COMPETITIVE AND SUSTAINABLE GROWTH (GROWTH) PROGRAMME

UNITE

UNIfication of accounts and

marginal costs for Transport Efficiency

Deliverable 5
Pilot Accounts- Results for Germany and Switzerland

Version 3.8

29 May 2002

Authors: Heike Link, Louise Helen Stewart (DIW), Claus Doll (IWW), Peter Bickel, Stephan Schmid, Rainer Friedrich (IER), Stefan Suter, Heini Sommer, Michael Marti (Ecoplan), Markus Maibach, Christoph Schreyer, Martin Peter (INFRAS)
with contributions from partners

Contract: 1999-AM.11157
Project Co-ordinator: ITS, University of Leeds

Funded by the European Commission
5th Framework – Transport RTD

UNITE Partner Organisations

ITS / UNIVLEEDS (UK), DIW (De), NEI (Nl), CES/KUL (Be), TIS.PT (Pt), IWW/UNIKARL (De), VTI (Se), IER/USTUTT (De), CERAS/ENPC (Fr), HERRY (Au), EIET/ULPGC (Es), ISIS (It), STRATEC (Be), SYSTEMA (Gr), JP-TRANSPLAN (Fi) VATT (Fi), ECOPLAN (Ch), INFRAS (Ch), EKI (Se)

UNITE

1999-AM.11157
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Pilot Account Results for Germany and Switzerland

This document should be referenced as:
Heike Link, Louise Helen Stewart (DIW), Claus Doll (IWW), Peter Bickel, Stephan Schmid, Rainer Friedrich (IER), Stefan Suter, Heini Sommer, Michael Marti (Ecoplan), Markus Maibach, Christoph Schreyer, Martin Peter (INFRAS) – UNITE (UNIfication of accounts and marginal costs for Transport Efficiency) Working Funded by 5th Framework RTD Programme. ITS, University of Leeds, Leeds, April 2001.

29 May 2002
Version No: 3.8
Authors: as above.

PROJECT INFORMATION

Contract no: 1999-AM.11157:
<u>UNIfication of accounts and marginal costs for Transport Efficiency</u>

Website: www.its.leeds.ac.uk/unite

Commissioned by: European Commission – DG TREN; Fifth Framework Programme
<u>Lead Partner</u>: Institute for Transport Studies, University of Leeds (UK)

<u>Partners</u>: ITS/UNIVLEEDS (UK), DIW (De), NEI (Nl), CES/KUL (Be), TIS.PT (Pt), IWW/UNIKARL (De), VTI (Se), IER/USTUTT (De), CERAS/ENPC (Fr), HERRY (Au), EIET/ULPGC (Es), ISIS (It), STRATEC (Be), SYSTEMA (Gr), JP-TRANSPLAN (Fi) VATT (Fi), ECOPLAN (Ch), INFRAS (Ch), EKONO (Fi), EKI (Se)

DOCUMENT CONTROL INFORMATION

Status: Final Draft, 29 May 2002
Distribution:
Availability: Public (only once status above is "Accepted" as part of Deliverable 5)
Filename:
Quality assurance:
Co-ordinator's review:

Signed: **Date:**

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Executive summary

In order to assist policy makers working in the area of transport pricing, the UNITE project endeavours to provide information about the costs and revenues of all transport modes including the underlying economic, financial, environmental and social factors.

One of the main areas of work used to achieve this goal is the development of country transport accounts (pilot accounts) that estimate the total social costs of transport and the corresponding transport charges for each country studied. These country transport accounts are referred to as pilot accounts. The methodology for these accounts has been developed within the UNITE project and is presented in "The Accounts Approach" Link et al. (2000). Other areas of the UNITE project are the estimation of marginal costs through the use of case studies and integration, a synthesis of the accounts and marginal cost case studies.

This report, as part of the UNITE project, presents a summary of the first tranche of the pilot accounts: the pilot accounts for Germany and Switzerland for the main account year 1998. The complete accounts, which document the years 1996 and 1998 and give a forecast for 2005, are presented as two separate annexes to this report (Link et al. 2002 and Suter et al. 2002).

At further stages within the UNITE project similar country transport accounts will be established for the following countries: Austria, Belgium, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK, thus presenting 18 sets of country accounts.

The purpose of this report is:

- to present the results obtained for the transport accounts in Germany and Switzerland;
- to test the feasibility of the methodological approach developed for the UNITE pilot account countries;
- to serve as guidance for the subsequent UNITE country accounts; and
- to draw conclusions for the further work in the accounts area.

Within the German pilot account it was possible to estimate the majority of the categories described in Link et al. (2000). Full infrastructure costs for road, national rail, airports and the inland waterway system were estimated. Infrastructure capital value and capital costs could be estimated for rail companies other than national rail (non-national rail), trams and metro systems and for inland waterway and sea harbours. Supplier operating costs for national rail were estimated, however, data was not sufficient to estimate the supplier operating costs of public transport companies. Congestion costs (calculated as delay costs) could be calculated for all modes of transport studied. Accident costs were estimated for all transport modes except maritime shipping. The major parts of accident costs, namely the risk value, the costs due to production losses and health costs were calculated for all transport modes (except maritime shipping as mentioned above). The further parts of accident costs, e.g. administrative costs of accidents and costs of material damages to vehicles were estimated for some of the transport modes depending on the data situation. Within the Environmental cost category air pollution costs and the costs of global warming were estimated for all transport modes except maratime shipping. These costs will be included in tranche C, as an estimation of the total European maritime shipping environmental costs. Noise costs were calculated for road, rail, air and inland waterway transport. The cost associated with nuclear risk arising from electricity production was estimated for rail transport. For road, rail and air transport the costs associated with nature, landscape, soil and water pollution could also be estimated. The taxes and charges for road, rail, public transport and air transport could be calculated. Subsidies for rail, public transport and aviation were documented. Partial revenues for inland waterway transport were estimated, but no actual data can be presented for maritime shipping.

The picture for Switzerland is similar: It was possible to estimate most of the cost and revenue categories for the two most important modes, i.e. road and rail transport. The calculations could profit from the fact that the elaboration of transport accounts for these two modes is not a new issue for Switzerland. First of all the assessment of infrastructure, accident and environmental costs has been subject of a number of studies or is even anchored in official annual statistics (Swiss road account). Nevertheless, the UNITE accounts provide new figures that will influence the transport policy discussion in Switzerland on subjects like the taxation and the financing of transport. Congestion costs, for example, have never been assessed in this detailed way, the figures given in the air transport account are new for Switzerland.

For road and rail transport, the "tradition" of Switzerland in estimating environmental costs of transport and the still quite large degree of uncertainty in these calculations result in a situation where the new UNITE figures only partly confirm existing estimates. In the cases of large differences (e.g. costs of air pollution) further analysis to explain these differences will be necessary.

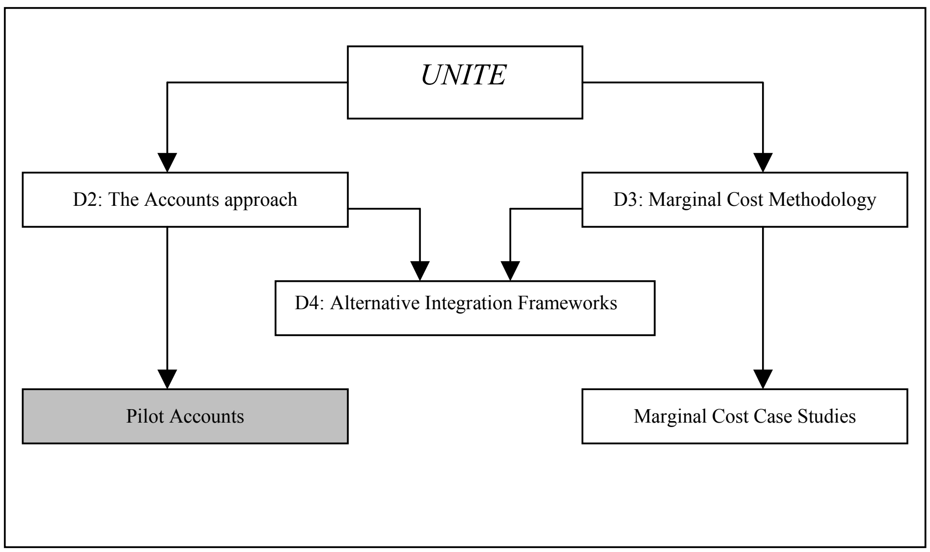
The information in the German and Swiss country accounts provides a complete and as exact as possible estimation of the total social costs of transport per transport mode and the corresponding transport charges and tax revenues. The information presented here can be of great value when developing relevant transport pricing and financing policy. The methodology presented in Link et al. (2000) has been found to be sound.

1 Introduction

1.1 Study context and purpose of this report

In order to assist policy makers working in the area of transport pricing, the UNITE project endeavours to provide information about the costs and revenues of all transport modes including the underlying economic, financial, environmental and social factors. To achieve this goal, three main areas of research are carried out within the UNITE project, called “transport accounts”, “marginal costs” and “integration of approaches” (see figure 1).

Figure 1 The building blocks of the UNITE Project



This document is a report of the results of the first UNITE country pilot accounts, the accounts for Germany and Switzerland. The purpose of this report is:

- to present the results obtained for the transport accounts in Germany and Switzerland,
- to test the feasibility of the methodological approach set up in Link et al. (2000) for the first tranche of UNITE countries (Germany and Switzerland),
- to serve as guidance for the subsequent tranches of UNITE accounts,
- to draw conclusions for further work in the accounts area.

The accounts approach divides the accounts into so called ideal and pilot accounts (Sansom et al. 2000). The ideal accounts reflect the perfect situation with the utmost disaggregation, showing factors such as the time, the location and duration of individual trips, all the relevant economic data as well as the individuals response to possible policy or infrastructure changes.

The pilot accounts are the actual, feasible accounts given the available data for the 18 countries that UNITE covers. They can be used to assess the costs and revenues of transport per transport mode. Generally, the costs and revenues presented in the pilot accounts are reported and documented at the current level of transport demand for the reference years 1996, 1998 and for the forecast year 2005. Reported transport costs are allocated to user groups when possible but without the use of arbitrary allocation methods. This summary report focuses mainly on the reference year 1998. Full results for 1996 and estimations for 2005 are included in the complete country reports for Germany and Switzerland (Link et al. 2002 and Suter et al. 2002 respectively) and intend to show a comparison between years and give a good indication of trends in transport for the near future.

1.2 The structure of this report

This report is a summary report of the German and Swiss pilot accounts. It presents one separate account per transport mode for 1996, 1998 and estimations for 2005 as well as detailed disaggregated results for the core year 1998. Attached to this report as individual annexes are the complete German and Swiss pilot accounts (Link et al. 2002 and Suter et al. 2002). These reports discuss in detail the methodologies applied, the input data used and the results for all accounting years. This summary report and the two annex reports are designed as stand-alone reports. A third annex (Nellthorp et al. 2001) contains the valuation conventions used within the pilot accounts.

The summary report contains five major parts. Chapter 2 briefly explains the general philosophy and methodology of the pilot accounts. Chapter 3 summarises the methodology developed for each of the cost categories in the pilot accounts. The main results for Germany and Switzerland are given in Chapters 4 and 5. The results in this chapter are organised within the following categories; infrastructure costs; supplier operating costs; congestion costs; accident costs; environmental costs; and taxes, charges and subsidies. The conclusion of this report, chapter 6, looks at methodological questions and the challenges which have arisen during the elaboration of the accounts and suggests where discussion and changes for the following accounts are needed.

2 A brief introduction to the pilot accounts

2.1 Aims of the pilot accounts

The pilot accounts attempt to show the general relationship between the costs of transport and the revenues from transport pricing, charging and taxation in the country studied. The aims and role of the pilot accounts are discussed in detail in "The Accounts Approach" Link et al. (2000). It should be stressed that the accounts are aimed at providing the methodological and the empirical basis for in-depth policy analysis (a monitoring tool) rather than serving as a guide for immediate policy actions such as setting higher/lower prices and charges or shutting-down transport services/links in order to achieve cost coverage. The pilot accounts are defined as follows:

The pilot accounts compare social costs and charges on a national level in order to monitor the development of costs, the financial balance and the structure and level of prices. Accounts can therefore be seen as monitoring and strategic instruments at the same time. They have to consider the country-specific situation and institutional frameworks.

The pilot accounts show the level of costs and charges as they were in 1998 (and 1996 respectively) and provide a workable methodological framework to enable regular updating of transport accounts. Furthermore, an extrapolation for 2005 is given. The choices of additional accounting years (1996 and 2005) were motivated by the need to show a comparison between years and to give a good indication of trends in transport for the near future. Furthermore, the inclusion of 1996 enables the elimination of any major statistical abnormalities that may occur in one year, for example very high infrastructure costs due to tunnelling operations or higher than average accident costs because of major incidents occurring in 1998. Note, however, that the core year of the pilot accounts is 1998. Both the results for 1996 and 2005 are derived from this core year.

2.2 Core and supplementary data in the pilot accounts

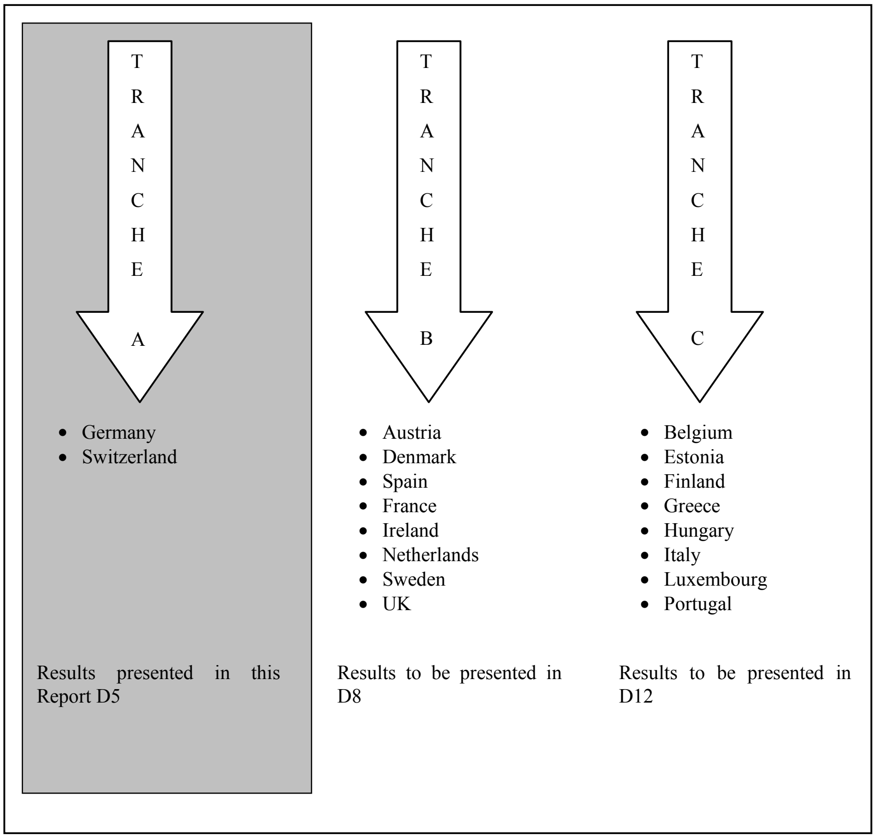
Input data for the pilot accounts has been divided into two groups: "core data" and "additional information". Data defined as core data are the values obtained for infrastructure costs, supplier operating costs, the part of accident costs that are considered to be transport system users external and the costs of air pollution, noise and global warming within the environmental category. On the revenue side of the accounts, taxes and charges are also considered to be core data. The methodology used to obtain core data is standard and the costs calculated show the costs that transport users impose on society as a whole.

