European Union 5% (including direct funding of EU research, administrative costs etc.), national 30%, regional 20%, municipal 45%. These figures do not reflect real data, but are given to show how different can be the "spending" capacity of the different levels of government from their "revenue raising" capacity. Usually the higher levels have more revenue raising than direct spending capacity, while the contrary happens for the lower levels, and especially the municipal one, because the local authorities are often the final providers of public services to the citizens.

As mentioned above, the "downward" revenue transfer flows are somewhat more stable and robust than the "upwards" flows, because they do not require the coordination of the political willing and budget decisions of a plurality of lower level governments. The

[8] As it is discussed later in Chapter 5, urban road pricing may cause a concentration of revenues paid by commuters from periurban jurisdictions to the central city, creating a surplus of financial resources in the central city budget. This situation is not equitable, because residents of the surrounding municipalities would end to finance central city services – e.g. if the central city use the financial surplus to finance new services for its citizens – without receiving any benefit. A solution could be an "upward" transfer of the road pricing surplus revenue from the municipal to the regional level, and then a redistribution of this surplus from the regional government to all the municipal jurisdictions within the region, according to some equitable allocation formula.

most striking example of this weakness is the European Union itself, whose budget is subject to an increasingly difficult negotiation between Member States, especially with the accession of New Member States.

A way to make the revenue flows stronger and more stable at the EU level would be a constitutional change, to allow the EU to become a full level of government with its own taxing power. Although currently an highly improbable scenario, there has been some discussion about an "European tax", for instance on CO2 emissions, to finance the EU current activities, including also the distribution of funds to national and regional governments to finance European value added projects.

In the scheme on the following page we imagine therefore the EU as a new level of government receiving directly an "European tax" from the citizens and/or companies residents in the EU. The new breakdown of revenues would be EU 10%, national level 40%, regional level 25% and municipal level 25%, which is transposed by means of the budget allocation mechanisms in a different breakdown of final expenditures: EU 5%, national level 22%, regional level 28% and municipal level 45%.[9] The aim of this imaginative exercise is to show how the revenue collection and allocation mechanisms could become even more complex depending on possible evolutions of the European Union political and institutional setting, but at the same time how it might be possible to maintain a coherent picture of the revenue flows.

2.1.2 Use of revenues from the transport sector

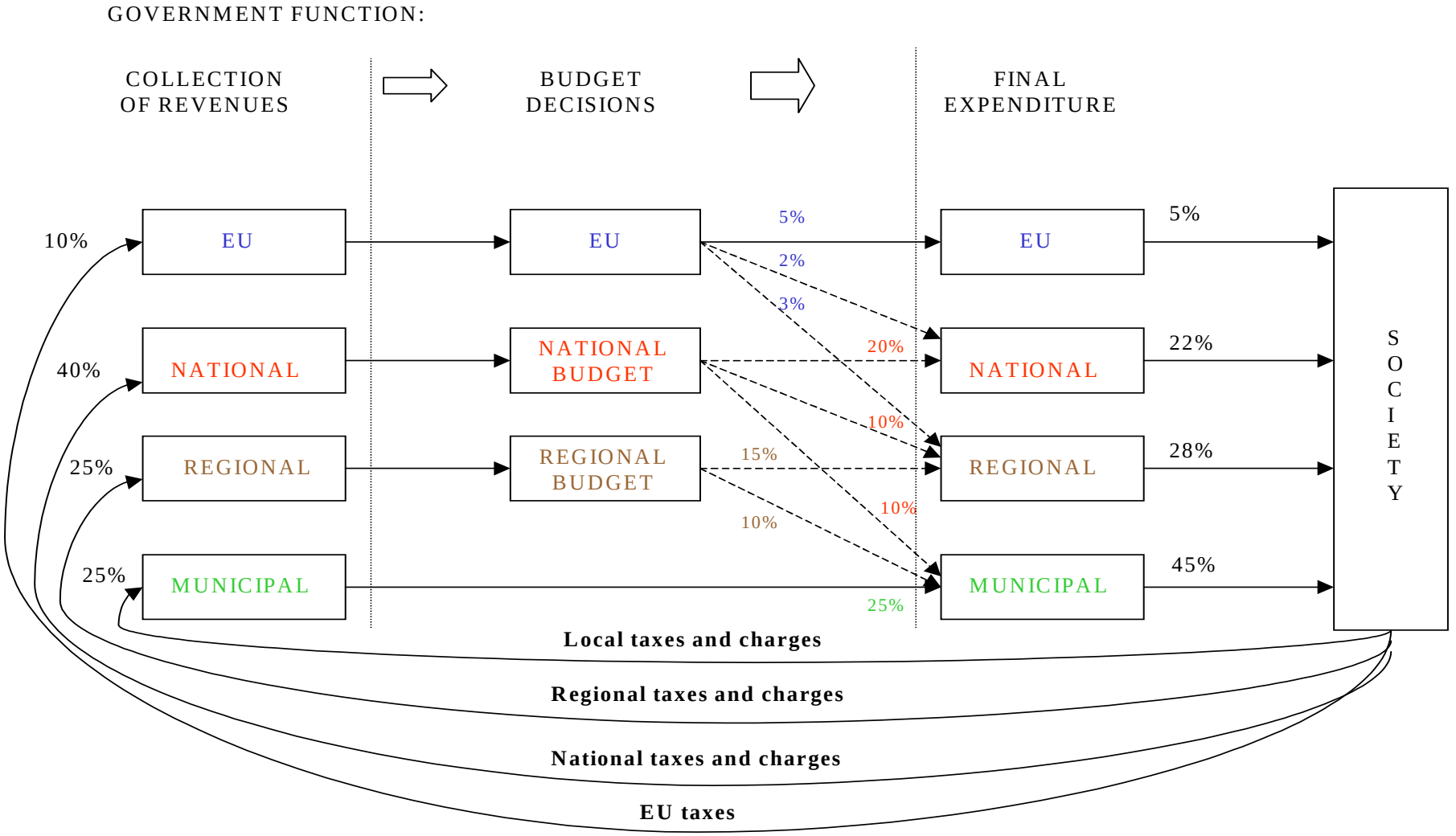
The picture discussed so far concerned public finance flows in general. Moving now to the specific topic of REVENUE, that is the use of revenues from the transport sector, it is useful to consider a matrix (see page 15) representing an overall economy divided in:

- A **transport sector**, which is further divided in six sub-sectors: highways, other road[10], rail[11], air, sea, inland waterways.
- The **rest of the economy**, which includes the production and use of all the other goods and services, including also government.

The columns of the matrix record the **collection of revenues** in each transport sector and in the rest of the economy. The rows record the **use of the revenue** in each transport sector – with the distinction of current expenditures for operation and maintenance and capital expenditures for investment - or in the rest of the economy.
Along the main diagonal, the matrix shows the internal earmarking of revenues, when the revenues collected in one transport sector – e.g. highways – are used to pay for the operation and maintenance or for the investment costs in the same transport sector. In the other cells of the transport section, the matrix shows the possible cross-subsidies from the (column) transport sector where the revenues are collected to another (row) transport sector where the revenues are used.

[9] In this imaginative scenario, the EU strengthen both the revenue raising and the expenditure capacity, and the same is assumed for the regional governments, while the national government revenue and spending capacities are reduced as compared with the previous scheme. The municipal spending capacity is left unchanged.
[10] This includes the road infrastructure and road-based services as public buses etc.
[11] This includes the railways and the rail-based urban transport services (metro, trams, etc.)

REVENUE - Overall picture of revenue collection and allocation mechanism



REVENUE – Scheme of transport revenue collection and use

REVENUE USE ⇩			REVENUE COLLECTION: TRANSPORT SECTOR – Highways (tolls, fuel taxes etc.)	Other Road (tolls, fuel taxes etc.)	Rail (fares, rail track charges)	Air (tickets, airport charges)	Sea (port charges, etc.)	IWW (locks charges, etc.)	REST OF THE ECONOMY – Labour taxes, VAT etc.
TRANSPORT SECTOR	Highways	Operation & maintenance							
		Investment							
	Other Road	Operation & maintenance							
		Investment							
	Rail	Operation & maintenance							
		Investment							
	Air	Operation & maintenance							
		Investment							
	Sea	Operation & maintenance							
		Investment							
	IWW	Operation & maintenance							
		Investment							
REST OF THE ECONOMY									Other goods & services

Internal earmarking (intramodal) Cross-subsidies between transport sectors (intermodal) Subsidies from/to the general budget

In the column of the rest of the economy, the matrix shows the possible subsidies from the general budget to each (row) transport sector, while in the row of the rest of the economy we find the revenue collected in each (column) transport sector and used to finance the general budget.

In practice, as illustrated with different colours in the scheme, there is a limited range of possibilities:

- **Internal earmarking** is obviously always possible and applied in each transport sector, where charges are used to pay for infrastructure use and services within the same transport mode (grey diagonal cells).
- **Cross-subsidies** are limited to intermodal funds which mostly collect revenues from the "other road" mode and are used to finance highways or rail infrastructure (yellow cells).
- **Subsidies to transport from the rest of the economy** include government budget grants to the railways, to urban metro and tram services, to public bus services, and to inland waterways. They may include also special cases, as the "versement transport" scheme in France or the electricity tax in Austria. [12] (blue cells in the last column)
- **Revenues from transport to the general budget** mainly concern the use of fuel taxes to finance the government budget (blue cells in the last row).

This scheme illustrates options of revenue recycling within each mode, between transport modes and through the general budget, referring to a single territorial system (e.g. a region or a nation). However, it is also frequently the case that a revenue raised in one region has to be spent in another region. Usually this implies a pooling of revenues in a fund under the authority of an higher level of government and the redistribution of subsidies to lower level governments, while direct forms of cross-subsidies between jurisdictions of the same level (e.g. between regions or municipalities) are more difficult to be found, probably because their acceptability is more controversial.

2.1.3 The territorial dimension of revenues from transport pricing

Another important issue concerns the territorial dimension of the revenues from transport pricing.

Indeed, given the boundaries of a territorial system – e.g. a nation, a region, a central city – we can identify four categories of mobility flows which will generate different typologies of revenue burden if transport pricing schemes are applied:

- **Local mobility**: trips whose origin and destination is within the territory.
- **Egress mobility**: trips with origin within the territory and destination outside, to the rest of the world.
- **Access mobility**: trips with origin in the rest of the world and destination within the territory.

[12] All companies in the Ile de France region that have more that 9 employees must pay a special tax that is earmarked entirely for urban public transport; in Austria 2,5% of the electricity tax is used to finance urban public transport (see Chapter 4)

- **Transit mobility**: trips crossing the territory, with origin and destination in the rest of the world.

For instance, at municipal level, the adoption of parking charge schemes with exemption for the residents in the central city will affect access mobility flows but not local, egress and transit mobility. Cordon charging may affect transit and access flows, but not local and egress flows, etc. In both cases, revenues collected in the central city are paid by people living in other places.

Applying the same reasoning at regional or national level, if a regional or national vehicle tax is applied to resident vehicle owners, the revenue collected is originated mainly from local and egress transport users, not from access and transit transport.[13] On the contrary, also the latter two categories of users will contribute to a regional or national fuel tax revenue, depending on the amount of gasoline purchased while travelling within the region/nation.

Understanding who pays the transport prices and taxes is obviously an important prerequisite to study strategies of revenue recycling between different geographical areas, aiming to equalise the burden for transport users and taxpayers living in different territories and increase the acceptability of transport pricing schemes.

2.2 Policies on pricing and use of revenue

European Commission infrastructure charging policy is based on "user-pays" and "polluter-pays" principles. The key message of the policy is that transport taxes and charges, in every mode of transport, should be varied to reflect the cost of different levels of congestion and pollution, as well accident risk and infrastructure costs. The Commission's 2001 and 1998 White Papers as well as the 1995 Green Paper clearly set out the case for **reforming transport prices** and the approach to be adopted. The core features of the 1998 White Paper focused on the need to relate charges more closely to underlying marginal social costs associated with infrastructure use and with extending these costs to include external costs. Additionally, it was recognised that there may be a need to depart from prices that are purely based on the direct costs of infrastructure use, such as vehicle operating costs and infrastructure maintenance, when cost coverage requirements, such as overheads, need to be met.

A key policy aspect of a change in pricing structure, and possibly price for the use of transport infrastructure, is **what happens to the revenue raised through the new charges**. An additional empirical question is whether the revenues raised by the new charging structure will be sufficient to cover total costs of the existing infrastructure, and importantly whether it will be sufficient to allow further development of new infrastructure. This is an important empirical question, from the perspective of government policy, given the budgetary constraints faced by national governments and the fact that a core aspect of the transport policy outlined in the 2001 White Paper is targeted investment in the TEN. Such investment would address accessibility issues in

[13] Vehicle taxes are not dependent on the actual use of the vehicles, so their burden cannot be directly allocated to any specific form of transport. However, it is reasonable to think that local and egress transport flows are mainly made by resident vehicles owners, while the access and transit flows mostly involve non resident vehicles.

key congested corridors within the existing EU and in remote regions and new Member States.

The 2001 White Paper states, "In a good many cases, taking external costs into account will produce more revenue than is needed to cover the costs of the infrastructure used". However it recognises that "in certain sensitive areas there might be insufficient surplus revenue" (p18-19). This is also recognised in the 1998 White Paper, where surplus revenues would be expected in congested areas (for all modes in unison) and potential deficits may occur in sparsely populated rural areas. At the network level, however, the White Papers expect that marginal cost pricing will lead to full cost recovery, though cross financing may be required at the modal, regional or national levels.
With respect to areas that generate a surplus of revenue, the 1998 White Paper proposed that it would be for Member States to decide how to use the surpluses. Options would include allocating funds to the infrastructure operators, to the general budget (e.g. restructure existing taxes), or to earmark revenues for infrastructure funds. The 2001 White Paper appears to take a slightly narrower view in that it only mentions directing surplus revenues into national or regional funds in order to finance transport projects to lessen or offset external costs associated with transport. It is envisaged that surplus revenue from one mode (e.g. road) may be used to finance projects associated with a different mode (e.g. rail). For example, building transport infrastructure that encourages intermodality and greater use of environmentally friendly modes such as rail.

Where insufficient surplus revenue is created to fund major new infrastructure, such as railway tunnels called for by transport policy considerations, the 2001 White Paper suggests an additional infrastructure charge may be levied. This charge would be additional to the amount added to offset external costs, and therefore in the presence of such a charge the total price paid for use of the transport infrastructure would exceed marginal social cost. The White Paper is clear that this additional charge would be for the financing of alternative, more environmentally friendly infrastructure, and would be reserved for infrastructure essential for crossing natural and environmentally fragile barriers. Additionally, the White Paper suggests that such an additional charge can be levied prior to the development of the proposed infrastructure.

In summary, EU transport policy sees an important link between pricing and financing in that pricing reform is seen as a key way of raising funds for investment. For instance, funds raised from road haulage users will can be devoted to the transport sector, and even they may be used to build rail infrastructure, where bottlenecks exist and there are environmental constraints. Whether policies on pricing and use of revenue of this nature can be justified is a key consideration for the REVENUE project.

2.3 Assignment of responsibilities according to the subsidiarity principle

Responsibility for transport policy formulation and implementation is vested with different levels of government. In Europe, local, regional, national and supranational (i.e. the EU) governments all play a role. Furthermore, the prevalence of through traffic between regions, and trans-boundary externalities such as pollution, create overlapping interests for governments in neighbouring jurisdictions. Where such vertical or horizontal relationships between governments exist, the assignment of responsibilities becomes an important policy issue.

The principle of subsidiarity, which is the agreed policy of the European Union, recognises that the location-specific nature of many transport externalities means that policy action is often better pursued at the national or local level, rather than the European level. This principle has meant that European policy development has focused much less on urban transport than on inter-urban transport.

It is for reasons of subsidiarity that the Commission has proposed a Directive for HGV infrastructure charging, but has no proposals for infrastructure charging of private cars. In terms of charging private cars only two member states have operational urban road charging systems. These are Norway (Bergen, Oslo, Trondheim, Stavanger, and Kristiansand) and the United Kingdom (London and a small scheme in Durham). With respect to these schemes it is interesting to note that they all have fixed charges (though the hours of operation of the schemes vary) and that in all instances the revenue is earmarked for spending in the transport sector.

It is important to note that, according to current empirical evidence, when the setting of charges is decentralised between governments covering different geographical areas of a single market, individual governments may have incentives to deviate from marginal social cost pricing in order to influence the distribution of revenues and costs. For instance, even if they are precluded from discriminating against foreign hauliers, countries with a high level of transit traffic may have an incentive to impose charges that are inefficiently high (Nash, Niskanen and Verhoef, 2003). This will ensure that transit traffic, which uses the country concerned, pays more than the marginal social costs. The result of this is not solely inefficient routing of international traffic, but distortions to production and distribution decisions throughout the economy. Thus there may be justification for imposing constraints on the levels of charges at the European level.

2.4 Theoretical issues: efficient pricing, cost recovering and the need of raising additional revenue

There is now a substantial theoretical literature on efficient pricing in urban systems, aiming to identify the most appropriate user charge levels. The central result is that Social Marginal Cost Pricing (SMCP) is the 'first best' policy, which secures a welfare maximum in the absence of a break-even constraint (see, for example, Small, 1992).
However, the implementation of SMCP pricing in the European transport sector has posed a number of problems that have led to departures from the "first best" policy of marginal social cost pricing. In this section we consider from a theoretical standpoint the implications of these departures. First we define SMCP as the efficient choice under first-best conditions and we show why these conditions are usually not met in reality. Second we consider whether there is any reason to suppose that SMCP pricing leads to full cost recovery, including servicing of capital costs. Third we consider if theory informs us whether there is a good reason to raise more revenue than SMCP pricing provides. Finally we consider what theory tells us regarding good reasons to tie surplus revenue to spending in the transport sector.

2.4.1 Efficient pricing

For two reasons efficient charges are also of central importance to the REVENUE project. First, the types and levels of user charges that are chosen affect passenger and freight transport flows, and consequently the allocative efficiency of transportation activity. Second, the system of charges determines the amount of revenue generated that can be allocated for various uses.

If **first-best conditions** hold throughout the economy, charges should be set accordingly to Social Marginal Cost Pricing principles; i.e. equal to the difference between the social marginal cost of each trip or transport activity and the average private cost borne by users. The nature of the service or externality (e.g. congestion, road damage, emissions, etc.) and the spatial and temporal variation of the costs dictate what types of charges are required (e.g. highway tolls differentiated by time of day, vehicle size and axle weight) and the levels of the charges. A number of EU transport projects have investigated the economic and practical aspects of SMCP along these and other dimensions.

Unfortunately first-best conditions are not satisfied in the real world, and the more complex problem of second-best pricing must be tackled:[12]

- One reason why first-best conditions fail is inefficient pricing of substitute or complementary transport modes. Auto transport is typically underpriced in urban areas, and this has been a longstanding argument for subsidising public transit. Similarly, the environmental costs of freight transport are higher for truck than rail, and the EU has been advocating policies to increase the rail share. Modal diversion can be encouraged by raising taxes or charges on modes with high social costs, and by lowering taxes or subsidising investments for competing modes.

- A second reason why first-best conditions fail is heavy reliance throughout the economy on labour taxes and Value Added Taxes. These taxes impose an excess burden because they distort economic incentives and are costly to collect and administer. Because the revenues from efficient transport user charges can be used in lieu of revenues from more distortionary sources, a case can be made for deviating from SMCP in the transport sector to boost revenues. Typically, this calls for transport charges above first-best levels.

- A third source of distortions are flaws in the way transport policies are formulated and in the way transport infrastructure and services are provided. Politicians and other decision makers may pursue their own interests. And unregulated private-sector agents with market power create distortions by setting prices above competitive levels.

2.4.2 Cost recovering

The amount of revenue derived from transport user charges depends on many factors: the objectives, scope and flexibility of the pricing scheme that is adopted; the functional dependence of user costs on traffic volume and capacity; the mix of user types; the

[12] The intricacy of second-best pricing has been intensively analysed in the economics of the public sector (e.g. Bos 1985, Section 2) as well as transportation economics (e.g. Nowlan 1993; Verhoef 2002). Social-marginal cost-pricing in the face of second-best constraints is sometimes called social marginal-cost-*based* pricing, as in the AFFORD and MC-ICAM projects. An extensive overview of these concepts can be found in Chapter 4 of this deliverable.

degree of cost economies in capacity investment; capacity indivisibilities; competitiveness of factor markets and so on.

When one takes a pure efficiency objective, disregards equity and procurement issues, and disregards the costs of financing deficits by taxes in other sectors, one can make use of a series of powerful cost recovery theorems. These theorems give the degree of cost recovery that can be reached with optimal transport pricing (pricing equal to short run marginal cost) and optimal investment (marginal cost of expansion equal to discounted marginal savings in user costs). Cost recovery is to be understood in net terms: the discounted sum of total revenues of short run marginal cost pricing (excluding revenues derived from taxing externalities other than congestion) and after deduction of all operation and investment costs.

The key theoretical result, due to Mohring and Harwitz (1962), is the **cost recovery theorem** that revenues from efficient user charges just suffice to pay for the long-run costs of building, operating and maintaining infrastructure. If the conditions of the Theorem hold, each transport mode will be self-financing. Neither surpluses nor deficits will arise and there will be no *prima facie* case for cross-subsidisation within modes or between modes, or for net transfers between the transport sector and the rest of the economy.

Mohring (1976) explains the problem diagrammatically (Figure 1). The curve SRMC shows the short-run marginal cost for use of a highway of capacity T*, in terms of infrastructure maintenance and congestion costs. It is upward sloping due to the congestion effects of increased use, which push up marginal user costs. AVC is the corresponding short-run average variable cost function. The curve LRAC, 'long-run average cost', shows the average cost of providing for different levels of use by varying highway capacity, including expenditure to service the capital costs. In this hypothetical case, there are increasing returns to scale, or decreasing average costs with capacity. LRMC is the corresponding long-run marginal cost function, including capital costs but excluding congestion. Traffic level T* is the level at which capacity T* will be optimal since SRMC=LRMC.

Given the nature of the cost functions in this figure, in particular the **decreasing long-run average cost**, a price equal to marginal cost when traffic is at this level will recover only the revenue 0T*CD, leaving ABCD to be covered from other sources, for example cross-subsidy from other goods & services, or subsidy from a public budget. That is, decreasing long-run average costs will cause a **revenue deficit**.

By contrast, if there are **constant returns to scale** in supplying highways (i.e. LRAC=LRMC=a horizontal line, and there is no change in congestion costs per driver as capacity is expanded in line with traffic), then the area ABCD will be equal to zero. That is, **full cost recovery** will be achieved.

By extension, diseconomies of scale with **increasing long-run average costs** will give rise to a **revenue surplus**.

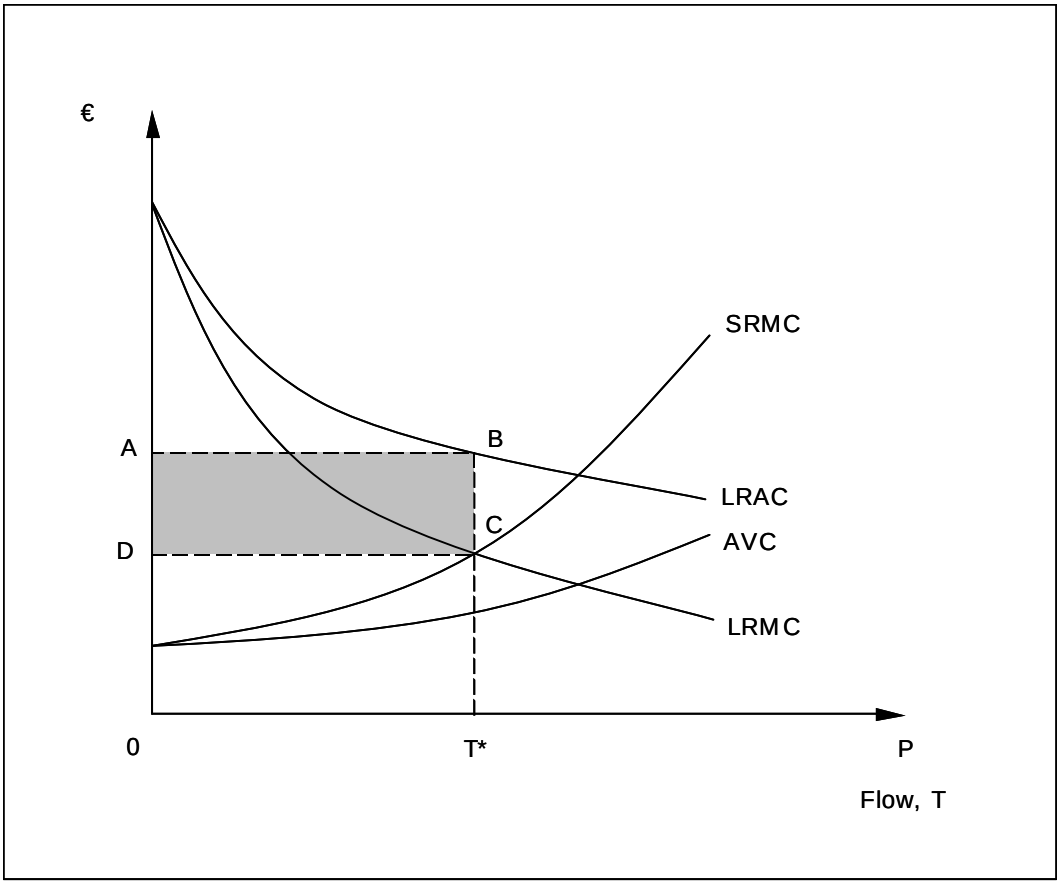


Figure 1: Subsidy requirement in the presence of economies of scale for a highway with capacity T*

Mohring concludes that "setting marginal cost prices for highway trips and, more generally, transportation services is not necessarily incompatible with having a self-supporting system" (1976, p21).

However, while the Cost Recovery Theorem is a useful benchmark result, the conditions that underlie full cost recovering according to the theorem are too strong to be found frequently in reality:

1. first-best conditions apply and user charges are set according to SMCP principles;
2. capacity is perfectly divisible and can be expanded at constant marginal cost;
3. user costs are homogeneous of degree zero in capacity and usage[13]; and
4. capacity is at its long-run optimal level

Condition 1 is most unlikely to hold. Condition 2 is also doubtful because of lumpiness of capacity as well as space and environmental constraints on expanding capacity. Empirical evidence on Condition 3 varies, and it is usually violated for public transport because of economies of traffic density. Finally, due to the rigidity of infrastructure and the long lead times often required to add capacity, Condition 4 is unlikely to be fulfilled except perhaps at infrequent points in time.

[13] This means that if usage and capacity are both doubled, private user costs are unchanged.

The theorem shows that the cost recovery will be a function mainly of the characteristics of the cost functions for operation and investment, and this conclusion opens up a set of empirical questions about economies of scale in transport, which have been addressed in the literature.

Unfortunately, the empirical knowledge of the characteristics of the cost function of transport infrastructures is imperfect:

- *Roads*: Statistical evidence indicates that there are constant or slightly increasing returns to scale for roads, whereas engineering data indicates moderately increasing returns. There are substantial scale economies in durability with respect to pavement thickness. Together, these observations suggest that pricing roads optimally will result in a deficit. However, there are diseconomies of scope with respect to road width and durability. Charging for both congestion and damage charges would lead to recovery of at least 80% of long-term capital and maintenance costs.
- *Rail*:. Economies of traffic density prevail except at very high densities that are rarely attained.. Thus first best pricing for railways would entail considerable subsidies.
- *Public transport*:. Similar to railways, public transport exhibits substantial economies of traffic density. .
- *Airports*: Airports enjoy scale economies for traffic volumes up to 3-4 million passengers/year. External diseconomies can weigh in eventually on account of on-site congestion, pollution and congestion on access roads.

An important provision must be added. Most of the evidence cited above related either to constructing new roads or railways of different capacities, or to comparing existing transport systems on a cross section basis. The implications of adding capacity to existing systems may be rather different, particularly in built up areas where expansion may require substantial property demolition and environmental externalities. In this case the cost of incremental capacity may be substantially above that of the inherited capacity (even if that is valued at replacement cost). This is why first best charging on congested roads (and railways where the only way to expand capacity is to build new infrastructure) in urban areas in particular may yield substantial surpluses.

2.4.3 Raising additional revenue

Whether or not SMCP pricing allows full cost recovery is largely an empirical issue. This implies that SMCP pricing may in principle give rise to either surplus revenue or revenue deficits compared to infrastructure costs. This is an important point, particularly in the latter case, as from a policy perspective there may be a political desire to **raise price above marginal social cost to ensure full cost recovery where this is possible**. We are therefore interested in what economic theory informs us regarding the implications of raising more revenue than pricing at MSC would permit, and if so what form the price increase should take.

In this context, we should be aware of the literature on the **Marginal Cost of Public Funds (MCPF)**, which seeks to measure the welfare loss associated with increased

public sector taxation and expenditure (e.g. Ballard, Shoven and Whalley, 1985; Mayeres and Proost, 1997, 2001a).

In a general equilibrium setting, the effect of any overall change in public sector expenditure on transport will be felt in other sectors. In principle, these effects can be treated endogenously with Computable General Equilibrium (CGE) models, but these are not easily available, because their building is data demanding and time consuming. In practice, distortions are usually accounted for in rough-and-ready fashion by factoring up the social cost of raising revenues by some estimate of MCPF. Where such values are in use in public decision taking, as for instance in Norway, they often reflect a belief that, at the margin, one additional Euro of public funds has a cost of the order of 1.2-1.3 euros to obtain. However, this value will depend on precisely how the money is obtained, and the tax structure of the country concerned.

The Marginal cost of Public Funds concept is not used in all European countries but the problem of trading-off tax revenue and higher transport prices is at the core of the REVENUE project. As it is illustrated widely in Chapter 5 and 6, the MCPF approach was taken in most of the case studies. The studies vary widely in the base-case values adopted for the MPCF: 1 (Edinburgh), 1.1 (France), 1.25 (Oslo), 1.35 (Switzerland) and 2.21 (Germany). The disparity in these values may reflect real differences between the countries in the social costs of raising public money. However the "true" value of the MCPF in a given jurisdiction is difficult to determine precisely, and for sensitivity analysis the Oslo, German and French studies entertained alternative values.