Additional data falls into two categories. Firstly, for several cost categories being evaluated there is no standard methodology for the valuation of effects. An example of this is the valuation of loss of biodiversity due to transport infrastructure. Even though a valuation method has been developed for the UNITE pilot accounts, we feel that the level of uncertainty (due to lack of comparative studies) is high enough to warrant the information to be classified outside of the core data where tried and tested valuation methods have been utilised. Secondly, some costs which can be estimated and valued are caused and borne by the transport users themselves (for example user time and vehicle operating costs caused by delay). These costs are not relevant for setting of infrastructure charges and have been defined as supplementary costs in Link et al. (2000). Although these categories are not core categories the costs and the methods used to value them present valuable further information to the reader.

2.3 The tranches of the pilot accounts

The pilot accounts are carried out for the participating countries in three waves, called tranche A, B and C. Germany and Switzerland constitute the countries in the first tranche. See figure 2 for the organisation of the pilot accounts by tranches. The tranche approach allows for the experience gained in the first tranche to be passed on to tranches B and C.

Figure 2 Organisation of the pilot account tranche approach in the UNITE project



2.4 The six UNITE pilot account categories

Data for the pilot accounts are collected within six categories that are described in Link et al. (2000) and are described in the following section.

Infrastructure costs

For the pilot accounts, data for the assessment of infrastructure costs are structured to show the capital costs of transport infrastructure (including part of new investment and the replacement of assets) and the running costs of transport infrastructure (maintenance, operation and administration) for all modes of transport studied. As far as possible with current methodological knowledge, total infrastructure costs are allocated to user groups and types of transport. No arbitrary split of joint infrastructure costs for the presentation of average variable costs is attempted in this report. Country specific allocation procedures for the determination of average costs are documented within the individual country accounts only.

Supplier operating costs

All monetary costs incurred by transport operators for the provision of transport services are documented in the category supplier operating costs. Ideally, the data is structured to show what costs are incurred for vehicles, for personnel and for administration. However, this depends on data availability and will differ from country to country. Since collecting and supplementing this data for all modes is extremely time consuming, the UNITE project focuses on estimating supplier operating costs only for those modes where significant state intervention and subsidisation is present. Therefore, the main emphasis in this category is on rail and other forms of public transport. Whether other modes also have to be covered depends on the degree of state intervention in the respective countries.

Delay costs due to congestion

In the European Commission's White Paper "Fair payment for infrastructure use" (1998), costs caused by transport delays, accidents and the environmental effects caused by transport are estimated to be the three major causes of external transport costs. In the category congestion costs, the costs of delay and delay-caused additional operating costs (time and fuel costs) are estimated. Note, within UNITE no quantification of the deadweight welfare loss was carried out, only an estimation of delay costs was calculated. In Link et al. (2000), this cost category is referred to as user costs. The use of this term for the estimation of delay costs might be misleading as other user costs exist that are not quantified within the UNITE pilot accounts. Therefore, we use the term "delay costs due to congestion" within this deliverable.

The estimation of delay costs as defined here was carried out for all transport modes, provided data was available. This data is classified as supplementary data although these costs are external to the individual users, they are caused and borne by transport users as a whole.

Accident costs

The loss of lives and the reduction of health and prosperity through transport accidents are of major concern to all countries and to the European Commission. In this section of the accounts, the health related accident costs are calculated by assessing the loss of production, the risk value and the medical and non-medical rehabilitation of accident victims. Where the available data basis allows, the damage to property and the administrative costs of accidents are also considered. The external part of accident costs (defined in this report as accident costs imposed by transport users on the rest of society) is included in the core section of the accounts. Total accident costs however, include a substantial proportion of costs imposed by one transport user on another and are therefore treated as supplementary data.

Environmental costs

A wide range of transport-related environmental impacts and effects, presently being hotly debated in all countries, is considered in this section of the accounts. Included in this cost category are: air pollution, global warming, noise, changes to nature and landscape, soil and water pollution and nuclear risks. The valuation of these environmental effects is carried out for all transport modes, provided adequate data is available. Only the costs of air pollution, global warming and noise pollution are considered to be core data for the accounts.

Taxes, charges and subsidies

In this section, the level of charges and taxation for the transport sector is documented for each mode of transport. Wherever possible, the revenues from taxes and charges are shown as fixed or variable components. This information plays an important part in the ongoing discussions about the level of taxation between transport modes and countries. The comparison between taxes levied and the costs of infrastructure provision and use accrued per mode is central to this debate and holds a high level of political significance. Environmental taxes that apply to transportation are considered separately in this section. Taxes such as VAT that do not differ from the standard rate of indirect taxes are excluded from this study as these are not specific to the sector but are considered as general taxes. Transport related taxes such as VAT that differ from the standard tax rate are included where ever possible in the account. Where these taxes are less than the standard rate, they are considered to be indirect subsidies.

A further part in this area is reporting on subsidies. The need to maintain free and undistorted competition is recognised as being one of the basic principles upon which the EU is built. State aid or subsidies are considered to distort free competition. Subsidies to the transport sector provided by the member states are not exempted from the general provisions on state aid set out in the Amsterdam Treaty. There are, however, special provisions set out in the treaty in order to promote a common transport policy for the transport sectors of the member states (Treaty establishing the European Community : Articles 70 – 80). Subsidies to the transport sector are considered in this section of UNITE, however, it should be noted that a complete reporting on subsidies would require extremely time-consuming analyses of public budget expenditures at all administrative levels. Furthermore, the subsidies reported in the pilot accounts refer mainly to direct subsidies (e. g. monetary payments from the state to economic subjects).

2.5 The transport modes covered in the pilot accounts

The main transport modes covered in UNITE are road, rail, other public transport (tram, metro, trolley bus), aviation, inland waterway navigation and maritime shipping. The level of disaggregation into types of networks and nodes, means of transport and user groups depends on data availability and relevance per country. Table 1 summarises the disaggregation for the German and the Swiss pilot accounts used for data collection within the country pilot accounts.

Table 1
The modes, network differentiation, transport means and user breakdown utilised in the German and Swiss country pilot accounts

Transport modes	Country	Network and institutional differentiation[1)]	Means and user breakdown[1)]
Road	Germany	-Motorways -Other federal roads -Other roads	-Motorcycles -Passenger cars -Buses[2)] -Light goods vehicles -Heavy goods vehicles (HGV) rigid articulated, lorry with trailer -Special HGV and agricultural vehicles
	Switzerland	-Motorways -Inter-Urban/Rural roads -Urban/Local Roads	
Rail	Germany	-National rail -Non-national rail	-Passenger transport regional transport long distance transport -Freight transport
	Switzerland	All rail	
Other public transport	Germany/Switzerland	–	-Trams -Metro -Trolley buses -Buses[2)]
Aviation	Germany/Switzerland	-Airports -Air transport	-Passenger -Freight
Inland waterway	Germany/Switzerland	-Inland waterways -Inland waterway harbours	–
Maritime shipping	Germany	Seaports	–

[1)] Quantitative results per mode are given in Link et al. (2002) and Suter et al. (2002). – [2)] Note, buses appear in road or public transport accounts dependant on the cost category dealt with.

Source: Link et al. (2002), Suter et al. (2002).

2.6 Results presentation and guidelines for interpretation

The goal of the data collection and the estimation of cost and revenues in each category is to obtain a level of disaggregation that allows all pertinent costs and charges of the relevant transport mode to be shown. A structure for reporting this transport related data has been developed (Link et al. 2000). Within the country accounts, results are documented firstly for each cost category and are then summarised into modal accounts covering all cost and revenue categories. Modal summaries are also utilised for the reporting of the country accounts within this document. Additionally, a set of data needed as basic data for all cost categories was complied to ensure that commonly used data have consistency between cost categories. This was especially important for the German account where three institutions were involved in the data collection and valuation of costs. Minor discrepancies in the basic data used between cost categories are due to the fact that the level of disaggregation in the input data required for each cost category differed. However, every effort was used to consolidate the basic data used to ensure consistent results for all cost categories.

The cost categories present a comprehensive estimation of transport costs and revenues. They are, however, not a total estimate of transport costs. Each cost category could include data in further areas and a definite border had to be drawn around the data to be collected for this project. For example, the estimation of environmental costs does not include the environmental costs incurred during the manufacturing of vehicles, even though these costs could be estimated. These costs would be included in an ideal account, but lie outside the scope of the pilot accounts. Further transport costs categories such as vibration as a part of environmental costs are not evaluated because no acceptable valuation method has been developed.

The main difference between the country pilot accounts and existing country accounts lies in the detail of the disaggregation and the avoidance of arbitrary allocation of aggregate costs to vehicle types or user groups. The pilot accounts for Germany and Switzerland answer relevant questions about transport such as: What are the costs of transport per transport mode and cost category? What are the transport revenues raised per transport mode? How will the costs and revenues of transport develop over the next years up to 2005?

It should be noted that the results are presented separately for core and additional data. This separation acknowledges the different levels of uncertainty and with different cost types (costs borne by transport users themselves versus external costs).

3 Summary of UNITE pilot accounts methodology

The methodology developed to estimate transport costs and revenues within UNITE is documented in the publication "D2 – The Accounts Approach" by Link et al. (2000). Here we will focus on a short description per cost and revenue category.

3.1 Methodology for estimating infrastructure costs

Infrastructure costs are considered to be core data for the pilot accounts. These costs contain capital costs (depreciation and interest) for new investment and for replacement of assets on the one hand and running costs for maintenance, operation and administration/overheads on the other hand. The major methodological steps for the UNITE infrastructure costs accounts are: valuation of the capital stock, derivation of capital cost from the asset value, estimation of running costs and allocation of costs to transport types, user groups and vehicle types.

The basis for estimating capital costs is the value of the capital stock. Several methods to quantity the capital stock are described in Link et al. (2000). The preferred method for asset valuation is the perpetual inventory approach because it is based on sound economic principles and since it can be elaborated and updated with realistic resources. The main principle of the perpetual inventory concept is to calculate the asset's value by cumulating the annual investments and by subtracting either the value of those assets that exceeded their life-expectancy (written down assets) or the depreciation. For the German pilot accounts it was possible to apply this approach to all modes, with underlying long investment time series not only for the mode in total, but disaggregated for asset types per mode. Generally, assets were valued at 1998 prices. In the Swiss pilot accounts the perpetual inventory approach was only applied for road, with underlying long investment time series valued at purchase costs. For all other modes business accounts were used.

Running costs for both countries accounts were taken either from official statistics and/or from business accounts, or when necessary they were estimated. Non-transport related infrastructure costs had to be considered in particular for urban roads (market function, general access function in residential areas), in the German pilot accounts also for inland waterways (flooding prevention, electric power generation). For both the Swiss and the

German pilot accounts it was not possible to separate non-transport related costs of airports (commercial part of airports such as restaurants, shops etc.) from transport related costs.

Cost allocation in both country accounts was only carried out for road (breakdown by vehicle types) and rail (breakdown to passenger and freight transport) and is reported in the respective annex reports. Note, however, that there are different methods of cost allocation per country without an EU-wide accepted and harmonised approach. The choice of methods can affect the results considerably as shown in DIW et al. (1998) for the road sector. Due to these reasons, this information, though highly interesting within the country doing the account, can not be used as a base for comparisons between countries using different allocation methods.

3.2 Methodology for estimating supplier operating costs

Within the UNITE pilot accounts methodology it was decided to calculate supplier operating costs only for transport modes where the revenues from the transport users do not cover the costs of the supplier. This is mainly true for rail transport and for other modes of public transport (here metro, trolley bus and tram) and is considered to be core data for these transport modes. In the German pilot accounts the national rail carrier Deutsche Bahn (DB), other German companies providing rail transport services (about 180 companies) and public transport companies (tram, metro, buses) were analysed. In the Swiss pilot accounts this cost category was analysed for rail and urban public transport.

Aggregated annual cost and revenue data from business reports were used and as far as possible the following categories: materials, goods and services, personnel, depreciation, other running costs, and, interest were used for the evaluation of supplier operating costs.

3.3 Methodology for estimating delay costs resulting from congestion

The additional time and fuel costs for the transport user that are caused by delays due to congestion are used to estimate congestion costs. Transport users are defined as the users of traffic infrastructure in individual and private commercial motorised road traffic (including passengers and drivers of cars and motorcycles and road hauliers), of passengers in public passenger transport modes (rail, other public transport, aviation) and of shippers (represented by units of cargo) in all freight transport modes (rail, aviation, waterborne transport). Congested traffic conditions are defined per mode, taking into consideration characteristic fluctuations in travel time and the system-specific consequences of delays. For all road modes, acceptable traffic conditions are defined by off-peak travel speeds and the related operating costs, while for rail and air traffic scheduled travel times are used. In general the UNITE approach values late arrivals rather than late departures or longer in-vehicle travel times in public transport. Delay costs are determined as late arrivals of passenger and goods against scheduled arrival time. Crowding costs, in contrast, are based on the analysis of actual loading factors, capacities and annual traffic volumes performed by trains, aeroplanes and ferries. The valuation of delays or extra travel time costs is restricted to serious delays. Small delays or simply disturbed traffic are considered to be normal attributes of traffic systems.

The methodology applied for estimating congestion costs differs between the modes and the two pilot accounts countries. Therefore, no direct comparison of these costs between the countries and the modes is sensible. For road transport, the German pilot account has used a modelling approach while Switzerland has derived the delay costs from a combination of different methods ranging from a modelling approach up to reports on traffic jams. For the remaining modes, delay statistics (for rail obtained from the Swiss Railways and from the German consumer's association, for aviation obtained from the Swiss Federal Office on Civil Aviation and in case of Germany from CODA and from AEA) and comparisons between observed delays and scheduled arrival times were used.

Time-related costs are by far the most important costs in this category. Therefore, in order to establish a basis for the UNITE cost valuations, state of the art research studies for the value of time were reviewed and are summarised in Annex 3: "Valuation Conventions for UNITE" Nellthorp et al. (2001). For the UNITE accounts the values of time have been standardised and adjusted to each country by the use of real GDP per capita at purchasing power parity.
Information gained by the estimation of congestion costs is not regarded as a core section of the transport accounts because the costs are fully internalised by those taking part in transport.

3.4 Methodology for estimating accident costs

Material damage, administration costs, medical costs, production losses and the risk value are the subcategories used for the evaluation of accident costs.

The risk value which represents, in quantitative terms, the most important component of accident costs was set according to the recommendations of the UNITE valuation conventions as € 1.5 million for fatalities, as € 195 000 for severe injuries (13% of the risk value for fatalities) and as € 15 000 for slight injuries (1% of the value of statistical life). These values are adjusted to each country by the use of relative values of real GDP per capita. Risk values for relatives and friends were not considered. In the pilot accounts the risk value is defined as being entirely internal to the individual. This means that we implicitly assume that accident risks are fully anticipated by individuals when they decide to participate in transport. All valuations used for estimating accident costs are documented in Nellthorp et al. (2001).

Each of the subcategories of accident costs was valued by using the number of incidents and the costs arising from the incident. The numbers and costs from materials damage, administration and medical subcategories were obtained from insurance companies and from police. Production losses represent an estimation of the losses to the national economy due to replacement costs, lost output of employed persons and lost non-market production (e.g. domestic work) resulting from accidents.

In the pilot accounts accident costs are divided into internal and external accident costs. “External” accident costs are defined as costs imposed by transport users on those outside the transport sector. Hence “internal costs” embrace all costs borne by the individual transport users, the risk associated with using transport and costs borne by the community of transport users (including all costs covered by traffic insurance companies). Explicitly external costs are administrative costs for police or the legal system, the costs of medical treatment not covered by traffic insurance companies and production losses. External accident costs are considered to be core data while internal accident costs, because these costs are caused and borne by the transport user and not society as whole, are considered to be additional information only.

3.5 Methodology for estimating environmental costs

For the evaluation of environmental costs, five subcategories have been developed. These are; air pollution; global warming; noise; costs due to environmental impacts on nature, landscape, soil and ground water; and, finally, the valuation of the risk associated with nuclear energy production. The first three of these subcategories (air pollution, global warming and noise) are considered to be core data, the remaining categories are additional data.

For quantifying the costs due to airborne pollutants the impact pathway approach (IPA) was used both for Germany and Switzerland. The IPA is a bottom up approach which consists of the following modelling steps; estimation of emissions; dispersion and chemical conversion modelling; calculation of physical impacts; and, monetary valuation of these impacts. Detailed geographically-coded information about the emissions of air pollutants was used as input data both for the Swiss and the German pilot account.

The method of calculating costs of global warming due to CO_2 emissions basically consists of multiplying the amount of CO_2 emitted by a cost factor. Due to the global scale of the damage caused, there is no dependency on how or where the emissions take place. A European average shadow value of €20 per tonne of CO_2 emitted was used for valuing CO_2 emissions within UNITE. This value represents a central estimate of the range of values for meeting the Kyoto targets in 2010 in the EU based on estimates by Capros and Mantzos (2000). They report a value of €5 per tonne of CO_2 avoided for reaching the Kyoto targets for the EU, assuming a full trade flexibility scheme involving all regions of the world. For the case that no trading of CO_2 emissions with countries outside the EU is permitted, they calculate a value of €38 per tonne of CO_2 avoided. Fahl et al. 1999 estimate €19 per tonne of CO_2 for meeting a 25% emission reduction from 1990 to 2010 in Germany. It is assumed that measures for a reduction in CO_2 emissions are taken in a cost effective way. This implies that reduction targets are not set per sector, but that the cheapest measures are implemented, no matter in which sector.

For the valuation of noise, costs due to health impacts caused by exposure to noise were estimated using exposure-response functions. Therefore, costs due to amenity losses, based on studies quantifying a noise sensitivity depreciation index, were added.

The methodology for the valuation of costs arising from transport related negative impacts on nature, landscape, soil and ground water followed the approach taken by INFRAS/IWW (2000). The damages were monetarised based on a compensation cost approach. This data is considered to be additional data.

The estimate for the costs due to nuclear risks was based on the damage cost approach. The cost factor per kWh of electricity produced in a nuclear power plant given in European

Commission (1999) was adapted to the UNITE valuation conventions. This data is considered to be additional data.

3.6 Methodology for estimating taxes, charges and subsidies cost categories

The aim of the UNITE accounts was not to compile a complete data set of all taxes, charges and subsidies of the transport sector but rather to define and estimate properly those taxes and charges paid by infrastructure users (individual passengers as well as transport operators) which can be seen as revenues corresponding to the cost side of the accounts. Note, that although the taxes and charges analysed are defined by their relationship to the different cost categories (infrastructure costs, accident costs, environmental costs, supplier operating costs) they can hardly be directly compared with the respective cost category. The reason for this is first of all the historical evolution of national taxation systems with different and from time to time differing justification of taxation purposes, levels, structures and (eventually existing) earmarking procedures (see Link et al. (2000) for a more detailed discussion). Fuel taxation, for example, shows that taxes can be linked to different cost categories. An example of this is the situation in Germany where revenues from fuel tax are earmarked partly for infrastructure financing and partly for general revenue raising. Since 1999 an eco tax, based on environmental concerns but earmarked for funding social security systems has been raised. We have grouped revenues from taxes and charges into those that relate directly to a specific cost category (mainly to infrastructure and supplier operating costs, for example revenues from Vignettes, rail track access charges) and those that do not relate directly to a specific cost category (for example: annual circulation tax, fuel tax).

In the philosophy of the UNITE transport accounts with a cost side and a revenue side subsidies have to be treated at both sides of the account. Subsidies paid for infrastructure financing have to be considered as costs of infrastructure provision. The input data on investments used for capital stock valuation with the perpetual inventory model contain all investments spent per mode independent of their financial source. On the other hand, direct subsidies paid to transport operators (for example for public service obligations but also as compensation payments for reduced tariffs for certain social groups) increase the revenues of the respective companies and are often contained in the item “tariff revenues” in their business accounts. As far as possible the subsidies contained there are reported as additional information outside the main body of the accounts.

Indirect subsidies such as tax exemptions/reductions are quantified and reported separately as additional data whenever possible. It should be noted, however, that due to the fact that certain modes or user groups are exempted from taxes the accounts show at the revenue side either no entries or lower numbers (in case of tax reduction). Thus, indirectly these tax exemptions are always considered even when they are not quantitatively reported. VAT is reported as an additional information and only in such cases where the rate of VAT for the transport sector differs from the main rate of indirect taxation.

4 Pilot accounts for Germany

In order to obtain a clear picture of the transport situation in Germany, basic social and economic indicators are presented before the detailed results of the German pilot accounts are discussed.

Table 2
Basic indicators for Germany 1996 and 1998

	unit	1996	1998
Land area	sqkm	357 021	357 022
Population	1 000	82 012	82 037
Population density	inhabitants/sqkm	230	230
Population employed	1 000	35 982	35 860
Employment Rate	%	43.88	43.71
GDP[1)]	€ billion	1 877.49	1 921.89
GDP per capita	€ million	0.023	0.023
GDP growth rate (change to previous year)	% (in prices of 1995)	0.8	2.2
Consumer price index	1995 = 100	101	104

[1)] At market prices.

Sources: Statistical yearbook for Germany 1999, 2000.

In table 3, basic transport indicators used within the German pilot account are presented.

The main features of the German transport system including a discussion on the organisational structure are summarised within this chapter. For more detailed information please refer to Annex 1: The Pilot Accounts for Germany (Link et al. 2002).

Table 3
Basic transport related indicators for Germany 1998 per mode

Indicator	Unit	Road	Rail	Public transport[1)]	Aviation	Inland waterway navigation	Maritime shipping	Total
Transport performance[2)]								
Passengers carried	Mill.	50 616	1 939	7 762	104	0	0	60 422
	%	84	3	13	0.2	0	0	100
Passenger-km	Bill. Pkm	754	72	76	38	0	0	940
	%	80	8	8	4	0	0	100
Goods transported[3)]	Mill. t	3 197	306	•	2	236	214[4)]	3 955[5)]
	%	86	8	•	0	6	–	100[5)]
Tonne-km[3)]	Bill. tkm	316	74	•	0.7	64	1 023[4)]	454.7[5)]
	%	70	16	•	0	14	–	100[5)]
Network length	1000 km	661	42	3.16	•	7	•	•
Employees	1000	404[6)]	287	163	47[7)]	8[8)]	14[9)]	923[10)]
Gross investments[11)]	€ mill.	9 827	5 128	2 705	2 378	190	4 080	24 308
	%	40	21	11	10	1	17	100
Gross capital stock[12)]	€ mill.	450 876	178 443	65 903	33 269	11 907	39 119	817 768
	%	58	23	8	4	2	5	100
Accidents								
Number of injuries[13)]	Casualties	607 166	1 147	[14)]	363	35	:	60 8711
Number of fatalities	Casualties	7 870	320	[14)]	86	3	:	8 279
Environment								
Direct transport emissions				[15)]				
CO_2	Mill. t	166.8	7.1		19.3	1.2	:	194
$PM_{2.5}$	1 000 t (exhaust)	40.5	0.56		0.58	0.7	:	41.7
PM_{10}	1000 t (non-exhaust)	8.7	0.19				:	9.4
NO_x	1 000 t	862.9	32.5		7.1	0.7	:	903.3
SO_2	1 000 t	26.2	5.8		0.4	0.4	:	32.8
NMVOC	1 000 t	435.3	2.5		7.0	1.6	:	446.4

1) Metro, tram and trolley bus only. – 2) Transport within Germany. – 3) Excluding goods transported in pipelines. – 4) Performance between German ports and to/from ports abroad. – 5) Without maritime transport. – 6) Road freight only. – 7) Including 28000 employees working in airports. – 8) Excluding employees in harbours. – 9) Excluding employees in seaports. – 10) Excluding employees in inland waterway harbours, seaports, storage facilities, shippers etc. – 11) Excluding land purchase. Including rolling stock except road. At current prices. – 12) Excluding land value. At prices of 1995. – 13) Slight and severe injuries. – 14) Within road account. – 15) Indirect emissions only. – electricity production for tram and metro. Emissions for buses are within road account.

Source: DIW/IWW/IER.

4.1 Road transport

In table 4 the total costs of road transport documented within the German pilot account are presented.

Table 4
German road account for 1996, 1998 and 2005
- € million at 1998 prices -

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs	25 889	26 176	*27 293*
Fixed	22 006	22 250	*23 199*
Variable	3 883	3 926	*4 094*
Accident costs (user external)[1)]	13 819	14 592	*17 324*
Environmental costs	17 813	18 505	*19 410*
Air pollution	8 124	8 411	*7 030*
Global warming	3 712	3 849	*4 555*
Noise	5 977	6 245	*7 825*
Total	**57 521**	**59 273**	***64 027***
Additional information			
Congestion costs[2)]	16 080	17 381	*21 586*
Time costs	15 248	16 491	*20 484*
Fuel costs	833	593	*1 102*
Accident costs (user internal)[3)]	57 435	57 919	*68 764*
From this: risk value	44 504	45 963	*54 568*
Environmental costs			
Nature and landscape, soil and water pollution[4)]	950	967	*1 119*
Nuclear risk[4)]	0	0	0
Revenues			
Directly related to a specific cost category			
Charges for infrastructure usage			
Fixed	407	411	*0*
Variable	0	0	*1 918*
Total	**407**	**411**	***1 918***
Other transport specific revenues			
Annual circulation tax	7 027	7 757	*9 561*
Fuel tax	28 588	28 983	*28 937*
Eco tax[5)]	0	0	*10 501*
VAT[6)]	4 288	4 565	*6 310*
Total	**39 903**	**41 305**	***55 309***
Subsidies[7)]	0	0	*0*

[1)] Refers to those parts of road accident costs which are not borne by road users and insurance companies but by the public sector and third parties. – [2)] Expressed as delay costs. – [3)] Refers to those parts of accident costs which are caused by and borne by road users and insurance companies. – [4)] Because there is no standardised methodology for the calculation of these costs, the figures given here are to be regarded only as approximate indications that may change greatly over time with the development of a standard methodology.–[5)] Eco tax was introduced in 1999. It is collected together with fuel tax. – [6)] VAT levied on fuel and eco tax. – [7)] Subsidies included here refer to subsidies given for debt relief, for the provision of services etc. These subsidies can clearly not be allocated to either the cost or to the revenue side of this table. Subsidies are in cash flow terms and are not on the same basis as the economic costs.

Source: Link et al. (2002)

In 1998, the core year of the pilot accounts, the largest cost block was accident costs. Total accident costs amounted to € 72.5 billion, out of these 20% (€ 14.6 billion) were external accident costs, i.e. those parts of accident costs which are not borne by road users themselves or by transport insurance companies. Infrastructure costs were the second largest cost block (€ 26.2 billion), followed by total environmental costs (core and additional environmental costs) with almost € 20 billion. Congestion costs, which in the UNITE accounts refer to costs of delay (e.g. time and fuel costs) and not to the deadweight welfare loss of congestion, were at € 17.4 billion. These costs were of the same order of magnitude as the costs road transport causes with respect to core environmental damages (air pollution, global warming and noise). For 2005, we have estimated rather moderate cost increases for infrastructure costs (4%) and environmental costs (6%). External accident costs (22%) and congestion costs (26%) are the cost components which will increase most dramatically.

On the revenue side we have estimated total road transport related revenues of € 41.7 billion in 1998. The share of charges which relate directly to infrastructure usage was low (€ 411 million), this represents only 1% of all road transport related taxes and charges. Note, however, that the charging and taxation regimes in Germany have evolved historically with a focus on tax-based financing of road infrastructure by fuel tax and annual circulation tax. With the introduction of the distance related HGV charging scheme, the contribution of charges that relate directly to infrastructure use are estimated to increase to € 1918 million in 2005, four times higher than in 1998. The estimated total road transport related revenues will increase by more than one third. This increase will mainly be due to the stepwise increase of eco tax raised together with the fuel tax on fuel consumption (stepwise tax increases of in total € 0.15 per litre since 1999).

Comments on specific cost categories

Infrastructure costs

Road infrastructure costs were calculated using the perpetual inventory model. Running costs were obtained from the Ministry of Transport and from the Federal Statistical Office. Data quality is considered to be very good.

Cost allocation to vehicle types using the official German method (BMV 1969) was carried out and shows a share of 52% of all road infrastructure costs for passenger cars. 41% of all road infrastructure costs were allocated to heavy goods vehicles. When looking only at motorways over half the costs can be allocated to HGVs (58%), which reflects the high mileage of these vehicles on motorways. These figures cannot be directly compared with the Swiss allocation, as the method varies greatly within the two countries (see tables 5-9). For Germany, these allocation proportions are expected to remain stable for 2005.

Congestion costs

The estimated road congestion costs are comprised of fuel and time costs of road users caused by delays. They were estimated by using a modelling approach. Basic data was taken from several sources such as BMVBW/DIW (2000), and is considered to be of good quality. Values of time were taken from the UNITE standard valuations (Nellthorp et al. 2001).