The most common mechanisms for charging above marginal cost pricing are average cost pricing, multi-part tariffs and Ramsey-Boiteux pricing.[14] Multi-part tariffs and Ramsey-Boiteux pricing are both pricing systems that try to implement marginal social cost pricing with minimum efficiency cost deviations to attain a given balanced budget or revenue objective (of course multi-part tariffs and Ramsey-Boiteux pricing may be combined in a single price structure; they are not necessarily alternatives). Such methods are, on efficiency grounds, clearly superior to average cost pricing, since average cost pricing fails to minimise the cost of deviations from optimal pricing. On the other hand average cost pricing may be simpler and cheaper to implement.

2.5 Equity and Acceptability

Policy evaluations made on the basis of changes in aggregate welfare may be considered adequate in some contexts, but are deficient for analysing transport pricing and revenue allocation policies that affect diverse groups. One reason is that groups generally differ in economic status, so that equity concerns arise. A second and related reason is that the benefits and costs of policies tend to fall unequally in the population, and those who perceive themselves to be losers may declare the policy to be unacceptable. Previous EU projects (PRIMA and PATS) have studied acceptability, and there is now broad agreement in the literature that an unpopular proposal is unlikely to be implemented.

[14] See the description of second-best pricing mechanisms in Chapter 4

Though the terms **equity and acceptability** are sometimes used interchangeably, the two concepts are distinct. Equity relates to how individuals or other agents fair relative to each other. Acceptability concerns approval or disapproval.[15] A head tax on identical households may be considered equitable but unacceptable.[16] Conversely, a policy that confers small benefits on most people while concentrating the costs on a few may be considered acceptable (by the majority) but inequitable.[17]

Acceptance, by the public, of a policy is important for implementation of that policy. This is because within a political process that is democratic and representative, only policies that are not opposed by a majority of relevant actors are likely to be implemented. While none of the White Papers directly discusses public acceptability of the infrastructure charging frameworks that are proposed, research suggests that public acceptability may well require transparency of the institutional mechanisms of fee setting, subsidy distribution, collection of surplus revenues and spending of revenue, either in case of publicly owned or private infrastructure.

2.6 Role of the private sector

The private sector can be harnessed to provide transport infrastructure in many ways ranging from a simple maintenance contract to a comprehensive Design-Finance-Build-Own-Operate concession. Private sector involvement has several potential advantages *vis à vis* wholly public schemes. Private-sector financing helps to circumvent public-sector borrowing constraints by tapping an independent source of funds. Experience suggests that private firms are often better at identifying attractive investment projects and able to build infrastructure more quickly and cheaply. And the private sector may have a greater incentive than do public agencies to achieve productive efficiency and to seek innovative ways to cut costs and/or improve service quality.

Private involvement also has potential drawbacks. Contracts must allow private operators to earn an adequate rate of return, and risks related to demand uncertainty, cost overruns and other contingencies must be dealt with. And private operators have an incentive to exercise market power while disregarding externalities such as emissions and noise that do not adversely affect customer demand.[18]

In any event, for the private sector to be involved, full cost recovery on their part is imperative, either through user charges alone or a mixture of user charges and government subsidy. Therefore if private capital is to have a further and growing involvement in the transport sector a way has to be found of paying the private

[15] Acceptability to individuals can be assessed by whether their utility rises or falls – although complications such as incorrect perceptions and envy make this an imperfect test (Mayeres and Proost 2003).

[16] A distinction should be made between public and political acceptability. Politicians may be cool towards policies that the public supports if the politicians would lose power as a consequence (Conference Board 2005, p.22).

[17] However, such a policy may fail to be implemented because only the losers consider their personal stakes large enough to justify voicing their opinion or voting in a referendum (Olson 1971).

[18] This is not to say that similar incentive problems do not arise in the public sector. Politicians and other officials have their own agendas that may be imperfectly aligned with social welfare. Government agencies for example may succumb to the temptation to boost revenues by raising tolls above optimal levels, restricting capacity or reducing service quality to cut costs.

infrastructure provider or service provider the full cost. Private sector pricing constraints may result in the private sector either receiving insufficient revenue to cover full costs (thereby requiring a public subsidy) or receiving a significant revenue surplus (e.g. if marginal social cost pricing leads to a very high cost recovery). In the latter case governments will generally wish to find a way of recovering such surpluses, rather than allowing the private sector to retain large profits resulting from scarcity of infrastructure capacity. In both situations it will be necessary to make financial arrangements to deal with the surpluses or deficits.

2.7 Earmarking of revenue for transport spending

Current EU policy does allow revenue raised from one mode to be spent on infrastructure associated with another mode and also for revenue raised in one region to be spent in another region (e.g. the proposed HGV directive (CEC, 2003)). Such a hypothecation policy, however, is only one option regarding the use of revenue. Other options would include using revenue for general taxation purposes (e.g. reducing labour taxes or social transfers) or more restrictive options such as directing revenue towards projects within the region or the mode from which it was raised. Each type of revenue use has important implications for efficiency, equity and acceptability:

- **Efficiency:** Traditional public finance theory assumes all sources of government revenues are pooled and used for all types of expenditures. The government is benevolent, has perfect information, can redistribute income through lump sum transfers and operates in an economy without distortions in other sectors. In such a situation government investments are targeted towards the projects with the largest net present value (no budget constraints) or benefit cost ratio (with budget constraints). This investment decision is independent of the sector in which the project lies as it maximises economic efficiency. As there is no guarantee that transport projects will be the most efficient projects, standard theory informs us that hypothecation of funds to transport budgets may result in a loss of efficiency, in that it may require that a set of projects be undertaken which does not maximise social welfare. However, this simple theory takes no account of institutional arrangements. For instance, in a system with various levels of government (European, national, regional), governments at the lower levels may take no account of the effects of their decisions on the rest of the system outside their area. For instance, governments may select projects that favour local rather than transit traffic. To the extent that detailed investment decisions are sensibly left to national or regional government, earmarking funds to be invested in the Trans European Network may offset this inefficiency.

- **Equity:** In an ideal world, the taxation and income redistribution system would ensure that all in society had an appropriate share of the benefits of economic activity. If this were the case, then the issue of equity wouldn't need to be considered in the context of transport pricing policy. To the extent that this is not the case, equity issues have to be taken into account as part of transport pricing decisions. For instance, economic efficiency may dictate low infrastructure charges for rail, and high for bus (because of the external costs buses create). But an examination of the income distribution of users of the two modes may dictate that relative charges for buses should be lower. Equity issues are introduced by considering a weighted sum of utilities where the individuals with lower incomes

receive higher weight (Mayeres and Proost, 2003). This will lead to deviations from marginal social cost pricing which reduce economic efficiency but improve equity. There is no reason to suppose in general that earmarking will improve equity in this sense, although there may be specific cases where it would (for instance earmarking revenue from bus infrastructure charges to be used on bus priority measures rather than on measures that benefit rail passengers). Equity arguments for earmarking more often take the form of saying that those who pay should get corresponding benefits for their money. This would again only be fair in general if the existing distribution of income were fair. Even so, it would not be the most efficient way of using the revenue, which would be to undertake the most beneficial set of projects across all sectors subject to the requirement that the existing distribution of income was not changed.

- **Acceptability:** the prospect of a pricing reform being implemented will be enhanced if it enjoys public acceptability; that is, a majority of the population support it. In turn, it may be thought that this is most likely if a majority of the population benefit from it – that is, it shows a welfare gain or no welfare loss for a sufficiently large majority of the voters (Mayeres and Proost, 2003). However, for some types of reform the utility impacts on voters will be unequally distributed which makes the reform more difficult to accept. The above argument therefore implies that if surplus revenue is used to minimise the number of individuals that will experience a reduction in utility from the transport pricing reform then the acceptability of that reform will increase. Earmarking of surplus revenues to the transport budget is one method for ameliorating the harmful impacts of pricing reform that raises prices for certain users. For example earmarked revenue can be used to develop transport projects that improve accessibility by alternative modes (e.g. Norwegian toll rings and London's congestion pricing scheme).

To conclude, the arguments in favour or against earmarking are more or less balanced. Economists vary in their stance towards earmarking generally, and earmarking of road-usage charge revenues specifically.[19] According to normative public finance theory, tax revenues should not be locked into any particular expenditure pattern because spending priorities change over time and in unforeseen ways. Moreover, most EU research projects on transport pricing have concluded that governments should be free to use transport revenues in whatever way provides the greatest benefit (Laird et al. 2004: 1). Earmarking creates inflexibility in the allocation of funds, hampers effective budget control, and can result in shortages of revenues for some modes and excesses for others. A number of arguments have been advanced in favour of earmarking. One is that it is consistent with the benefit theory of taxation. A second is that it facilitates long-term planning and can reduce project costs by lowering interest rates. A third is that earmarking helps to prevent political abuse of funds (cf Buchanan (1963)). Yet another argument that has gained widespread currency is that earmarking revenues for specific uses makes policy reform more acceptable to voters and consequently improves the chances that reforms will actually be implemented.

[19] A diversity of attitudes is evident in the contributions to a recent special issue on road pricing in *Transport Policy* (Saleh 2005, ff.).

3 METHODOLOGICAL FRAMEWORK FOR THE ASSESSMENT OF ALTERNATIVE REGULATION SCHEMES

In the REVENUE project, transport charging and use of revenue are examined together as two parts of a so called **regulation scheme**, which encompasses a specific combination of pricing, revenue use and investment rules (see Proost S. et al., 2004).

Figure 2 below depicts the elements of a regulation scheme.

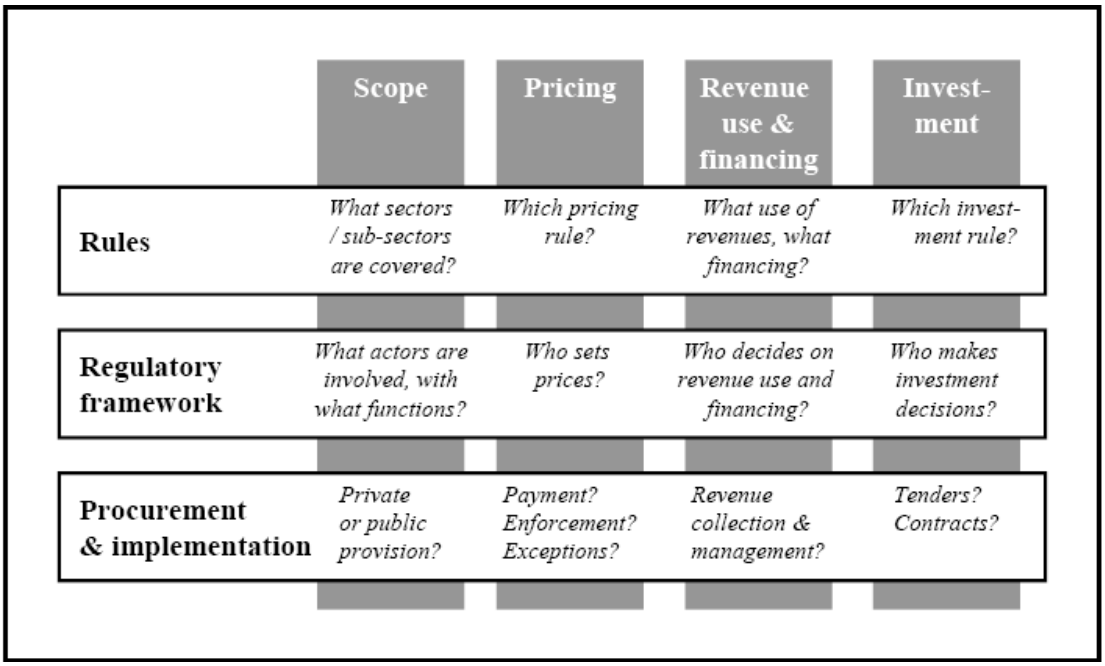


Figure 2 – Elements of a regulation scheme

As depicted in the figure, a regulation scheme is more effectively featured answering to a sequence of **basic questions** about what are the rules, who are the actors of the regulatory framework, and how actions are implemented. These basic questions cover the "scope", the "pricing mechanism", the "revenue allocation mechanism" and the "investment" activities.

These basic questions represent a reference set of research questions to be addressed in each case study, to assess alternative regulation schemes. However, not all the case studies addressed all the basic questions presented in Figure 2 above.[20]

Although differences among the various case studies were unavoidable, they aimed all to follow a common assessment framework which is depicted in Figure 3 below:

[20] The specific research questions addressed in each case study are described in the related sections of Chapter 5 (Interurban case studies) and Chapter 6 (Urban case studies).

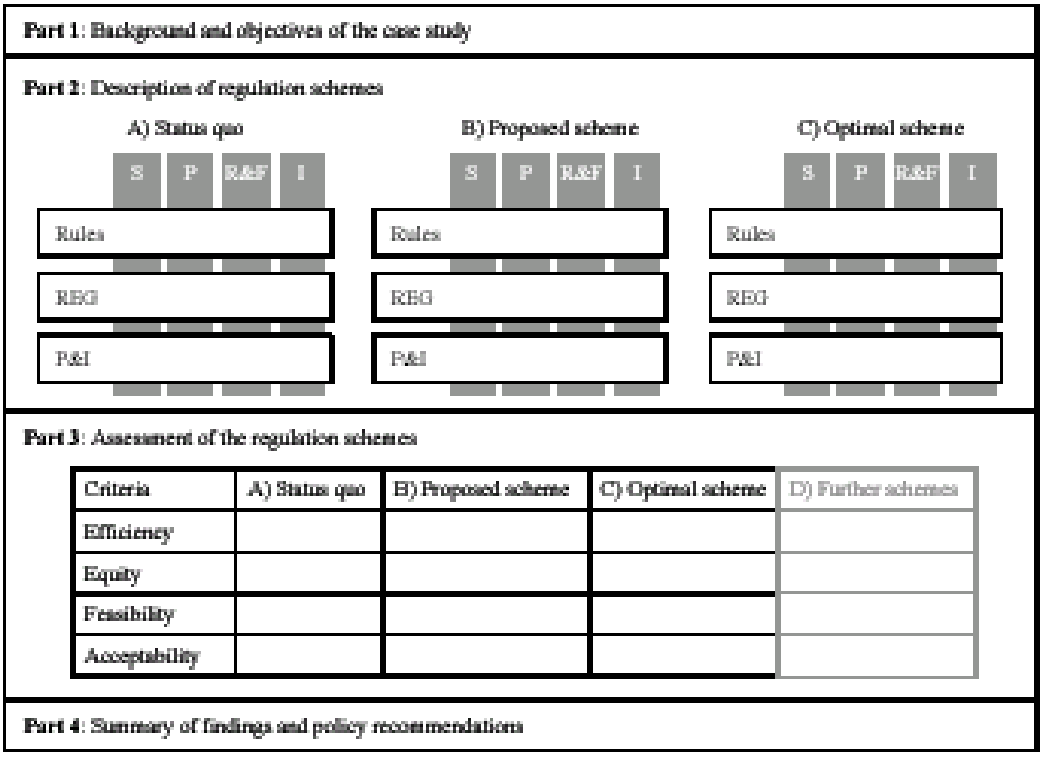


Figure 3: Common assessment framework for REVENUE case studies

This framework includes four parts:

1. **Background and objectives of the case study**, which includes the description of the geographical scope (case study area), the main features of the transport system of concern, a brief description of the historical background and current situation, and of the political and institutional context, and finally the formulation of the specific research questions to be addressed in the case study.

2. **Description of regulation schemes**, which encompasses for each case study a minimum of three regulation schemes covering: the **status quo**, which describes the existing situation (or existing regulation scheme); **one or more proposed schemes** (when these schemes exist within the case study); a **theoretically optimal scheme** (or a scheme superior to the status quo)

3. **Assessment of the regulation schemes**, which is undertaken along four assessment criteria, namely, efficiency, equity, technical and organisational feasibility and acceptability. However not all case studies took into account all assessment criteria as the main focus of each case study differs. In fact, most case studies focus on efficiency and equity effects.

4. **Summary of findings and policy recommendations**, where the results achieved from the analysis are summarised and tradeoffs, for example between theoretical optimal solutions and acceptability and feasibility issues are discussed.

Different tools and methodological approaches, including the use of quantitative models and qualitative analysis, have been used in the assessment of the regulation schemes. In the following sections we will describe the main methodological tools used respectively for the interurban and urban case studies.

3.1 Methodology for the assessment of interurban case studies

The assessment of efficiency and equity impacts in the interurban regulation schemes was mainly undertaken using the MOLINO model.

MOLINO is a partial equilibrium model for the analysis of investment and pricing policies. This model studies transport problems that be can described in terms of two alternative transport links. The links may refer to one mode, for example a tolled stretch of motorway versus a non-tolled link or to two competing modes. This is the case in several interurban case studies where road versus rail transport is the problem examined. For each link studied a regulation scheme is defined providing input data for the basis scenario. This status quo scenario is then compared with the alternative regulation schemes.

The complete description of MOLINO model can be consulted in Proost et al. (2005). The model can be summarized as follows:

- **Demand model:** Given the level of generalized cost, the model computes the number of users selecting the different modes, for different time periods. The demand model can deal with passenger as well as freight demand for any combination of modes.
- **Supply model:** Given the number of users selecting the different modes, the model computes the level of congestion on the different modes and for different time periods.
- **Equilibrium model:** Given the demand and supply functions, the model computes the corresponding fixed point solution in terms of prices and congestion levels.
- **Evaluation criteria**. The direct outputs of the model are: flows, travel times, tolls levied. Indirect output can be computed using the direct output: a social welfare function, toll revenues, etc.
- **Control.** There are a variety of control variables: pricing, access control, maintenance policies and investment policies. There are different potential objectives: first or second best welfare maximization, revenue maximization, cost minimization, etc. These objectives can be computed for the whole system or for a part of the system. The system can be managed by one or several competing (or cooperating) agents. The objectives of the agents can be: social welfare maximization, cost minimization, constrained optimization (financial or equity constraints).
- **Accounting model.** For each setting, this model computes the accounts for some of the agents.

Since the demand model, MOLINO adopts a simplified representation of the transport system, in which the transport network consists of two routes in parallel (1 and 2

connecting an origin O to a destination D), there is one class of users (private cars) and two types of individuals (low-income and high-income), who differ in their incomes, values of time and preferences. Each individual has a choice between transport and consumption of a composite other good, a choice of time use, and a choice of route. The model enables the study of different market equilibria: no toll equilibrium, tolled roads, marginal social cost equilibrium, Nash equilibrium, and mixed oligopoly.

The decision tree for each individual type is represented in Figure 4 below.

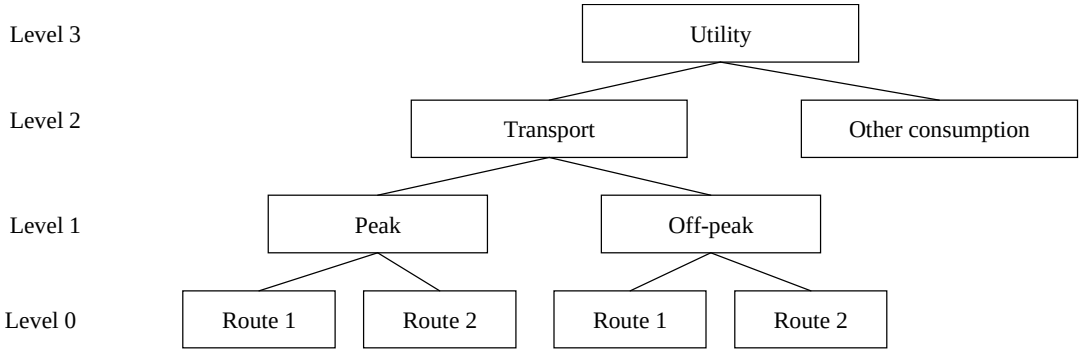


Figure 4: Decision tree for two routes in parallel

At **level 3**, the individual decides how much to purchase of the other good ("Other Consumption") and of the transport good ("Transport") (he has not yet decided the precise allocation between the routes, but his subsequent decision process will be consistent).

At **level 2**, the individual chooses between transport consumption during the peak (“Peak”) and transport during off-peak (“Off-Peak") period.

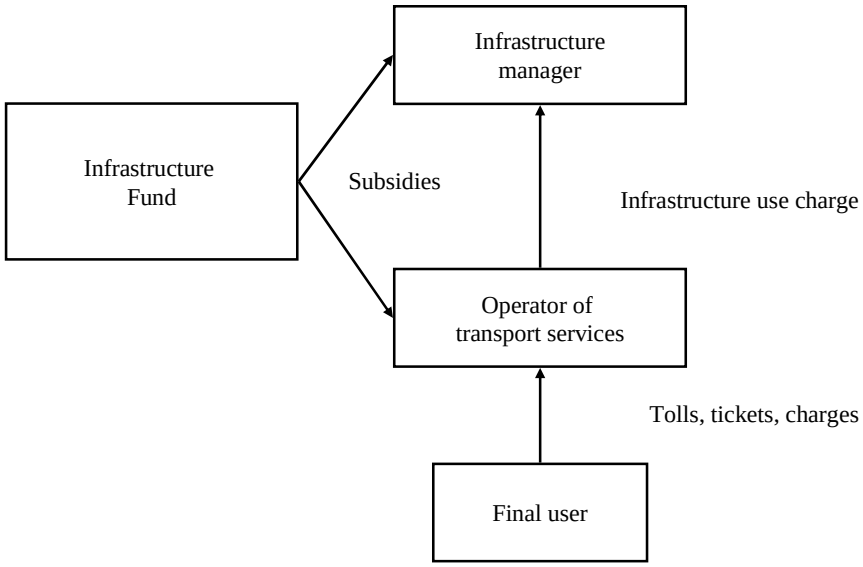
At **level 1**, the individual chooses which route to select, "Route 1" or "Route 2". The corresponding utility levels are represented on level 0.

To calibrate the model, we need the transport consumption on route 1 and 2 at level 0. Together with the generalized prices, the elasticities of substitution and the percentage of income spent on transport; these data are sufficient to calibrate the utility functions and the demand functions.

As it concerns the supply model, there are two types of agents involved in each infrastructure: the manager of the infrastructure (one for each route) and the operator of the transport services (one for each route). The manager of the infrastructure decides upon (and pays for) the capacity maintenance and investments. He receives a fixed fee (or infrastructure-use charge) from the transport services operator (or a fraction of the net revenue of the operator). The operator sets the level of tolls, receives the toll revenue and pays for the operation cost and a fixed or variable amount of the toll revenue to the infrastructure manager. This is schematically given in Figure 5 below,

where arrows stand for payments.

Figure 5: Flow of funds



This is obviously a somewhat simplified representation of the flows of funds, because in the real world there might be also flows from operators or infrastructure managers back into the infrastructure fund.

With regard to the evaluation criteria, the social welfare function is an equity-weighted sum of nine different utility terms:

- Utility of low income users of transport.
- Utility of high income users of transport.
- Tax revenue collected by the central government, weighted with the marginal cost of public funds of the central government which depends on the way the revenues are used (e.g. to lower labour costs or decrease other taxes).
- Tax revenue collected by local government, weighted with the marginal cost of public funds of the local government.
- Profit of transport service operator of route J = 1,2, with weights depending on whether the routes are privately or publicly operated.
- Profit of transport infrastructure manager of route J = 1,2, with weights depending on whether the routes are privately or publicly managed.
- External costs (other than congestion).

Finally, concerning what can be simulated with the MOLINO tool, the user can choose five different regimes:

1. No toll equilibrium (free market with no pricing and no state intervention)
2. Tolled roads (tolls are exogenously set)
3. Marginal Social Cost: in this case, the tolls are set equal to the marginal social cost including the marginal congestion costs, the environmental costs and the maintenance costs.

4. Nash equilibrium: in this case the two roads are privately operated and maximize their profits
5. Mixed oligopoly, where one road is privately operated and maximizes its profits while the other sets the toll equal to the marginal social cost.

In what concerns the use of MOLINO the following points have been identified as being important to consider when interpreting the results of the assessment of interurban transport regulation schemes:

- ✓ Speed flow relationship - MOLINO uses a simple speed flow relationship to describe traffic flows within two time periods (peak and off-peak). This relationship entails several important simplifications. All vehicles are assumed to travel at the same speed for each mode. In reality this is not the case for private and goods vehicles or for freight and passenger trains. This problem has to be indirectly accommodated by using higher values of time for the slow modes. Restrictions for vehicle classes, such as for HGV transport at night, cannot be reflected within the model. Again, an indirect approach has to be chosen where the off-peak period as night period would be defined and the restriction via higher charges during the night would be simulated. A solution to this latter problem is provided in the Swiss case study where an adjusted model, MOLINOinGAMS was constructed which allows restricting HGV traffic at night time directly.
- ✓ Constant load factors - This is problematic for rail transport as this assumes that rail network congestion and infrastructure user charges increase in proportion to demand. This implies that the profits of railways are not really affected by a better market performance, which is not the case in reality. However, a linear cost function for rail which includes a fixed cost accommodates for some of these problems.
- ✓ Dynamics of capacity expansion - In MOLINO the capacity expansion occurs at the same time as investment in transport infrastructure. This could result in an over estimation of welfare due to reduced time costs that does not reflect the actual situation as there is always a time lag between investment and end of the infrastructure construction period. The adaptation of MOLINO in the Swiss case study on transport investment funds - the MOLINOinGAMS model - explicitly allows considering a time lag between investment expenditure and actual availability of capacity. An alternative solution is to take the lag between investment and capacity provision by including interest charges into the investment expenditures, as it is standard practice in investment models.
- ✓ Elasticities of substitution - It was found that this parameter is a very sensitive one for the MOLINO model, indicating problems for the modelling results if the respective input data are not set correctly. It should also be noted that for demand responses on networks this problem is reinforced if only aggregate elasticities of substitution are used (see the German case study where the road and rail network were represented as being transport links only).
- ✓ Welfare analysis: MOLINO does not reflect long-run effects of transport investments such as stimulating other sectors which feeds back into the transport sector via increased demand for transport services from these sectors. In the German case study, the MOLINO analysis was therefore supplemented by an additional analysis with a system-dynamics model (ASTRA).
- ✓ Network deterioration function: MOLINO assumes that the network is kept in proper condition and that this requires a certain level of maintenance costs to be specified by the user. The development of the model was not aimed at reflecting and

optimizing maintenance strategies and does therefore not contain a network deterioration function required to analyse the effect of money spent for infrastructure maintenance and re-investment measures as well as to reflect the long-term obligations arising from new capacity provision. It is thus possible that the positive effect of new investments is over-estimated by the model. The German case study ,which is the only one dealing with the trade-off between maintenance and new capacity enlargement, reflects the impacts of maintenance in an indirect way by using an elasticity of travel speed with regard to maintenance expenditure spent.

- ✓ Marginal cost of funds: Marginal cost of public funds (MCPF) is an important parameter in Molino which drives results in scenarios analysing the use of revenue. Consequently the model may over- or under-estimate the impact on welfare depending on the value chosen. It should be noted that this is in fact not a caveat of the model but rather a problem of choosing the value of MCPF. As far as possible sensitivity analyses were performed to address this problem.
- ✓ Marginal external environmental costs: Marginal external congestion costs are modeled in Molino using generalized transport prices where travel times are endogenous and depend on a congestion function. Marginal external environmental costs are however exogenously to be specified by the user, e.g. no feedback loop is implemented. The model may thus under-estimate effects on welfare since decreasing external environmental effects due to taxation do not produce any welfare gains except this is considered by the model user through exogenous specification of changed environmental costs.

The ASTRA system-dynamics model is applied in parallel to MOLINO in order to analyse further the long-term effects of pricing and investment measures. As the ASTRA model allows the consideration of several distance bands per mode and transport market therefore cover aspects not considered in single link approaches like MOLINO.

ASTRA consists of a macro-economic module containing different business sectors, a state module and international trade relationships. Using this structure the substitution between and the contribution of transport to the rest of the economy can be presented more realistically than with the substitution elasticity concept followed by Molino. In particular ASTRA can model complex developments of economic indicators over time, arising from market imperfections, different speeds of adaptation to new conditions, policy changes (e.g. future vehicle emission standards) and the development of the population structure.

The ASTRA model, however, does not compute market equilibria and consequently can not deliver neo-classical welfare measures as MOLINO does. Model results are given as time series of indicators, such as GDP, GVA by sector, employment, vehicle stock, transport volumes, air emissions, etc. In the ASTRA framework it was decided not to combine different indicators to a single welfare measure as such a simplification would not embrace the complexity of socioeconomic evolutions. Thus, the simple ranking of alternative policy scenarios based on ASTRA model outputs can become difficult when indicators point in different directions.

In practice, only in the German case study[21] the MOLINO and ASTRA models were both used for the assessment.

3.2 Methodology for the assessment of urban case studies

The assessment of the REVENUE urban regulation schemes was carried out using different methods and tools. The MOLINO approach, widely used for the interurban case studies, was abandoned in favour of other urban models with more detailed representations of the respective urban road networks than the MOLINO model can accommodate.

The **Oslo case study** used the FINMOD model. This is a model for the investigation of optimum policies for public transport at an aggregate level for regions or smaller local areas. As an aggregate model it does not handle single routes, but uses aggregate measures of public transport supply. It is a numerically implemented model that can be adapted to different areas and public transport systems by changing or calibrating some of the parameters. Formally FINMOD solves a problem of non-linear optimisation with non-linear constraints. In the Oslo case study the FINMOD model was used in order to analyse the effect of different road user charging schemes, as well as the regional distributional effects of different revenue use and budget constraints. In practice, the analysis focus on the social costs and benefits of alternative scenarios for the different regulation schemes of the Oslo case study[14]. In order to understand the reason for the restrictions on revenue use in each of the different financing packages it was also carried out a process evaluation (using primary and secondary information sources). The acceptability analysis of the regulation schemes was carried out from the perspective of citizens, politicians and professionals. Thus, the case study includes an attitudinal survey among citizens in the Oslo region towards the toll ring, the fare system and revenue use are included, as well as a Stated Preference survey among politicians and transport planners towards different transport funding schemes and revenue use.

The **Warsaw case study** has been done using the Warsaw Computer Traffic Model, which works under the VISUM platform, enables the production of traffic forecast at a regional and local scale for individual and public transport traffic (including rail, light rail, metro, tram and buses). Travel demand was split in several market segments by journey purpose and car availability. The model outputs are used as inputs to financial and economic analysis (efficiency). The following calculations have been carried out for a period of 30 years:

- ✓ Gross and net estimations of cordon charging scheme revenues;
- ✓ Financial analysis of the cordon pricing system for different assumptions concerning the investment and operating costs;
- ✓ Economic analysis from the point of view of user costs and benefits.

[21] See Chapter 5

[14] The model was first developed by Larsen (1993) to analyse optimal subsidies under various constraints. The structure of the model was inspired by Jansson (1979 and 1984). The model was further developed to investigate optimal incentives for public transport contracts in different urban and regional areas (Norheim and Johansen 1997, Carlquist et al 1998, Norheim and Johansen 2000, Fearnley et al 2001, Longva et al 2002, Fearnley et al 2004). REVENUE Deliverable 5 also contains more detailed information on the model.

The outputs of the financial and economic analysis were the net present value and the internal rate of return (financial and economic perspectives).
The approach followed in the research of the cordon charging system acceptability consisted in two surveys, respectively targeted to car drivers (680 interviews) and other stakeholders (26 interviews)[15].
Technical feasibility focussed on the definition of the cordon scheme area and on the selection of toll gates locations.

In the **Edinburgh case study** the MARS[16] (Metropolitan Activity Relocation Simulator) model has been applied. This is a strategic, interactive land-use and transport interaction model. The first stage of the development of MARS consisted in a qualitative analysis using causal loop diagramming. The following Figure 6 picture depicts the result of this initial process.

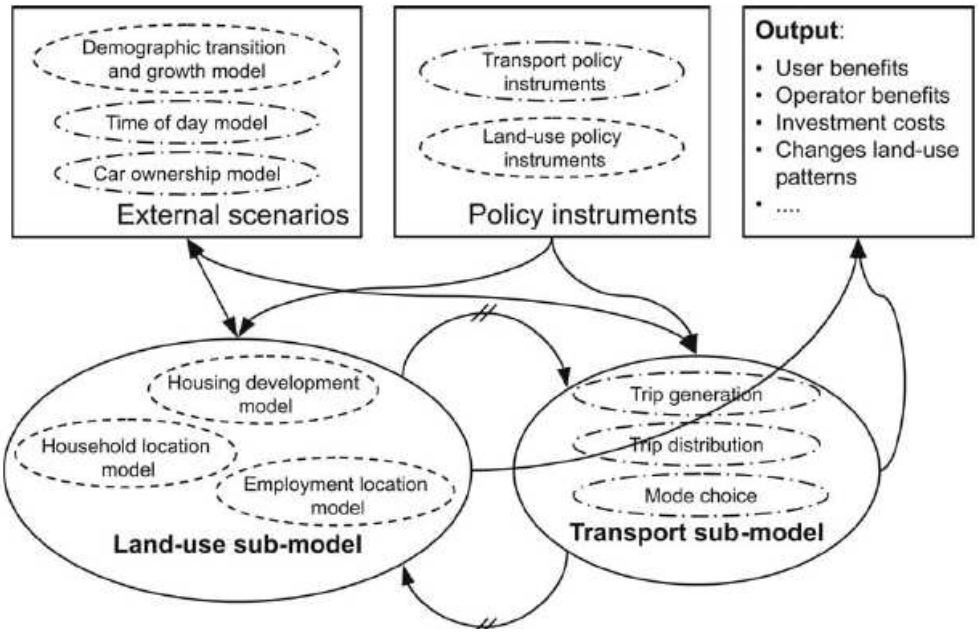


Figure 6: Structure of the MARS model

MARS can model the transport and behavioural responses to several demand and supply side instruments. These impacts can then be used to carry out a standard cost-benefit analysis. The model assumes that land-use and use is not a constant but is rather part of a dynamic system that is influenced by transport infrastructure. This interaction process is modelled using time-lagged feedback loops between the transport and land-use sub-models over a period of 30 years. Input to MARS comes from external scenarios and policy instruments. Outputs can be in the form of indicators or these indicators can be adapted to form an objective function. The outputs of the transport

[15] Interviewed stakeholders include policy making institutions (central and local level), civil servants (local level), non governmental organisations, private sector representatives and professionals (planners, consultants).
[16] For a more technical description of the MARS model see Pfaffenbichler and Shepherd (2003).

model include accessibility measures for each zone (in the case of the case study, within the city and immediate surroundings). The outputs of the land-use model consist in workplace and residential locations preferences per zone. Therefore, MARS calculates changes in transport related impacts, including changes in travel demands by mode, travel time, accidents and pollution. The combination of this data with the unit valuations generates an input to a welfare function (i.e. the objective function)[17].
The same welfare function was used for the scenario's evaluation. Welfare for the different geographic areas (City of Edinburgh Council and rest of study area) was analysed separately. The welfare function used is based on the research work carried out in the PROSPECTS project (May et al, 2003). The welfare function consists of a transport user benefit term (consumer surplus), a transport supplier cost term (producer surplus), a government revenue term, a CO2 costs term and a term for monetised values for local pollution and accidents (Minken et al, 2003). All these costs are discounted at the same rate, in this case corresponding to the official UK government test discount rate of 3.5%, over a 30-year evaluation period. The government revenue term includes a calculation for changes in indirect taxation - including fuel tax. Therefore, each of the scenarios is therefore fully monetised. The welfare calculation does not consider the effect of the marginal cost of public funds.
An adapted version of the welfare function was used to analyse the scenario if Edinburgh residents (i.e. the City of Edinburgh Council) were responsible for setting the cordon charges and determining the investment strategy. In this context, the welfare function for Edinburgh residents' comprised the user benefits that accrue to them, the change in external costs that are felt by them, the change in revenues that accrue to transport providers in Edinburgh and the total increase in transport provider operating costs plus the costs of any investment associated with cordon charging (except that already committed by the Scottish Executive). The welfare results and its components are the first means of comparing the relative impacts of the transport instruments.
Complementarily, the cost implications of each transport instrument are examined in terms of the change in Present Value of Finance (PVF). The PVF of an instrument or set of instruments is defined as the net discounted financial benefit to government and other providers of transport facilities, both public and private, over a 30-year time horizon, relative to the do-minimum scenario.

Finally, in the **cross boundary acceptability case study**, the approach for the assessment of technical and organizational feasibility and acceptability was based on three work streams:

- ✓ A set of nine in-depth interviews with stakeholders (key actors who played a role or had a stake I the road user charging process). The interviews were carried out over a 2 week period, shortly after the public referendum (March 2005);
- ✓ Analysis of the secondary information related with the public consultation process;
- ✓ Analysis of the secondary information related with the public enquiry (referendum) carried out after the consultation process.

[17] Aside from the exclusion of the MCPF the welfare function (or objective function) used in the Edinburgh case study has the same structural form as that used in the MOLINO model used in some interurban case studies.

4 OVERVIEW OF CURRENT PRACTICE IN PRICING AND REVENUE USE IN EUROPE

Currently transport pricing in the European Union is not consistent across modes or across countries. Road users are subject to a number of different charges, some of which have no bearing on where or how the road vehicle is used, just on where it is registered. Road user charges are high in some countries and low in others; some countries rely heavily on fuel tax whilst others have low fuel tax plus additional tolls. Rail infrastructure charges also vary substantially with different levels of charge and charging structures between countries. Aviation charges and maritime charges reflect – to a certain extent – infrastructure use through airport charges and port charges, though typically are not based on principles of marginal cost pricing. In the following section we will give a more detailed picture of the situation, with the help of EU country fact sheets.

4.1 Overview of pricing schemes in Europe

4.1.1 Pricing instruments

Charges and taxes are the two types of pricing instruments to be identified in the national transport pricing regimes. The corresponding concepts are explained below:

- **Charge:** A levy which requires a direct and clear service in proportion to the payment from the part of the public or private provider. Some examples of charges are: infrastructure access charges (vignettes enabling use of a section of network, road tolls, bridge/tunnel charges, rail track access charges, airport landing fees, lock fees, port charges, etc.), freight tariffs, public transport fares and vehicle insurance payments.
- **Tax:** A levy that must be paid with either no discernible service in exchange from the State or a service that is not in proportion to the payments. Examples of taxes are: annual vehicle registration taxes, passenger taxes, fuel duty, value added tax on fuel duty, taxes for scrapping and environment related taxes (e.g. carbon tax).

4.1.2 Pricing principles

The REVENUE D3 fact sheets made a systematic description of pricing principles for each of the considered countries; those principles are explained below.

4.1.2.1 First-best pricing

Under first-best conditions (perfect information, divisible investment, convex costs), optimal prices in transport networks correspond to short-run marginal costs (SRMC).. Two types of marginal cost pricing can be distinguished:

- *Pure social marginal cost pricing (SMCP)***:** In this case prices are set equal to the short-run price relevant cost[18] consisting of the producer marginal cost (e.g. reconstruction, wear & tear, maintenance cost), the price-relevant user cost (congestion cost, scarcity cost) plus the marginal transport system external cost (environmental cost, external accident cost). No consideration is given to the

[18] See Jansson and Lindberg (1997), Transport Pricing Principles in Detail.

financial implications of the pricing scheme in terms of surpluses or deficits for each mode.

- *Private marginal cost pricing:* With this pricing scheme, the price-relevant user cost and the transport system external costs are disregarded and prices are based on the marginal producer cost alone. Short-run marginal-cost pricing implies setting prices equal to short-run marginal costs given the existing infrastructure. In contrast, under long-run marginal cost pricing prices are set at a level equal to the costs of optimally adjusting infrastructure capacity to the given level of usage. Short-run and long-run marginal costs will be the same if infrastructure provision is optimal.

4.1.2.2 Second-best pricing

When first-best conditions are not achievable or not known, and prices are set optimally conditional to constraints or imperfections, the result is second-best pricing. Second-best pricing implies deviations from social marginal costs. These deviations may be imposed by cost recovery objectives, i.e. financial constraints either by mode or for the entire transport sector. The most common ones are listed below:

- *Mark-ups* can be added to the marginal costs in order to achieve cost coverage. One particular form of a mark-up is *Ramsey pricing* which requires that prices are increased and that the increase is inversely proportional to the price elasticity of demand.[19] With this scheme, the mark-ups above marginal social costs may differ between transport services (e.g. peak vs. off-peak, passengers vs. freight).
- *Multipart Tariffs*. Multi-part tariffs consist of fixed, blockwise[20] variable and variable parts. They can flexibly be adjusted to the cost and demand characteristics and are Pareto-superior to linear tariffs once a defined level of cost recovery is desired.[21]
- *Fully Distributed Cost* schemes (FDC) are another form of second-best pricing, which takes SRMC as a starting point and allocates the remaining costs according to selected parameters.[22] It can involve high differentiation and additional incentive elements.

Finally, transport pricing may be specifically designed to achieve specific practical targets. Possible targets could be (for example) a maximum level of transport volume, a maximum level of air pollutants exhausted by road traffic, or financial targets – but most commonly the target is cost recovery. The constraints in the case of second-best pricing and the objective of the target-oriented pricing approach may try to achieve the same issue (e.g. a certain cost recovery degree). The remaining difference is that second-best pricing approaches intend to meet the constraint in a most efficient or optimal way which is not the explicit goal of target-oriented pricing approaches. *Average cost pricing* is an example of a target-oriented pricing approach (cost recovery is the target). In average cost pricing schemes, prices are set equal to the sum of financial costs divided by the total traffic volume of that mode. No distinction is made between sunk and variable costs, and external costs are disregarded. All transport

19 The inverse elasticity rule applies if demands are independent. When demands are interdependent the pricing formulas are considerably more complicated.

20 An example of blockwise variable costs are the use of electricity supply in railways, that diesel train operators do not use and thus do not pay for.

21 See Rothengatter (2003), How Good is First Best? Marginal Costs and Other Pricing Principles for User Charging in Transport.

22 See Peter (2003), Railway Infrastructure: Pricing and Investment. Paper for the fifth IMPRINT-EUROPE seminar.

services (freight, passengers etc.) are treated in the same way, but the prices are not the same because of different units of measurement (e.g. passenger-km or freight ton-km). If a more differentiated average cost pricing regime is desirable (e.g. a distinction between sub-modes), the cost allocation problem arises, i.e. the difficulty in deciding how to allocate common costs.

4.1.3 Observed pricing schemes

The pricing schemes were investigated by mode. For a more detailed description, see the country fact sheets in Deliverable 3. It should be stressed that a detailed analysis of the advantages and disadvantages of the different solutions was beyond the scope of this research project.

4.1.3.1 Road

Road transport taxes in Europe consist of vehicle taxes and fuel taxes. In addition, value-added tax (VAT) is levied on sales of vehicles, fuels and services.

Vehicle taxes include annual ownership taxes, driving license fees and insurance taxes. They often have a flat rate (a percentage of the vehicle value), but there are also countries where the rate varies by vehicle type (e.g. Belgium and Germany) or engine size (Austria). Some countries also have a tax to cover the cost of the scrapping the vehicle at the end of its lifetime. In Denmark, Germany, Italy, Sweden an the UK, annual ownership taxes account for a sizeable share of total revenues from road transport.

Fuel taxes (VAT and excise duties) account for **about 50% of total revenues** in all European countries. More than half of the fuel price paid at the petrol station can consist of taxes; the exact level varies by fuel type).

Value-added tax on sales of vehicles and repair parts or services account for 20 - 30% of total revenues in all countries. In Germany, for example, VAT on servicing and repair parts amounted to €24 billion, more than a quarter of total revenues (€78 billion)

In addition to the taxes described above, there are various types of **road charges**:

A well-known example is the HGV **Eurovignette** scheme[23] that has been implemented in the Netherlands, Belgium, and Sweden (as well as Luxembourg and Denmark, that were not considered in this project). A vignette is bought for a fixed price per vehicle per year. Similar "vignette" schemes are in place in Austria, Switzerland (only for bikes, cars and light goods vehicles) and France.

In several countries, heavy vehicle charges are differentiated according to number of axles (Austria) or number of axles and emission category (Germany). The HGV charges are levied only on motorways in Austria and Germany. These schemes, as well as the Eurovignette schemes can be considered as Fully Distributed Costs (FDC) schemes. In Switzerland, HGV charging takes place on all roads, and is dependent on the kilometres driven, the permissible vehicle weight and the emission category of the truck.

Traditional **motorway charging** exists in many countries; it is the most common form of pricing in case of private concessionaires operating the motorway. Motorway charging can be distance-based or gate-based. Usually multipart (second best) tariffs are used, and in some cases externalities are also considered.

Additionally, **tolls** are collected in various countries for the crossing of bridges, tunnels etc., but in the majority of countries this happens only at a very small number of loca-

[23] Established through the Eurovignette Directive 1999/62/EC which is currently (March 2005) under revision.

tions. These tolls are mentioned in the country reports, but in the summary table only if they occur on a wide scale. Tunnel and bridge tolls are nearly always target-oriented, and are usually based on average cost pricing.

Cordon tolling implies charging road traffic to enter a particular zone. The most well-known example is London where £5 must be paid to enter the City. This type of scheme also exists in Durham (UK) and in Norway (Oslo, Bergen, Trondheim). The Norwegian tolls are based on recovering the costs of specific investments; those in London on achieving objectives regarding congestion .

4.1.3.2 Rail

For the purpose of this study, railway pricing has been defined as the pricing mechanisms between railway infrastructure managers and train operating companies. Management and operation have been separated in almost every EU member state now, and normally **access charges** are paid by the operators for using the network (exception being Greece where no charges exist for the time being).[24]

Normally, operators pay rates that are differentiated according to gross train weight and, distance travelled, and sometimes also by train type, route type and size of station served – these are multipart tariffs. Besides, average costs are often charged for services such as shunting, catenary, gauge change facilities etc.. In a number of countries (Sweden, Finland, Switzerland, Britain and Austria), the wear and tear component is calculated according to marginal cost principles, but mark ups to improve cost recovery are common.

Taxes are limited to fuel taxes and in some countries these are set at a lower rate than for road vehicles, reflecting the fact that fuel taxes on road vehicles are designed partly as user charges for roads.

4.1.3.3 Urban Public Transport

Road based urban public transport is often treated favourably regarding fuel taxes and vehicles taxes, as well as receiving direct subsidies. Ticket prices often have price-cap mechanisms, and are based on social considerations rather than any of the pricing principles outlined above. However, in Greece they are target-oriented (aiming for 50% cost coverage), whilst in Britain – outside London – bus fares are predominantly set by commercial operators without regulation.

4.1.3.4 Aviation

Airport pricing includes a broad range of **charges** such as airport take-off and landing fees, local air traffic control (ATC) fees, and handling fees. These charges often have a multipart-tariff structure, at least in the large airports with scheduled flights; most of them are target-oriented. ATC charges are set by Eurocontrol and are fully-distributed and target-oriented. The pricing scheme is based on distance flown, aircraft weight and country unit rate. Airport charges usually depend on the Maximum Take-Off Weight (MTOW) or engine noise (usually according to the ICAO noise chapter categories).

A number of airports levy noise or other environmental charges, some of which are earmarked. Moreover, some airports have imposed (higher) security fees since 11 September 2001. Kerosene is exempted from VAT by the 1944 Chicago convention in case of international flights. On domestic flights, VAT is charged in some countries.

[24] Based on the Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification.

4.1.3.5 Inland waterways

Taxes and charges in inland waterways are relatively uncommon. Target-oriented average cost schemes are in place in several countries (all using charges), and Finland is the only country that also has a second-best (multipart tariff) pricing regime. In some cases, pricing is explicitly forbidden by law. The 19th century Mannheim Act prohibits pricing on the Rhine, one of Europe's most important waterways; and in the Netherlands, where inland waterways are very extensive and account for a significant amount of overall freight transportation, charging is also forbidden by law. However, one may have to pay for passing some locks or bridges on the smaller waterways.

4.1.3.6 Ports

Ports are often not regulated by governments and can thus set their dues as they wish. In practice, this leads to a pricing strategy where competition plays a decisive role. In many cases, ports are financially self-supporting, although port dues are only a part of a larger spectrum of incomes. Both second-best pricing and target-oriented pricing systems are common. In France, a form of Ramsey pricing is also used.

Table 1 - Country overview table: Pricing

Country	Mode					
	Road	Rail	Urban PT	Air *	Inland waterways	Maritime
Austria	Second best FDC (HGV charges) + fuel & vehicle taxes. Private car light motorway charges are average cost (vignette). Tunnel/road tolls (average cost or multipart tariffs).	Second-best (Multipart tariffs with elements of SMCP). Aimed at a target level of cost recovery.		Passenger charges (average cost). Second-best landing charges (Multipart tariffs), plus security fees.	Target-oriented charges.	Not applicable.
Belgium	Eurovignette HGV charging (Second best FDC) + fuel & vehicle taxes (the latter varying by car type). One tolled tunnel.	Second-best (Multipart tariffs, with elements of SMCP).		Passenger charges (average cost). Second-best landing charges (Multipart tariffs), plus noise and environmental charges.	Taxes and charges. Target-oriented and competitive pricing.	Second-best charges (multipart tariffs).
Finland	Fuel & vehicle taxes.	Taxes and charges. Second-best (Multipart tariffs, with elements of SMCP)..	Lower VAT rate (8%)	Passenger charges (average cost). Second-best landing charges (Multipart tariffs) that are target-oriented (aimed at full cost recovery).	Target-oriented charges (multi-part tariffs).	Second-best charges (multipart tariffs).
France	Target-oriented motorway charging (second best, multipart tariff) with elements of marginal cost pricing. Fuel and vehicle taxes. Also vignette (target-oriented).	Second-best (Multipart tariffs).		Passenger charges (average cost). Target-oriented second best landing charges (multi-part tariffs). Noise charge.	Charges (Average cost).	Charges, often according to Ramsey pricing.

Country	Mode					
	Road	Rail	Urban PT	Air *	Inland waterways	Maritime
Germany	Fuel & vehicle taxes that vary by fuel/vehicle type, second-best heavy vehicle charge ("LKW-Maut") on highways (FDC).	Target-oriented, second best multi-part tariffs that distinguish between train type , service type, line type. Elements of SMCP (congestion charges). Reduced electricity taxes.	Fuel tax breaks.	Passenger charges (average cost). Second-best landing charges (Multipart tariffs).	Charging on some channels and some tax breaks	Second-best charges (Multipart tariffs) and some tax breaks
Greece	Some second-best road charging (multipart tariff). Target-oriented in case of concessions, one of them with a toll ceiling. Fuel and vehicle taxes	No pricing in railways	Tickets are target-oriented (should cover about 50% of costs)	Passenger charges (average cost). Second-best landing charges (Multipart tariffs). Additional development charges.	Target-oriented charges	Target-oriented charges
Italy	Second-best motorway charging (multipart tariff). Distinguishes five vehicle classes. Charges are target-oriented and use a price-cap formula. Fuel and vehicle taxes. Tolled tunnels.	Second-best (Multipart tariffs, with elements of SMCP). Also target-oriented and using price-cap formula.	A price-cap is in place for ticket prices.	Passenger charges (average cost). Second-best landing charges (Multipart tariffs) with elements of SMCP. Noise charge.		Target-oriented charges
Netherlands	Fuel & vehicle taxes. Second-best Eurovignette HGV charging (FDC). Two tolled tunnels (target-oriented multipart tariffs).	Second-best (Multipart tariffs). Target-oriented. Some elements of SMCP (externalities may be included).	Average cost pricing. A price-cap is in place for ticket prices.	Passenger charges (average cost). Second-best landing charges (multipart tariffs). Charges with elements of SMCP (emission and noise charges). Domestic flights pay fuel tax.	Target-oriented charges, mostly no pricing at all	Second-best (multipart tariffs)

Country	Mode					
	Road	Rail	Urban PT	Air *	Inland waterways	Maritime
Norway	Fuel taxes have SMCP and MCP elements. Cordon tolls. Charges for bridges/tunnels etc. with multipart-tariffs and some elements of SMCP.	SMCP based pricing for freight; no charges for passenger.	Taxes only in case of petrol. Other energy sources are not taxed.	Passenger charges (average cost). Second-best landing charges (Multipart tariffs). Domestic flights pay fuel tax.	No pricing.	Target-oriented charges.
Portugal	Second-best motorway charging (multipart tariff) and bridge tolls (multipart tariffs) Fuel, vehicle and other taxes.	Second-best (Multipart tariffs). One operator has charges based on performances.	Target-oriented average cost pricing.	Passenger landing charges (average cost). Fees are target-oriented second-best charges (Multipart tariffs).	Target-oriented average cost pricing.	Target-oriented
Spain	Second-best motorway charging (multipart tariff). Fuel and vehicle taxes.	Charges only on Madrid-Lleida high-speed line. Second-best, multipart tariffs. No charging yet on the rest of the network.		Passenger landing charges (average cost). Second-best charges (Multipart tariffs).	No pricing identified	Target-oriented
Switzerland	Heavy vehicle fee (second-best FDC including externalities). Fuel and vehicle taxes. Vignette for passenger cars.	Second-best pricing (Multi-part tariff) with elements of MCP.	Target-oriented pricing.	Passenger charges (average cost). Landing and handling charges are target-oriented average cost pricing with elements of SMCP (differentiated emission and noise charges).	Basle only: Target-oriented charges, average cost pricing.	Not applicable
Sweden	Flat vehicle taxes. Fuel tax (level set such as to internalise externalities). Eurovignette (second best FDC with elements of SMCP).	Second-best pricing (Multi-part tariff),	Tax breaks.	Passenger charges (average cost). Second-best landing charges (Multipart tariffs)	No pricing identified.	Target-oriented. Some tax breaks for non-fossil fuels. Fairway charges are target-oriented.

Country	Mode					
	Road	Rail	Urban PT	Air *	Inland waterways	Maritime
UK	Fuel & vehicle taxes. tolls based on cost recovery principles on some bridges and tunnels and one private unregulated toll road. Cordon pricing in two cities (average cost).	Marginal cost pricing, plus fixed charges for franchised operators.	Target-oriented pricing with tax breaks. Outside London mainly unregulated commercial bus operators.	Passenger charges (average cost). Second-best landing charges (Multipart tariffs)		

* Excluding ATC charges, since they are calculated in the same way throughout all countries (see Annex A of D3).

4.2 Earmarking and other revenue allocation rules

4.2.1 Allocation classifications

REVENUE considered those allocation rules that have a (semi-)permanent character and that are based on a law or similar legal government document.
Earmarking is a specific type of allocation rule where not only the beneficiary and/or purpose of the revenue is specified, but also the percentage of revenue that must be allocated. It is important to have knowledge about the rules and/or criteria that are applied to decide on investments and on fund allocation, in order to analyse the impact of the decisions in terms of efficiency. REVENUE investigated if and how transport revenue is earmarked – sometimes non-transport revenue is earmarked for transport spending, and vice versa. This was an important dimension to be considered both in the comparison of current practice to the theory in D3, and in the development of the case studies in D4 and D5.

4.2.2 Observed allocation schemes

The allocation schemes are discussed by mode. A condensed overview of pricing schemes is given in table 2Table 2. A more detailed description has been given in the country fact sheets of D3.

4.2.2.2 Road
Road transport is the mode that generates **most surplus revenue**, and unsurprisingly this mode has the **largest number of earmarking and allocation schemes** associated with it.
Road revenue is often earmarked for the improvement of existing road infrastructure and the construction of new roads and tunnels. In Austria, revenues from motorway charging (from HGV by electronic charging and LGV/cars by vignette charging) are allocated to ASFINAG, an enterprise under private law owned by the federal state. ASFINAG plans, manages and finances the Austrian motorway and highway system. In Germany, revenues from HGV charging go to the VIFG, which is a company under private law owned by the federal state. VIFG spends the revenues on transport projects defined by the federal government, in the first instance for motorways and federal primaries. Belgium is another example where revenue goes to the regions. Geographical equity issues are important in both countries.
In case of road being operated by a private concessionaire, road revenues are often internally earmarked. In this way, concessionaires can recover their investment or finance new investment. At the end of the concession period, it is common that the revenues from road charging are obtained by the state.
Intermodal funds only exist in two countries: France and Switzerland. France recently implemented the AFITF intermodal fund.[25] This fund receives motorway toll revenue as well as government subsidy, and uses the resources for the construction of new infrastructure, predominantly high-speed rail. The AFITF budget for 2005 foresees a government grant of €200m, and revenues from the tolls of motorway concessionaires of €280m, as well as a rent of €155m that the concessionaires must pay for the use of the land that they occupy. The main projects that AFITF will finance in 2005 include the TGV Est and the high-speed link Perpignan-Figueiras. Other projects that will

[25] AFITF = French Agency for Transport Infrastructure

receive financing in 2005 are railway lines (TGV Rhin-Rhône, Nîmes-Montpellier, Haut-Bugey), port works of the "Fos 2XL" initiative, motorways (A19 Orléans-Courtenay, A41 Annecy-Genève), and some studies and preparation of new projects (TGV Sud Europe-Atlantique, the Lyon-Turin railway and the canal Seine-Nord Europe). In total AFITF will assist in the financing of 35 projects until 2012, and invest €7.5 billion (with the total cost of those projects being €20 billion). The AFTIF fund is subject of the French REVENUE case studies.

The other example of an intermodal fund is the FinöV[26] fund in Switzerland where 67% of the revenue form the heavy vehicle fee are spent on heavy rail infrastructure construction, the vast majority of it being invested in the Gotthard and Lötschberg railway tunnels. 33% of the HVF revenue goes to the regions, which use it, among other things, for road construction and maintenance. At the moment, the fund is heavily indebted because of the high construction costs (current level of debt: CHF 2,378m). Total income of the fund in 2003 was €1,098m (CHF 291m from the VAT, CHF 440m from the HVF, CHF 331m from the fuel tax, and CHF 34m from sales of transit rights), total expenditure for construction equalled CHF1,979m. The FinöV fund will be analysed in the Swiss REVENUE case study.

According to the law in the United Kingdom, revenue from road pricing schemes must be invested in the transport sector during the first ten years.

In most cases, **fuel tax revenues** enter the general budget without any earmarking. However, there are some earmarking schemes: In Finland and the Netherlands, a small part of the fuel tax is earmarked to cover the expenses made for guaranteeing the supply of fuel by maintaining a strategic oil reserve. VAT is usually charged as well. In Germany, 3% of the fuel tax is earmarked for urban public transport. In the UK, the government has promised that any increase in the fuel tax above inflation level will be used for transport projects. In Switzerland, 50% of the revenues from the fuel tax belong to the treasury. The other 50% are used for construction and maintenance of the national motorway network as well as the construction of the new transalpine railway tunnels.

Vehicle taxes are sometimes earmarked as well. In Germany and Switzerland, these taxes are earmarked for the regions. Finally, the car scrapping tax that some countries levy, is internally earmarked.

4.2.2.3 Rail

Cost coverage for the railway infrastructure managers varies dramatically but rarely reaches 100%, and railway revenues were always observed to stay within the same mode. Some road pricing revenue is earmarked for rail infrastructure (see intermodal funds and Austrian HGV charging in the road section above). All charges paid by railway operators belong to the infrastructure managers (internal earmarking).

4.2.2.4 Urban Public Transport

Urban Public Transport is often benefits from of allocation schemes of other modes, and these allocation schemes sometimes even extend beyond transport. For example electricity taxes are earmarked in Austria, where 2,5% of the tax must be used for urban public transport. France also has a municipal tax scheme in which a special tax, payable by any company larger than 9 employees, is used for local public transport based in the city where the company is based.

[26] FinöV = Bau und Finanzierung von Vorhaben des öffentlichen Verkehrs ("Construction and financing of projects of public transport).

In the Netherlands, a fund exists for the allocation of revenues from public transport ticket sales. All public transport except trains use one ticket system (the so-called "strippenkaart"). Revenues from this system are allocated to the various operators in the country in negotiations that take place in a three-year interval. This system has no incentives built into it, however. In Portugal, parking fees are sometimes used for the financing of urban public transport.