The congestion costs of € 17.4 billion estimated for Germany in 1998 represent 0.95% of Germany's GDP. This share is lower than the 2 % of GDP estimated in the EU Green Book on Fair and Efficient Pricing for Transport Infrastructure (CEC 1995) as an approximate level of external congestion transport costs. This estimate, which is frequently quoted, is based on delay estimates. As the value of time and the definition of delay used in the study are unknown, it is not possible to compare the results.

Accident costs

The input data for estimating road accident costs (passenger cars, motor cycles and goods vehicles) is of good quality. Estimates were made to ensure that the problem of underreporting of road accidents would not affect the results. The costs are extremely dependant on the valuation of risk which has been standardised for the UNITE project. For Germany we used a risk value for fatalities of € 1.62 million. 13% of this was applied for severe injuries and 1% of this for minor injuries.

The estimated external road accident costs of € 14.6 billion are composed as follows: 93% are attributed to production losses, 1.5% from the costs arising for medical treatment and 6% from administration costs. Risk value accounted for 79% of internal accident costs and material damage 20%. Material damage was only estimated for damage to vehicles, making this cost component wholly internal to the transport sector. Due to lack of input data no further valuation of material damages could be estimated.

Environmental costs

The basic data used for the estimation of environmental costs is of good quality. Specific data relating to road emissions was available.

Environmental costs were calculated using the methodology outlined in Link et al. (2000) and summarised in chapter 3 of this document. For road transport, the total core and additional environmental costs amount to € 19.5 billion. These costs represent 89% of all modes environmental transport costs and reflect the dominant role of road transport within Germany.

Air pollution is the major environmental cost component for road transport (€ 8.4 billion), with the costs of primary and secondary particles being the major cost drivers. This is, however, a much lower value than calculated for 1995 in INFRAS/IWW (2000). The underlying reason for these differences is the road vehicle emission estimates used in the 1995 study, which are a factor of 5 higher for PM_{10} and by 1.2 higher for NOx. The considerable difference in PM_{10} emissions stems mainly from the inclusion of re-suspended particles from road dust, tyre and break wear. Empirical evidence about the recirculation of particles is, however, still scarce. The UNITE estimate was based on more detailed, spatially disaggregated emission model than the model used in INFRAS/IWW (2000).

The costs of noise emissions, the second most important environmental cost category, are based on data from 1992 and can be considered to be a broad estimate only. The valuation takes the reduced value of property and the increase of adverse health effects for citizens exposed to road noise into account.

The low costs related to global warming in the account reflects the lower (but currently accepted) avoidance costs of CO_2 emissions, as the costs relate directly to these valuations. For UNITE, a shadow value of €20 per emitted tonne of CO_2 was used for valuing CO_2 emissions. This value represents a central estimate of the range of values for meeting the Kyoto targets in 2010 in the EU based on estimates by Capros and Mantzos (2000). They report a value of €5 per tonne of CO_2 avoided for reaching the Kyoto targets for the EU, assuming a full trade flexibility scheme involving all regions of the world. For the case that no trading of CO_2 emissions with countries outside the EU is permitted, they calculate a value of €38 per tonne of CO_2 avoided. Fahl et. al. (1999) estimate €19 per tonne of CO_2 for meeting a 25% emission reduction from 1990 to 2010 in Germany. Note, that this valuation could feasibly be raised in the future if a 50% CO_2 reduction target for 2030 (Intergovernmental Panel on Climate Change – IPCC) is accepted.

The valuation of damage to nature and landscape and for soil and water pollution are low compared to the other environmental cost categories. The costs of nuclear risk from the use of vehicles driven by electricity are negligible for Germany.

Taxes, charges and subsidies

The input data was obtained from official sources such as the German Ministry of Finance and is of good quality. The low share of charges directly related to usage is dependant on the historical system of tax-based financing for road infrastructure using fuel and annual vehicle circulation tax.

In table 5 the average variable costs of road transport for all roads and vehicle types are presented. Because we avoid arbitrary allocation within the UNITE accounts and the allocation of variable costs would mean an arbitrary split of joint costs to vehicle classes, infrastructure costs are not allocated within the variable costs results.
In tables 6 – 9 the total costs of road transport are shown per road type (all roads, motorways, other federal roads and other roads) and disaggregated by vehicle type (motorcycles, passenger cars, buses, light goods vehicles weighing 3.5 tonnes or less and heavy goods vehicles weighing over 3.5 tonnes).

Table 5
Average variable costs of road transport per vehicle km: Germany
- €/km at 1998 prices -

All Roads					
	1998				
	Motor-cycles	Passenger cars	Buses	LGV	HGV[1)]
Core information					
Infrastructure costs	:	:	:	:	:
Fixed	:	:	:	:	:
Variable	:	:	:	:	:
External accident costs[2)]	0.1295		0.1110	0.0282	0.0228
Environmental costs	0.0348	0.0172	0.1552	0.0767	0.1264
Air pollution	0.0054	0.0077	0.0964	0.0161	0.0718
Global warming	0.0022	0.0049	0.0180	0.0075	0.0196
Noise	0.0272	0.0046	0.0408	0.0531	0.0350
Total I	:	:	:	:	:
Additional information					
Delay costs	0.0236		0.0798	0.0355	0.0688
Internal accident costs[3)]	:	:	:	:	:
Material damages	:	:	:	:	:
Risk value	:	:	:	:	:
Environmental costs	:	:	:	:	:
Nature, landscape, soil and water pollution	0.0014	0.0024	0.0077	0.0036	0.0056
Total II	:	:	:	:	:
Revenues					
Fixed	:	:	:	:	:
Vignette	:	:	:	:	:
Annual circulation tax	:	:	:	:	:
Variable	:	:	:	:	:
Fuel tax	:	:	:	:	:
Eco tax[4)]	.	.	.	.	.
Distance related infrastructure charges[5)]	:	:	:	:	:
VAT [6)]	:	:	:	:	:
Basic data					
Million vehicle km	15 315	525 585	3 680	29 113	53 927
Million passenger km	755 700			.	
Million tonne km	.	.	.	316 000	

[1)] Including special and agricultural vehicles. – [2)] Both external and internal accident costs. – [3)] Figures are included in item "External accident costs" of the core information section. – [4)] Eco tax introduced in 1999. – [5)] No distance related charges before 2005. – [6)] VAT on fuel tax.

Source: Link et al. (2002)

Table 6
Total costs of road transport: Germany
- € million at 1998 prices –

All Roads						
	1998					
	Motor-cycles	Passenger cars	Buses	LGV	HGV[1]	Total
Core information						
Infrastructure costs	172	13 560	363	1 325	10 757	26 176
Fixed	:	:	:	:	:	
Variable	:	:	:	:	:	
External accident costs	14 082		79	172	258	14 592
Administrative	215		1	3	4	223
Health costs	837		5	10	15	867
Production loss	13 031		73	159	239	13 502
Environmental costs	533	9 040	571	2 231	6 129	18 505
Air pollution	82	4 023	355	469	3 481	8 411
Global warming	34	2 581	66	217	951	3 849
Noise	417	2 436	150	1 545	1 697	6 245
Total I	**37 387 [2]**		**1 013**	**3 728**	**17 144**	**59 273**
Additional information						
Delay costs	8 293		1 287	2 463	5 338	17 381
Internal accident costs	55 969		329	648	973	57 919
Material damages	11 610		79	107	161	11 957
Risk value	44 359		250	541	812	45 962
Environmental						
Nature, landscape, soil and water pollution	8	687	13	45	215	968
Total II	**64 957[2]**		**1 629**	**3 156**	**6 526**	**76 268**
Revenues	413	28 256	373	1 457	6 652	37 151
Fixed						
Vignette	·	·	·	·	411	411
Annual circulation tax	:	:	:	:	:	7 757
Variable						
Fuel tax	:	:	:	:	:	28 983
Eco tax [3]	·	·	·	·	·	·
Distance related infrastructure charges[4]	·	·	·	·	·	·
VAT[5]	:	:	:	:	:	4 565
Total	:	:	:	:	:	**37 151[6]**
Basic data						
Number of vehicles (thousand)	2 926	42 003[7]	83	1 565	3 009	49 586
Million vehicle km	15 315	525 585	3 680	29 113	53 927	627 622
Million passenger km	755 700			·	·	
Million tonne km	·	·	·	316 000		

[1] Including special and agricultural vehicles. – [2] Motor cycle and passenger cars. – [3] Eco tax introduced in 1999. – [4] No distance related charges before 2003. – [5] VAT on fuel tax.– [6] Not including VAT on fuel tax. – [7] Including recreational vehicles.

Source: Link et al. (2002)

Table 7
Total costs of road transport: Germany
- € million at 1998 prices -

Motorways						
	1998					
	Motor-cycles	Passenger cars	Buses	LGV	HGV[1)]	Total
Core information						
Infrastructure costs	10	1728	30	128	2 587	4 483
Fixed	:	:	:	:	:	
Variable	:	:	:	:	:	
External accident costs	1 218		7	16	23	1 263
Administrative	19		0.1	0.2	0.4	19
Health costs	72		0.4	0.9	1.4	75
Production loss	1 127		6	14	22	1 169
Environmental costs	19	2 047	61	168	2 425	4 720
Air pollution	13	1 248	50	113	1 850	3 274
Global warming	6	799	11	55	575	1 446
Noise[2)]	:	:	:	:	:	:
Total I	**5 022** [6) 7)]		**98** [7)]	**312** [7)]	**5 035** [7)]	**10 466** [7)]
Additional information						
Delay costs	2 168		324	429	3 310	6 231
Internal accident costs	4 706		27	57	85	4 875
Material damages	871		6	8	12	897
Risk value	3 835		21	49	73	3 978
Environmental costs						
Nature, landscape, soil and water pollution	1	176	3	10	93	283
Total II	**7 051** [6)]		**354**	**496**	**3 488**	**11 389**
Revenues	73	7 855	62	344	3 492	11 825
Fixed						
Vignette	.	.	.	.	411	411
Annual circulation tax	:	:	:	:	:	1 363
Variable						
Fuel tax	:	:	:	:	:	10 051
Eco tax [3)]	•	•	•	•	•	•
Distance related infrastructure charges[4)]	•	•	•	•	•	•
VAT[5)]	:	:	:	:	:	1 583
Total	:	:	:	:	:	**11 825** [8)]
Basic data						
Million vehicle km	1 908	157 889	765	6 509	27 639	194 711

[1)] Including special and agricultural vehicles. – [2)] Total road noise costs of € 6245 million can not be allocated to road type. – [3)] Eco tax introduced 1999. – [4)] No distance related charges before 2003. – [5)] VAT on fuel tax. – [6)] Motor cycle and passenger cars. – [7)] Excluding noise costs. – [8)] Not including VAT on fuel tax.

Source: Link et al. (2002)

Table 8
Total costs of road transport: Germany
- € million at 1998 prices -

Other federal roads						
	1998					
	Motor-cycles	Passenger cars	Buses	LGV	HGV[1]	Total
Core information						
Infrastructure costs	28	2 441	64	187	1 607	4 327
Fixed	:	:	:	:	:	:
Variable	:	:	:	:	:	:
External accident costs[2]	7 067		37	92	138	7 334
Administrative	108		0.6	2	2	112
Health costs	420		2.2	6	8	436
Production loss	6 539		34	85	128	6 786
Environmental costs[2]	59	2 068	102	162	1 010	3 400
Air pollution	41	1 160	81	102	785	2 169
Global warming	18	908	21	60	225	1 231
Noise[3]	:	:	:	:	:	:
Total I	**11 663**[7) 8)]		**203**[8)]	**441**[8)]	**2 755**[8)]	**15 061**[8)]
Additional information						
Delay costs[2]	1069		270	367	1 028	2 734
Internal accident costs[2]	26 013		143	325	488	26 969
Material damages	3 754		26	35	52	3 867
Risk value	22 259		117	290	436	23 102
Environmental costs[2]						
Nature, landscape, soil and water pollution	6	511	10	33	123	683
Total II	**27 599**[7)]		**423**	**725**	**1 639**	**30 386**
Revenues	83	6264	85	266	1 228	7 926
Fixed						
Vignette	.	.	.	.	.	.
Annual circulation tax	:	:	:	:	:	1 179
Variable						
Fuel tax	:	:	:	:	:	6 746
Eco tax[4]	•	•	•	•	•	•
Distance related infrastructure charges[5]	•	•	•	•	•	•
VAT[6]	:	:	:	:	:	1 063
Total						**7 926**[9)]
Basic data						
Million vehicle km	3 486	134 505	875	5 888	11 325	156 106

1) Including special and agricultural vehicles. – 2) Here trunk roads = other inter-urban roads. – 3) Total road noise costs of € 6245 million cannot be allocated to road type. – 4) Eco tax introduced 1999. – 5) No distance related charges before 2003. – 6) VAT on fuel tax. – 7) Motor cycle and passenger cars. – 8) Excluding noise costs. – 9) Not including VAT on fuel tax.

Source: Link et al. (2002)

Table 9
Total costs of road transport: Germany
- € million at 1998 prices -

Other roads						
	1998					
	Motor-cycles	Passenger cars	Buses	LGV	HGV[1]	Total
Core information						
Infrastructure costs	134	9 390	269	1 010	6 563	17 366
Fixed	:	:	:	:	:	:
Variable	:	:	:	:	:	:
External accident costs[2]	5 799		36	64	96	5 995
Administrative	89		1	1.0	2	92
Health costs	345		2	4	6	356
Production loss	5 365		33	60	89.0	5 547
Environmental costs[2]	38	2 489	257	357	996	4 138
Air pollution	28	1 615	223	254	846	2 967
Global warming	10	874	34	103	150	1 171
Noise[3]	:	:	:	:	:	:
Total I	**17 850** [4) 5)]		**562** [5)]	**1 431** [5)]	**7 655** [5)]	**27 499** [5)]
Additional information						
Delay costs[2]	5 056		692	1 667	1000	8 415
Internal accident costs[2]	25 250		161	267	400	26 078
Material damages	6 985		48	65	97	7 194
Risk value	18 265		113	202	303	18 883
Environmental costs[6]						
Nature, landscape, soil and water pollution	:	:	:	:	:	:
Total II	**30 306**[4)7)]		**853**[7)]	**1 934**[7)]	**1400**[7)]	**34 493**[7)]
Revenues	257	14 138	227	847	1 932	17 400
Fixed						
Vignette	.	.	.	.	.	.
Annual circulation tax	:	:	:	:	:	5 214
Variable						
Fuel tax	:	:	:	:	:	12 186
Eco tax[8]	.	.	.	.	.	.
Distance related infrastructure charges[9]	.	.	.	.	.	.
VAT[10]	:	:	:	:	:	1 919
Total						**17 400** [11)]
Basic data						
Million vehicle km	9 921	233 191	2 041	16 716	14 937	276 806

1) Including special and agricultural vehicles. – 2) Here urban roads. –– 3) Total road noise costs of € 6245 million cannot be allocated to road type.– 4) Motor cycle and passenger cars. – 5) Excluding noise costs. - 6) No additional environmental costs calculated for other (urban) roads. – 7) Delay and internal accident costs only. – 8) Eco tax introduced 1999. – 9) No distance related infrastructure charges before 2003. – 10) VAT on fuel tax. – 11) Not including VAT on fuel tax.