4.2.2.5 Aviation

Aviation-related taxes are usually earmarked. **Noise charges** are the most common type, which is 100% earmarked for noise abatement measures, such as insulation of houses in the vicinity of large airports. There are also security taxes that are earmarked for aviation security measures at airports.

The aviation charges are usually internally earmarked for the authority that levies them. Thus, landing fees, handling fees etc. stay within the airport that supplies these services, while navigational airspaces are earmarked for the Air Traffic Control authority for every country whose airspace is used, even if the flight just crosses that airspace without landing.

Some countries have a slightly different allocation scheme. In France, there is an aviation fund (BAAC) that collects all aviation charges and redistributes them over the various airports that it operates. In practice, this means that the two Paris airports are cross-financing other, smaller airports. Finally, another issue in airport financing is the single-till/dual-till question (i.e. whether revenues from commercial developments at airports are used to finance transport activities). Both options are common in Europe at the moment, but a thorough examination of these fell beyond the scope of the REVENUE project as it would have required a very detailed investigation of airport finances.

4.2.2.6 Inland waterways

Normally, the charges levied for the use of inland waterways, locks and other facilities are internally earmarked for use by the charging authority. The only country where a specific revenue allocation scheme was observed is France, where part of the hydro power tax must be spent on inland waterways.

4.2.2.7 Ports

Port dues and charges are normally earmarked internally. Some specific charges, such as the fairway charges in Sweden and Finland, are intended to be spent on that activity.

Table 2 - Country overview table: Revenue allocation schemes

Country	Mode					
	Road	Rail	Urban PT	Air	Inland waterways	Maritime
Austria	All road charges (vignette, HGV and others) are fully earmarked for road construction and maintenance. 58% of the HGV charges are earmarked for underground constructions.	Charges belong to the infrastructure manager.	2.5% of electricity tax is used to help finance urban PT (both infrastructure and operation).	Airports receive charges, security tax fully earmarked for security expenses.	No allocation scheme identified	Not applicable.
Belgium	Road charging and tax revenues are passed to the regions	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges. Noise and environmental charges fully earmarked for their respective purposes.	No allocation scheme identified	Port dues and charges belong to the ports.
Finland	A small part of the fuel tax is earmarked for the fuel supply.	The track charges must be used for railway maintenance. The track tax goes to the general budget.	Ticket revenue is not enough for cost coverage and stays with the operators.	Revenue use decided by airport authorities.	Some of the charges must be used for waterway maintenance	Fairway charges are fully earmarked. Port dues and charges belong to the ports.
France	Road revenue goes to AFITF, the newly created intermodal fund. This fund decides about the allocation of resources. There is no fixed allocation rule. A considerable amount of the fund's budget is spent on high-speed railway infrastructure construction.	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators. A special company tax (for all companies > 9 employees) is 100% earmarked for urban PT.	Noise charges are 100% earmarked for noise abatement expenses. Charges go to a aviation fund that deals with aviation investments nationally.	A tax on water consumption is used for the maintenance of inland waterways. €15m of collected user charges are earmarked for development of tourism, transport and recreation.	Port dues and charges belong to the ports.

Country	Mode					
	Road	Rail	Urban PT	Air	Inland waterways	Maritime
Germany	The net revenues from the heavy vehicle fee (ca. 2.4 bill. EUR) are fully earmarked to infrastructure: 50% to motorways, 38% to railways and 12% to waterways. Vehicle taxes go to the regions (Länder), parking fees to the municipalities. 3% of fuel tax is earmarked for municipal public transport.	Charges belong to the infrastructure manager. Part of the track access charges are used to repay investment grants from the federal government.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges.	No allocation scheme identified	Port dues and charges belong to the ports.
Greece	In case of a concession, road charges are fully earmarked to recover the investment. Upon achieving this, the charges will go to the general state budget.	No allocation scheme identified.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges. Airport development taxes are earmarked for an airport development fund.	Charges are earmarked internally.	Port dues and charges belong to the ports.
Italy	Concessionaires pay 20% of the charges to the government as VAT. The rest remains within the concessionaires	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges. In case of public-private airports, the aeronautical charges go to the state, the handling fees to the concessionaire. Noise charges are fully earmarked for noise expenditure.	No allocation scheme identified	Port dues and charges belong to the ports.
Netherlands	A very small bit of fuel tax is earmarked for expense of strategic oil reserves.	Charges belong to the infrastructure manager.	Ticket revenue goes to a general fund that is redistributed according to operator negotiations held every three years.	Airports receive charges. Noise charges are used for noise abatement.	Charges are earmarked internally.	Port dues and charges belong to the ports.
Norway	Charges are used by tunnel/bridge concessionaires for maintenance	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges.	No allocation scheme identified	Port dues and charges belong to the ports.

Country	Mode					
	Road	Rail	Urban PT	Air	Inland waterways	Maritime
Portugal	Charges are used by motorway concessionaires for construction and maintenance. Bridge tolls were used for the construction of a new bridge.	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators. In some cities PT is partly financed by other types of transport charging (e.g. parking).	Airports receive charges.	No allocation scheme identified	Port dues and charges belong to the ports.
Spain	Charges are used by motorway concessionaires for construction and maintenance.	Charges belong to the infrastructure manager.	No allocation scheme identified	Airports receive charges.	No allocation scheme identified	Port dues and charges belong to the ports.
Switzerland	Two thirds of the revenues from the HVF go to an intermodal fund (railway construction fund "Finöv"). One third goes to the regions, which use it, among other things, for road construction and maintenance. Vehicle taxes levied by the cantons are also partly earmarked for road construction and maintenance. Half of the revenues from the fuel tax belong to the treasury, the rest is used for construction and maintenance of the national motorway network as well as the construction of the new transalpine railway tunnels.	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges. Noise charges are allocated to an aviation noise fund, which uses most of them for noise abatement purposes.	No allocation scheme identified	Not applicable.
Sweden	No allocation scheme.	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators.	Airports receive charges.	No allocation scheme identified	Port dues and charges belong to the ports. Fairway charges are fully earmarked.
UK	Revenue from road pricing schemes must be used for the transport sector in the first ten years of the scheme.	Charges belong to the infrastructure manager.	Ticket revenue is not enough for cost coverage and stays with the operators.	Charges go to the airport operator.	No allocation scheme identified	Port dues and charges belong to the ports.

4.3 Combinations of pricing, revenue use, scope and institutional arrangements

After the assessment of the various pricing and revenue allocation schemes in Europe, one interesting question was whether there are any combinations of the two that occur more often than others, or are more successful.
Transport pricing schemes have already been described and analysed in numerous research projects. The same is true for revenue use and investment schemes. Therefore REVENUE focussed especially on combinations which are either typical or especially interesting from a theoretical point of view.

4.3.1 Pricing and revenue use

REVENUE sought to analyse according to which principle funds are used in pricing regimes that come close to social marginal cost pricing, and whether certain patterns could be identified. SMCP is a concept of neo-classical economics. However, neo-classical economics does not provide a justification for earmarking of revenues. Rather, it suggests that funds be used for those projects/investments that show the highest cost-benefit-ratio. Was this pattern observed in practice?
In **road pricing**, internalisation of externalities happens, but is still rare. One country that has some elements of SMCP pricing is Switzerland (i.e. transport-system external costs are taken into account in the pricing regime). This pricing scheme has a very detailed earmarking scheme connected to it, 100% of the charges are earmarked. Earmarking can also be found in those cases where congestion costs have been an argument for introducing road pricing. Thus, although SMCP is a neo-classical concept, the neo-classical doctrine does not apply in practice to the extent of not allowing earmarking.
Another observation is that revenue in **rail**, the only mode where a significant number of countries use elements of SMCP in their pricing scheme (e.g. time-varying congestion charges), is fully earmarked internally (except Finland). As mentioned before though, none of the railway pricing schemes results in a surplus. So although the railway schemes seem to suggest conformity with neo-classical theory at first, railway infrastructure often does not have a high benefit-cost ratio from a purely economic perspective and should therefore not be invested in, so the theory is not consistently applied to both pricing and investment schemes..

4.3.2 Revenue use and investment

France, Germany and Switzerland all have multi modal investment funds. Generally speaking, the **road** mode is the mode that generates surplus revenue that is often used for cross-financing; although surpluses are also observed in aviation and maritime ports, these usually remain within the (air)port that creates them, or they are used to finance other facilities in the same mode (e.g. BAA and ADP airport authorities). Other modes have internal earmarking of the revenues that they generate – railway infrastructure charges, noise charges in aviation, fairway charges in maritime/inland waterways. But essentially road is the only mode where intermodal cross-financing is observed.
Furthermore, if a road or motorway has a direct charging scheme and is managed by a **concessionaire**, then usually there is **full earmarking**, and all revenue will stay within the concessionaire, to be refinanced in the same road, or used for new infrastructure of the same

concessionaire, or to provide an adequate return on investment. After the end of the concession, the charges often stay in place to contribute to government funds.

4.3.3 Regional scope of a pricing-/revenue allocation scheme and role of private actors in implementation

We often observe that strictly defined tasks (e.g. highway construction and maintenance) are provided by private entities. On the other hand, Deliverable 2 of the REVENUE project suggested that large networks are seldom run by private operators. The biggest exception to this is Britain, where all rail services, most bus services and for a time rail infrastructure were in the hands of the private sector. However, following a fatal accident due to inadequate maintenance, the former infrastructure manager, Railtrack, which was a private company listed on the stock market was declared bankrupt. Its successor, Network Rail, although legally a private company, has its loans guaranteed by the government. Railtrack was a large private company running a large network, and is therefore an example that went against the trend in railways of keeping infrastructure managers state-owned.
Many other countries franchise some rail services to private operators. For instance, in the **Netherlands**, after the liberalisation of the railway market, passenger services of some local branch lines have been taken over by new railway operators, often in close cooperation with local PT companies, while the passenger services on the main network are still handled by NS, a semi-independent company that used to be state monopolist. This formula seems to work well, as NS can concentrate on the main lines that it manages to operate efficiently and with profit (in the sense of a surplus over operating costs), while the local operators achieve a synergy from good connections with local (non-rail) transport, on lines that would otherwise have been loss-making.
There are also many private owners of motorways. For instance in **Portugal**, BRISA, a private (formerly state-owned) company, is operating a significant amount of the motorway network, while smaller concessionaires are operating the remaining sections of motorways. The latter are selected through public tendering. . The **French motorway network** sees many concessionaires, who together run most of the French motorway network. Some of these companies are state-owned, some are privately owned, and some have mixed ownership.

4.3.4 Government subsidies and their targets

Government subsidies can be given either for investment in new infrastructure and rolling stock, or for operations and maintenance of existing infrastructure. Some classification was given to distinguish the (allocation) rules that exist for transport-related subsidies.
In road transport, most **roads** that charge their users have little or **no additional subsidies** for operation. This means that subsidies in this case (if they exist at all) will mostly deal with investment in new infrastructure.
In **rail**, the cost of maintenance and operation of infrastructure is not covered by charges in most countries. This means that in the rail mode government subsidies are required for operation as well as for investment in new infrastructure. Freight train operation has been deregulated and is generally not receiving subsidies anymore. The operation of passenger transport is normally co-financed through payments for public service obligations or other subsidies. This also goes for **urban public transport**, which relies heavily on government subsidies in almost every country.

Inland waterways rely almost completely on government subsidies (with the exception of the tax on hydro power in France), and are normally for operations only, as investment in new waterways is rare – most inland waterways in Europe have excess capacity.
Finally, **air and maritime transport** receive government subsidies for operations in some cases (small ports and airfields), but the larger ports and airports usually are **financially self-supporting** or even **profitable**, and therefore normally do not need subsidies for operations. In case of infrastructure investment, the state will normally subsidise a significant part of the projects. Furthermore, navigational aid (radar, air traffic control etc.) normally covers operational costs through charges.

4.3.5 Geographically defined earmarking and allocation schemes

Some revenue is earmarked for use in particular geographical regions, either for investment or operations. The institutional arrangements in these cases are described below.
In **Switzerland**, the HGV charges are 33% earmarked for the cantons which must use it primarily to pay uncovered costs in connection with road transport. The national "Autobahnvignette" scheme, the revenues from the circulation tax and the registration tax are collected nationally and then passed on to the regions. In some cantons, the revenues from cantonal vehicle taxes must be spent on road construction or maintenance.
Belgium is an interesting case as geographical equity issues are very important, and perceived unfairness between the Flanders and Walloon regional governments would immediately lead to bitter political fights. Having a strong geographically defined earmarking scheme managed by the Belgian national government might be a way of managing this situation, yet no such scheme seems to have been implemented in Belgium, surprisingly.

4.3.6 Other revenue allocation schemes

Some significant alternative financing schemes were also found, and their organisational and institutional framework is briefly described here.
Although the vast majority of revenue allocation schemes uses **road pricing** as a primary source of funding, there are some interesting other schemes. One example is **Austria**, where 2,5% of the electricity tax is used to finance urban public transport - tax revenue that is not generated in the transport sector at all.
Something similar happens in **France** (the "versement transport" scheme), where all companies that have more than 9 employees must pay a special tax that is earmarked entirely for urban public transport. This tax is levied over the salaries paid to employees. And in inland waterways in France there is a scheme, where some tax on electricity generated through hydro-power is earmarked for the maintenance of inland waterways.

5 REGULATION SCHEMES IN INTERURBAN TRANSPORT

This chapter is dedicated to the main conclusions stemming from the analysis of a set interurban transport regulation schemes that have been considered within the REVENUE case studies. Seven case studies focussing in interurban transport have been carried out. In each one, different options for revenue use in road, rail, urban public transport, air and maritime transport have been assessed. The scope of the questions addressed in the case studies was largely determined by practical political proposals and discussions in the respective countries.

The assessment of the REVENUE interurban regulation schemes was carried out through different methods and tools which have been more extensively described in the relevant REVENUE deliverables. The following chart shows which tools have been used in the interurban case studies.

Assessment criteria	**Tools**	**Case studies**							
		Interurban road financing	German HGV toll	Transport investment funds in Switzerland		France road funds	Zurich airport	Port of Rotterdam	Road haulier´s acceptability of road charges
				Road/rail	Bern				
Efficiency	MOLINO	X	X			X		X	
	ASTRA		X						
	MOLINOinGAMS			X					
	Other model						X		
	Qualitative/quantitative analysis				X				
Equity	MOLINO	X	X			X		X	
	MOLINOinGAMS			X					
	Qualitative/quantitative analysis				X		X		
Technical and organisational feasibility	Qualitative/quantitative analysis	X		X	X		X	X	
Acceptability	Qualitative/quantitative analysis			X	X	X	X	X	X

Table 3 - Tools used in the analysis of interurban case studies

In the following sections each REVENUE interurban case study is presented and discussed according to the following structure:

- Scope
- Research questions;
- Regulation schemes;
- Results in terms of efficiency, equity, technical and organisational feasibility, acceptability.

Finally, preliminary conclusions from the interurban case studies are drawn in the last section of the chapter.[27]

[27] The final conclusions and recommendations of the project are presented in Chapter 7.

5.1 Road financing in Finland

5.1.1 Scope

The case study on **interurban road financing in Finland** (Moilanen, 2005) addresses the possible use of transport related revenues for financing the planned investment in a 60km stretch of the motorway between Turku and Helsinki.

5.1.2 Research questions

The research questions both address the welfare effects of using revenues from taxation and transport pricing to increase the road infrastructure capacity and the welfare effects of opting for Public-Private Partnerships (PPP) and other procurement options. The research questions on the use of revenues from road charging and taxation are as follow:

- ✓ What are the welfare effects of the motorway investment, considered within a partial equilibrium framework rather than standard cost-benefit approaches?
- ✓ How does the new "life-cycle-financing" scheme, which is a variation of PPP, affect welfare and revenues?
- ✓ How does the potential revenue shortfall from SMCP stack up against the potential welfare loss from pricing schemes that achieve full cost recovery?
- ✓ What kind and level of taxes or user charges would be able to cover the capital and maintenance costs of the given facility?
- ✓ Is social marginal cost pricing politically feasible to be applied on top of the current fiscal taxes?
- ✓ How much revenue does SMCP generate compared with charges aimed at investment cost recovery?
- ✓ Conversely, what is the welfare impact of charges aimed at investment cost recovery?
- ✓ What are the welfare effects of financing the transport infrastructure investments and maintenance a) from current transport taxes, b) with new charging schemes or c) from the general budget?
- ✓ How do the price levels affect the welfare and the use of the infrastructure? Do the distortions of labour tax matter?

5.1.3 Regulation schemes

Status Quo scenario: This scheme reflects current transport policy in Finland. Existing transport pricing is based on fiscal taxes that go to the general budget and there is no form of earmarking. The scenario has no investment.

Proposed Scheme: This scheme considers investment in the E18 motorway between Muurla and Lohjanharju with an estimated cost of € 337 million using the planned life-cycle (PPP) procurement scheme for 25 years. The impacts on efficiency, compared to the current procurement scheme, have been estimated to result in 3.4 % lower investment cost. Risk transfer amounting to 6.2 % of the investment costs during construction and 68 % of the maintenance costs during the period of operation and interest rates (5.2 % instead of 4.2 %) have been obtained from a public sector comparator carried out for the project (Antikainen and Tolvanen, 2004). Existing transport pricing is used. The general budget provides the financing of investment in transport infrastructure.

Current Procurement scheme: This scheme considers the continuing use of existing DB (design and build) model and financing through the budget to compare the effects of the more efficient PPP model of the proposed scheme (albeit with higher cost of financing).

Social Marginal Cost Pricing (SMCP): This scheme introduces marginal cost pricing in addition to the present fuel taxes (0.11 €/km for car, 0.29 €/km for heavy goods vehicles (HGV). Marginal costs included are maintenance costs, congestion and environmental costs of fuel consumption according to the official cost-benefit framework in Finland (Finnish Road Administration, 2001). The proposed investment is financed with the PPP life cycle procurement and using the pricing scheme revenues if possible. Pricing scheme implementation and operation costs have been estimated and included in the welfare assessment.

Investment Financing Scheme: This scheme is designed to recover investment and maintenance costs by topping of current fiscal tax revenues with additional user charges. Road (PPP) investment is financed through the use of a modal investment fund fed from transport pricing measures. Pricing scheme implementation and operation costs have been estimated and included in the welfare assessment.

Welfare Maximum Scenario: This scheme optimises pricing level to maximise the MOLINO welfare measure. Proposed investment is financed with the PPP life cycle procurement from the general budget. Variations of the pricing levels have been tested to consider their effects on welfare, traffic demand and revenues.

The regulation schemes addressed in the Finland case study are synthetically described in the following Table.

Question/Scenario	Regulatory Framework	Pricing	Revenue Use	Investment	Procurement & Implementation
1: Status Quo	No earmarking, State Budget used to finance or to collect revenues	Existing fiscal transport taxes	Finance investments and current other uses	No investment	Current DB (Design & Build) model
2: Proposed Scheme	See above	See above	See above	New motorway	PPP procurement (life-cycle scheme)
3: Current procurement	See above	See above	See above	See above	Current DB (Design & Build) model
4: SMCP Pricing	Additional scheme to include the externalities	Existing taxes, Marginal Social Cost Pricing (SMCP)	See above	See above	PPP procurement (life-cycle scheme)
5: Investment Financing	Additional earmarking through the state budget	Existing taxes, Pricing	See above	See above	See above
6. Welfare maximum	State Budget used to finance or to collect revenues	Pricing	See above	See above	See above

Table 4 - Alternative regulation schemes for the Finnish case study on interurban road financing

5.1.4 Efficiency

The Proposed Scheme investment yields € 113 million total benefits compared with the Status Quo. This is largely due to the fact that the motorway has a higher speed limit than the existing road. In addition, the modelling results indicate that a PPP scheme as foreseen in the Proposed Scheme is more efficient than the Current Procurement Scheme (Design & Build model). The PPP procurement generates a € 30 million higher welfare score than current procurement due to the better efficiency. The welfare change of the SMCP scheme is € 36 million lower than for the Proposed Scheme. The lowest welfare score (€ -125 million) is received by the Investment Financing Scheme. Finally, the Welfare Maximisation Scheme increases the welfare measure only by € 13 million.

Although the Proposed Scheme earns the highest welfare score, the publicly financed Current Procurement Scheme generates more revenues (€ 218 million vs. € 189 million) due to lower cost of financing (government debt interest rate 1 % lower). The government net revenues become lower (revenues cover 35 % - 46 % of all costs) than in the Status Quo in all scenarios except in the Investment Financing Scheme (which was explicitly designed to fully recover costs) which, however, had the lowest score of welfare. Nearly 70 % of infrastructure costs (investment and maintenance) are covered by current taxes in the Proposed Scheme. In the Status Quo only maintenance costs are relevant, and a huge surplus results. When the welfare is maximised in the Welfare Maximum Scheme, the investment costs are not covered, just the maintenance costs.

5.1.5 Technical and Organisational feasibility

The free flow electronic tolling system necessary to charge for use of the highway section studied is technically feasible. Similar systems are presently in use in Toronto and Melbourne.

5.1.6 Acceptability

Currently, no road pricing schemes are implemented in Finland. Interurban road charging is not really relevant as Finland, as a sparsely populated and large country. Notwithstanding, there is a widespread discussion about the introduction of HGV tolls in Finland and the general lack of funding for the road investments. An acceptability interview study carried out in the EU project PROGRESS in Finland revealed that a feasible tolling scheme would have to be as simple as possible and the revenues should be earmarked to the transport sector.

A summary of the case study results is presented in the following Table.

Indicator	Status Quo	Proposed Scheme	Current procurement	SMCP Pricing	Investment Financing	Welfare maximum
Car price level [€/km]	0.11	0.11	0.11	0.13	0.22	0.02
HGV price level [€/km]	0.29	0.29	0.29	0.35	0.51	0.04
Charge level [% of tax]	100%	100%	100%	113%	196%	15%
Social Welfare change [€ million]	-113	*Base*	-30	-36	-125	13
User Benefits change [€ million]	17	*Base*	-38	-5	-22	-111
Gov't Net Revenues (inc inv. costs) [€ million]	507	189	218	231	506	-275
All scheme costs (Tax+Charge+inv.) [€ million]	*Base*	-317	-288	-276	-1	-782
Scheme cost recovery [%]	*Base*	37%	43%	46%	100%	-54%
Infrastructure costs [€ million]	-18	-273	-331	-273	-272	-276
Infrastructure Cost Recovery [%]	2793%	69%	66%	85%	186%	-100%
Investment Benefit/Cost-ratio	*Base*	1.9	1.8	1.8	1.6	1.4

Table 5 – Synthesis of the results of the Finnish case study on interurban road financing

5.2 Heavy Good Vehicles (HGV) tolls in Germany

5.2.1 Scope

In January 2005, a distance related charge for HGV with a gross vehicle of 12 tonnes or over was introduced for the use of the German federal motorway network. The scheme determines that the toll revenues are distributed as follows:

- ✓ Roughly 20% are granted to the toll operator for the operation of the toll technology;
- ✓ The remaining 80 % of revenues are allocated solely to the federal transport networks (motorways, other roads, rail and inland waterways)
- ✓ The state-owned Transport Infrastructure Financing Society (Verkehrsinfrastrukturfinanzierungs-Gesellschaft VIFG), founded in October 2003, is responsible for the allocation of revenues to particular investment projects.

The case study deals with the assessment of a set regulation charging schemes for **HGV tolls in Germany** (Doll, 2005).

5.2.2 Research questions

- ✓ If funds would entirely be earmarked to the motorway sector, which would be the preferred distribution between capacity extension and maintenance, replacement and repair in the short and in the long run?
- ✓ If funds would be earmarked to the transport sector as a whole (which is the current situation), which would be the preferred allocation between the modes in the short and in the long run?
- ✓ If no earmarking rules are specified, which is the preferred allocation of funds between the transport sector and the general budget in the short and in the long run?

- ✓ Would decision rules on allocating revenues differ with the charging principle applied (marginal cost instead of the currently applied average-cost based tariffs)?
- ✓ Does the organizational form of the toll collector and investment company matter?
- ✓ Could a strong increase in average costs, e.g. in case of heavily occupied network parts and/or in mountain areas with high construction and maintenance expenditures, be compensated by installing public-private procurement models?
- ✓ Should congestion, accidents and environmental problems on the secondary road network be fought by investing in these hotspots (on secondary roads) or by increasing motorway capacity and comfort?

5.2.3 Regulation schemes

The German case study includes two sets of regulation schemes, due to the two complementary modelling approaches used in the case study (MOLINO and ASTRA). Five regulation schemes have been analysed through MOLINO:

- ✓ The basic regulation scheme (A) reflects the situation before the introduction of distance related road pricing for HGVs on January 2005 in Germany;
- ✓ The current policy scheme (B) describes the situation where road pricing has been implemented. HGV motorway tariffs are based on average infrastructure costs (ACP);
- ✓ The extended average cost pricing scheme (C) examines the extension of the average cost pricing regime to all vehicles and to the entire network in road transport;
- ✓ In addition to the previous scheme (C) the private regulation scheme (D) considers all infrastructure operators and investors as private enterprises. To reflect private sector involvement average charges are assumed to increase by 50%;
- ✓ The marginal social cost pricing regulation scheme (E) addresses the hypothetical case of introducing social marginal cost prices, including the marginal cost for maintenance, congestion and externalities for all modes.

The complete set of regulation schemes analyzed trough MOLINO are presented in the following table.

Research Question	Pricing regulation	Procurement = Privacy status of road network operator and road and rail/IWW investor	Use of transport pricing revenues			
			Earmarking to transport sector	Distribution within the transport sector		
				Earmarking for road	Earmarking for motorways	Use for maintenance
Reference case	Scheme A: No road charging, average cost charging on rail/IWW, current taxes as it is.	Public	-	-	-	-
1. Revenue use for maintenance vs. new investments	Scheme B: HGV-Charging on motorways based on average infrastructure costs on top of current taxes	Public	100%	50%	not specified	75% 50% 25%
2. Revenue use for road vs. rail/IWW	Scheme B: HGV- Charging on motorways based on average infrastructure costs on top of current taxes	Public	100%	100% 75% 50% 25%	not specified	50%
3. Revenue use in transport vs. general budget	Scheme B: HGV- Charging on motorways based on average infrastructure costs on top of current taxes	Public	100% 67% 33% 0%	-	not specified	50%
4. Welfare effects of different pricing scenarios	Scheme B: Average cost pricing HGVs on motorways on top of current taxes Scheme C: Average cost pricing for all road vehicles on all networks on top of current taxes Scheme E: Marginal social cost pricing all modes and all networks	Private	100%	50%	not specified	50%
5. Public administration of roads vs. private sector involvement	Scheme D: Average cost pricing all road vehicles on all networks Scheme D: ACP with 50% profit add-on top of current taxes	Public Private	100%	100% 100% 50% 50%	not specified	50%
6. Revenue use for motorways vs. trunk roads	Scheme B: HGV-Charging on motorways according to average infrastructure costs	Public	100%	50%	100% 75% 50% 25%	50%

Table 6 – Overview of the regulation schemes analysed through MOLINO in the German case study

The other four regulation schemes that have been analysed using the ASTRA model are as follow:

- ✓ Business As Usual (BAU): The BAU scheme assumes that no major change in policy takes place. For Germany the situation in 2000 without distance-related road tolls is considered. Unchanged policy also means that existing road tolling systems in France, Italy, Spain and Portugal are kept as they are and that their revenues are transferred to the general budget;
- ✓ Road**:** All revenues are earmarked to the road sector, where 50% are spent for motorways and 50% are spent for trunk roads. Within each road category the vast majority of revenues are spent for capacity extension measures;
- ✓ Cross**:** In this case an equal share of funds is allocated to road and to rail transport. For the railways 60% are invested into new network capacity, 20% into facilities (e.g. inter-modal terminals) and 20% into rolling stock;
- ✓ Direct Taxes: This scheme assumes the transfer of funds to the general budget and the decrease of direct taxes. In this case 100% of revenues are transferred to consumers.

In the ASTRA schemes it is assumed that inter-urban road transport entails distances above 150 km, average infrastructure construction and maintenance cost prices of €0.02 per passenger.km and €0.15 per tonne.km are levied.

The following Tables present a synthesis of the results achieved through the use of the MOLINO and ASTRA models.

Research question	Parameter values varied	Total welfare	Welfare of low income users	Welfare of high income users
		(measured as difference to reference case in € million for the period 2000 – 2020)		
1. Optimal level of maintenance activities				
Share of revenues spent for maintenance activities	75%	**-4.58**	5.81	37.48
	50%	-13.72	9.62	43.52
	25%	-18.71	**11.63**	**46.69**
2: Optimal revenue allocation between modes				
Share of revenues earmarked to road	100%	**-6.19**	**12.35**	**53.09**
	75%	-9.05	11.03	48.49
	50%	-13.72	9.62	43.52
	25%	-20.05	8.18	38.36
3. Optimal allocation of revenues between the transport sector and the general budget				
Share of revenues earmarked to transport	100%	-13.72	9.62	43.52
	67%	31.57	20.05	83.61
	33%	75.82	30.40	123.37
	0%	**119.52**	**40.79**	**163.25**
4: Optimal pricing scheme				
Pricing regime	B: Average cost pricing HGV	-13.72	**9.62**	**43.52**
	C: Average cost pricing all vehicles	-142.63	-20.53	24.42
	E: Social marginal cost pricing	**2761.52**	-895.25	-1172.37
5: Public vs. private network operation				
Legal status / earmarking for road	C: public / 100%	**-126.83**	**-9.34**	**64.16**
	D: private / 100%	-493.56	-30.21	-149.65
	C: public / 50%	-142.63	-20.53	24.42
	D: private / 50%	-367.63	-22.12	-92.42
6. Optimal allocation of funds between road classes				
Share of revenues earmarked to motorways	100%	-8.82	8.27	35.12
	75%	**-7.64**	8.98	38.00
	50%	-8.14	9.68	40.83
	25%	-10.68	**10.33**	**43.41**

Figures in bold show the welfare-superior scheme within each case study.
Source: Doll (2005).

Table 7 – Overview of the MOLINO results in the German case study

Parameter	Percent change against reference case 2020 Use of HGV charge revenues		
	Earmarking to road	Cross-subsidisation to rail	Reduction of direct taxes
Transport demand			
Passenger road	-3,97	-4,13	-4,06
Passenger rail	9,47	10,21	8,24
Freight road	-8,26	-8,88	-9,82
Freight rail	5,47	6,92	4,79
Economy and environment			
GDP	**-0,22**	-0,29	-1,98
GVA chemicals	**-1,28**	-1,33	-3,02
DVA trade	**-0,70**	-0,80	-2,57
Employment	**-0,21**	-0,32	-2,46
Disposable income	**-0,21**	-0,32	-2,46
Consumption	**-0,38**	-0,51	-3,63
Exports	-1,15	**-1,11**	-1,36
CO_2-emissions	-4,55	-4,84	**-5,31**
Figures in bold show the calculated optimum. *Source:* Doll (2005).			

Table 8 - Overview of the ASTRA results in the German case study

5.2.4 Efficiency

If HGV revenues are earmarked to the transport system the MOLINO model indicates that for most cases it is welfare optimal to allocate revenues to the road sector and within the road network to motorways. These results are in line with the results of the ASTRA model (medium and long run). The MOLINO results support investment in network maintenance and renewal rather than the construction of new transport infrastructure capacity. If no earmarking rules are given the MOLINO clearly indicates that high road user charges are positive from a welfare point of view if all revenues flow to the general budget.

The analysis shows that introducing average cost pricing for HGVs on motorways as well as for all vehicles on all roads does not automatically increase welfare compared to the present situation. The best performing regulation schemes, in the perspective of society and transport users, are those which assume marginal social cost prices. However, it should be stressed that this result is highly sensitive to the values chosen for the marginal cost of public funds (MCPF). The structure of the fuel taxes (which constitute the major source of transport-related revenues in Germany) justifies the assumption that the value of the MCPF for HGV charges lies between the MCPF for proportional and for regressive tax reforms. On the other hand, the MCPF for average cost-based HGV charges is chosen lower than that for fuel taxes. The rationale behind this assumption is the fact that the German HGV tolls are differentiated according to vehicle weight and pollution standards and it have positive environmental impacts which lead to a welfare increase. Sensitivity tests performed by assuming the same MCPF for taxes and charges show that the welfare loss due to the introduction of road tolls is lower compared to assuming two different values.

While in the initial periods after introducing road pricing the ASTRA model confirms the MOLINO results, in the long run the model preference changes. After eight to ten years

reinvesting revenues back into the transport sector turns out superior to the tax reduction scenario. More specifically, the major recommendation arising from the ASTRA model is to keep revenues in the mode where they have been collected.

The main preference for allocating transport revenues to the motorway system is reversed when both for motorways and secondary roads road operation and investment are privatised. In this case a balanced structure of fund allocation aiming to avoid deficits for either operator is most effective. This finding is based on the MOLINO results.

In contrast to the other REVENUE case studies presented in this report, the German case focuses on the question how a given amount of charging revenues should be used. Nevertheless, if cautiously interpreted the results may provide some indications for this issue. The welfare analysis performed with the MOLINO model recommends using all revenues for the public budget, which indicates that additional investments should not be financed at all. On the other hand, the analysis performed with the ASTRA model yields long-term stimulating effects of network improvements on the economy. From this approach it can be concluded that performing additional investments is superior over using the revenues to reduce direct taxes.

Except in the MOLINO scenario mentioned above where revenues flow into the public budget, all regulation schemes analysed both with MOLINO and ASTRA, show at the end of the time horizon 2020 absolute welfare figures which are below those in the reference case. But the development path of the welfare-related indicators within the ASTRA framework is such that the welfare level of the reference scenario is exceeded after another three to five years if revenues are re-invested into the transport sector. This indicates that in the long-run financing of additional investments via average cost-based road user charges appears to be superior over the sole application of the state-financed basic investment programme. Conclusions on the superiority of public funds over user revenues can, however, not be drawn by this type of analysis.

5.2.5 Equity

The assessment of MOLINO regulation schemes suggest that maximum welfare gains, both for high and low income user groups, can be achieved if all transport revenues flow to the general budget. However, a number of results diverge between the perspectives of the society as whole (total welfare) and that of the user groups. For instance, from the point of view of the society (total welfare), the best option is to allocate 75% of the revenues to maintenance activities, whereas, from the point of view of the welfare of transport users the best option is to allocate only 25%. Transport users are also better off in the case of HVG average cost pricing on top of current taxes in motorways, whereas the best option for the society is MSCP for all modes. The preferences of high and low income users are identical for all cases investigated. However, within the framework of the MOLINO model the government only has the power to re-distribute transport revenues to cover the deficits of infrastructure operators and owners and to increase the income of its citizens; alternative forms of spending revenues (e.g. for education or health
care) are not considered. The model calculation is based on a single elasticity of substitution and on the marginal costs of public funds. This simplification might well be acceptable for short-term analyses, but as it neglects the incentives and the production effects emerging from investment activities the model setting is not suitable for long-run predictions.

5.3 Railway investment fund in Switzerland

5.3.1 Scope

The case study on **railway investment fund in Switzerland** (Cretegny, Springer, Suter, 2005) concerns the existing railway investment fund – FINOV - which is financed through distance related HGV road charges. This fund was set up to finance the construction of new rail infrastructure, particularly the New Alpine Rail Tunnels (NART). The analysis is limited to the transalpine corridors Lötschberg and Gotthard, where the main expansion of transport infrastructure is taking place. Specifically, two railway links (Gotthard and Lötschberg-Simplon) with a length of 88 km, and one road link (Gotthard) with a length of 80 km.

5.3.2 Research questions

- ✓ What are the welfare implications of earmarking and cross-financing from the road to the railway sector in the case of a given investment (NART)?
- ✓ Would it be welfare increasing to extend railway and road capacity in the Swiss transalpine corridors?
- ✓ Does welfare increase if transport pricing is adjusted taking into account congestion and environmental costs?
- ✓ What are the welfare implications if this adjustment is implemented in addition to the existing transport taxes or if it replaces them?
- ✓ What are relevant equity implications of the different strategies in transport pricing, investment and revenue use?
- ✓ Are alternative pricing and revenue use schemes technically feasible and acceptable to the public?

5.3.3 Regulation schemes

The complete set of regulation schemes addressed in the railway investment fund –FINOV case study, which can grouped in three main groups are, presented in the Table below:

Scheme	Scenario	Pricing	Revenue use	Investment
A	A1	**P1:** Existing transport pricing	**RU1:** No cross-financing	**I1:** Two new railway tunnels.
	A2	**P1:** Existing transport pricing	**RU2**: Equal distribution	**I1:** Two new railway tunnels.
	A3	**P1:** Existing transport pricing	**RU3:** Partial cross-financing	**I1:** Two new railway tunnels.
	A4	**P1:** Existing transport pricing	**RU4:** Full cross-financing	**I1:** Two new railway tunnels.
	A5	**P1:** Existing transport pricing	**RU1:** No cross-financing	**I2:** New railway and road tunnels.
	A6	**P1:** Existing transport pricing	**RU2**: Equal distribution	**I2:** New railway and road tunnels.
	A7	**P1:** Existing transport pricing	**RU3:** Partial cross-financing	**I2:** New railway and road tunnels.
	A8	**P1:** Existing transport pricing	**RU4:** Full cross-financing	**I2:** New railway and road tunnels.
B	B1	**P2:** Existing taxation and internalisation	**RU1:** No cross-financing	**I1:** Two new railway tunnels.
	B2	**P2:** Existing taxation with internalisation	**RU2**: Equal distribution	**I1:** Two new railway tunnels.
	B3	**P2:** Existing taxation with internalisation	**RU3:** Partial cross-financing	**I1:** Two new railway tunnels.
	B4	**P2:** Existing taxation with internalisation	**RU4:** Full cross-financing	**I1:** Two new railway tunnels.
	B5	**P2:** Existing taxation with internalisation	**RU1:** No cross-financing	**I2:** New railway and road tunnels.
	B6	**P2:** Existing taxation with internalisation	**RU2**: Equal distribution	**I2:** New railway and road tunnels.
	B7	**P2:** Existing taxation with internalisation	**RU3:** Partial cross-financing	**I2:** New railway and road tunnels.
	B8	**P2:** Existing taxation with internalisation	**RU4:** Full cross-financing	**I2:** New railway and road tunnels.
C	C1	**P3:** Congestion charging	**RU1:** No cross-financing	**I1:** Two new railway tunnels.
	C2	**P3:** Congestion charging	**RU2**: Equal distribution	**I1:** Two new railway tunnels.
	C3	**P3:** Congestion charging	**RU3:** Partial cross-financing	**I1:** Two new railway tunnels.
	C4	**P3:** Congestion charging	**RU4:** Full cross-financing	**I1:** Two new railway tunnels.
	C5	**P3:** Congestion charging	**RU1:** No cross-financing	**I2:** New railway and road tunnels.
	C6	**P3:** Congestion charging	**RU2**: Equal distribution	**I2:** New railway and road tunnels.
	C7	**P3:** Congestion charging	**RU3:** Partial cross-financing	**I2:** New railway and road tunnels.
	C8	**P3:** Congestion charging	**RU4:** Full cross-financing	**I2:** New railway and road tunnels.

Table 9 - Regulation schemes in the Swiss case study

The different assumptions about pricing, revenue, use and investment, are as follows:

- ✓ In the existing transport pricing or status quo scenario (A) transport pricing is based on fuel and vehicle taxes, the passenger car vignette, the heavy vehicle fee, and railway track charges;

- ✓ In the existing taxation with internalization or politically feasible scheme (B) the existing fuel and vehicle taxes, as well as track charges, remain in place. Instead of the HVF, charges for marginal environmental and congestions costs are levied for passenger and freight transport. This scheme represents a politically feasible road pricing scenario (the complete abolition of fuel taxation is not considered politically viable);
- ✓ In the congestion charging scheme (C) all existing taxes and charges are replaced by transport prices which equal the sum of marginal costs of infrastructure operation, marginal costs of infrastructure maintenance, marginal external environmental costs and marginal external congestion costs. It should be noted that the resulting transport prices are not optimal transport prices for two reasons. Firstly, they include a mark-up for the financing of infrastructure. The second reason is associated with the fact that only congestion costs are endogenously determined in the modeling work, being the other cost components exogenous inputs to the model.[28]

The investment path options considered are as follows:

- ✓ Two new railway tunnels opening in 2007 (Lötschberg), and 2015 (Gotthard), respectively. Road capacity at the Gotthard is not expanded. This scenario corresponds to the current Swiss transport policy strategy for transalpine traffic;
- ✓ Two new railway tunnels are built and road capacity is expanded from two to four lanes in the Gotthard tunnel.

Moreover, four cross financing scenarios have been examined:

- ✓ No cross-financing (RU1): None of the revenues from the HVF are used to finance the construction of the new railway tunnels. Moreover, 2/3 of HVF revenues are allocated to the road investment fund and 1/3 goes to the local government. This implies that the railway tunnels are financed by labour tax and fuel tax money;
- ✓ Equal distribution (RU2): The revenues from the HVF are distributed in equal shares between the railway investment fund, the road investment fund and the local government (1/3 of revenues each);
- ✓ Partial cross-financing (RU3): In this option 2/3 of the revenues from the HVF are used to finance the construction of the new railway tunnels and 1/3 is allocated to the local government. This corresponds to the existing policy;
- ✓ Full cross-financing (RU4): All revenues from the HVF are used to finance the construction of the new railway tunnels (fuel and vehicle taxes are partly earmarked for road construction and maintenance). This alternative can be interpreted as a scenario supported by environmentalist groups (a "lobby scenario").

5.3.4 Efficiency

The results on MOLINOinGAMS indicate that earmarking two thirds of the heavy vehicle fees (HVF) to the railway construction fund is an efficient way of financing new railway infrastructure. Under the existing pricing regime welfare would decrease if a smaller share of HVF revenues were used to finance the new railway tunnel. On the other hand the allocation

[28] The second reason relates with the way the toll is implemented in MOLINO. The introduction of the toll leads to a change of transport demand. In order to determine the level of the optimal toll, the model would have to take into account the change of demand resulting from the implementation of the toll. This feed-back, however, is only implemented for the congestion charge, but not for the other three components.

of all HVF revenues to the railway investment fund results in a welfare increase (in comparison to the current solution).
With the assumed investment levels, welfare increases with the magnitude of earmarking in all scenarios. The reason for this lies on the assumption that investment in railways tunnels is financed though a kind of Pigouvian tax - the HVF. As the marginal cost of public funds is lower for the HVF than for the labour tax (general budget revenue), then, high levels of earmarking goes hand in hand with welfare increases.
Several factors contribute to the welfare change under the different earmarking rules. With a low share of HVF revenues allocated to the railway fund, the Swiss federal government needs to raise distortionary labor taxes to finance investments in railway infrastructure. The higher the share of HVF revenues allocated to the railway fund becomes, the less "expensive tax money" is needed, and the higher the welfare effects of the federal government's financing of transport infrastructure attributed to high income passengers. The welfare of the local government, in contrast, decreases with an increasing share of earmarking. If all HVF revenues are allocated to the railway fund (earmarking share of 3/3), none of the HVF revenues are left for the local government, which results in a welfare loss. Finally, the transport sector welfare decreases as a consequence of higher transport prices, regardless of the earmarking rule.
The pricing regime **"**existing taxation with internalisation" is the most efficient. It reduces welfare from transport, since tolls are above the optimal level. However, the welfare gains from the use of revenues (HVF revenues substitute "expensive" labour tax money) exceed the welfare loss associated with the reduction of traffic volumes.
A reform of transport pricing could produce substantial welfare gains. In the best performing regulation scheme, that corresponds to existing taxation with internalization, full cross-financing and new railways and road tunnels the potential welfare gain is about 1 600 mill €.[29]
In contrast, investing only in railways in combination with the existing pricing regime and no earmarking of HVF revenues would decrease welfare by approximately 1360 mill €[30].

5.3.5 Equity

Revenue use and transport pricing have significant impacts on passenger transport. Under the current earmarking scheme (2/3 of HVF to railway fund), the introduction of alternative pricing regimes would benefit low and high income groups. However, low income households benefit slightly more than high income households. A similar pattern can be found in the full earmarking scheme (3/3). For the other pricing regimes, both income groups are equally affected. Thus, whereas increasing cross-subsidization benefits low income households more than high income households reducing cross-subsidization has the opposite effect. The reason is that the government's welfare gain attributed to households represents a larger share of total welfare for low income households than for high income households. Overall, there are only small differences between the welfare impacts on low income households and high income households.
The conclusions presented above for passenger transport do not hold for freight transport. While passenger transport would gain from the introduction of pricing schemes oriented at social marginal costs, freight transport is likely to lose from higher transport prices. However, this result should be interpreted at the light of the characteristics of the modeling tool used. In MOLINOinGAMS no welfare benefits arising from the government's reduced financing

[29] Or 215 € per inhabitant of Switzerland over the whole lifetime of the railway investment fund.
[30] Or 183 € per inhabitant of Switzerland over the whole lifetime of the railway investment fund.

costs, are allocated to freight transport whereas passenger transport benefits from toll revenues.
The results of MOLINOIinGAMS also suggest that transit freight transport would be more positively affected than domestic freight transport by the introduction of alternative pricing regimes.

5.3.6 Technical and organisational feasibility

The existing price scheme is technically feasible and has proved to be reliable. Technical solutions for congestion pricing systems covering large areas and charging vehicles based on their marginal damages do not yet exist. Even if congestion charging in the transalpine corridor would be easier to implement than a system covering the entire country, the technical solution would have to be developed.

5.3.7 Acceptability

The HVF system was approved twice by the voting Swiss population at referendums in 1994 and 1998. The overall acceptability of the system remains high. In contrast, road pricing for passenger cars is not accepted by the public.

5.4 French multimodal transport funds

5.4.1 Scope

The **French multimodal transport funds** case study (Raux, Mercier and Souche, 2005) addresses a number of issues related to cross-financing as an alternative to public subsidies and pricing rules as a revenue source and demand management tool. The case study has two distinct sections.

The first concerns the financing and pricing of a programme of ten new motorway projects and it is developed against the background of the establishment of the AFITF infrastructure investment agency. This agency started in 2005 and will receive every year land fees (a tax paid for the use of public land estate) and motorway dividends coming from existing toll motorway companies. The State is shareholder of these motorway companies. The following Table provides an overview on the characteristics of these motorway projects.

Tolled motorway project	Length	Alternative road	Construction cost* € million	Total public subsidies* € million	Public subsidies / construction cost	Construction period
A24 Motorway "Amiens-Lille-Belgium"	120 km	A1 Tolled motorway	666	375	56%	2009-2012
A48 Motorway "Amberieu-Bourgoin Jallieu"	55 km	N 75 Highway	605	365	60%	2010-2015
A51 Motorway "Grenoble-Sisteron"	80 km	N75 Highway	1 200	670	56%	2011-2018
A585 Motorway "Les Mees- Digne-les-Bains"	25 km	Highway 85	209	169	80%	2008-2010
A831 Motorway "Fontenay le Comte-Rochefort	64 km	Highways 11 and 135	468	243	52%	2009-2012
A89 Motorway "Lyon-Balbigny"	50 km	Highways 7, 82 and 89	769	625	81%	2006-2011
A19 Motorway "Artenay-Courtenay"	100 km	N60 Highway	607	165	27%	2006-2009
A41 Motorway "Saint-Julien -Villy"	18 km	N201 Highway	674	277	41%	2007-2010
A45 Motorway "Lyon – Saint-Etienne	52 km	A47 Toll-free motorway	1,300	1,118	86%	2008-2011
A65 Motorway "Pau-Langon"	142 km	N10 and N134 Highways	910	142	15%	2008-2011
Excluding VAT.						

Table 10 – Overview on the motorway projects of the French case study

The second section addresses the cross-financing of the Lyon-Turin rail link from Alpine motorways. The Lyon-Turin project is expected to initiate a modal shift from road to rail and to balance the traffic between these two modes. The new link between Lyon and Turin is divided into 8 projects. The assessment focuses on the cross-financing of new rail infrastructures by road revenues under different regulation schemes. The transport fund considered here is slightly different than the one that has been considered in the first section of the case study. Here a kind of "Alpine fund" has been formulated. The only two Alpine motorway crossings (Mont-Blanc and Fréjus), which compete with the Lyon-Turin rail link, would be a possible source of cross-financing.

The following Table presents the total costs and the level of subsidies associated with each individual project.

Lyon-Turin project	Total cost (€ million 2005)	Public Subsidies (M€ 2005)
Alpine high speed	1898	155
Access to the Chartreuse tunnel	644	579
1st line Chartreuse tunnel	1503	1353
2nde line Chartreuse tunnel	536	483
1st line Belledonne tunnel	1310	118
2nde line Belledonne tunnel	461	418
Studies and galleries reconnaissance, French part	235	235
Franco-Italian part	3172	2832
Total Lyon-Turin	9759	8631

Table 11 – Costs of the Lyon-Turin rail link of the French case study

5.4.2 Research questions in the motorways programme case

- ✓ How much revenues are necessary to provide sustainable financing for the planned transport investment?
- ✓ Which pricing rule is the most efficient?
- ✓ How should the revenues be allocated between the modes for optimal efficiency?
- ✓ How will AFITF be "accepted" by different transport actors?

5.4.3 Regulation schemes in the motorways programme case

The assessment of the regulation schemes concerning the motorways programme aims at answering a double question:

- ✓ What is the optimal pricing on road infrastructures? and;
- ✓ How should new interurban roads be financed?

The characteristics of the regulation schemes for the motorways programme are presented in the following Table.

	Regulation scheme	Pricing	Revenue use
A	Planned tolling scheme + public subsidies	Tolling scheme as originally planned for the new projects	Revenues from road tolls on each new motorway go to the motorway concessionaire. Additional public subsidies to cover new motorway construction costs.
B	Planned tolls + transport fund (AFITF) + public subsidies	tolling scheme as originally planned for the new projects	Revenues from road tolls on each new motorway go to the motorway concessionaire. Tax on existing toll motorways goes to the transport fund. The transport fund subsidises new motorways. Additional public subsidies when needed.
C	Optimised tolls + transport fund (AFITF) + public subsidies	Markups on tolls for the new projects	Road tolls on new motorways go to motorway companies. Motorway dividends + land fees of existing motorways go to AFITF AFITF subsidies to finance new motorways Public subsidies when needed Cross-financing
D	Pure SMCP	SMCP pricing on new motorways and their free highway alternatives	No transport fund No public subsidies
E	Pure SMCP + transport fund + public subsidies	SMCP pricing on new motorways and their free highway alternatives	Tax on existing motorways go to the transport fund AFITF AFITF subsidies to finance new motorways Public subsidies when needed

Table 12 – Overview of regulation schemes in the motorway programme case

5.4.4 Efficiency issues in the motorway programme case

The first stage of the analysis addressed the issue of optimal financing with scenarios A, B and C. In scenario A the planned pricing and revenue use scheme is applied to the new motorway projects. Since the revenues from tolls of each individual project are insufficient to cover the construction costs, public subsidies are needed. Scenario B introduces cross-financing, e.g. the new motorway projects are financed from the forecast toll revenues from these projects, from subsidies of a transport fund (AFITF) and additional public subsidies if they are needed to achieve full cost recovery. The cross-financing from AFITF helps to lower the level of public subsidies. Scenario C adds markups to the tolls planned for the new motorway projects in order to reduce the need for public subsidies for these new projects.

In relation to the financing issue one main conclusion can be draw. When compared with public subsidies from the general budget, cross-financing from existing motorways to new motorways slightly increases the level of welfare for all the projects (except for one project where the level of welfare is more than doubled). This overall result is a consequence of the fact that public subsidies bear a levy cost in the economy (i.e. the Marginal Cost of Public Funds) while subsidies from a transport fund (when revenues come from a mark-up on tolls as in our study) have a lower levy cost. Moreover the sensitivity of welfare improvement depends directly on the level of the Marginal Cost of Public Funds. Note that, because of this difference in levy cost, this only shows the advantage of direct earmarking of additional taxes on tolls, whether transiting through a transport fund or not, compared to public subsidies coming from the general budget (with higher levy costs).

The second stage of the analysis addressed the issue of optimal pricing with scenario D, a pure short-run marginal cost pricing (SMCP) scheme in which central (fuel) taxes are suppressed. This pricing is applied simultaneously on the planned new motorways and on existing competing highways which are currently free. Existing tolled motorways are not considered in this scheme. Finally, in scenario E optimal financing and pricing are combined.

With regard to optimal pricing, SMCP permits a slight increase in overall welfare when compared with the planned tolling scheme, despite the low forecast level of congestion on the studied projects. This can mainly be explained by the fact that road traffic will increase since the overall costs borne by road users would fall by 65 % with a switch to SMCP. However, because of the low level of congestion, pure SMCP cannot solve financing problems. It must be supplemented by subsidies from a transport fund or from central (or local) governments. This does not mean that new investments are not justified. Indeed, motorway projects are planned mainly not to reduce congestion but to improve the quality and safety of road transport. This improvement and especially the expected time savings induce a socio-economic rate of return high enough to warrant these projects.

In short, the results of the MOLINO runs indicate that pure SMCP is the most efficient pricing scheme (without considering financing problems), while cross-financing appears to be more efficient as a means of financing new motorway projects. A combination of the two rules yields a higher increase in overall welfare than either policy does independently. Indeed, for all projects the scheme that combines pure SMCP with cross-financing provides the greatest increase in overall welfare of all the alternative schemes.

5.4.5 Equity issues in the motorway programme case

The SMCP scheme generates an overall 65 % reduction in road use pricing (toll + fuel taxes compared with SMCP) for both motorway and alternative highway users. This generates a 10 % overall increase in freight traffic and an 18 % overall increase in passenger traffic. When put in the balance against a decrease in central government net revenues due to the absence of fuel taxes, there is only a slight overall welfare improvement.

5.4.6 Acceptability issues related with the funding of infrastructure through transport funds

Some insights into the acceptability of funding transport infrastructure through funds can be made by examining the FITTVN fund, which was created in 1995. The FITTVN was created as an electoral promise to finance access to less developed areas and to promote combined transport. The fund was fed through the "taxe d'aménagement du territoire" (a tax of approximately € 0.007/km in 2000 paid by tolled motorway users and collected by the motorway operator) and a tax on hydroelectric energy (between € 0.006 - € 0.012/kwh). The revenues from these two taxes amounted to € 3 billion between 1995 and 2001, and several major transport infrastructure links such as the A20 and A75, parts of the Estuaries motorway, the Route Centre Europe Atlantique and the Mediterranean TGV line as well as some stretches of inland waterways were financed through the fund. However the fund was heavily criticised both nationally and by the European Union. There were many reasons for the criticism, in particular because no difference could be determined between projects financed through the general budget and the fund. The cross financing of infrastructure from road to rail was one of the controversial issues.

Several lessons can be drawn from this example as far as how to enhance the acceptability of infrastructure funds. These are as follow:

- ✓ The objectives and scope of the fund need to be clearly defined;

- ✓ Fund revenues should be kept separate from the general budget and they should be used to meet the aims of the fund – even at times of budget constraint.
- ✓ Interest groups should participate in the initial design and functioning of the fund, and;
- ✓ The fund should be compatible with European guidelines both for the levels of charges levied to feed the fund and for the use of revenues.

5.4.7 Research questions in the Lyon-Turin rail link case

The assessment focuses on the cross-financing of new rail infrastructures by road revenues. The decision to invest in the Lyon-Turin link is taken as given. Therefore, only alternative ways of financing and pricing the use of this infrastructure are examined.

5.4.8 Regulation schemes in the Lyon-Turin rail link case

The characteristics of the regulation schemes for the Lyon-Turin rail link case are presented in the following Table.

Alternative pricing and funding schemes	Pricing	Revenue use
Scheme A: current motorway tolling scheme + public subsidies	Current tolling scheme on existing motorways	Rail revenues go to rail operator or manager. Toll revenues go to motorway operator. Public subsidies for the rail link. No cross-financing.
Scheme B: increase in road tolls by 25% + transport fund + public subsidies	Mark-ups (25%) on current tolling scheme on existing motorways	Rail revenues go to rail operator or manager. "Base" toll revenues go to motorway operator. Additional surplus of existing motorways goes to the Alpine fund. The fund subsidises rail infrastructure. Public subsidies when needed.
Scheme C: increase in road tolls by 80% + transport fund + public subsidies	Mark-ups (80%) on current tolling scheme on existing motorways	As above.

Table 13 – Overview of regulation schemes in the Lyon-Turin rail link case

5.4.9 Efficiency and equity issues in the Lyon-Turin rail link case

The second case study of the Lyon-Turin rail project shows the limited impact on welfare of cross-financing rail by road by using toll mark-ups on alternative Alpine motorways.
However, there is a redistribution from high-income to low-income passengers. It should be stressed that while public subsidies amount to 97 % of the construction costs in the first scheme (no cross-financing) this ratio decreases to 75 % (€ 7.3 billion subsidies) and 64 % (€ 6.2 billion subsidies) with cross-financing by motorway toll mark-ups of respectively 25 % and 80 %. Nevertheless, public subsidies are still needed to finance the rail project (the possibility of increasing rail prices has not been considered).
Moreover, the revenues from road toll mark-ups are limited to traffic crossing the Franco-Italian border through the Mont-Blanc and Fréjus tunnels. The toll mark-up base could be widened to all traffic using the Alpine motorway network, on the premise that this traffic

would benefit from lower road congestion resulting from modal transfer to rail. This option would yield much higher revenues, but it raises policy and equity issues that require more thorough analysis.

5.5 Zurich airport

5.5.1 Scope

The **Zurich airport** case study (Schreyer et al., 2005) addresses different pricing schemes and the related revenue options. An important factor for the future development of the Zurich airport is the solution of its environmental problems especially with regard to noise. Today's capacity limitations are mostly due to political restrictions (night curfew, German restrictions during early morning and late evening) rather than to runway or terminal congestion. Since increased noise exposure is responsible for major opposition from different population groups the airport authorities have created a so-called noise fund which is fed by earmarked passenger and aircraft noise charges. A core aspect of research in this case study relates to the efficiency effects of this noise fund.

5.5.2 Research questions

- ✓ What impacts do alternative pricing, regulation and investment schemes have on the noise exposure of residents? Are there any possibilities to increase the overall welfare of the system via alternative pricing, financing and investment options?
- ✓ Could alternative schemes provide enough revenues to fulfill the financial needs of the airport as well as the needs of noise-affected residents?
- ✓ What impacts do different investment and financing options (runway extensions, noise protection measures) have on welfare?
- ✓ What effects do alternative schemes have on equity, feasibility and acceptability compared to the status quo?

5.5.3 Regulation schemes

In the Zurich airport case study three regulations schemes have been examined.

- ✓ The first corresponds to today's pricing and regulation scheme. This is close to a two-part scheme having fixed charges to ensure coverage of fixed costs and charges with elements of SMCP (especially the variable part of the noise charge and the NOx emission charge). Parts of the Passenger charge (security, ground handling) are based on average costs. Revenues from these charges (charge per passenger) cover security control costs and ground handling costs at the airport. The revenues of the noise charge are 100% earmarked for a specific noise fund. Noise abatement measures, compensation payments etc. are financed out of this fund. The following Table depicts the main features of this regulation scheme.