Source: Link et al. (2002)

4.2 Rail transport – National rail carrier Deutsche Bahn AG (DB Netz, DB Regio, DB Fernverkehr & Touristik, DB Cargo)

Table 10
German rail account for DB 1996, 1998 and 2005
– € million at 1998 prices –

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs	12 447	12 621	*14 012*
Fixed	:	:	*:*
Variable	:	:	*:*
Services			
Supplier operating costs[1]	7 200	7 336	*7 699*
Accident costs (user external)[2]	55	83	*111*
Environmental costs[2]	1 335	1 403	*1 538*
Air pollution	253	220	*200*
Global warming	151	152	*179*
Noise	931	1 031	*1159*
Total core social costs	**21 037**	**21 443**	**23 360**
Additional information			
Congestion costs[2) 3)]	584	682	*902*
Accident costs (user internal)[2]	:	:	*:*
From this: risk value	591	581	*773*
Environmental costs[2]			
Nature and landscape, soil and water pollution[4]	41.0	41.0	*48.0*
Nuclear risk[4]	0.2	0.2	*0.3*
Revenues			
Directly related to Supplier Operating Costs [5]			
Subsidies for concessionary fares	3 815	4 244	*:*
User Tariffs [6]	8 130	8 614	*:*
Total	**11 945**	**12 858**	
Additional Information			
Revenues directly related to infrastructure costs (DB Netz)			
Track charges[7]	3 620	3 873	*4 090*
Fixed	0	:	*0*
Variable	3 620	:	*4 090*
Station charges[8]	:	693	*780*
Other transport specific revenues			
Fuel tax	236	217	*144*
Eco tax[9]	0	0	*69*
VAT[10]	35	34	*34*
Subsidies[11]	10 524	7 175	*:*
Non-transport related revenues of rail companies	:	:	*:*

[1] Excluded from these costs and revenues are rail track and station charges of € 3508 million for 1996, €4267 million for 1998 and estimate of € 4507 million for 2005. These represent a monetary transfer between DB companies. – [2] Totals for German National and other German rail companies. – [3] Expressed as delay costs. Totals for German National and other German Rail Companies – [4] Because there is no standardised methodology for the calculation of these costs, the figures given here are to be regarded only as approximate indications that may change greatly over time with the development of a standard methodology. – [5] All DB companies except DB Netz.– [6] Subsidies and VAT are excluded – [7] Track access charges paid both by DB companies (DB Regio, DB Fernverkehr & Touristik, DB Cargo) and by other users of DB Netz. – [8] Station charges paid both by DB companies (DB Regio, DB Fernverkehr & Touristik, DB Cargo) and by other users of the DB network – [9] Eco tax introduced in 1999 and collected together with fuel tax. – [10] VAT levied on fuel and eco tax. Totals for National and non-national rail. – [11] Subsidies included here refer to subsidies given for debt relief, for the provision of rail services etc. These subsidies can clearly not be allocated to either the cost or to the revenue side of this table. Subsidies are in cash flow terms and are not on the same basis as the economic costs.

Source: Link et al. (2002)

The German rail market is characterised by one dominating company, the national rail company Deutsche Bahn AG (DB). The DB is obliged to separate transport and infrastructure accounts at least at the bookkeeping level and has set up three transport companies and two infrastructure companies to meet this requirement. Track and station charges paid by DB transport companies to the appropriate DB infrastructure providers represent a monetary transfer between DB companies only. Access charges paid by other non-DB rail companies represent only 7% of the total access charges paid to DB infrastructure companies. Because an unknown part of the rail ticket price is based on and pays for track access charges, it is not possible to add ticket revenues and revenues from track access charges to build, with other components of rail revenues, the total revenues of German rail. This would cause the double counting of the unknown part of the ticket price that pays for infrastructure use. For this reason, we have excluded rail access charges from the total revenue sum. These revenues must be considered, however, when looking at the costs and revenues of the infrastructure and/or supplier operating costs cost categories.

Within the German pilot account (Link et al. 2002) an account for other German non-national rail companies is also presented. These rail companies provide approximately 1% of all rail passenger kilometres in Germany and less than 1% of all rail freight km. Although the cost and revenue structure of German non-national rail is interesting as a comparison to the national rail company, it is of minor importance within the transport sector and therefore not included within this summary report.

As it can be seen from table 10 the largest cost blocks in the rail account for DB are infrastructure costs (€ 12.6 billion) followed by supplier operating costs (€ 7.3 billion). Note, that the figure for supplier operating costs given in table 10 excludes the charges paid by the DB companies to DB Netz for access to track and stations. These charges, totalling € 4.3 billion, were excluded in order to avoid double counting. However, track and station charges make up more than one third of the total supplier operating costs of € 11.6 billion and should be considered when reviewing this cost category separately . Total core and additional environmental costs are, at € 1.4 billion, the highest block of the remaining cost categories. Note that the figures for environmental costs, accident costs and congestion costs also include other German rail companies because the available data did not allow a separation of DB and other rail carriers. For 2005, accident costs and congestion costs are estimated to be those costs with the highest increases compared to 1998 (both categories show a growth by almost one third). Expected cost reduction programmes will only lead to a moderate increase of supplier operating costs (5% estimated) while the necessary infrastructure investments (both replacement and new investments) will be responsible for an increase of infrastructure costs by 11%.

Total rail transport related revenues, excluding all subsidies except those granted for concessionary fares (which can be seen as a payment of services) and excluding track and station charges (in order to avoid double counting) amounted to € 13.1 billion in 1998. Out of these the most important block is user tariffs, including subsidies for concessionary fares, which amounted to € 12.9 billion. For comparing these revenues with supplier operating costs it is necessary to add the figure for supplier operating costs given in table 10 (€ 7.3 billion) to the charges paid for track and station access (€ 4.3 billion) since access charges are an important cost block for the companies. This means that finally revenues of € 12.9 billion relate to costs of € 11.6 billion. Infrastructure user charges consisting of rail track access charges and station charges to be paid by all infrastructure users, e.g. also third parties, were € 4.6 billion. This revenue category relates directly to infrastructure costs totalling € 12.6 billion. The share of direct infrastructure user charges is higher in the rail sector than in the road sector. If we exclude the tariff revenues (since this category was not estimated for the road account) we can state that rail infrastructure user charges represent 94% of total revenues in the rail account compared to 1% in the road account. Again one can see here the historical evolution of taxation and charging regimes: with the opening up of the DB network in 1994 a change towards direct user charges was introduced.

Due to the extremely high level of uncertainty in the German rail sector we were not able to estimate tariff revenues and subsidies for 2005. The revenues from track and station access charges were estimated to increase by 7%. Although the eco tax also concerns diesel consumption in rail transport, we have estimated a slight decrease in fuel tax to be paid by DB. The reason for this is firstly the decreasing share of services operated with diesel trains, and secondly the assumption that more of the tendered services in regional passenger transport will be operated by non-DB companies.

Comments on specific cost categories

Infrastructure costs

Rail infrastructure costs were calculated using the perpetual inventory model and are for German National Railways (DB) only.

Supplier operating costs

Data for estimating supplier operating costs was taken from the aggregated profit and loss statement of the DB and estimates made by the DIW.

Congestion costs

The delay costs for rail transport are based on a punctuality study carried out by the German consumer's society. This study reports on average delay statistics for selected railway stations in Germany. The use of this study as the basis for delay costs implies some uncertainty within the results, but as delay statistics for rail are not routinely recorded it remains the only available alternative. The methodology used is as described in chapter 3.

The results of the study are highly dependant on the value of time used and represent almost exclusively passenger costs as the value of time for freight is low per tonne when compared to passenger values. From the total overall transport delay costs, less than 4% can be attributed to rail transport, signalling once again the relative insignificance of rail transport when compared to road transport.

Accident costs

The data for rail accident costs cannot be split between the German National Railways and other German railway companies as only one figure is published by the German Office of Statistics for all rail transport. In contrast to road transport the underreporting of accidents was not problematic. The methodology explained in chapter 3 was used.

As in road transport, the major accident component is the risk value. Production losses are the second major component and all other accident costs are negligible. It should be remembered however, that because of the lack of data, material damage could not be estimated.

Environmental costs

The basic data for rail transport within Germany is of good quality. Because no split between emissions from German National Rail (DB) and other rail companies could be made, the environmental costs for all railway companies are presented here. Even if this split was possible, the amount of transport carried out by private rail companies is so small compared to the DB, that the results in the environmental analysis for non-DB rail would be insignificant. The methodology used is described in chapter 3.

The major costs are related to noise pollution but the basis used to calculate noise emissions is from 1992 and values could change with an updated input. The costs of air pollution and global warming are much lower in comparison to road transport and reflect the high share of electric traction from non-fossil fuel power plants used by German railways.

Taxes, charges and subsidies

Rail revenues related to track access charges, station charges and tariff revenues are documented by DB and used in this study. Fuel taxes paid on diesel fuel were the only relevant taxes for this mode. Subsidies associated with the transformation of the DB into a private rail company have been given since 1994. In the account year (1998) these subsidies were mainly related to administrative and personnel costs. Even though these subsides are decreasing they still amounted to over € 7 billion in 1988.

The average variable costs of rail transport are shown in table 11.

Table 11
Average variable costs of rail transport per vehicle km: Germany National Rail
- €/train km at 1998 prices -

National Rail (DB)		
	1998	
	Passenger	Freight
Core information		
Infrastructure costs	:	:
Fixed	:	:
Variable	:	:
External accident costs[1) 2)]	0.651	0.498
Administrative		
Health costs	:	:
Production loss	:	:
Environmental costs[1)]	1,334	2,251
Air pollution	0.256	0.203
Global warming	0.156	0.207
Noise	0.922	1.841
Total I	:	:
Additional Information		
Delay costs[1)]	0.617	0.617
Internal accident costs[3)]	:	:
Material damages	:	:
Risk value	:	:
Environmental costs[1)]		
Nature, landscape, soil and water pollution [4)]	0.037	
Nuclear risk	0.002	0.003
Total II	:	:
Revenues		
User tariffs	:	:
Track charges	:	:
Station charges	:	:
Fuel tax	:	:
Eco tax[5)]	.	.
VAT[6)]	:	:
Subsidies	:	:
Basic data		
Passenger km (bill)	72	.
Tonne km (bill)	.	74

[1)] All German Rail (national rail and other rail companies). – [2)] Internal and external accident costs. – [3)] Included in core account. - [4)] No allocation to freight/passenger transport possible. – [5)] Eco tax introduced in 1999. – [6)] VAT on fuel tax.

Source: Link et al. (2002)

Table 12 shows the total costs of rail transport for passenger and freight transport.

Table 12
Total costs of rail transport: Germany National Rail (DB)
- € million at 1998 prices -

National Rail (DB)			
	1998		
	Passenger	Freight	Total
Core information			
Infrastructure costs	:	:	12 621
Tracks	:	:	10 277
Fixed	:	:	:
Variable	:	:	:
Stations[1)]			2 343
Fixed	:	:	:
Variable	:	:	:
Supplier operating costs	:	:	11 603
Out of these: track + station charges	:	:	4 267
External accident costs[2)]	71.3	11.9	83.2
Administrative	0.2	0.0	0.2
Health costs	1.8	0.3	2.1
Production loss	69.3	11.6	80.9
Environmental costs[2)]	919	485	1403
Air pollution	176	44	220
Global warming	108	45	152
Noise	635	396	1 031
Total I (excluding track and station charges)			**21 443.3**
Additional information			
Delay costs[2)]	673	9	682
Internal accident costs[2)]	:	:	:
Material damages	:	:	:
Risk value[1)]	:	:	581
Environmental costs[2)]			41.2
Nature, landscape, soil and water pollution[1)]	:	:	41
Nuclear risk	0.1	0.1	0.2
Total II	:	:	**1 304.2**
Revenues			
User tariffs	5 228	3 386	8 614
Subsidies for concessionary fares	4 244		4 244
Track charges[1)]	:	:	3 873
Station charges[1)]	:	:	693
Fuel tax	185	32	217
Eco tax [3)]	.	.	.
VAT[4)]	29	5	34
Total (excluding track and station charges)			**13 109**
Subsidies			**7 175**
Basic data			
Passenger km (bill)	72	.	
Tonne km (bill)	.	74	

[1)] No allocation to passenger and freight transport possible. – [2)] All German Rail (national rail and other rail companies). - [3)] Eco tax introduced in 1999. – [4)] VAT on fuel tax.

Source: Link et al. (2002)

4.3 Public transport: tram, metro and trolley bus

Table 13
German account for metro, tram, trolley bus 1996, 1998 and 2005
- € million at 1998 prices -

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs	:[1)]	:[1)]	*:[1)]*
Fixed	:	:	*:*
Variable	:	:	*:*
Services			
Supplier operating costs	:	:	*:*
Accident costs (user external)	5	6	*7*
Environmental costs[2)]	:	:	*:*
Air pollution	22	21	*25*
Global warming	24	24	*28*
Noise	:	:	*:*
Additional information			
Congestion costs[2)]	121	125	*149*
Accident costs (user internal)[2)]	24	25	*29*
From this: risk value	17	19	*22*
Environmental costs[2)]			
Nature and landscape, soil and water pollution[5)]	:	:	*:*
Nuclear risk[5)]	0	0	*0*
Revenues			
Directly related to a specific cost category			
Charges for infrastructure usage	:	:	*:*
Fixed	:	:	*:*
Variable	:	:	*:*
Subsidies for concessionary fares[3)]	1485	1622	*1650*
User Tariffs[3) 4)]	6944	7262	*7150*
Other transport specific revenues			
Fuel tax[7)]	:	:	*:*
Eco tax[7)]	:	:	*:*
VAT[2)]	:	:	*:*
Subsidies[6)]	:	:	*:*

[1)] Capital costs as part of total infrastructure costs amounted to € 2060 million in 1996, € 2067 million in 1998 and € 2246 million in 2005. No running cost estimates available. – [2)] Buses are included in the road account. – [3)] Including buses. - [4)] Subsidies and VAT are excluded. – [5)] Because there is no standardised methodology for the calculation of these costs, the figures given here are to be regarded only as approximate indications that may change greatly over time with the development of a standard methodology. – [6)] Subsidies included here include subsidies given for the provision of infrastructure, for debt relief, for the provision of rail services etc. These subsidies can clearly not be allocated to either the cost or to the revenue side of this table. Subsidies are in cash flow terms and are not on the same basis as the economic costs. – [7)] Eco tax and VAT on eco tax for electric traction of tram and metro operation not available.