Status Quo				
	Scope	**Pricing**	**Revenue use & financing**	**Investment**
Rules				
Questions	What sectors are covered?	Which pricing rule?	What use of revenues, what financing?	Which investment rule?
Status quo	Aviation (Airport Zurich)	Two-Part Pricing Fixed charges: › Passenger Tax (security, ground handling and one part of noise) Variable charges: › Landing (MTOW dependent) › Parking (partly variable) › Fueling › Noise charge › Emission charge	Airport budget (operation, maintenance, running costs) Security charge is earmarked 100% for security on the airport Noise fund: Noise protection measures, compensation payments (100% earmarked) Single till regime, i.e. deficits of the aviation sectors is covered by revenues from the non-aviation sector (retail, etc.)	There are no clearly formulated investment rules, but multi-criteria analysis and partly internal cost-benefit analysis were used for investment decisions. Investment decisions are also based on long term plans and long term traffic forecasts. The last considerable investment was the construction of a new terminal (Dock Midfield).
Regulatory framework				
Questions	What actors are involved, with what functions	Who sets prices	Who decides on revenue use and financing	Who makes investment decisions
Status quo	Airport Operator (Unique), Canton of Zurich, Regulator: Federal Office for Civil Aviation (FOCA)	Unique, prices have to be approved by the Federal Office for Civil Aviation (FOCA)	Airport operator	Airport Operator
Procurement & implementation				
Questions	Private or public provision	Payment? Enforcement? Exceptions?	Revenue collection & management ?	Tenders? Contracts?
Status quo	Private airport operator since 1999	Reduced charges for transfer passengers	Passenger taxes collected by airlines or tour operators	In case of investments, tenders are used to find the most cost efficient solution

Table 14 – Status Quo regulation scheme in the Zurich airport case study

✓ The second is a SMCP scheme, which is not expected to be able to cover full costs of aviation services at the airport due to specific conditions at Zurich airport (no capacity constraints for the moment, hub carrier). An important question is therefore how the

possible deficit of an SMCP-scheme should be financed. This concerns the airports in different ways:

- For a privately operated airport cost coverage and profit-making is crucial. A SMCP scheme would only be accepted if the deficit and an acceptable profit would be covered by the government. In reality this is only thinkable in a situation where the ownership of the airport is returned to the public hand.
- In the case of a heavily congested airport with high congestion prices and therefore sufficient revenues, SMCP would eventually be beneficial if cross-subsidies between non-aviation and aviation were possible (single till). The non-aviation commercial sector of the airport is dependent on high passenger numbers which are likely under a SMCP regime.

The use of a SMCP scheme has therefore first and foremost implications on the organizational form of the airport. For the case study this implicates a change of the ownership structure when a SMCP-scheme is envisaged. In the assessment this aspect is addressed. The revenues from the noise charge in the SMCP scheme are not earmarked to the noise fund (AZNF). Therefore no noise protection measures can be financed.

The main elements of this regulation scheme are presented in the following table.

Social Marginal Cost				
	Scope	**Pricing**	**Revenue use & financing**	**Investment**
Rules				
Questions	What sectors are covered?	Which pricing rule?	What use of revenues, what financing?	Which investment rule?
SMCP	Airport Zurich	-SMCP for infrastructure and operating costs, noise and environmental costs -Peak/Off-peak differentiation for scarcity costs	Revenues are used to cover variable and marginal costs Deficits would be covered in case of a publicly operated airport by tax revenues, in case of a private airport operator by revenues from the non-aviation sector (single till) No noise fund is foreseen.	Cost-benefit analysis
Regulatory framework				
Questions	What actors are involved, with what functions	Who sets prices	Who decides on revenue use and financing	Who makes investment decisions
SMCP	Private operator or public authorities	Operator of the airport	Operator of the airport/public authorities in the case of the airport as a public enterprise	Operator or public authorities
Procurement & implementation				
Questions	Private or public provision	Payment? Enforcement? Exceptions?	Revenue collection & management	Tenders? Contracts?
SMCP	Private or public provision	-	Airline charges collected by the airport.	In case of a publicly owned airport: tenders for airport operation and investments In case of a private operator: tenders for investments

Table 15 – Social Marginal Cost regulation scheme in the Zurich airport case study

✓ The third regulation scheme corresponds to a Ramsey pricing scheme. This scheme is based on marginal costs and considers price elasticities of different demand groups (airlines) of the airport. This is the only regulation scheme where the effects of a runway extension are envisaged. In one of the revenue use options the revenues from the noise charge are earmarked to noise protection measures (for example noise protection windows). This earmarking corresponds to the noise fund which is currently established at Zurich airport.

The following table presents the main elements of this regulation scheme.

Ramsey Pricing				
	Scope	**Pricing**	**Revenue use & financing**	**Investment**
Rules				
Questions	What sectors are covered?	Which pricing rule?	What use of revenues, what financing?	Which investment rule?
Ramsey	Aviation sector	Ramsey pricing	Airport operation costs, capacity increase, infrastructure investments (runway enlargements to reduce noise emissions) to raise acceptability of the public Noise fund with different spending options: compensation payment, financing of noise protection measures, etc.	Private decisions based on cost-benefit analysis
Regulatory framework				
Questions	What actors are involved, with what functions	Who sets prices	Who decides on revenue use and financing	Who makes investment decisions
Ramsey	Private airport operator, FOCA as a regulator	Airport operator	Airport operator	Airport operator
Procurement & implementation				
Questions	Private or public provision	Payment? Enforcement? Exceptions?	Revenue collection & management	Tenders? Contracts?
Ramsey	Private	-	Airline charges collected by the airport.	Contracts

Table 16 – Ramsey pricing regulation scheme in the Zurich airport case study

Three analytical tools have been used in the assessment of the regulation schemes. These are as follow:

- ✓ Existing models of production, accessibility and noise exposure. The airport production model has been used for the estimation of value added of airport services and infrastructure costs. The accessibility model allows for the estimation of regional attractiveness within a world model measured by an indicator of gravitation. The noise model allows for the estimation of number of persons per dB-classes within a certain noise category.

5.5.4 Efficiency

Investments in runway extensions financed with Ramsey pricing are welfare reducing because investment costs (expressed as annuities) are higher than the reduced external noise costs. Since the effects on delays and congestion of a runway extension are not computable it remains open, if an additional consumer surplus is achieved by higher schedule stability

which would be an ancillary benefit of a runway extension. However, delays at Zurich airport are due more to regulations on airport operations than to capacity scarcity. Runways and terminals are currently used only to about 66 % of their capacities.

In the Ramsey pricing scheme, if parts of the revenues are earmarked for noise protection measures (as is the case for the present noise fund), efficiency decreases only slightly provided that the remaining producers' surplus (net benefit of the airport) is redistributed to the public. However, this would only be possible if the airport were to revert to public enterprise. In addition, because of methodological problems in estimating the effects of noise protection measures on external noise costs, only tentative statements regarding the efficiency effects of noise protection measures. Related to the financing of noise protection measures, the question of compensation payments to noise victims is crucial in the discussion.
The positive effect of an SMCP scheme in higher consumers' surplus is outweighed by a significant increase in airport deficits and thus a considerable loss of producers' surplus. Revenues are insufficient to cover costs, let alone to finance additional noise protection measures for residents. In the Ramsey pricing scheme costs are covered, but investments in runway extensions or additional noise protection measures would reduce overall welfare.
A funds solution for compensation payments as well as for noise protection measures is basically a useful tool as long as it is not over financed. An over-financed fund would lead to a less efficient use of the fund. Strict control of the fund is therefore crucial if the fund is only used to finance noise protection measures.

5.5.5 Equity

When comparing the status quo scheme with the MSCP regulation scheme only air transport users (in case of the cross subsidisation between aviation and non aviation in the private airport operator format) and the non aviation sector are better well-off. Residents will be affected from higher air transport movements and the abolition of the noise fund which is currently used (status quo) to finance noise protection measures.
When adopting the Ramsey pricing scheme instead of the status quo scheme air transport users would pay slightly higher prices on specific connections. On the other hand, residents would profit from significantly lower noise exposure in case of extension of runways and slightly lower noise emissions even without investments due to decreasing air traffic movements.
Still in the case of Ramsey pricing while the southern and northern part of the airport would benefit from significant relief of noise emissions, the eastern region around the airport would face higher noise exposure. The reason is that with a new runway system the main landing direction would be from the east.

The question of compensation payments to noise victims is central in the context of the discussion of the financing of noise protection measures. Compensation payments are especially relevant with regard to equity and acceptability because they compensate property owners for house and land value loss. On the other hand, as long as people do not move to the airport region to benefit from noise related payments, equity and acceptability will be increased among residents. Therefore, compensation payments should be restricted to those residents who could not foresee the negative effects of airport noise.

5.5.6 Technical and organisational feasibility

The specification of SMCP pricing remains difficult though possible from the technical point of view. What seems to be a primary obstacle to the introduction of MSCP is that the operation of the Zurich airport is carried out by a private company. Since SMCP leads to considerable deficits the only realistic path consists in increasing the cross subsidisation between aviation and non aviation (in the single till context). However, it seems not very realistic that the non aviation sector of the airport could increase its profits in a way which would allow full financial sustainability. On the other hand, the return to a state owned format, in order to allow coverage of deficits resulting from SMCP, is not currently an option.
From the technical point of view, the adoption of Ramsey pricing is possible requiring knowledge on price elasticities of different demand groups. On the other hand, Ramsey pricing is not completely in line with directives emanated from supra national organisations, such as ICAO and the EU, which call for cost oriented pricing approaches. Therefore, there would be a risk that international courts would reject such proposal.

5.5.7 Acceptability

In principle, only airlines and air transport users would accept SMCP since it induces lower air travel costs. On the other hand, the abolishment of the noise fund, which is associated with the introduction of SMCP, would not be accepted to residents around the airport, taxpayers in the airport region and the airport itself.
In the case of the Ramsey pricing scheme the acceptability of residents is probably given due to decreasing noise exposure. However, runway extensions are faced with reserve because an increase of capacity could lead to increased air traffic and thus higher noise emissions in the long run. Acceptability of airlines is presumably much lower, especially of those airlines which are confronted with increased charges. The same is true for air transport users of these airlines.

5.6 Rotterdam port case study

5.6.1 Scope

The **Rotterdam port** case study (Rudzikaite, Visser, Kiel, 2005) focus on the current practice of pricing, investment and revenue use at the Port of Rotterdam and the Port of Antwerp. The two competing transport options considered are:

- ✓ Container transport via the port of Rotterdam;
- ✓ Container transport via the port of Antwerp.

Both ports target the same large-scale hinterland and market niches and have enjoyed a significant growth of container traffic over the last decade. These ports are presently experiencing capacity problems in handling the present volume of containers and therefore are in a period of expansion. For Rotterdam this means the reclamation of sea land (project Maasvlakte 2) and the construction of additional container terminals. For Antwerp the capacity expansion means building a new tidal container dock (the Deurganck dock) on the left bank of the Scheldt River. In order to be able to accommodate larger container vessels and to improve the access to the port of Antwerp, the deepening of the Westerschelde Sea waterway connection is considered necessary. This raises a number of cross-border issues and is politically controversial as the sea-access route to Antwerp is on Dutch territory. Two scenarios are considered:

- ✓ Expansion of port infrastructure at the Port of Rotterdam – the project Maasvlakte 2;
- ✓ Project Maasvlakte 2 in combination with deepening of Westerschelde Sea.

5.6.2 Research questions

The research questions addressed in the two scenarios are presented below.

Port of Rotterdam (Maasvlakte 2)

- ✓ What are the social costs and benefits of the expansion of the port infrastructure? (restricted to the container handling facilities)?
- ✓ What are the impacts of the possible cost recovery mechanisms for the Maasvlakte 2 investments for the Netherlands (e.g. 'user pays' and other pricing mechanisms, port dues adjustment, creation of a Scheldt fund, port rent adjustment, financial transfers between various authorities, etc.) in terms of efficiency, equity, feasibility and acceptability considerations?
- ✓ Can the proposed cost recovery mechanism from the Maasvlakte 2, as approved between stakeholders (Port Authority Rotterdam, Gemeente Rotterdam and the Dutch Government) be justified on the basis of the findings of the study?

Port of Rotterdam (Maasvlakte 2 in combination with deepening of Westerschelde)

- ✓ What are the social costs and benefits of the deepening of Westerschelde for Dutch society?
- ✓ What are the impacts of the possible cost recovery mechanisms for the Westerschelde investments for the Netherlands (e.g. 'User pays" and other pricing mechanisms, port dues adjustment, creation of Scheldt Fund, port rent adjustment, financial transfers between various authorities etc) in terms of efficiency, equity, feasibility and acceptability considerations?
- ✓ What are the possible cost recovery mechanisms for the Westerschelde investments for the Netherlands (e.g. 'user pays" and other pricing mechanisms, port dues adjustment, creation of Scheldt Fund, port rent adjustment, financial transfers between various authorities, etc.) in terms of efficiency, equity, feasibility and acceptability considerations?

5.6.3 Regulation schemes

The three case study regulations schemes and all the respective variants are described in the table below.

Regulation Scheme	Scenario	Pricing	Revenue Use	Investment
Status Quo	**(0)** status quo 2004	• Reference • Fixed toll • MSC tolling	Revenues shared between the Port Authority and the Municipality of Rotterdam	*Option 1:* investment to build Maasvlakte 2 (Port Authority), hinterland access (State, local authorities); *Option 2:* Investment to build Deirganck dock (Port Authority, Local and Central Authority); hinterland access (State, local authorities);
Adopted Policy	**(1-A)** • *Horizon 2012* • *New container terminals* • *Westerschelde maintenance* • *Protection of nature* • *No Belgium contribution*	• Reference • Fixed toll • MSC tolling (no financial contribution by Belgium to Westerschelde costs coverage)	Maasvlakte profit to be shared 50:50 between the Municipality of Rotterdam and the State	*Option 1:* Maasvlakte 2 in operation; State investment into sea-wall, nature protection in Rotterdam area *Option 2:* Deurganck dock in operation;
	(1-B) • *Horizon 2012* • *New container terminals* • *Westerschelde maintenance* • *Protection of nature* • *Belgium contribution*	• Reference • Fixed toll • MSC tolling (Belgium contributes to Westerschelde costs coverage)	Revenues to be shared between the Port Authority, Municipality and the State. Revenues from Westerschelde charges to be used for maintenance of Westerschelde	*Option 1:* Maasvlakte 2 in operation; State investment into sea-wall, nature protection in Rotterdam area *Option 2:* Deurganck dock in operation; Belgium co-invests in the maintenance of port access on Westerschelde
Trade-off Policy	**(2-A)** • *Horizon 2012* • *New container terminals* • *Westerschelde maintenance* • *Deepening* • *Protection of nature* • *No Belgium contribution*	• Reference • Fixed toll • MSC tolling (no financial contribution by Belgium to Westerschelde costs coverage)	Revenues and costs from Maasvlakte to be shared between the Port Authority, Municipality and the State	*Option 1:* Maasvlakte 2 in operation (port Authority); Deepened Westerschelde (State & local authorities); State investment into sea-wall, nature protection in Rotterdam area; *Option 2:* Deurganck dock in operation; sea and hinterland access improved

Regulation Scheme	Scenario	Pricing	Revenue Use	Investment
	(2-B) • *Horizon 2012* • *New container terminals* • *Westerschelde maintenance* • *Deepening* • *Protection of nature* • *Belgium contribution*	• Reference • Fixed toll • MSC tolling (Belgium contributes to Westerschelde costs coverage)	Revenues and costs from Maasvlakte to be shared between the Port Authority, Municipality and the State, Revenues from Westerschelde charges to be used for maintenance and deepening of Westerschelde	*Option 1:* Maasvlakte 2 in operation (Port Authority); Deepened Westerschelde (State & local authorities of the Netherlands, Belgium contribution); State investment into sea-wall, nature protection in Rotterdam area; *Option 2:* Deurganck dock in operation; sea and hinterland access improved, Belgium co-invests in the deepening of port access on Westerschelde

Table 17 – Features of the regulation schemes in the Rotterdam port case study

Note that the adopted policy scheme and the trade-off policy scheme are each further subdivided into two variants (A and B). The B-variant considers a cross-country transfer between Belgium and the Netherlands for the cost of Westerschelde deepening.

5.6.4 Efficiency

Fixing the level of charges sufficiently high to recover, in a reasonable time, the investment costs allocated to container transport, significantly reduces the volume of container transport and has a negative impact on welfare levels. The introduction of MSCP leads in all cases to an improvement of freight volumes and welfare levels at relatively low level of toll revenues. Though this would be favourable for the port users (container operators, transhipment companies) the revenues would not be sufficient to fund the infrastructure investments made to realise container transport and transshipment capacity extensions. From all scenarios with MSCP, the best performing in terms of welfare gains is the one that considers trade-off policy with Belgian contribution.

5.6.5 Equity

No distinction was made between small/medium enterprises and large enterprises using container transport services provide at the port of Rotterdam. Equity impacts were only addressed at the level of changes between Belgium and Dutch societies. In this respect the regulation schemes that considers contributions from Belgium to the Dutch infrastructure Fund yields significant welfare increases to the Dutch society.

5.6.6 Technical feasibility

The specification of MSCP may be technically difficult because it is not straightforward to determine transparent charge levels.

5.6.7 Acceptability

The core acceptability problem is that under the current legal arrangements the costs of maintaining and deepening the Westerschelde are being paid by the Dutch government and the regional authorities of Zeeland, e. g. to 100% by Dutch taxpayers. The benefits of this arrangement are enjoyed by users of Antwerp port and the Antwerp port authority. Therefore, all schemes which foresee a compensation payment for this burden would increase acceptability.

With regard to political feasibility/acceptability it must be remarked that according to the early 2005 it was agreed that the Dutch government and Zeeland authorities would pay the investment costs fully. Instead of agreeing on a direct financial contribution of Belgium to the Westerschelde deepening project, Belgium will ensure the necessary technical/financial arrangements for accommodating Dutch requirements with regard to services on the high-speed 'North-South' railway line from Amsterdam-Paris (thus creating a possibility for the citizens of The Hague to reach Paris by rail in 3 hours). It is very difficult to estimate welfare impacts from such a political "trade off" between infrastructure projects because that implies that one should also model other infrastructure projects.

From a more general point of view, it must be stressed that such cross-border political "deals" are not recommendable to make infrastructure financing more transparent. For example applying the "user-pays" principle may now become more difficult. Having in mind the above-mentioned agreement between the two governments, the trade-off regulation scheme should be considered as purely theoretical.

5.7 Acceptability of HGV charges

5.7.1 Scope

The case study on **road haulier's acceptability of HGV charges (**Link and Stewart-Ladewig, 2005) addresses two acceptability issues. The first refers to the acceptability of distance related HGV road charges paid in transit through Switzerland and Germany. The other addresses the acceptability of distance related road charges paid in Germany by German haulier's.

5.7.2 Research questions

The case study focuses in the following research questions.

- ✓ What matters for acceptability of HGV charges and in particular for the use of revenues collected?
- ✓ What influence has the charging technology, the interoperability of charging technology and the institutional framework?
- ✓ Is there a trade-off between charge level and use of revenues?
- ✓ What are the outcome beliefs of hauliers and their associations and how do they influence the overall acceptability of the schemes?
- ✓ How are foreign hauliers that pay HGV charges in Germany and Switzerland disposed towards use of revenues in other modes than road?
- ✓ How do they see the national compensation measures envisaged in Germany?

5.7.3 Regulation schemes

Different packages, involving combinations of pricing and spending options, have been examined in the part of the case study that surveyed the acceptability of distance related road

charges, paid in Germany by road hauliers, and the relation with the planned use of these revenues. Two different average charge levels (25 and 18 cents/km) and five revenue spending options are taken into account in addition to the reference case. The revenue spending options are as follows:

- ✓ Maintenance of roads;
- ✓ Maintenance of roads and partly new construction (relief of bottlenecks, by-pass roads for heavily utilised urban roads);
- ✓ Intermodal use of revenues for road, rail and inland waterways;
- ✓ Use of revenues for the road sector and for combined transport;
- ✓ Contribution to the general government budget.

The reference case, corresponding to the HGV road pricing scheme introduced in Germany on the 1st of January 2005, entails the following core elements:

- The average charge is 12.4 cents/km. After the approval of compensation measures by the European Commission the road charge is foreseen to increase to an average of 15 cents per kilometre;
- From total revenue of €2.8 billion, €600 million are used to compensate commercial transport operators (it is planned to compensate a part of the commercial diesel fuel tax paid in Germany against the presentation of the tanking receipt. This scheme must be approved by the European Commission). The remaining revenues of €2.2 billion will flow to an independent infrastructure financing agency and will be used for the improvement of the transport network (road, rail and inland waterway). The majority of the revenues will be used for maintenance and construction of the motorway network.

Against this reference case, the study considered the following options:

- ✓ Five options for the use of revenues from road charges, as follows;
  - o Revenues raised through road pricing should be used to reduce the government budget deficit;
  - o Revenues raised through road pricing should be used for improving and extending the road network only;
  - o Revenues raised through road pricing should be used for improving and extending road and rail networks;
  - o Revenues raised through road pricing should be used for improving and extending all transport networks;
  - o Revenues raised through road pricing should be used for reducing taxes.

- ✓ Different options to compensate foreigner transport operators for the increased costs arising from the introduction of road charges in Germany and Switzerland (measures to be adopted by other countries), as follows:
  - o No compensation for road charges raised in Germany and Switzerland is necessary as the charges only cover some of the costs that a vehicle causes by using the roads;
  - o No compensation for road charges raised in Germany and Switzerland is necessary as the charges are used to maintain and construct transport networks;
  - o If compensation measures are introduced they should be granted to all commercial vehicles paying road charges – no matter what country the vehicle is registered in;

- The best way to compensate commercial transport operators for increased costs due to road charges in Germany and Switzerland would be to reduce fuel tax on commercial fuel purchased in Germany and Switzerland;
- The best way to compensate commercial transport operators for increased costs due to road charges in Germany and Switzerland would be to reduce vehicle related taxes for all commercial vehicles registered in Europe;
- The best way to compensate commercial transport operators for increased costs due to road charges in Germany and Switzerland would be to relax rules on restricted driving times in Germany and Switzerland;
- The best way to compensate commercial transport operators for increased costs due to road charges would be to relax rules on maximum vehicle weights allowed on roads in Germany and Switzerland;
- The best way to compensate commercial transport operators for increased costs due to road charges in Germany and Switzerland would be to let each country be responsible for granting tax breaks to their commercial transport companies;

5.7.4 Acceptability

Either in the case of acceptability of distance related HGV road charges paid while in transit transport in Germany and/or Switzerland and paid in Germany by German hauliers a general common conclusion can be draw. Worsening of road condition and congestion are seen as severe problems by road freight operators, whereby the key informants who were specifically asked for problems in transit traffic, rated congestion in cities as more severe than on motorways.

Both German hauliers and representatives from associations of road transport operators from other countries are unequivocal regarding the severity of environmental and accident problems and in particular whether this should be a major field of state intervention.

Distance related road user charges are preferred over other forms of transport related taxes or charges (key informant survey) but are not considered to be effective in solving transport related problems such as better road conditions, less congestion, ease of environmental problems and accidents (both surveys).

The adaptation strategies of both companies using German and Swiss roads in transit and of German hauliers using the German motorways are similar: First priority is to pass the extra costs caused by the HGV charges on to the customer. Other strategy consists in changing the fleet structure towards more environmentally friendly vehicles which are charged at lower levels, rather than changing the fleet towards smaller vehicles. From this strategy one can conclude that the environmental incentives in the charging design seem to work.

Despite of perceived congestion problems hauliers refuse congestion charging, in particular if implemented as real-time charging. Also an extension of charges to the whole network is refused. An obvious preference for low system costs for the charging technology has also been stated. There is a strong refusal of revenues collected with the HGV charges flowing to the general state budget and a strong preference for using them in the road sector, e.g. without cross subsidisation.

Though the stated preference for earmarking revenues for transport infrastructure is met in the regulatory framework of both the German and the Swiss HGV charging schemes, the cross-subsidisation foreseen in both schemes (intermodal fund in Germany, use of two thirds of the HGV charging revenues for rail in Switzerland) is obviously not in line with the preferences of those affected by the charge.

This is in particular relevant for the Swiss scheme where transit traffic has clearly other preferences than the population affected by the negative effects of road freight in alpine transit traffic. The transit group was strongly in favour for using part of the revenues to compensate the companies affected by the road charges. Reduction of vehicle taxes and fuel taxi rebate is indicated as the preferred compensation scheme, national programmes for compensation were rejected.
An important finding from the German road hauliers case was that there exists a trade-off between charge level and use of revenues. German hauliers would accept higher charges if revenues were used for road maintenance and relief of bottlenecks.
Furthermore, the institutional framework chosen plays a crucial role in acceptability of HGV charging and is closely related to the use of revenues. The preferred solutions are either a motorway operator who collects the charge and decides on the use of revenues, or a solution where the state collects the charge and an independent agency (fund) receives the revenues and decides on their spending for the different modes, for maintenance vs. new construction etc. Clearly, these preferences are at least partly driven by the negative experience made with the German toll operator TollCollect. They reflect also the mistrust into the government and the refusal of an option where all revenues flow to the general budget.

5.8 Conclusions from interurban case studies

This section presents a synthesis of the conclusions that emerged from the REVENUE's interurban case studies. These conclusions can be broadly categorised as follows:

- ✓ Social marginal cost pricing and deficit coverage;
- ✓ Earmarking of revenues and cross subsidization between modes;
- ✓ Cross subsidization between different types of roads;
- ✓ Use of revenues for maintenance versus new construction;
- ✓ Use of charging revenues to ease environmental problems;
- ✓ Procurement options.

5.8.1 Social marginal cost pricing and deficit coverage

An expected lesson from all case studies is that pricing schemes which have elements of social marginal cost pricing are welfare superior. In fact, the theoretical assumption of welfare superiority of MSCP schemes has been in general confirmed. Notwithstanding, MSCP schemes fail to recover investment costs and lead to deficits for the infrastructure operators, reflecting the occurrence of increasing returns to scale.
An exception to this general conclusion stems from the result of the Swiss railway investment fund case study. In this case a pricing scheme based on the marginal cost of infrastructure operation and maintenance, congestion, environmental burden and accidents, which replaces all other taxes such as fuel and vehicle taxes, yields the lowest welfare gains comparing to the other schemes[31]. However, it should be noted that this pricing scheme is merely oriented towards MSCP and that transport prices are exogenously considered in the specific modeling work. The positive welfare effect of having higher charging revenues due to introducing marginal cost-based charges on top of existing taxes can be explained by welfare gains of the federal and the local government from higher toll revenues which allow to finance

[31] Namely, compared to the status quo and to a scenario where existing fuel and vehicle taxes would be supplemented by charges based on marginal and environmental costs.

infrastructure projects with cheaper money, e. g. funds from a kind of Pigouvian tax (the HVF charge) rather than from the more distortionary labour taxes. These welfare gains outweigh the welfare losses within the transport sector from charges which are above the optimal level. The effects of different solutions to the deficit problem arising from SMCP schemes, including public subsidies, financing via mark-ups on SMCP or Ramsey pricing have also been addressed. The Zurich airport case study considers specifically deficit recovery through the private capital market, through cross-subsidisation from the non-aviation sector of the airport or through government subsidies. The conclusion from the French case study is that a combination of SMCP with subsidies from an infrastructure fund like AFITF (sources of the fund are the motorway company dividends and land fees) could be a good compromise with regards to economic efficiency, financing requirements and acceptability. In the case of Zurich it can be concluded that the efficiency effects of profit distribution or investments from a Ramsey pricing scheme are not able to outweigh the negative effect on consumer surplus.

5.8.2 Earmarking of revenues and cross-subsidisation between modes

Diverging results were obtained with respect to the questions whether revenues should be earmarked to the transport sector and whether cross-financing between modes is welfare optimal. First of all, the results of the German tolling case study show that independent of the charging principle the most efficient solution is to give all revenues to the general budget. However, if HGV charging revenues have for some reason (for example acceptability or legal feasibility) to be earmarked for transport, then it is welfare superior to use them in the road sector and not for cross-subsidising rail[32]. In contrast to this finding, the results of the Swiss case study indicate that the current Swiss solution of earmarking two thirds of the HGV revenues for constructing the new rail tunnel is an efficient solution, and welfare could even be improved if all revenues were earmarked for rail. The reason for this result is the lower marginal cost of public fund for financing infrastructure via HGV charging revenues. In addition to this, the results also indicate that the extension of road capacity in addition to new construction in rail would increase welfare; however, such an option seems to be unacceptable for the population concerned. Similar to the Swiss study, the analysis in the French study of cross-financing from alpine motorways to the Lyon-Turin rail link shows that welfare increases with intermodal cross-subsidisation. However, in both cases it is assumed that the rail tunnels will be built anyway. In other words, the conclusion in these cases is that if transport infrastructure is to be built it is better to fund it by increasing the taxes in the transport sector than out of the general revenue because the resulting tax increases are less distorting, even where they result in raising transport prices above marginal social costs.

There are several reasons which might explain the diverging results of the case studies regarding cross-subsidisation. These are discussed right below.

- ✓ The German case study aggregated the effects of the HGV charging scheme and the spending of revenues because the whole German transport network was treated using the two-link representation in the MOLINO model. This means that, for example, benefits in travel times from transport investment are aggregated effects. Across the entire networks it was found that, despite the more cost-effective capacity increase

[32] This result was obtained with both the partial equilibrium model MOLINO and with the system dynamic model ASTRA.

and the more sensitive speed-flow-relations of rail and inland waterways, investing in the motorway network is more favourable because of the much higher traffic volumes on roads. In contrast to this aggregated approach, both the Swiss and the French case studies examined specific projects involving road-rail link competition in alpine transport;

- ✓ Cross-subsidisation of rail by road may have been more effective in Switzerland than in Germany because of the higher market share of railways in Switzerland. However, financing new road capacity in addition to cross-subsidising rail would increase social welfare further;
- ✓ In the Swiss case study the marginal costs of public funds for labour taxes and for the HVF charge are assigned different values (1.0 for the HVF charge and 1.35 for the labour tax) while the German case study uses one value (2.21) only. Consequently, the Swiss case study incorporated a built-in advantage to financing transport infrastructure using charge revenues rather than more expensive tax money from the general fund. All the other case studies that used the MOLINO model in the original implementation were due to the structure of MOLINO restricted to run with one value only. All case studies employed OECD-recommended values for the marginal costs of public funds;
- ✓ As mentioned above, possibly even more important, the case studies dealt with different subjects. While in the German case the amount and the sources of revenues are fixed and the level of expenditures for new construction and maintenance in the different networks was varied, the Swiss case considered a fixed investment scenario;
- ✓ A further fact to be considered when interpreting results is that the assumed exclusive use of HGV charging revenues to lower income taxes in the German case study does not cause any lags in carrying out required new investments and regular maintenance because those measures financed by revenues from the HGV toll are made in addition to the government's basic investment programme.

The German acceptability study has shown that road hauliers clearly prefer to spend revenues from HGV charging within the road sector. All options in which revenues go to the general budget were rejected, and less support was expressed for cross-subsidising rail or even combined transport. Furthermore, the survey results revealed that there is a trade-off between charge level and use of revenues. German road hauliers would accept higher HGV charges if there were a guarantee that the revenues would be used for road maintenance and improvement. The situation is different in Switzerland where the public voted in favour of the FINÖV scheme with cross-subsidisation from road to rail.

5.8.3 Cross-subsidisation between different types of roads

The results from the German HGV toll case study indicate that if earmarking is required for some reasons, HGV charging revenues collected for the use of motorways should in most cases be used for motorways, especially for motorway maintenance. However, this preference for allocating transport revenues to the motorway system is reversed when road operation and investment for both motorways and other trunk roads are privatised. In this case a balanced structure of fund allocation aiming to avoid deficits of one or the other operator is most effective.

The French AFITF solution where motorway dividends and the land fees from existing tolled motorways are used to finance new motorways shows that cross-subsidisation between roads leads to welfare gains against the status-quo, although when reviewing each of the project studied in detail there exist also two out of ten projects where this is not true. Obviously, it is highly depending on the construction costs of the project, the transport demand and the substitutability with the competing road. This might also be the reason why the German case study comes to a diverging result. Here, no specific projects were analysed. Instead, the complete motorway and trunk road networks were modelled as if they were just two competing links.

5.8.4 Use of revenues for maintenance versus new construction

The results of the German HGV toll case study indicate that it is welfare superior to use the HGV charging revenues for maintenance instead of building new road capacity. No comparison with other case studies is possible since this issue was only studied for the German case. Some cautious interpretation is necessary due to the fact that the approach used to address this issue (i.e.MOLINO) does not consider a road deterioration model[33].

5.8.5 Use of charging revenues to relieve environmental problems

The results from the Zurich airport case study show that the existing solution of a noise fund for compensating noise victims, financed through the noise surcharges by the airlines, is more efficient than a runway expansion in order to ease noise problems by a different location which would be financed by airline charges and airport revenues. Again, however, this has to be seen case-specific because the need for new capacity in Zurich is not given in terms of demand, and the construction costs exceed the benefits of this expansion.

5.8.6 Procurement options

The conclusions regarding the most efficient type of procurement are diverging. While the Finish interurban road financing case study shows that a PPP scheme increases welfare compared to the status quo of the Design & Build model, the HGV German case study results do not recommend a private institutional form. However, if motorway operation is to be privatised then all revenues should go back to the road sector.

5.8.7 Concluding remarks

The scope and nature of the questions addressed in the case studies have been dictated in large part by practical political proposals and discussions in the respective countries. Naturally, this hampers a straightforward comparison of the results. One complication arises with the transport markets studied and the way they were translated into the MOLINO setting. For example, while the Finnish, the Swiss and the French case studies analysed actual, physical transport links (single rail and/or motorway projects), the German case study had to aggregate all data for the road and rail network and to treat them as competing links instead of networks. Similar difficulties had to be solved in the Rotterdam port case study where the two ports of

33 The impacts of maintenance activities are indirectly reflected by using elasticities of travel speed with regard to maintenance expenditures.

Rotterdam and Antwerp had to be treated as links rather than nodes. Second, the pricing policies and revenue use options analysed were taken from policy proposals and/or policy measures that have been approved for implementation and vary from case to case. For example, the Swiss case study considers a given investment (the railway tunnels). The analysis was focused on a comparison of different pricing schemes and cross-subsidisation options between road and rail, and on whether the money needed to finance the given investment would better be raised via an HGV charge or be taken from then general budget. In contrast to this context, the German case study investigated the welfare impacts of different pricing rules for the German HGV toll in combination with earmarking and cross subsidisation issues, e.g. alternative investments, in addition to an anyway given basic investment programme, financed from the state budget. The French case study again differed regarding the situation analysed. Here an increase of already existing tolls was considered in order to answer the question whether it is welfare optimal to charge road users higher tolls and use the additional revenue to finance a rail link.

It should be borne in mind that both the methodology used for analysing the impacts of different spending options and the implementation of the model to practical case studies require further research. The MOLINO model needs to be further tested and the existing rather limited structure of the model will have to be extended to allow study of a greater range of problem settings.

However, it appears from the set of case studies analysed here, that no general conclusions can be drawn about the use of revenues from inter urban pricing. Earmarking for use on the same road, cross-subsidy between roads and cross-subsidy between modes may all be desirable depending on circumstances. Theoretical models which derive more general results rely on assumptions which do not necessarily hold in practice. In the real world, pricing and revenue use packages must be designed specifically for the particular case in question.

6 REGULATION SCHEMES IN URBAN TRANSPORT

This chapter describes the REVENUE urban case studies. Four case studies focussing in urban transport have been carried out, namely the Oslo, Warsaw, Edinburgh and cross-boundary acceptability case studies.[34] In addition, the study of an urban transport fund for the city of Berne has been included in the (originally interurban) Swiss case study.

For each case study it is presented a brief overview on the scope as well a description of the research issues and questions. The background includes elements such as historical developments, characteristics of the relevant parts of the transport sector, the geographical scope and the political environment. Research questions deal with the multiple dimensions of analysis that are further translated in terms of regulation schemes, i.e. to specific combinations of pricing, revenue use and investment rules.

In the assessment of regulation schemes four criteria have been considered, namely, efficiency, equity, technical and organisational feasibility and acceptability. Not all case studies took into account all assessment criteria as the main focus of each case study differs.

The assessment of the REVENUE urban regulation schemes was carried out through different methods and tools, more extensively described in the relevant REVENUE deliverables. The following table shows which tools have been used in the urban case studies.

Assessment criteria	**Tools**	**Case studies**			
		Oslo	Warsaw	Edinburgh	Cross-boundary acceptability
Efficiency	FINMOD	X			
	WCTM (Warsaw Computer Traffic Model) and standard algorithms for a numerical method of calculation		X		
	MARS			X	
Equity	FINMOD	X			
	MARS			X	
Technical and organisational feasibility	Qualitative/quantitative analysis		X		X
Acceptability	Qualitative/quantitative analysis	X	X		X

Table 18 – Assessment criteria and methodological approaches in case studies

Source: Revenue Deliverable 5.

[34] Actually the latter two cases refer both to Edinburgh.

In the following sections each REVENUE urban case study is presented and discussed according to the following structure:

- Scope
- Research questions;
- Regulation schemes;
- Results in terms of efficiency, equity, technical and organisational feasibility, acceptability

Finally, conclusions[35] from the urban case studies are drawn in the last section of the chapter.

6.1 Oslo case study

6.1.1 Scope

The chief objective of the **Oslo case study** is to investigate the changes in revenue use and financing schemes for Oslo toll ring. The Oslo toll ring was initiated in 1990 (Oslo package 1). Initially planned as a standard toll road with the objective of raising finance for the construction of tunnels below the city centre, the toll ring scheme soon become an instrument to finance several other projects as well. Later in the process, a decision was taken to earmark 20% of the revenue raised by the toll ring for public transport infrastructure investments. Besides the municipality of Oslo the system also covered the neighbouring county of Akershus.

Following extensive road investments in the region, a growing concern about car traffic increasing more rapidly than expected, as well the lack of infrastructure investments in the public transport system prompted the reformulation of the financing scheme. To meet this challenge, in 1996, the Norwegian Parliament invited Oslo local authorities to develop an enforced public transport plan based on national and local co-financing. This initiative resulted in a new plan (Oslo package 2), launched in 1998 and approved by Parliament and local authorities in 2001. The planning of Oslo package 2 involved two counties and different authorities/organisations. The new plan is essentially an extension of Oslo package 1, consisting of an increase in the toll fare of approximately €0.25 per trip, earmarked for public transport infrastructure investments. The new plan also includes an increase in the public transport fare of approximately €0.1 per trip, earmarked for rolling stock investments. The co-financing plan for Oslo package 2 also involved extraordinary national funding and Public-Private Partnership funds raised from the re-development of the old Oslo airport into a residential and commercial area.

The Oslo toll ring was planned to end in 2007. Currently there are no political consensuses to remove or to change the toll ring after that date. However, until new plans are agreed at political level the existing toll ring will continue. The prospect plan for the new financing scheme, which has the working title “Oslo package 3”, points in two alternative directions. The first alternative is some kind of toll financing as exists today but with a more efficient location of the toll ring, with little or no focus on fare differentiation. The second alternative consists in a move towards road pricing with a stronger emphasis on fare differentiation.

[35] The final conclusions and recommendations of the project are presented in Chapter 6.

6.1.2 Research questions

- ✓ What are the characteristics of the content and organisation of the financing packages? This entails researching on how packages have developed over time, both in content and scope as well as the processes behind the packages.
- ✓ What are the impacts of the organisation of the packages on the attainment of political goals and priorities? The rationale behind this question is to consider whether the packages have developed into an organisational framework that facilitates common priorities between the different stakeholders and make them pursue these, or if the packages are primarily an organisation that merely deals with the exchange of information.
- ✓ What are local decision maker's preferences for alternative forms of funding and different types of spending? i.e. What are the political sets of opportunities for the different regulation schemes?
- ✓ What are the social costs and benefits of alternative regulation schemes?

6.1.3 Regulation schemes

The regulation schemes addressed in the Oslo case study are presented in the following table.

Regulation scheme	Scenario	Pricing	Revenue use	Investment
A)	A1	Oslo package 1: Low toll fare (€1) Fixed subsidy level for public transport and fixed PT capacity constraints in the peak period.	RU 1: Fixed subsidy level in each market segment.	Road investments only.
B)	B1	Oslo package 2: Additional toll fare (+€0.25) and PT fare (+€0.1) targeted on capacity increases in peak period. Fixed subsidy level but flexible PT capacity in the peak period.	RU 1: Fixed subsidy level in each market segment	Revenue earmarked for public transport, but not including operational cost.
	B2	As B1	RU 2: Fixed total subsidy level for all market segments, but possible regional redistribution.	Revenues earmarked for public transport, but not including operational cost.
C)	C1	Oslo package 3: SMCP (around €4) and optimal subsidy level for PT in the region.	RU 1: Fixed subsidy level in each market segment.	Revenues earmarked for public transport with the possibility to use the revenue for operational costs.
	C2		RU 2: Fixed total subsidy level for all market segments, but possible regional redistribution.	Revenues earmarked for public transport with the possibility to use the revenue for operational costs.
	C3		RU 3: Welfare optimal subsidy level without financial constraints.	Revenues earmarked for public transport with the possibility to use the revenue for operational costs.

Table 19 –Regulation schemes in the Oslo case study

The first scenario (reference scenario A) corresponds to the existing toll ring system in Oslo. In this system the average toll fare is low, with respect to marginal cost pricing (€1). Revenue use for public transport is constrained by a fixed subsidy level and a fixed capacity constraint

in the peak period for public transport (PT). All investments are used for road investment purposes.
Scenario B corresponds to the Oslo package 2 system. This scenario introduces an additional toll fare (+€0.25) earmarked for public transport infrastructure investments. In the modelling specification this is done by removing the capacity constraint on public transport in the peak period. In addition, an increased public transport fare (+€0.1) is introduced, which is earmarked for public transport operation. This is added to the overall operating subsidy in the model. This includes increased rolling stock as well as rolling stock renewal. A fixed subsidy level for public transport combined with increased fares will earmark this part of the revenue flow. The additional toll fare will increase the demand for public transport.
In scenario C, which corresponds to the Oslo package 3 alternatives, a road pricing scheme with no restrictions on revenue use is introduced. For modelling purposes, the road pricing aspect is approached by introducing social marginal cost pricing of cars equal to €4 in peak periods (219% increase in relation to Oslo package 1). The road pricing revenue will exceed the subsidies needed for an optimised public transport service level. There will be no upper limit for the subsidy level. Five distinct public transport modes are considered, namely, urban bus, metro, tram, regional bus and train. Tram, metro and urban bus fall under the authority of the city of Oslo, regional bus fall under the authority of the Akerhus county and trains under the Ministry of Transport and Communications. These modes correspond to the market segments referred in the Table above. All scenarios are based on the initial market demand and take into account the marginal cost of public funds.

6.1.4 Efficiency

The Oslo package 2 scenario with fixed fares and a fixed subsidy per mode (implying a more optimal use of the revenue on the different public transport modes) would generate a total social benefit increase of €146M compared to Oslo package 1 (reference case) and 10% more public transport passengers. The modeling work also reveals that most of the benefit would accrue from increased frequency on the Metro. The Oslo package 3 scenario which considered social marginal cost pricing for public transport fares and road charge and a welfare optimal subsidy level without financial constraints increases social benefit by €322 million, compared to Oslo package 1 (reference case) and 33% more public transport passengers. Social marginal cost pricing of public transport under the toll fare regimes of Oslo package 1 and 2 implies a reduced public transport capacity peak fare level. On the other hand, in the context of the Oslo package 3 scenario[36] public transport fares should increase due to the removal of under-priced car traffic. The optimised subsidy level (i.e. considering subsidisation with no restrictions) is €115 million higher than the reference level in the Oslo package 1 and €103 million under Oslo package 2. The difference between the optimised subsidies levels in the Oslo package 1 and in the Oslo package 2 is due to the higher Oslo package 2 toll fare. If road pricing is introduced (Oslo package 3), there will be no need to increase public transport subsidies. A synthesis of the major effects from the regulation schemes is presented on the following table.

[36] We refer to the scenario that considered social marginal cost pricing for public transport fares and road charge as well as a welfare optimal subsidy level without financial constraints.

		Reference case - Oslo Package 1	Oslo package 1			Oslo package 2			Oslo package 3
			No budget restrictions	Fixed subsidy per mode	Fixed total subsidy	No budget restrictions	Fixed fares and fixed subsidy per mode	Fixed fares and fixed total subsidy	Social marginal cost pricing for public transport fares and road charge. Welfare optimal subsidy level without financial constraints.
Fare level (€/trip)	Fare peak	1,44	-21%	-21%	21%	-14%	7%	7%	62%
	Fare off-peak	1,44	2%	44%	43%	3%	7%	7%	-3%
Network km (1000/hour)	Frequency off peak	1,64	30%	13%	13%	34%	-14%	-15%	30%
	Frequency peak	1,94	165%	145%	146%	169%	73%	68%	200%
Passenger capacity / vehicle	Off peak	144	-25%	-27%	-27%	-24%	2%	0%	-24%
	Peak	144	-60%	-59%	-59%	-61%	-45%	-47%	-54%
Optimised number of trips	Capacity peak trips	90,5	28%	18%	18%	30%	15%	15%	52%
	Non capacity peak trips	34,1	20%	4%	4%	24%	15%	15%	23%
	Off peak trips	75,3	14%	-4%	-3%	19%	2%	2%	16%
	Total number of trips	200	21%	7%	8	21	10%	10%	33%
Cost and benefit	Change in subsidy (M €)		115	0	0	103	0	0	0
	Passenger benefit (M €)		226	85	85	261	107	108	255
	External benefit (M €)		62	44	47	64	40	39	67
	Total benefit (M €)		173	129	131	221	146	147	322

Table 20 – Synthesis of effects from regulation schemes

Source: Revenue Deliverable 5.

Concerning the marginal cost of public funds one can conclude that they will depend on the budget constraints and the alternative use of public money and/or the external cost of raising funds by taxation. Wage taxation will have different marginal costs compared to road pricing, but this is only relevant if the taxation is earmarked for specific revenue use. A marginal cost of public funds of 25% has been used in the analyses since this is the recommended value for cost-benefit analysis in Norway. However the level of budget constraints will strongly influence the actual level and thus the conclusions from the modeling work. Note, that an optimization run, using a marginal cost of public funds of 15% would indicate a lower potential for "fare-financed" service improvements.

Considering the optimal pooling of funds from model estimations of the different packages, one can conclude that Oslo package 2 is a small step in the right direction. Due to the additional funding from the increased toll fare being used for public transport purposes, it is possible to improve the level of service with a lower fare increase compared to Oslo package

1. On the other hand, increased subsidies yield a positive cost benefit ratio, with benefits depending on the level of freedom that operators have to reallocate the service level. The road-pricing scheme is a "superior scheme" in many ways as the model evaluations suggests. The potential benefits from introducing it are much greater compared to the other scenarios. This is primarily due to the fact that service improvements are made possible without increasing the level of subsidy.

Complementarily to the modeling work it is also worth to discuss the factors affecting the behaviour of a lobby group and how their pressure can influence the design of a regulation scheme. In the Oslo case study two counties and seven authorities/organisations were involved in the planning of Oslo package 2. The project has been supported by several players with a common interest in improving public transport in the region. All players agree that a good public transportation system is essential for the overall transportation in the region. A professional-administrative cooperation has been established. This assures that most of the controversies are solved. However, one general observation must be made. In Oslo package 2, restrictions on car use were recommended to make the investments efficient in socio-economic terms. However, such restrictions have not been included in the package. This can be explained by the need for local political compromise, which gives some players a veto in the process. As a result there is an incentive structure which probably leads to overinvestment as each player (organisation) will focus on projects with strong symbolic effect with minimal political risk. With all players having a veto, each is able to put at risk the notion of local agreement. Therefore, it can be expected that the package will only be accepted if all players have some symbolic projects included. Hence, there is clearly a scope for prioritising investments of high symbolic value.

6.1.5 Equity

Spatial equity issues from road pricing or tolls arise due to the changes of the generalized travel costs of drivers travelling between different origin-destination (O-D) pairs. In the Oslo region the tolls are levied on drivers entering the city from the neighbouring county Akershus, whereas car use inside the city is not levied. This created a political problem as both Oslo and Akershus had to accept the scheme. The solution was to earmark the revenue use according to who paid the tolls. As a result there has been an understanding that the revenue use from Oslo package 1 is to be split in a 60/40 proportion respectively between projects in Oslo and Akershus with no regard to where the projects would be most beneficial. For Oslo package 2, it has been easier to cope with the problem of spatial equity as there is a clear need for public transport infrastructure investments both in Oslo and in Akershus. Furthermore, the revenue from increased public transport fare is used on the actual mode where it is collected. The extraordinary revenue from the toll is used for projects in both regions. Spatial equity has been a major issue with regard to the current toll schemes. The proposed Oslo package 3 has taken this into account. Making drivers inside the city also pay is a major issue. This could be done by a new inner city toll circle or a road user charging-style scheme.

Horizontal equity implies that people with a similar ability to pay should pay the same amount. In the Oslo packages this has been tried by introducing discounts for the heaviest users. There are both monthly and annual passes. Thus, this has been a priority rather than an efficiency reason for users to pay for their external costs. The reason for this seems to be built upon acceptability reasons. To make the scheme politically acceptable such discounts were agreed upon. Our model scenarios show great benefits from introducing a road user charging-style scheme. This implies that charges are levied for all trips and that no annual or monthly

passes exist. On the whole, there seems to be a strong conflict between efficiency issues and acceptability issues with regard to horizontal equity. The need for political acceptability has made it necessary to put focus on horizontal equity instead of economic efficiency through marginal cost pricing.

6.1.6 Acceptability

Attitudes towards the toll ring turned out to be more positive after it was introduced compared to before its introduction, but citizens with a positive attitude of "environmental reasons" turned out to be more negative. The public acceptance of a prolongation of the toll ring, through Oslo package 2 and 3, is strongly dependent on the revenue use. The public is more positive if the revenue is earmarked for public transport. Both the political level and the administrative levels are more positive towards packages, such as Oslo package 2, compared to the public. It is important that central government also contributes to the packages if the different players are to reach agreement.

6.2 Warsaw case study

6.2.1 Scope

The **Warsaw case study** deals with the concept of congestion charging (toll ring type) and the use of the respective revenues for financing selected components of the urban transport system. Currently, the introduction of a road user charging scheme is not planned in Warsaw. Notwithstanding, this possibility is formulated in the 1995 long-term transport policy of the Warsaw City Council. This conclusion stems from the following policy document's quotation:

"Adapting the system of financing transportation to the requirements of a market economy, and creating a mechanism linking expenditures on roads with revenues from the system users through:

- ✓ Using parking fees to supplement the financing of road, parking and mass transit;
- ✓ Use of other fees as collected to date (leasing of traffic lanes, driver's licenses, participatory fees of economic entities, etc.);
- ✓ Bringing about the financial participation in transportation costs of employers who benefit from the subsidised services of mass transit as used by their employees (these fees should be designated for the subsidising of the operations and development of mass transit);
- ✓ Creating the system of charging for use of selected roads (e.g. bridge crossing, and/or access to the central area); and
- ✓ Establishment of an electronic fee collection system for use of roads and parking (the rate should be linked with the level of congestion and the state of the environment)"

So far, only city center parking charging systems were introduced being the respective revenues earmarked for road maintenance and road investment.

6.2.2 Research questions

- ✓ How the introduction of cordon charging and the allocation of revenues from charging may influence travel behavior and overall quality of the transport system; and
- ✓ What is the acceptability of cordon charging by the public and stakeholders?

The research of the cordon charging system acceptability, targeted car drivers and other stakeholders, and mainly consisted in the following questions:

- ✓ What is your opinion about introducing cordon charging in Warsaw within 5-10 years?

- ✓ For the cordon surrounding the central area what charge level is appropriate (from various options given)?
- ✓ How should revenues be used? For roads, public transport, for both or should the decision be left to the city authorities?

6.2.3 Regulation schemes

In the case of Warsaw four regulation schemes were analysed:

- ✓ Regulation scheme 1 - Entering the central area without tolls;
- ✓ Regulation scheme 2 - Entering the central area with a toll of 1.12 €. This toll is applied from 7 AM to 7 PM (total of 10 hours);
- ✓ Regulation scheme 3 - Entering the central area with a toll of 1.12 €, which is applied from 7 AM to 7 PM. Revenues from congestion charging are used for the development of additional arterial road with bridge in the outer zones and for financing additional public transport services needed as a result of modal split (a tram line).
- ✓ Regulation scheme 4 - Entering the central area with a toll of 1.12 €, which is applied from 7 AM to 7 PM. Revenues from congestion charging are used to upgrade the tramway system and for financing additional public transport services.

Moreover, the following assumptions were considered for the purpose of the economic and financial analysis (efficiency):

- ✓ The cost of providing additional public transport services for additional passengers was calculated through an assessment of the additional vehicle-km need. An increase in the quality service standard was not considered;
- ✓ Economic benefits were calculated taking into account the value of time saving for passenger in individual and public transport and also for goods vehicles.

6.2.4 Efficiency

In the case of Warsaw, the charging concept has never been studied in depth. The simplified analyses carried out, which entailed many assumptions based on expert judgments and experience from other case studies, drove to results and conclusions that should be considered as preliminary. One of the main conclusions relates to the fact that a low willingness to pay meant that a relatively low toll rate (approximately €1) had to be selected. However, even with relatively low willingness to pay, a cordon charging system could be financially viable and provide additional financial means for investment in transport infrastructure. If the whole net revenues were allocated to financing infrastructure serving the outer area of the city, user benefits would place the project just at the edge of viability. Allocating revenues to investment in roads will give similar effects as investing in upgrading existing tramway systems.

6.2.5 Acceptability

The results from the acceptability surveys showed that there would be strong opposition from the public in relation to the introduction of a cordon charging scheme. However, the support for this scheme can be expected from the side of all other stakeholders' groups (policy makers, civil servants, professionals, private sector and NGOs). In relation to the use of revenues while car drivers stated preference for roads other stakeholders stated the preference for two alternatives, namely, for a 50/50 split between the use in roads and public transport or for the sole use in public transport. The following Table presents the results from both surveys.

What is your opinion about introducing in Warsaw (within 5-10 years) charges for entering the central area?

	Positive	Negative	None	Total
Car drivers	26%	67%	7%	100%
Stakeholders	85%	11%	4%	100%

What charge seems to be the most appropriate?

	2,49 €	1,24 €	0,50 €	No opinion	Other	Total
Car drivers	6%	13%	31%	13%	37%	100%
Stakeholders	20%	46%	19%	0%	15%	100%

How to use revenues from cordon charging?

	Roads	50% on roads and 50% on public transport	100% public transport	Decision left to authorithies	Other	Total
Car drivers	52%	15%	7%	3%	22%	100%
Stakeholders	4%	46%	35%	4%	11%	100%

Table 21 – Results from the car drivers and stakeholders surveys.

Source: Revenue Deliverable 5.

The experience with parking charges (introduced in Warsaw in 1999) showed that, in transitional economies, societies are opposing these types of solutions. However, following the introduction of charging, surveys showed that it was widely accepted. This leads to a possible conclusion that, as was the case in London, the determination of policy makers is essential. In general, it can be expected that the acceptance of cordon charging and other forms (such as bridge tolls) will expand if there are further cases of scheme implementation in other European cities of comparable size. At this respect, the level of economic development / wealth is one of the main factors to be taken into account.

6.3 Edinburgh case study

6.3.1 Scope

The **Edinburgh case study** deals with the planned implementation of a road user charging scheme, which was proposed for Edinburgh in Scotland. The case study area includes the City of Edinburgh Council authority and the adjacent authorities (adjacent areas are referred to as the Lothians). The City of Edinburgh Council's original plans for road user charging go back as far as the 1993 Lothian Transport Policies Programme. The 1999 Local Transport Strategy for Edinburgh reiterated this intention. A number of initial charging schemes were considered. These included single and double cordon options with an investment package for public transport improvements in Edinburgh. The revenue to be raised was legally bound to be used for transport improvements. The City of Edinburgh Council finally proposed a double cordon charging scheme with a 3.20 € charge on vehicles inbound to Edinburgh. This scheme went to

public enquiry in 2004. Following the results of a local referendum in February 2005, the proposals for the implementation of the charging scheme were abandoned.

6.3.2 Research questions

- ✓ What would a system of charging and revenue sharing that maximized social welfare within the local political and institutional constraints look like for Edinburgh?
- ✓ What would be the equity impacts of such a system?

6.3.3 Regulation schemes

In the Edinburgh case study three types of regulation schemes were analysed. The main elements of each one are the described below.

- ✓ Regulation scheme 1, which corresponds to the exiting situation (the base situation), which entails no road user charging scheme. It also includes an investment package that would occur irrespective of whether or not a congestion charge went ahead. The necessary funds would be raised from existing revenue sources. The following Table shows the planned base investment package.

Package	Area		
	Edinburgh	**SESTRAN* authorities**	**Total**
Base Investment Package (public sector funding unconditional on the congestion charge)	€ 681M	€ 90 M	€ 771 M

Note: 2002 prices

Note: TIE (2004) "Statement of case"

* SESTRAN is a voluntary regional transport body for South East Scotland whose members comprise the local authorities within the region

Table 22 - Edinburgh's base investment package

Source: Revenue Deliverable 5.

- ✓ Regulation scheme 2, which corresponds to the congestion charging proposal and associated use of revenues set out by the City of Edinburgh Council. This scheme is characterised by the following aspects:
  - o Charging for Monday to Friday only (no charge at weekends or public holidays);
  - o Two charging cordons. These are the city centre cordon operating from 7am to 6.30 pm and the outer cordon inside city bypass operating from 7.00 am to 10.00 am;
  - o A 3.20 € charge on vehicles inbound to Edinburgh. The charge applies only one time each day independently on how many times both cordons are crossed, After introduction in 2006, the charge would be linked to inflation;
  - o Charge would only apply to vehicles entering the city. No charge would be made for crossing either cordon on trips heading out of the city;
  - o Exemption of charge payment applies to:

  - Certain categories of vehicles such as emergency vehicles, motorcycles, taxis[37], buses and coaches, etc.
  - Residents of Edinburgh, living outside the outer cordon (incl. Currie, Balerno, Juniper Green, Ratho, South Queensferry, Kirkliston), would be exempt from paying the charge at the outer cordon.
- All revenue raised by the charging scheme is earmarked for the transport sector. Moreover, the City of Edinburgh Council proposed a revenue sharing scheme in which the net revenue from the congestion charge would be used for projects which would benefit residents of local authorities in proportion to the trip origins of those paying the congestion charge.
- An investment package, proposed by the City of Edinburgh Council that would be associated with the congestion charge. To differentiate transport investments arising from the congestion charge from those that would occur using funding from existing sources CEC set out two transport investment packages for use in the public consultation, the public inquiry and the referendum. The base package (referred to as regulation scheme 1 for the purpose of the REVENUE study) occurs irrespective of whether or not a congestion charge goes ahead and a Base + Additional package that was contingent on funding from the congestion charge. In March 2003, four months after the Scottish Executive had given approval in principle to the congestion charge and its associated Additional investment package, the Scottish Executive decided it would provide up to €600M of public funding for a tram scheme in Edinburgh. This funding was not contingent on the congestion charge. The effect of this decision was to move the two highest profile transport infrastructure projects from the Additional investment package to the Base investment package. The following Table presents the funding totals for the two packages by area and funding source.

Package	Area		
	Edinburgh	SESTRAN authorities	Total
Regulation Scheme 1: Base Investment Package (public sector funding unconditional on the congestion charge)	€ 681M	€ 90 M	€ 771 M
Regulation Scheme 2: Additional investment package (funded by surplus revenue from congestion charge)	€ 661M	€ 566 M	€ 1277 M
Total	€ 1342 M	€ 656 M	€ 1998 M

Note: 2002 prices

Note: TIE (2004) "Statement of case"

Table 23 - Edinburgh's base + additional investment package

Source: Revenue Deliverable 5.

[37] Taxis licensed under the Civic Government (Scotland) Act 1982

- o A penalty charge would be applied if the standard charge had not been paid by midnight on the day cordons are crossed. The penalty charge was proposed to be equal to the parking penalty charge, i.e. 96.77 €[38];
- o The responsibility for setting the charge, collecting the revenue and overseeing revenue has to lie with a single local authority. The City Council of Edinburgh was proposed as the responsible authority. This institution formed a wholly owned arms-length company, Transport Initiatives Edinburgh (TIE), to deliver major transport projects. TIE would have been responsible for administering the congestion charge and overseeing the investment of the revenue.

✓ Regulation scheme 3, which corresponds to variants of the other two regulation schemes.

The following table presents the main features of the complete set of the regulation schemes scenarios.