Source: Link et al. (2002)

It was not possible to elaborate a complete pilot account for this segment of the German transport system. Infrastructure costs, supplier operating costs and noise costs could not be quantified due to methodological and/or data problems. Note furthermore, that buses are included in the road account except for subsidies and user tariffs – which are totals.

The public transport account shows low accident and external costs whereby environmental costs refer to air pollution and global warming only. Congestion costs were estimated to € 125 million with an increase by 19% to 2005. It could be expected that infrastructure and supplier operating costs would form the largest cost block if it were possible to quantify them. This view is supported by the fact that capital costs of tram and metro infrastructure, a cost part which could be estimated with the available data, amounted to € 2067 million in 1998. For 2005 an increase by 9% was forecast.

User tariffs and subsidies for concessionary fares form, at € 8.9 billion, the most important component on the revenue side. Charges for infrastructure use do not exist for tram and metro infrastructure since these companies are vertically integrated. It was not possible to quantify subsidies other than those granted for concessionary fares.

Comments on specific cost categories

Infrastructure costs

Infrastructure costs for bus transport are included in the road account. Urban railway lines are included in the rail account. The estimation of capital costs of tram and metro lines only are considered in this account. No running costs could be estimated.

Supplier operating costs

The information available is not adequate to estimate supplier operating costs for non-rail public transport.

Congestion costs

The basic data (metro, trams and trolley buses only) used to estimate delay costs in public transport is good. Estimations of occupancy rates had to be made but are plausible when compared to other studies. The methodology used is described in chapter 3.

Congestion costs (expressed as delay costs) totalling €125 million are the major cost factor for public transport and are higher than all other costs together. This is mainly because of the incomplete data situation for the remaining cost categories and the results should not be interpreted as disproportionally high congestion costs for public transport.

Accident costs

Only accident costs for trolley buses and trams are considered. The major components of public transport accident costs are the risk value and the costs associated with material damage. If buses were considered in this category the accident costs would increase considerably.

Environmental costs

The basic data used for this category is based on the electricity used to run electrically driven public transport modes. The data was available and is of good quality. The methodology used is outlined in chapter 3. Buses are accredited to the road account. Urban rail systems (for example the German S-Bahn System) are considered under railways. No costs could be calculated for noise as these costs cannot be separated from the road and rail accounts.

The environmental costs associated with public transport (in this section only mass rapid transport, tramways and trolley buses are covered) are only related to the production of electrical energy for traction and for this reason remain low. If bus transport using diesel fuel for example could be taken from the road account and put into the public transport account, the totals for the environmental costs would increase dramatically.

Taxes, charges and subsidies

Taxes and charges which can be directly allocated to infrastructure use do not exist in Germany for public transport. Fuel taxation is included in the road account for buses and in the rail account for urban rail transport. Subsidies for concessionary fares could be included in the account.

In table 14 we have attempted to show the average variable costs of metro, tram and trolley bus services. As can it be seen from the table more research is needed in this area. In order to obtain better figures for this transport mode, some form of central data collection must be developed. In table 15, the total costs of public transport (metro, tram and trolley bus) are shown disaggregated by vehicle type.

Table 14
Average variable costs of metro, tram, trolley bus per vehicle km: Germany
- €/km at 1998 prices –

	1998	
	Metro and other	Tram and trolley bus
Core information		
Infrastructure costs	:	:
Fixed	:	:
Variable	:	:
Supplier operating costs	:	:
External accident costs[1)]	:	0.1109
Administrative	:	:
Health costs	:	:
Production loss	:	:
Environmental costs	0.06446	0.08677
Air pollution	0.03028	0.04076
Global warming	0.03418	0.04601
Noise	:	:
Total I	:	:
Additional information		
Delay costs	:	0.0720
Internal accident costs [2)]	:	:
Material damages	:	:
Risk value	:	:
Environmental costs	:	:
Nature, landscape, soil and water pollution	:	:
Nuclear risk	0.00005	0.00007
Total II	:	:
Revenues		
User tariffs	:	:
Subsidies	:	:
Basic data		
Passengers carried (million)	7762	
Passenger km (bill)	76	

[1)] Both external and internal accident costs. – [2)] Included in external accident costs, core account.

Source: Link et al. (2002)

Table 15
Total costs of metro, tram, trolley bus: Germany
- € million at 1998 prices -

	1998		
	Metro and other	Tram and trolley bus	Total
Core information			
Infrastructure costs	:	:	:
Fixed	:	:	:
Variable	:	:	:
Supplier operating costs	:	:	:
External accident costs	:	6.2	:
Administrative	:	0.1	:
Health costs	:	0.4	:
Production loss	:	5.7	:
Environmental costs	24	22	45
Air pollution	11	10	21
Global warming	13	12	24
Noise	:	:	:
Total I	:	:	:
Additional information			
Delay costs	:	125	:
Internal accident costs	:	25	:
Material damages	:	6	:
Risk value	:	19	:
Environmental costs	:	:	:
Nature, landscape, soil and water pollution	:	:	:
Nuclear risk	0	0	0
Total II	:	:	:
Revenues			
User tariffs	:	:	7262
Subsidies	:	:	1622
Basic data			
Passengers carried (million)			7762
Passenger km (bill)			76

Source: Link et al. (2002)

4.4 Aviation

Table 16
German air transport account for 1996, 1998 and 2005
- € million at 1998 prices -

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs[1)]	3 475	3 488	*4 707*
Fixed	:	:	*:*
Variable	:	:	*:*
Accident costs (user external)	24	35	*53*
Environmental costs	817	874	*1315*
Air pollution	151	162	*239*
Global warming	406	434	*692*
Noise	260	278	*384*
Total	**4316**	**4397**	***6075***
Additional information			
Congestion costs[2)]	121	147	*245*
Accident costs (user internal)	:	:	*:*
From this: risk value	171	176	*267*
Environmental costs			
Nature and landscape, soil and water pollution[3)]	70	71	*82*
Nuclear risk[3)]	:	:	*:*
Revenues[4)]			
Directly related to a specific cost category			
Charges for infrastructure usage			
Airport revenues	2 925	3 121	*4 690*
ATM charges	872	767	*1 065*
Meteorological services	63	48	*50*
Total	**3 860**	**3 936**	***5 805***
Loss of revenues due to tax exemptions			
Kerosene tax[5)]	:	-2 262	*:*
VAT on ticket price[5)]	:	-252	*:*
Other transport specific revenues			
Fuel tax	0	0	*:*
Eco tax[6)]	0	0	*:*
VAT[7)]	0	0	*:*
Subsidies[8)]	:	:	*:*
Non-transport related revenues of airports	:	:	*:*

[1)] All infrastructure costs including those for non-transport related business. Includes also National Air Traffic Control (DFS) and National Meteorological Service (DWD). – [2)] Expressed as delay costs. Costs based on statistics from the three main German airports (Frankfurt, Düsseldorf and Munich) only and represent approximately 58% of all air traffic.– [3)] Because there is no standardised methodology for the calculation of these costs, the figures given here are to be regarded only as approximate indications that may change greatly over time with the development of a standard methodology. – [4)] Including revenues from non-transport related business. – [5)] For Lufthansa only.– [6)] Eco tax introduced in 1999 and collected together with fuel tax. – [7)] VAT levied on fuel and eco tax.– [8)] Subsidies included here include subsidies given for the provision of infrastructure, for debt relief, for the provision of services etc. These subsidies can clearly not be allocated to either the cost or to the revenue side of this table. Subsidies are in cash flow terms and are not on the same basis as the economic costs.

Source: Link et al. (2002)

By far the largest cost block in 1998 was infrastructure costs which amounted to € 3.5 billion. Total core and additional environmental costs were estimated to be € 945 million. Total social costs of accidents and congestion costs amounted to € 211 million and € 147 million respectively. Aviation is the mode where between 1998 and 2005 the highest cost increases for all categories were estimated: infrastructure costs will increase by 35%; external accident costs by 51%; environmental costs by 50%; and, congestion costs by 67%. The reason for this is first of all the underlying transport forecast which estimated for aviation high increases of passenger-km and aircraft movements. Furthermore, expansion projects of airports (Frankfurt and the new Berlin-Brandenburg airport) contribute in particular to the increase of infrastructure costs. Congestion costs are estimated to be the cost block which will increase most dramatically.

Infrastructure related revenues (e.g. airport revenues, ATM charges, charges for meteorological services) were estimated at € 3.9 billion in 1998. It is expected that they will increase by 47% to € 5.8 billion in 2005. This will mainly be caused by an increasing number of passengers carried.

According to the conventions set for the UNITE, accounts can report indirect subsidies as supplementary data. Indirect subsidies play a major role in the aviation sector. Commercial aviation is exempted from paying kerosene tax and no VAT is levied on the ticket price for international flights. According to a DIW study on subsidies in the aviation sector (see DIW 2001) the tax loss due to the lack of kerosene taxation amounted in 1998 to € 2262 million (calculated as weighted average tax rate in the EU countries of 0.39 Euro/litre) and the VAT loss to € 252 million for the Lufthansa Group of airlines alone.

Comments on specific cost categories

Infrastructure costs

Input data for infrastructure costs is of good quality. Calculation of the capital stock was carried out using the PIM. Running costs were calculated using data supplied by the Association of German Airports. German air traffic control and German meteorological services were also included in the calculations. It was not possible to exclude non-transport related infrastructure costs from the account.

Congestion costs

For the calculation of congestion costs (expressed as delay costs) delay statistics only from the three main German international airports (Dusseldorf, Frankfurt and Munich airports) could be utilised. This means that only 57.9% of flight movements were studied. The results shown here (€ 147 million) were not extrapolated to 100% but show results for the available data only. The methodology used is described in chapter 3.

Accident costs

The major accident cost for the aviation sector is the risk value. This represents the importance of air safety to society. All other accident costs are low in comparison. Data needed for the estimation of material damage was not available and this cost segment was not included in the evaluation.

Environmental costs

Environmental costs for the aviation sector are based on Landing and Take-off cycles at 52 German airports and the civil aviation fuel tanked in Germany. The estimated costs of aviation are dominated by global warming due to the high emissions of CO_2 in this transport mode. Direct and indirect emissions of air pollutants are considered in the air pollution costs but are considerably lower than the CO_2 emission avoidance costs.

Estimates for noise exposure are based on data from 1990. It is assumed that the renewal of the aircraft with quieter aircraft compensates the increase in aircraft movements from 1990 to 1996. From 1996 to 1998 and from 1998 to 2005 increases in noise exposure costs are assumed to be proportional to the increase in aircraft movements.

In table 17 the average variable costs of passenger and cargo air transport per kilometre are shown. An exception are delay costs which are shown per arriving flight for approximately 58 % of all flights and all environmental costs which are shown per aircraft landing/take-off cycle (2 360 000 LTO for 52 German airports in 1998).

Table 17
Average variable costs of Aviation per vehicle km or movement: Germany
– €/km at 1998 prices –

	1998	
	Passenger	Cargo
Core information		
Infrastructure costs	:	:
Fixed	:	:
Variable	:	:
External accident costs[1)]	0.4507	0.4507
Administrative	:	:
Health costs	:	:
Production loss	:	:
Environmental costs[2)]	:	:
Air pollution	68.54	
Global warming	183.90	
Noise	117.98	
Total I	:	:
Additional information		
Delay costs: per arriving flight	387	387
Internal accident costs [3)]	:	:
Material damages	:	:
Risk value	:	:
Environmental costs[2)]	:	:
Nature, landscape, soil and water pollution	30	
Nuclear risk	•	•
Total II	:	:
Revenues		
Charges for infrastructure usage	:	:
Airport revenues	:	:
ATM charges	:	:
Meteorological services	:	:
Fuel tax	0	0
Eco tax[4)]	0	0
VAT[5)]	0	0
Subsidies		
Exemption for kerosene tax	:	:
Exemption of VAT on ticket price	:	:
Basic data		
Passenger km (bill)	38	•
Tonne km (bill)	•	0.7

[1)] Both external and internal accident costs. – [2)] No allocation to passenger/cargo possible. – [3)] Included in external accident costs, core information – [4)] Eco tax introduced in 1999. – [5)] VAT on fuel tax.

Source: Link et al. (2002)

In table 18 the total costs are disaggregated between passenger and freight transport.

Table 18
Total costs of Aviation: Germany
- € million at 1998 prices -

	1998		
	Passenger	Cargo	Total
Core information			
Infrastructure costs[1]	:	:	3 488
Fixed	:	:	:
Variable	:	:	:
External accident costs	30	5	35
Administrative	0.1	0	0.1
Health costs	1.0	0.1	1.2
Production loss	28.6	5.1	33.7
Environmental costs[1]			874
Air pollution	:	:	162
Global warming	:	:	434
Noise	:	:	278
Total I	:	:	**4397**
Additional information			
Delay costs	146	1	147
Internal accident costs			
Material damages	:	:	:
Risk value	:	:	176
Environmental costs[1]			
Nature, landscape, soil and water pollution	:	:	71
Nuclear risk	•	•	•
Total II	:	:	**394**
Revenues[1]			
Charges for infrastructure usage			
Airport revenues	:	:	3 121
ATM charges	:	:	767
Meteorological services	:	:	48
Fuel tax	0	0	0
Eco tax[2]	0	0	0
VAT[3]	0	0	0
Total	:	:	**3 936**
Subsidies			
Exemption for kerosene tax[4]	:	:	-2 262
Exemption of VAT on ticket price[4]	-252	:	-252
Total	:	:	**-2 514**
Basic data			
Passenger km (bill)	38	•	
Tonne km (bill)	•	0.7	

[1] No allocation to passenger/cargo possible. - [2] Eco tax introduced in1999. – [3] VAT on fuel tax. - [4] Lufthansa only.

Source: Link et al. (2002)

4.5 Inland waterways

Table 19
German inland waterway account for 1996, 1998 and 2005
- € million at 1998 prices -

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure costs – inland waterways	1 178	1 203	*1 303*
Fixed	:	:	*:*
Variable	:	:	*:*
Infrastructure costs – inland waterway harbours	:	:	*:*
Fixed	:	:	*:*
Variable	:	:	*:*
Accident costs (user external)	4	2	*3*
Environmental costs	251	198	*254*
Air pollution	199	143	*184*
Global warming	52	55	*70*
Noise	0	0	*0*
Total	**1 433**	**1 403**	***1 560***
Additional information			
Congestion costs[1)]	:	:	*:*
Accident costs (user internal)	:	:	*:*
From this: risk value	12	8	*11*
Environmental costs			
Nature and landscape, soil and water pollution[2)]	7	7	*8*
Nuclear risk[2)]			
Revenues			
Directly related to a specific cost category			
Charges for infrastructure usage[3)]	76	75	*85*
Fixed	0	0	*0*
Variable	76	75	*85*
Total	**76**	**75**	***85***
Other transport specific revenues			
Fuel tax	0	0	*0*
Eco tax[4)]	0	0	*0*
VAT[5)]	0	0	*0*
Subsidies [6)]	12	15	*:*
Non-transport related revenues of ports	:	:	*:*

[1)] Expressed as delay costs. – [2)] Because there is no standardised methodology for the calculation of these costs, the figures given here are to be regarded only as approximate indications that may change greatly over time with the development of a standard methodology. – [3)] Excluding charges for pilotage due to lack of data. – [4)] Eco tax introduced in 1999 and collected together with fuel tax. – [5)] VAT levied on fuel and eco tax. .– [6)] Subsidies included here include subsidies given for the provision of infrastructure, for debt relief, for the provision of services etc. These subsidies can clearly not be allocated to either the cost or to the revenue side of this table. Subsidies are in cash flow terms and are not on the same basis as the economic costs.