Scenario		Tram lines 1 and 2 (investment)	Tram line 3 (investment)	Increase in PT frequency outside Edinburgh (%)	Increase in PT frequency inside Edinburgh (%)	Cordon charges peak (off-peak) €	Revenue sharing
Regulation Scheme 1	**Base scenario**	Yes	No	-		None	N/A
Regulation Scheme 2	**Base + additional scenario**	Yes	Yes	3%	3%	3,2 (1.6)€	Shared
Regulation Scheme 3	**V0 scenario**	Yes	Yes	-	-	3,2 (1.6)€	Shared
	V1 scenario	Yes	Yes	-	-	10,0 (5.0)€	Shared
	V2 scenario	Yes	Yes	-	-	13,0 (0) €	Shared
	V3 scenario	Yes	Yes	-	-	3,2 € rising to 15 €	Shared
	V4 scenario	No	No	-	20%	None	N/A
	V5 scenario	No	No	-	20%	3,2 (1.6) €	Shared
	V6 scenario	Yes	Yes	-	-	40,0 (20.0) €	None-CEC only
	V7 scenario	No	No	-	-	40,0 (20.0) €	None-CEC only

Note: 2002 prices

Table 24 - Edinburgh's regulation schemes scenarios.

Source: Revenue Deliverable 5.

6.3.4 Efficiency

If the City of Edinburgh Council acts so as to maximise the welfare of its own residents, without any form of external constraint or regulation by a higher authority, in its decisions on cordon charges and revenue use this may give rise to a suboptimal situation (from the regional perspective and country perspective). In the worst case, such a scenario may lead to a more inefficient situation for the region compared to the existing situation (where congestion

[38] A 50% reduction on the value of the penalty charge is applied if the payment is made within 14 days, rising to 145.16 € if the penalty is not paid after 28 days.

charging does not exist). This is because the City of Edinburgh Council, by acting so as to maximise the welfare of its own residents, has a significant incentive to charge residents of other authorities' high prices (i.e. a high cordon charge). Surplus revenue would be invested in schemes that benefit only Edinburgh residents, which leads to low investment in public transport services (compared to for example alternatives such as reducing local taxation). Residents of Edinburgh would benefit at the expense of those in the surrounding area.

In practice, the City of Edinburgh Council actually proposed charges below the level that would maximise the welfare of its residents as well as below the economically efficient level for the region. It also proposed a revenue sharing agreement with its neighbouring authorities. There are various possible reasons for this. Firstly, it may have feared the consequences of excessive charges for the retailing and business sector (such impacts were not included in the MARS model). This will be a restraining influence on cities particularly where they have closely competing neighbours. Secondly, in Edinburgh the proposal faced a public inquiry and was subject to the approval of the Scottish Executive and therefore subject to a degree of higher control. Thus there was a need for the City of Edinburgh Council to try to establish consensus with its neighbouring authorities.

The optimal cordon charges (i.e. the cordon charges that maximise regional/national welfare) are €10 in the peak and €5 in the off-peak. Such charges generate more revenue than can be efficiently invested back into the transport system and could only therefore be charged by a government that was not constrained by earmarking to the transport sector. However the road user charging legislation in Scotland constrained the City of Edinburgh Council to earmarking. In such a situation, the toll at which maximum economic efficiency is achieved is lower than that if earmarking was not required. For Edinburgh the modelling analysis indicated that the optimal toll with earmarking appears to be approximately that proposed by the City of Edinburgh Council (i.e. €3.20 in peak and €1.60 in off-peak), which is about a third of the optimal transport price.

A related issue is that not only would a benevolent government be able to charge optimal transport prices and generate a revenue surplus, but would it be able to use that surplus to reduce other forms of taxation. If the other forms of taxation were distortionary (e.g. income tax) then this would generate further economic efficiency benefits. Other research using the MARS model[39] indicates that the toll that maximises social welfare is higher if the marginal cost of public funds is taken into account than if it is not. As the optimal toll without accounting for the marginal cost of public funds generates very high levels of revenue surplus (more than can be efficiently invested in the transport system) one can anticipate that the optimal toll whilst accounting for the marginal cost of public funds would generate even higher revenue surpluses. Moreover, if revenue surpluses were used to reduce distortionary taxation then, for a given toll, the welfare gain would be higher than reported if the marginal cost of public funds had been included in the modelling process. Note that the economic efficiency effects arising from the marginal cost of public funds have not been modelled in the Edinburgh case study.

Current legislation in the UK requires that revenue raised has to be used to finance local transport schemes and there are only a limited number of economically efficient public

[39] And other models such as START, MEPLAN and RETRO/IMREL (Fridstrom et al, 2000; Fridstrom et al, 2001; Timms et al, 2005).

transport projects. If one was to maximise the regional welfare then the optimal cordon charges produce a significant financial surplus which could not be spent in the transport sector without investing in inefficient projects. A relaxation of current legislation to permit any financial surplus to be spent in other sectors would therefore be necessary. In theory, then, control of price setting and revenue distribution should reside with either a joint partnership of local authorities or the Scottish Executive as realistic scheme managers.

The following Table presents a synthesis of the overall impacts on welfare and present finance value associated with regulation schemes scenarios analysed in the Edinburgh case study.

Scenario		Welfare effect - overall study area	Welfare effect - Edinburgh residents'	Present Value of Finance (PVF)
Regulation Scheme 1	**Base scenario**	31,7	-232,0	-669,1
Regulation Scheme 2	**Base + additional scenario**	830,8	525,0	220,6
Regulation Scheme 2	**V0 scenario**	940,0	683,0	393,6
	V1 scenario	1.650,8	2.456,0	2.982,3
	V2 scenario	1.819,8	1.423,0	1.039,2
	V3 scenario	1.698,5	1.148,0	711,3
	V4 scenario	16,0	-8,8	-78,9
	V5 scenario	867,7	882,0	1.257,8
	V6 scenario	-2.251,6	4.630,0	8.449,9
	V7 scenario	-2.186,1	4.824,0	9.426,2

Note: 2002 market prices, €M, 30 year present value.

Table 25 – Synthesis of the overall impacts on welfare and present finance value in the Edinburgh case study.

Source: Revenue Deliverable 5.

6.3.5 Equity

The modelling work shows that an inequitable outcome would occur if the City of Edinburgh Council was able to set up the congestion charges and use the respective revenue in a way that maximised the welfare of just its own citizens. In this context tolls would be set at such high level that the residents of neighbouring authorities would experience such a disbenefit that the region as whole would be worse off than if transport prices were left as they are now. On the other, the modelling results also suggest that allocating the revenue in proportion to trip origin was, in general, equitable in a spatial perspective. In fact, populations of the areas which borne additional costs as a consequence of the congestion charge would be compensated as a consequence of the congestion charge. Whether or not the cordon charging structure is perceived as being equitable and therefore acceptable is another issue.

Other equity concerns emerged when considering the potential impact of greater delay within Edinburgh through an increase in the usage of private transport, and a decline in the usage of public transport. This could have lead to a deterioration in the service quality provided, which would impact on the lowest paid workers within the city. This results from the fact that

around 45% of Edinburgh residents do not have access to a car. A major concern among regular bus users relates to overcrowding on services. The results from the modeling work carried out in this case study[40] did not support these concerns. They showed that road user charging reduced congestion and improved journey times for both private motorists and bus users, and consequently improved the quality of public transport.

6.4 Cross-boundary acceptability case study

6.4.1 Scope

The **Cross Boundary Acceptability** case study builds upon the work developed in the Edinburgh case study and analyses the cross boundary issues. Whereas the latter primarily deals with efficiency and equity impacts, the former focus on technical and organisational feasibility and acceptability, with particular emphasis to the acceptance of the scheme by neighbouring authorities. Hence, the acceptability case study is essentially related with the Edinburgh's road user charging scheme that went to public enquiry in 2004 (Regulation Scheme 2). It is worth reiterating that the case study areas covered both the City of Edinburgh Council authority and the adjacent authorities. The acceptability case study addressed the following research issues:

- ✓ Institutional structures governing the road user charging scheme;
- ✓ Review of consultation process, the range of consultees and its effectiveness
- ✓ Development of an acceptable strategy for spatial distribution of road user charging revenues,
- ✓ Development of practical guidance for authorities planning an equitable distribution of resources.

6.4.2 Research questions

- ✓ Who should set the cordon charges?
- ✓ Who should collect the revenue?
- ✓ Who should decide on how the revenue should be spent?
- ✓ What is the effectiveness of the consultation process as a decision-making tool?
- ✓ How to develop an acceptable strategy for the spatial distribution of road user charging revenues?

6.4.3 Regulation schemes

The cross boundary acceptability case study focus on technical and organisational feasibility and acceptability for the scheme proposed in Edinburgh, with particular reference to the acceptance of the scheme by neighbouring authorities. The regulation scheme under investigation is characterised by the features presented below:

- ✓ Which investment rule? According to the law, all revenues raised from the pricing scheme were earmarked transport improvements in the Edinburgh area. Moreover, the revenue could not replace funding allocations previously earmarked for transport improvements. Thus, the pricing scheme revenue was all to be additional expenditure on transport, over and above the level originally determined in the absence of such scheme.
- ✓ Who makes investment decisions? Transport Initiatives Edinburgh was established in May 2002 to deliver major transport projects for the city. It is a private limited company with non-profit status, solely owned by City of Edinburgh Council.

[40] Similar results have been achieved in a modelling work that addressed the London congestion charge case.

- ✓ What use of revenues, what financing? The revenue raised must be treated as an additional source, "with no claw-back of existing sources of funding for transport". There is also a commitment to "fair treatment of those who pay the charge, and those who benefit from the scheme"[41]. However, there were no clear plans at this stage (2004) as to the process for enabling revenue allocation, particularly for the longer term. It was recommended that SESTRANS[42] members should convene on a regular basis, (a Congestion Charge Revenue Allocation committee), in which members should have met, discussed and agreed the allocation of funds between authorities. City of Edinburgh Council and Transport Initiatives Edinburgh had not, at that stage, produced a package of investment measures necessary to complement the impacts of the congestion charge. The Local Transport Strategy Base Strategy would see funding continue as it is at present. This strategy involves expenditure of around €672M (€6.4022M) between 2006 and 2026, within Edinburgh City limits and roughly €80M (£50M) for schemes in neighbouring council areas. The €672M includes €600M for the implementation of trams in the city, funded by the Scottish Executive. This would allow some new transport investment, but under this scenario, in the absence of congestion charging, the predicted expenditure available for other transport would be very limited. Under the Preferred Strategy, a congestion charging scheme would be introduced. The Scottish Executive requires that all the revenue generated from the scheme (€1184M expected) is additional to whatever was already earmarked for transport.
- ✓ Who sets prices? The charge was based on the idea that those who create the pollution should pay the charge, based on the 'polluter pays principle' (those who create pollution and contribute to congestion will pay for the damage they inflict upon unwilling third parties). If however, drivers actually paid prices that reflected the "true" cost to society, then the price could potentially be far higher than €3.20 per vehicle per day. It was predicted that the €3.20 charge would fall short of the marginal social cost of one vehicle upon another.
- ✓ What actors are involved, with what functions? Transport Initiatives Edinburgh was set up by City of Edinburgh Council to implement and operate the charging scheme. and has the following tasks:
    - o Develop, finance and procure major transport schemes identified in the Local Transport Strategy;
    - o Develop the business case for congestion charging and procure the resultant scheme;
    - o Manage the finances arising from congestion charging.
- ✓ Public or private provision? Transport Initiatives Edinburgh was set up as a private limited company.

6.4.4 Technical and organisational feasibility

A problem with collection of tolls exist. Some motorists would have to pay both bridge tolls (which are viewed by some as a charge to enter the city) and also the congestion charge. The single cordon scheme (with a cordon around only the city centre) would have been easier to implement than the double cordon scheme as it had much less impact upon other local authorities - although it neither solved the transport problems nor raised enough revenue. It

[41] The commitment to the use of revenues is documented in "Equity issues for Fife from Edinburgh Road User Charging proposals".

[42] SESTRAN is a voluntary regional transport body for South East Scotland whose members comprise the local authorities within the region.

should be stressed that there was a general perspective that the scheme was politically driven than a transport problem. Although, Transport Initiatives Edinburgh was committed to follow the principle of direct connection between who pays the toll and who benefits, the criteria for this was not clear since the Ministerial guidance was vague and formal regulations were not in place. Hypothecation of revenues would be required since it brings transparency. However the cost of administrating the scheme is a problem.

6.4.5 Acceptability

Had a single regional authority with appropriate legal powers existed, and been in a position to manage revenue collection and distribution, the neighbouring local authorities would have had greater direct ownership of the scheme and would have been less likely to oppose it. Although the scheme was ultimately blocked by Edinburgh residents, stronger support across the region might have helped to build a more effective campaign in favour of the scheme, and ensure wider media and political support. Hence, a single authority would be needed to develop the scheme on behalf of the entire region.

The referendum, which placed heavy emphasis on a yes-no decision, was a high-risk strategy which failed. As a decision-making tool, the referendum proved to be flawed because there was no legal process to use electoral register data for such a purpose and because City of Edinburgh Council, as scheme promoter, had no jurisdiction to canvas opinion amongst non-residents in this way. It can be concluded that the holding of a referendum was neither necessary, nor the best way of reaching a decision on a scheme of this type. Market research is probable better than a referendum as, if done effectively, can be used to show public support.

A key difficulty in the consultation process rested on the fact that although improvements and the potential of charging revenues were talked about at length improved services have not been provided prior to the referendum. If they had been provided before the referendum, there would have been an instant noticeable improvement in service provision which could have contributed to foster acceptability.

The congestion charging package was marketed on a few main features based on the principle of allocating revenue back into public transport. One of the features was the commitment to improving bus services within Edinburgh itself, which was largely concentrated on the improvement of largely non-commercially viable ‘orbital routes’. Whilst the revenues were promised to improve these lightly used daytime services, this funding would not have impacted positively upon accessibility on the dominant radial routes, made up of commuters from surrounding areas, including the Lothians and Fife. Therefore, the package was sold to a bus user market within Edinburgh, of whom played little role in the key problems of congestion along radial corridors. On this basis, it could be concluded that the scheme proposed was illogical, as it would have required a significant slice of charging revenue to subsidise inefficient and commercially unjustifiable bus services around Edinburgh.

6.5 Funding urban public transport in Berne

6.5.1 Scope

The Swiss case study included the analysis of existing and new proposals for a fund to finance additional investments in urban transport infrastructure for the Region of Berne. Indeed, like other urban areas in Switzerland, the Region of Berne lacks financial resources to alleviate bottlenecks in road transport infrastructure and in the public transport network.

6.5.2 Research questions

- ✓ What are the convincing design elements of the new proposals for fund solutions in Swiss urban areas if the theoretical findings developed in the REVENUE project are taken as guidelines? How could the proposals be improved?
- ✓ What are the consequences for the existing investments scenarios if urban transport pricing is oriented at a theoretically better pricing regime, i.e. at social marginal cost pricing?
- ✓ What cost recovery degree would result in this superior solution? Would the revenues be sufficient to cover the costs of investment scenarios under discussion?
- ✓ What are the key sources of efficiency gains and inefficiencies of the different proposals?
- ✓ Which organisational and institutional solution would be suitable taking into account the specific problems arising if several government levels are involved in transport pricing and investment?
- ✓ What are the politically most relevant distributional implications of the different proposals?
- ✓ Which design features are crucial for the acceptability of the urban transport fund and what is the current level of acceptability with regard to these design features?

6.5.3 Regulation schemes

In the Swiss urban transport fund three regulation schemes have been considered:

- ✓ The status quo regulation scheme (A) corresponds to the existing urban transport financing regime. All existing transportation related taxes are federal except for annual vehicle taxes (to cantons) and parking fees (to municipalities). Federal funding is restricted investment in infrastructure with a regional or national importance (not local) and for contributions for regional public transport. The Canton is the main source for investment in new road and railway capacity. Construction is approved by the regional parliament, planned by the regional administration and carried out by private contractors. Although the municipalities have little responsibility for transport planning they are responsible for spatial planning. An integrated transport network is also hampered because public and private transport are treated at different cantonal authorities;
- ✓ The proposed regulation scheme (B) consists in two newly created urban transport funds at the national level, which are financed by a part of fuel tax revenues, a surcharge on the fuel tax and vignettes. Existing transport taxes do not change. The funds are used to finance short term transport solutions (urgency fund) or more long term solutions (infrastructure fund – up to 20 years). Cantons and urban municipalities are responsible for the development of agglomeration programmes (investment proposals) if they wish to apply for funding from the infrastructure fund.
- ✓ The superior regulation scheme (C) considers an urban transport fund with optimal transport pricing in urban transport. The scheme is limited to the city area. Investment choices are made on the basis of a theoretically well founded approach and considering long term investment needs. The accruing revenues could be used instead of federal funding to finance optimal investment in urban transport systems.

6.5.4 Efficiency

Revenues from an urban road pricing scheme oriented at SMCP would be higher than the current revenues from transport charges and taxes generated in urban areas. Given the same expenditure for the urban transport system, less general tax money would be needed for the financing of an implementation of the optimised investment package. This could provide an

opportunity to lower general taxes at the local level (income tax and tax on assets). As these taxes have the higher marginal costs of public funds than an urban road pricing oriented at SMCP, a welfare increasing effect would be expected.

6.5.5 Equity

Assuming that the infrastructure fund should be partly financed by a mark-up on fuel tax then those living in non-urban areas would partly finance urban transport. Advocates of the proposal argue that about 70% of the Swiss population live in urban areas and that a similar share of the total vehicle kilometres driven by motorised road traffic in Switzerland is covered on urban road networks. A federal contribution to urban transport can be therefore justified from a distributional point of view. A similar argument can be brought forward in the case of the urban area of Berne for the proposed regulation scheme. About 10% of the total kilometres driven by private motorised road traffic in Switzerland are on the road network in the region of Berne and accordingly a similar share of the total mineral tax revenues are produced in this region. In financial terms, this share is much higher than the federal contribution the urban area of Berne can realistically expect for the investment projects of the optimised package.

Concerning distributional effects between low income and high income transport users the results show that a price increase through the introduction of SMCP would have a greater effect on lower income groups. Although high income groups spend more on private road transport in absolute terms, the share of these expenditures on total income is smaller. Note that a road pricing scheme oriented at SMCP should theoretically replace existing transport charges and taxes and not be added on top of them. Any adjustment of existing charges and taxes would have policy-relevant distributional effects between different state levels because the existing charges and taxes are predominately levied at the national and at the cantonal level.

6.5.6 Technical and organisational feasibility

The technical feasibility of the “proposed regulation scheme” remains challenging and can be only introduced in the long term. The organisational feasibility of the proposed regulation scheme requires substantial changes at the federal and cantonal level for a successful implementation. Some organisational challenges remain, for example, the timing and harmonisation of spatial and transport related planning instruments that have been developed and used by different bodies of the public authorities in a rather uncoordinated way. The implantation of the superior regulation scheme, based on optimal pricing, would be even more demanding.

6.5.7 Acceptability

The effectiveness of road pricing schemes is still questioned and and adverse impacts on low income groups and business activities located in the city centre are often mentioned. Anyway, the “proposed regulation scheme” has less acceptability problems than the “superior regulation scheme”.

6.6 Conclusions from urban case studies

The urban case studies generally show that marginal social cost pricing brings benefits which could be amplified if the revenue replaced other more distorting forms of tax revenue. This

would suggest avoiding earmarking. However, earmarking – not just in terms of the transport sector but also in terms of the geographical area for whose benefit the revenue is to be spent – appeared to be an essential element of getting acceptance. Such earmarking requires adequate institutional arrangements to facilitate the negotiation and enforcement of such revenue sharing agreements. The following are further conclusions stemming from the Oslo and Edinburgh cases studies.

6.6.1 Earmarking and efficiency

A main conclusion stemming from the Oslo case study is that whilst earmarking is a sub-optimal approach from an economic perspective, it is an important condition for acceptability. Note that an earmarking strategy causes revenues to be fixed to projects in the transport sector which may mean investing into inefficient projects over-and-above a certain level or as in Edinburgh's case reducing the cordon charges to reflect the limited amount of efficient transport projects that were available. For this reason, leaving a portion of revenue 'un-earmarked' that can be used flexibly may be a more efficient option. In the case of Edinburgh such a proposal would entail a relaxation of legislation to allow investment into alternative sectors. Edinburgh's findings further suggest that in the presence of cross-boundary competition there are incentives for revenues to be used sub-optimally if left to the local authority representing that city. This is due to the agenda that would be set by any local authority in terms of maximising the welfare of its own citizens at the expense of other authorities.

6.6.2 Political acceptance and consensus

Oslo's case study work has revealed that political acceptance is a priority and is something that must be achieved prior to considerations of efficiency in terms of the use of raised revenues. Edinburgh attempted to build consensus with other authorities on the basis of a revenue sharing system which, the modeling analysis demonstrated, worked well in moving towards an equitable and efficient situation. However, due to institutional shortcomings which made such arrangements unenforceable, acceptance between authorities was low. In the cross-boundary research it was concluded that consensus is required to be built on a regional basis, with an agreed and committed use of revenue, to be perceived as efficient and fair. The mechanism to deliver the scheme should not directly involve the local authority. An independent collector and distributor would be a suitable arrangement to develop the scheme on behalf of the entire region. The new Regional Transport Partnerships may work well to take forward future proposals. Consensus and acceptance both on the political level, and with stakeholders and the general public, is a key cornerstone in the development of any road user charging proposal-style proposal.

7 POLICY CONCLUSIONS AND RECOMMENDATIONS

The REVENUE project originated from a growing realisation that the efficiency, equity and acceptability of transport infrastructure charging policies depend on how revenues from the charges are used. This final chapter summarises some of the thinking that went into the project and the lessons that emerged. More in detail, the chapter has endeavoured to review and synthesise the principal findings of the case studies on the efficiency and welfare-distributional impacts of transport pricing and revenue use schemes. By design, the studies share some common features, most of them using the MOLINO model or a variant of this model. But the studies also differ in many ways: the modes of transport involved, the institutional settings including rules on revenue use, the nature of the questions that were addressed and so on. Conclusions on some of the questions also differ. These differences raise the issue whether general policy insights can be gleaned from the studies that carry over to other jurisdictions, transport modes, institutional environments and so on.

There are clearly limits on the transferability of detailed findings such as the economic merits of a particular type of investment, or the degree of public support for a given policy package. Results at this level are sensitive to case-study-specific factors such as congestion levels, the marginal cost of public funds, public trust in local governments and so on. The value of the case studies lies more in illustrating how pricing and revenue-use policy packages can be analysed and the range of results that are possible. They are also useful for illustrating general principles such as:

- interdependence between pricing, earmarking and investment decisions;
- dependence of policy impacts on characteristics of the *status quo* such as levels of fuel taxes, quality of public transport service and so on;
- sensitivity of welfare impacts to assumptions about how the benefits from expenditures are incident across population or traveller groups (e.g. low-income v. high-income households, local freight transporters v. transit freight operators, etc.).

The remainder of this concluding chapter elaborates on three of the questions that were addressed in the REVENUE project: the merits of earmarking, acceptability of charging and revenue use policies, and assignment of responsibilities for charging and revenue allocation before making some final comments.

7.1 Merits of earmarking

Although widely practiced, earmarking is controversial. Various arguments for and against it were reviewed in Chapter 2. It was seen that the circumstances in which complete earmarking of revenue for use within the mode on which it is raised could be theoretically justified were likely to be rare, and the case for earmarking is therefore more likely to rest on pragmatic grounds. The case studies identify circumstances in which revenues are best allocated to particular uses in which case earmarking the revenues for them is justified. This may entail returning the money to the facilities on which the charges are levied, or it may call for cross-subsidisation of other facilities or other modes. The case studies also report survey and other evidence that earmarking enhances acceptability. Earmarking may increase efficiency too if it deters politicians from making self-interested decisions that are socially wasteful. But

earmarking can harm efficiency by preventing money from going to the most economically worthwhile uses. A clear example of this is the requirement in Britain that all revenue from urban congestion charges must be devoted to transport. In the case of Edinburgh, efficient charges would produce more revenue than can efficiently be used in the transport sector, and the opportunity to use this revenue to reduce other distorting taxes is prevented by this requirement.

In some circumstances earmarking may in fact channel revenues to both economically efficient and publicly acceptable uses. Yet, even well-targeted earmarking schemes will be undermined if funds from other sources are reduced in an offsetting way.[52] This has been a concern in Britain as Richards (2005: 83) points out regarding local road user charges. Implementation of London's congestion charge was greatly facilitated by the fact that a large majority of London commuters use public transport. Earmarking the revenues for improved bus services was therefore virtually guaranteed to enhance acceptability of the charge. Devising a popular earmarking scheme is likely to be much more difficult almost anywhere else – as Edinburgh's experience demonstrates.[53]

7.2 Acceptability

There is now abundant evidence from various countries that acceptability is a *sine qua non* of transport policy reform. Acceptability appears to have been a major consideration in the design of the pricing and revenue use policy packages (both implemented and proposed) that were examined in the case studies. There is ample evidence in the case studies that earmarking may help achieve acceptability. However, stakeholders must be convinced that charges will be imposed fairly and evolve (or remain fixed as the case may be) as promised. And if revenues are earmarked, there must be assurance that moneys will be allocated as intended and without offsetting reductions from other sources. The **Edinburgh** study remarked on how a lack of legal obligation for the City of Edinburgh Council (CEC) to share revenues undermined the confidence of residents outside the city.

7.3 Assignment of Responsibilities

Thus institutional arrangements are very important. Assignment of responsibilities for user charging and revenue use decision-making depends on various considerations. One is local knowledge about congestion, the merits of alternative infrastructure investments and so on, which favours assignment of responsibility to local governments. By contrast, spill over problems between regions related to inter-regional traffic, pollution, etc., call either for centralised government control or coordination between neighbouring regional governments. The **Edinburgh** case study illustrates the dangers of delegating decision-making to an authority below the level at which the impacts will be felt, and correspondingly the need to develop proposals on a consensus basis between authorities. In Oslo, consent of all affected

[52] According to Bos's (2000) definition of earmarking dedicated revenues provide only part of the total revenues required to fund a public good. Alternative sources must therefore be tapped, and net funding will drop if they are withdrawn.

[53] The challenge is becoming apparent for the proposed UK national road-pricing scheme. A survey in late 2005 (RAC foundation 2006) points to a decline in support for road pricing since 2002. The decline is apparent not only for tolling in general but also for tolls that are earmarked for particular purposes: reductions in other motoring taxes (down by 3,5% to 71%), improvements of roads (down by 11% to 60%), and a package including better roads, better public transport and better traffic management (down by 10% to 61%).

authorities was required and the negotiation between neighbouring authorities worked more smoothly.

It has become popular to delegate transport infrastructure financing and operation to the private sector – this is common for ports and airports, as well as significant parts of the motorway system (only in rail transport is it rare). The primary motivation is to lower costs but it is naturally associated with earmarking of revenues. In other cases responsibilities have been devolved to independent bodies. The **Swiss** railway investment fund FINÖV and the **French** funding agency AFITF are two examples mentioned in the case studies. In this case the motivation usually derives from government failure. Politicians pursue hidden agendas or succumb to regulatory capture and this results in a loss of trust or credibility. Lack of trust in government is evident from the **German** survey of road hauliers who expressed a preference for revenue collection and allocation functions to be made either by an independent motorway operator or by separate government agencies. However, the survey also revealed a lack of support for charging and revenue collection by a private company. The case study attributes this attitude to adverse experience with TollCollect.[54]

7.4 Final Comments

Three of the case studies in this report (**Oslo**, **Switzerland** and **Germany**) describe transport charging *cum* revenue schemes that have been implemented and appear to be meeting their goals relatively well. In the case of **Oslo** passage of the legislation for Oslo Packages 1 and 2 was enabled by the ability and willingness of the major stakeholders to bargain towards a consensus. The **German** HGV toll was facilitated by the perception that congestion and infrastructure deficiencies were a major problem, and by a design scheme that addressed the problem and was also seen to be fair.[55]. On balance, it appears that transport charging is both efficient and politically feasible only if accompanied by an acceptable revenue-use plan and an effective information/marketing campaign .

We have seen that the theoretical case for earmarking revenue for use either in the transport sector as a whole or in the mode or region in which the revenue is raised rests on assumptions that are unlikely to be often realised in practice. Moreover, where earmarking is practiced it risks forcing the authority in question to use money inefficiently or (as in Edinburgh) to hold charges inefficiently low. Thus if governments could be relied upon to act efficiently earmarking would be at best pointless and at worst damaging.

However, earmarking may play a part in achieving an acceptable, fair and even efficient outcome. Moreover it must be remembered that the application of a systems dynamic model to Germany produced a stronger case for earmarking than the other studies, which used static models. This may be a result of particular circumstances or assumptions, or it may reflect the fact that long term dynamic behaviour brings into play factors not considered or modelled in

[54] Waning trust in government is also evident from an RAC (Royal Automobile Club) survey in Britain (RAC Foundation 2006). According to the survey the perception of road pricing as just another tax would be assuaged only if it were administered by an independent agency. Seventy nine per cent of respondents supported an independent body (up from 74% in 2002) while only 13% would trust government (up from 10% in 2002).

[55] Indeed, a case study for the TIPP project considered the scheme to be a Pareto improvement (Seidel et al 2005: xii).

other case studies. It is therefore necessary to take a pragmatic approach, treating each proposal for earmarking on its merits.

What is also clear from the REVENUE case studies is that whilst in general a move to marginal social cost pricing will improve efficiency, there is often a case for charging more than this for the use of transport infrastructure, where SMCP pricing will leave a need to meet deficits on existing infrastructure or investment needs from distorting taxes elsewhere in the economy.

Thus in conclusion we see a need for earmarking, but consider it necessary to design schemes carefully to ensure an acceptable trade-off between efficiency, equity and acceptability. We see an argument for multimodal infrastructure funds which permit cross financing and take detailed decision taking away from politics to more independent bodies. And we see a case for mark-ups over and above marginal social cost provided that these are designed to minimise distortions and to fund deficits or investment projects that are the result of efficient and equitable decisions on pricing and investment.

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