Source: Link et al. (2002)

Infrastructure costs play the major role in inland waterway transport. This can be stated even though we were not able to estimate the infrastructure costs of inland waterway harbours due to lack of data. The available figures (total infrastructure costs of € 1 203 million for inland waterways and capital costs, as an important part of infrastructure costs, of inland waterway harbours of about € 300 million) confirm this. The low figures for accident and environmental costs show that inland navigation is an environmentally friendly and safe mode of transport. For 2005, an increase of infrastructure costs by 8%, of accident costs by 40% and of environmental costs of 28% was estimated.

Inland waterway transport is a mode where the infrastructure costs of transport are not covered by infrastructure user charges. Charges for the use of waterways amounted in 1998 to € 75 million only compared to infrastructure costs of € 1.2 billion. Note, that similar to air transport no fuel taxes have to be paid, which has to be considered as an indirect subsidy. The amount of this indirect subsidy, however, was not estimated within the UNITE project.

Comments on specific cost categories

Congestion costs

There is only little knowledge about delay costs associated with inland waterway shipping. No formal statistics for this transport mode are kept in Germany and no estimation of the associated costs could be made.

Accident costs

The total accident costs for inland waterway shipping are very small and represent only a fraction of the total transport accident costs.

Environmental costs

The major environmental costs of inland waterway transport are attributed to air pollution. Noise costs are insignificant and the costs related to global warming are low compared to other modes.

4.6 Maritime shipping

Maritime shipping is the only mode where we were not at all able to compile any figure on costs and revenues except from capital values and capital costs. This reflects the very poor data situation within this transport mode. The gross capital stock value was € 20.2 billion for seaports in 1998. The net value was € 13.9 billion. From these values capital costs of € 779 million were derived. For methodological reasons, the environmental costs of maritime shipping will be evaluated for all European countries together, and presented within tranche C of the accounts.

For the remaining categories, the available data cannot provide a sufficient basis for an estimate of costs and revenues.

Tables 20 and 21 show the fully allocated and total costs of water transport disaggregated by shipping mode. It is obvious, that more research is needed in these areas.

Table 20
Average variable costs of Inland Waterways and maritime shipping per vehicle km: Germany
- €/km at 1998 prices -

	1998	
	Inland waterways	Maritime shipping
Core information		
Infrastructure costs	:	•
Inland waterway harbours	:	•
Fixed	:	•
Variable	:	•
Inland waterways		
Fixed	:	•
Variable	:	•
Sea harbours		
Fixed	•	:
Variable	•	:
External accident costs[1)]	0.515	:
Administrative	:	:
Health costs	:	:
Production loss	:	:
Environmental costs	3.7080	:
Air pollution	2.6812	:
Global warming	1.0268	:
Noise	0	:
Total I	:	:
Additional information		
Delay costs	0	0
Internal accident costs[3)]	:	:
Material damages	:	:
Risk value	:	:
Environmental costs	0.1294	:
Nature, landscape, soil and water pollution	0.1294	:
Nuclear risk	0	0
Total II	:	:
Revenues		
Charges for infrastructure usage	:	:
Fixed	:	:
Variable	:	:
Fuel tax	:	:
Eco tax[2)]	:	:
VAT	:	:
Subsidies	:	:
Basic data		
Goods transported (mill t)	236	214
Tonne km (bill t km)	64	1023

[1)] Both external and internal accident costs. - [2)] Eco tax introduced in 1999. - [3)] Included within external accident costs, core account.

Source: Link et al. (2002)

Table 21
Total costs of Inland Waterways and maritime shipping: Germany
- € million at 1998 prices -

	1998	
	Inland waterways	Maritime shipping
Core information		
Infrastructure costs		
Harbours		
Inland waterways	1203	•
Fixed	:	•
Variable	:	•
Sea harbours		
Fixed	•	:
Variable	•	:
Waterways		
Inland waterways		
Fixed	:	•
Variable	:	•
Maritime shipping		
Fixed	•	:
Variable	•	:
External accident costs		
Administrative	:	:
Health costs	0.1	:
Production loss	2.1	:
Environmental costs	198	:
Air pollution	143	:
Global warming	55	:
Noise	0	0
Total I		
Additional information		
Delay costs	0	0
Internal accident costs		
Material damages	:	:
Risk value	8	:
Environmental costs		
Nature, landscape, soil and water pollution	7	:
Nuclear risk	:	:
Total II		
Revenues		
Charges for infrastructure usage	75	:
fixed	0	:
variable	75	:
Fuel tax	0	:
Eco tax[1)]	0	:
VAT	0	:
Subsidies	15	:
Basic data		
Tonne km (bill t km)	64	1023

[1)] Eco tax introduced in 1999.

Source: Link et al. (2002)

5 Pilot account for Switzerland

Table 22 summarises the most important basic social and economic indicators for Switzerland.

Table 22
Basic indicators for Switzerland 1996 and 1998

	unit	1996	1998
Land area	sqkm	41 285	41 285
Population	1 000	7 081	7 124
Population density	Inhabitants/sqkm	172	173
Population employed[2)]	1 000	3 819	3 858
Employment Rate	%	53.2	53.4
GDP[1)]	€ billion	228.65	234.58
GDP per capita[1)]	€	32 291	32 928
GDP growth rate (change to previous year)	% (in prices of 1993)	0.30	2.10
Consumer price index	1993 = 100	103.4	104.0

[1)] At market prices. - [2)] The number of population employed is higher than the product of population and employment rate because the employment rate does not include cross-border commuters, seasonal workers etc.

Sources: Statistical yearbook for Switzerland (2001)

A similar overview over the most important basic indicators for the Swiss transport system is given in the table 23.

In the sections 5.1 to 5.5 the transport accounts for the five relevant transport modes of Switzerland are summarised, i.e.

- road transport
- rail transport
- non-rail public transport (buses, trolley buses and tram)
- air transport
- inland waterways

The five sections contain the main findings. More information is given in the Swiss Appendix Report (Suter et al., 2002). The comments to the following table refer first of all to the results shown for the UNITE base year 1998.

Table 23
Basic transport related indicators for Switzerland 1998

Indicator	Unit	Road	Rail	Public transport[1)]	Aviation	Total
Transport performance						
Passengers carried	Mill.	5 422.0	390.0	1 120.0	29.2	6 961.2
	%	77.9%	5.6%	16.1%	0.4%	100.0%
Passenger-km	Bill. Pkm	81.6	14.1[2)]	4.7	60.0[3)]	160.3
	%	50.9%	8.8%	2.9%	37.4%	100.0%
Goods transported	Mill. t	347.1	48.0	-	0.5	395.6
	%	87.7%	12.1%	-	0.1%	100.0%
Tonne-km	Bill. tkm	19.5	9.3	-	2.3	31.0
	%	62.9%	29.8%		7.3%	100.0%
Network length	1 000 km	71.21	5.04[4)]	0.51[5)]		76.8
Employees	1 000	n.a.	39.50[6)]	12.49[7)]	12.58[8)]	64.6
Gross investments	€ mill.	-	-	-	-	-
	%	-	-	-	-	-
Gross capital stock	€ mill.	-	-	-	-	-
	%	-	-	-	-	-
Accidents						
Number of injuries	Casualties	99 968	32	412	13	100 425
Number of fatalities	Casualties	597	32	0	30	659
Environment						
Direct transport emissions						
CO_2	Mill. t	13	[10)]	0.24[)]	0.47[12)]	13.75
PM_{10}	t (exhaust)	1 647	[10)11)]	180	n.a.	1 827
PM_{10}	t (non-exhaust)[9)]	4 151	[10)11)]	134	n.a.	4 285
NO_x	t	54 569	[10)]	3 400	1 790[13)]	59 759
SO_2	t	1 960	[10)]	56	149[13)]	2 165
NMVOC	t	33 853	[10)]	444	456[14)]	34 753

[1)] Includes urban and regional bus services, tram and trolley bus. – [2)] Figures for 1997. - [3)] Scheduled and charter traffic. - [4)] Figures for 1997. - [5)] Figures for tram and trolley bus only (1997). Length of road based public transport lines: Urban bus: 1 142 km (1997), Regional bus services: 14'086 km (1995/96). - [6)] Figures for 1997. - [7)] Figures for 1995. - [8)] Figures for 1996. - [9)] Total, no distinction made between more/less volatile particles. - [10)] No relevant diesel traction in Switzerland. - [11)] First estimate of PM10 emissions in Switzerland: 2'750 t (BUWAL, 2001). - [12)] Emissions from the LTO cycles at the three national airports (Zurich, Geneva, Basle), emissions of transit flights: 1.02 mill. t. - [13)] Emissions from LTO cycles at the three national airports. - [14)] Emissions from the LTO cycles at the three national airports and emissions during fuelling.

Sources: Suter et al. (2002)

5.1 Road transport

Table 24
Swiss road account for 1996, 1998 and 2005
€ million, at prices 1998

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs	4 018	4 030	*5 553*
Fixed			
Variable			
Accident costs (external)[1)]	895	925	*907*
Environmental costs	1 402	1 355	*1 200*
Air pollution	594	532	*386*
Global warming	287	302	*348*
Noise	521	521	*466*
Total	**6 315**	**6 310**	***7 660***
Additional information			
Congestion costs[2)]	529	587	*819*
Time costs	513	568	*795*
Fuel costs	16	19	*25*
Accident costs (internal)	6 494	6 743	*6 741*
From this: risk value	4 896	5 232	*5 278*
Environmental costs	40	45	*39*
Nature and landscape, soil and water pollution[3)]	40	45	*39*
Nuclear risk[3)]			
Revenues			
Directly related to a specific cost category			
Charges for infrastructure usage	254	266	*499*
Fixed	254	266	*141*
Variable[4)]			*358*
Total	**254**	**266**	***499***
Other transport specific revenues			
Annual vehicle tax	993	1 041	*933*
Fuel tax	2 757	2 858	*2 589*
Car import tax	80	125	*75*
VAT[5)]	177	192	*166*
Total	**4 007**	**4 216**	***3 763***
Subsidies			

[1)] Transport system external costs only: Included are those cost parts that are not borne by road users and insurance companies of the transport sector but by the public sector and third parties (i.e. uncovered payments of the social security, administrative and medical treatment costs not covered by payments of the auto liability insurance, production losses). The transport system internal costs are given below under "Additional information". – [2)] Total delay costs due to disturbed and congested traffic. – [3)] Because there is no standardised methodology for the calculation of these costs, the figures given here are approximate indications. – [4)] Introduction of the distance-dependent heavy vehicle fee in 2001. – [5)] Revenues from VAT refer on VAT raised on fuel tax part of petrol and diesel as well as the VAT on car taxes and duty payments for imports of vehicle components (revenues from VAT are officially regarded as revenues of the road account).

Source: Suter et al. (2002)

The total of the different cost categories given in the table above adds up to about € 13.7 billion which corresponds to approximately 5.8% of the Swiss GDP (UNITE base year 1998). The total social accident costs (sum of transport system internal and external costs) of more than € 7.6 billion are by far the highest cost block followed by the infrastructure costs. The largest part of the costs are borne by users within the road transport system: The total of the transport system external costs amounts to about € 2.3 billion or to almost 17% of the overall costs. Looking at the results for the year 2005, an increase of the total costs of road transport by more than 10% up to € 15.3 billion (in 1998 prices) can be estimated. This increase is first of all caused by higher infrastructure costs and congestion (user) costs. The overall lower environmental costs partly compensate these cost increases. The total social accident costs remain almost stable.

Comments on specific cost categories

Infrastructure costs

The estimation procedure and the results are based on data from the official national road account. Capital costs are calculated by a long term perpetual inventory method (considering an average depreciation rate and interest rates based on national refinancing costs). Road costs are allocated according to costs-by-cause principle. 45% of maintenance are weight dependent costs, according to axle weight factors.

The detailed analysis in Suter et al. (2002) shows that nearly 82% of total costs can be allocated to cars and 9% to trucks. A significant increase in infrastructure costs is to be expected by 2005 (+37.7%). This is mainly due to higher maintenance costs and new capital costs due to construction activities. The load related costs show an increase because of the ongoing increase in freight transport and the increased vehicle weight limit since 2001. At the same time HGV revenues will increase due to the new HGV-tax introduced in 2001.

Congestion costs

The methodological approach for congestion costs in road transport follows the methodology which was developed in a national study for 1998 (ASTRA/INFRAS 1998). The study embraces several basic approaches to estimate congestion costs on the Swiss road network (model calculations based on speed-flow relationships, traffic jam reports, model calculation for towns and cities, overall estimations based on differences between average travel speeds in peak-hours versus normal traffic conditions).

Values of time have been standardised for the UNITE pilot accounts (Nellthorp 2001). The UNITE value of time for Switzerland used in this document is low in comparison to official national Swiss values. Sensitivity calculations using Swiss values of time show an increase of congestion costs from 1996 to 2005 of more than 50%.

Accident costs

The estimate of accident costs is based on detailed information about the number and severity of road accidents in Switzerland as published annually by the Swiss Federal Statistical Office. Thanks to a special evaluation it was also possible to take into account non-reported accidents. Information from insurance companies, police departments, hospitals and public offices as well as from official statistics were used for the calculation of the different cost blocks (e.g. material damages, medical costs, production losses). The valuation of fatalities caused by road accidents starts from a common European value of statistical life (VOSL) of € 1.5 million / fatality (or € 1.77 million / fatality for Switzerland taking account of the higher income in Switzerland) as proposed for pilot accounts (see Nellthorp et al. 2001). For the valuation of injuries, a fraction of the UNITE VOSL is applied (light injury: 1%, severe temporary injury: 9%, severe permanent injury: 32%).

The estimate for the total social accident costs substantially exceeds available Swiss figures (e.g. about € 4.1 billion as estimated by Maibach et al. (1999) in a National Research Programme for the year 1995). The discrepancy is mainly caused by the comparatively high valuation of fatalities and especially injuries of road accidents within UNITE. This high valuation is reflected in the high risk value of € 5.2 billion. Almost 90% of the total social accident costs remain within the transport system: They are borne by the individual road users and the accident insurance. Therefore, the transport system external costs "only" amount to € 925 million, a figure which is confirmed in its order of magnitude by available estimates of the external road accident costs in Switzerland. Whereas between 1996 and 1998 the total social accident costs increased, the calculations for the year 2005 show a very slight decrease: Reductions in the accident rates overcompensate here the predicted increase in road traffic volumes.

Environmental costs

Air pollution: The costs of air pollution have been estimated (as for all UNITE countries) by applying the EcoSense model Bickel et al. (2000). Detailed geo-coded information about the emissions of air pollutants (NO_x, SO_2, NMVOC and particles) by road traffic from the Swiss Federal Office for Nature, Forests and Landscape (BUWAL 2000) were used as basic input for the bottom-up calculation of the costs of air pollution.

The result of € 532 million is much lower than the costs estimated in a WHO project (€ 2.2 billion for the year 1996, see Sommer et al. 1999). The reasons for this are lower levels of particle emissions emitted by road transport in Switzerland in the UNITE base year 1998 compared to 1996 on the one hand, and differences in the functions used for the calculations on the other hand. The functions describing long-term mortality are methodologically different. The discrepancy reveals the considerable uncertainty still connected with the valuation of adverse environmental impacts and damages to human health and it also shows the necessity to take further efforts to exchange and discuss these issues among specialists.

In road transport, the more frequent use of cleaner technologies seem to overcompensate the growth in traffic volume until 2005 – the costs of air pollution are expected to decrease between 1998 and 2005 by more than 25% though the traffic volume increases in the same period of time. This decreasing tendency is not new: In the year 1996 the costs of air pollution were about 10% higher than in 1998.

Global warming: The basic input data are the CO_2 emissions derived from the fuel consumption of road transport in Switzerland as published in BUWAL (2000). The valuation is based on a European average shadow value of € 20 per tonne of CO_2 emitted. This reflects the costs of meeting the Kyoto targets (central estimate of the range of values for meeting the Kyoto targets in 2010 in the EU based on estimates by Capros and Mantzos (2000): €5 per tonne of CO_2 avoided for reaching the Kyoto targets for the EU, assuming a full trade flexibility scheme involving all regions of the world; €38 per tonne of CO_2 avoided for the case that no trading of CO_2 emissions with countries outside the EU is permitted). Using this UNITE standard average value of €20/tonne, the costs of global warming are calculated to be €302 million for 1998. However, in Switzerland, a four times higher value of € 80 per tonne of CO_2 has been derived for the transport sector (see Suter et al. 2002, chapter 2.6.2). The calculations are based on the European average value following the general assumption that measures for reducing CO_2 emissions are taken in the most cost effective way, if they are based on reduction targets that are not set per sector and specific country but on more broadly defined targets that set incentives for the implementation of the cheapest avoidance measures, no matter in which sector and which European country. If the Swiss transport sector specific value is used the costs of global warming caused by road transport in Switzerland increases from € 302 million to € 1.2 billion. Whereas the costs of air pollution tend to decrease until 2005, this is not the case for global warming because CO_2 emissions will most probably show a further increase (costs +15%).

Noise: The calculations of the costs of noise suffer from rather old data about the population and properties exposed to road traffic noise. The valuation takes into account reduced values of real estates (hedonic pricing) and adverse effects on human health. The result given in the table is lower than existing Swiss estimates, e.g. about € 600 million for the year 1995 as given in Maibach et al. (1999). The difference of about 15% lies within the range of uncertainty of calculations in this external cost category. For the future, an improvement can be expected because of the realisation of comprehensive noise protection measures.

Nature, landscape and further environmental effects: The costs of nature and landscape are defined as the loss of ecological resources caused by the construction of transport infrastructure between a defined base year (1950) and today. The relevant infrastructure data are taken from official road and transport statistics.

About half of the road-based costs occur as costs for unsealing motorways. About 20% of the costs take into account the inter-urban and rural roads. Costs of habitat losses (barrier effect, etc.) are only taken into account for the larger motorways and not for the smaller inter-urban and rural roads.

Taxes, charges and subsidies

Only a very small part of the revenues is generated by charges immediately linked with infrastructure usage. This is only the case for the motorway vignette for cars and for the heavy vehicle fee - in 1998 still a fixed, from 2001 onwards a distance-dependent charge. The fuel tax is by far the most important source of revenues. In 1998, the revenues cover the total infrastructure costs. The situation is expected to change in the future (i.e. 2005).

The following two tables contain more detailed information for the year 1998 (table 26). Furthermore, cost and revenues per vehicle kilometre are derived (table 25).

Table 25
Average variable costs of road transport per vehicle-kilometre: Switzerland
€ / vkm, at prices 1998

	1998				
	Motor-cycles[1]	Passenger cars	Coaches and buses[2]	LGV	HGV[3]
Core information					
Infrastructure costs					
Fixed	-	-	-	-	-
Variable	-	-	-	-	-
(External) accident costs[4]	0.124	0.015	0.072	0.013	0.014
Environmental costs	0.062	0.017	0.201	0.025	0.148
Air pollution	0.005	0.006	0.121	0.012	0.074
Global warming	0.002	0.005	0.025	0.007	0.018
Noise	0.055	0.006	0.055	0.006	0.055
Total I					
Additional information					
Delay costs	-	0.012	-	0.005	0.009
Internal accident costs	0.739	0.065	0.353	0.051	0.053
Material damages	0.061	0.018	0.157	0.021	0.026
Risk value	0.678	0.047	0.196	0.030	0.027
Environmental costs	-	-	-	-	-
Nature, landscape, soil and water pollution	0.000	0.001	0.001	0.001	0.003
Total II					
Revenues					
Fixed	-	-	-	-	0.044
Car tax, import tax	-	-	-	-	-
Vehicle tax	-	-	-	-	-
Vignette	-	-	-	-	-
Heavy traffic tax	-	-	-	-	0.044
Variable	-	-	-	-	-
Fuel tax	-	-	-	-	-
Distance related infrastructure charges	-	-	-	-	-
VAT5)	-	-	-	-	-
Total					
Basic data					
Vehicle-kilometres (mill. vkm)	1 790	47 554	310	3 077	2 433
Passenger-kilometres (mill. pkm)	2 121	77 195	2 242		
Tonne-kilometres (mill. tkm)				1 344	18 160

[1] Includes mopeds. -[2] Privat an public buses. -[3] Only vehicles for goods transport. Agricultural vehicles and industria vehicles are not included. -[4] Includes external and internal accident costs. Because of the monitoring perspective of UNITE, the external accident costs cannot be allocated to the different vehicle categories unless arbitrary cost alloca is accepted. -[5] VAT on fuel tax.
Source: Suter et al. (2002)

Table 26
Costs and revenues of road transport in more detail: Switzerland
€ million, at prices 1998

	1998					
	Motor-cycles[1]	Passenger cars	Coaches and buses[2]	LGV	HGV[3]	Total
Core information						
Infrastructure costs	90.7	3 036.4	85.3	260.7	556.9	4 029.9
Fixed						
Variable						
(External) accident costs[4]	221.7	722.0	22.3	41.3	34.8	1 042.0
Administrative costs	92.0	481.5	16.5	30.2	27.0	647.1
Health costs	61.1	98.5	2.9	5.1	3.4	171.0
Production loss	68.6	142.0	2.9	6.0	4.4	223.9
Environmental costs	111.4	790.0	62.3	76.6	358.9	1 399.2
Air pollution	8.3	297.1	37.4	36.6	180.3	559.7
Global warming	3.9	229.4	7.7	22.9	43.8	307.7
Noise	99.2	263.5	17.2	17.1	134.8	531.8
Total I	**423.8**	**4 548.3**	**169.9**	**378.6**	**950.6**	**6 471.1**
Additional information						
Delay costs		550.0		16.0	21.0	37.0
Internal accident costs	1 321.4	3 101.5	109.3	159.4	127.9	1 717.9
Material damages	108.4	879.6	48.6	66.0	62.9	285.9
Risk value	1 213.0	2 221.9	60.6	93.4	65.0	1 432.0
Environmental						45.0
Nature, landscape, soil and water pollution	0.4	33.4	0.4	3.5	7.3	45.0
Total II	**1 321.8**	**3 684.9**	**109.7**	**178.9**	**156.2**	**1 799.9**
Revenues						
Fixed					107.0	1 432.0
Car tax, import tax						125.0
Vehicle tax						1 041.0
Vignette						159.0
Heavy traffic tax					107.0	107.0
Variable						3 050.0
Fuel tax						2 858.0
Distance related infrastructure charges						0.0
VAT[5]						192.0
Total	**89.9**	**3 391.4**	**35.3**	**338.7**	**626.9**	**4 482.2**
Basic data						
Number of vehicles	718 764	3 383 273	39 012	217 474	51 835	4 410 358

[1] Includes mopeds. - [2] Privat an public buses. - [3] Only vehicles for goods transport. Agricultural vehicles and industrial vehicles are not included. - [4] Includes external and internal accident costs. Because of the monitoring perspective of UNITE, the external accident costs cannot be allocated to the different vehicle categories unless arbitrary cost allocation is accepted. - [5] VAT on fuel tax.

Source: Suter et al. (2002)

5.2 Rail transport

Table 27
Swiss rail account for 1996, 1998 and 2005
€ million, at prices 1998

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs	2 768	2 762	*2 606*
Fixed			
Variable			
Supplier operating costs [1)]	2 251	2 095	*1 615*
Accident costs (external) [2)]	8.2	8.4	*7.0*
Environmental costs	63.4	64.2	*37.5*
Air pollution [3)]	3.6	4.5	*5.2*
Global warming	0.2	0.1	*0.1*
Noise	59.6	59.6	*32.2*
Total	**5 091**	**4 930**	***4 266***
Additional information			
Congestion costs	60	65	*79*
Accident costs (internal)	64	67	*58*
From this: risk value	56	58	*50*
Environmental costs	11.3	6.0	*7.9*
Nature and landscape, soil and water pollution [4)]	3.0	2.9	*2.8*
Nuclear risk [4)]	8.3	3.1	*5.1*
Revenues			
Directly related to Supplier operating costs			
User Tariffs [5)]	2 277	2 191	*2 145*
Additional information			
Revenues directly related to infrastructure costs			
Track and station charges	643	774	*774*
Fixed			
Variable			
Other transport specific revenues	0	0	*0*
Fuel tax			
Eco tax			
VAT			
Subsidies [6)]	1 733	1 621	*1 598*
Non-transport related revenues of rail companies [7)]	590	1 001	*609*

[1)] Excluded from these costs and revenues are rail track and station charges of € 643 million for 1996, € 774 million for 1998 and estimate of 774 million for 2005. – [2)] Transport system external costs only: Included are those cost parts that are not borne by rail users and insurance companies of the rail sector but by the public sector and third parties. The transport system internal costs are given below under "Additional information". – [3)] Emissions of particles not included.– [4)] Because there is no standardised methodology for the calculation of these costs, the figures given here are approximate indications. – [5)] Subsidies and VAT are excluded. – [6)] Subsidies include the provision of infrastructure, for debt relief, for the provision of rail services etc. – [7)] Not transport related revenues for the provision of infrastructure (stations, industrial areas and buildings etc.).

Source: Suter et al. (2002)

The total of the cost categories estimated for rail transport is significantly lower than for road transport: it amounts to approximately € 5.1 billion, or to about 37% of the figure assessed for road transport (without supplier operating costs: € 3 billion or about 21% of the costs of road transport). The largest cost blocks are the infrastructure and the supplier operating costs which are both in the same order of magnitude. The share of the transport system external part is significantly higher than for road transport: Almost 33% of the costs – about € 1.7 billion in absolute terms – are first of all borne by the public sector through subsidies and by third parties (accident and environmental costs).

For the future (i.e. the year 2005), a decrease of these costs by about 13% down to about € 4.4 billion (in 1998 prices) is estimated. The lower total costs are mainly the result of a decrease of supplier operating costs but also of infrastructure costs. The total amount of subsidies is estimated to stay rather stable between 1998 and 2005 (approximately € 1.6 billion, in 1998 prices). The same holds for the tariff revenues.

Comments on specific cost categories

Infrastructure costs

The yearly published official Swiss rail account (Swiss Federal Statistical Office) does not distinguish between infrastructure and operation. Thus a more detailed rail account was generated. The data input is based on the profit and loss accounts (divided into the categories infrastructure, transportation of passengers and freight) and the detailed asset and depreciation accounts carried out for all railway companies.

Since the separation between infrastructure and service provision is still in progress, the results cannot be compared easily with business accounts. About two thirds of the costs can be allocated to passenger transport and one third to freight. More than 70% are running costs. The capital costs will increase after 1998 because of major railway infrastructure investments (e.g. ‘Bahn 2000’). This increase is more than compensated by the lower running costs connected with the outsourcing and/or selling of non-core infrastructure by the railway companies (e.g. restaurants, parts of stations).

Supplier operating costs

Basically, for the computation of the supplier operating costs of rail the same input data as for infrastructure was used. Above all these is the Swiss rail account (Swiss Federal Statistical Office) and the more detailed sectoral account with data on all subdivisions (infrastructure, transportation of passengers and freight) of the Swiss Federal Railways SBB which provides the basis for cost allocation.

70% of the costs can be allocated to passenger transport. The costs will decrease between 1998 and 2005 by about 17% due to expected productivity increases.

Congestion costs

The main database was the delay statistic of the Swiss Federal Railways covering a sample 12 major stations (data used by SBB for their quality assessment). Computations of congestion costs in rail transport are based on arrival delays. Each train category has its own reporting structure for delays. Separate estimations have therefore been made for each train category.

The most sensitive factor regarding the magnitude of rail delay costs is the fixed benchmark (5 minutes according to SBB estimates) from which a train is regarded as delayed. Despite the improvement of infrastructure on major lines in Switzerland (the so-called “Bahn 2000”), some bottlenecks in the rail infrastructure network are still very sensitive. The database for delay costs in rail freight transport is only provisional and the allocation of delay causes of international train services to national networks is controversially discussed between national railway companies.

Accident costs

As in the case of road transport, detailed information is available about the number and severity of rail accidents in Switzerland (Swiss Federal Statistical Office). Underreporting is of almost no relevance for rail transport because only minor accidents are not reported. The valuation of the different cost blocks of the total social accident costs are partly based on the same values as for road transport (e.g. UNITE VOSL of € 1.5 million) and on rail sector specific values mostly collected from the SBB.

As expected, the total social accident costs of € 75 million are lower by dimensions compared to road transport: They amount to about 1% of the total social costs of road transport. Similar relations can also be found in Maibach et al. (1999) and Infras/IWW (2000).

Environmental costs

Air pollution: Because diesel traction is not relevant for Switzerland (more or less only used for shunting), the basic inputs for the calculation of the costs of air pollution are the energy consumption of the rail sector and the air pollutants emitted in the electricity production process. For the calculation itself, the EcoSense model developed within the ExternE Projects has been used.

The results suggest that the costs of air pollution of rail transport in Switzerland are negligible. The main reason for the very low value given in the table is the fact that by far highest proportion of electricity consumed in the rail sector is produced by hydroelectric power stations (approximately 90%). The rest comes mainly from nuclear stations. However, it should be kept in mind that particle emissions of rail have not been taken into account. Initial, rather tentative studies for Switzerland (BUWAL 2001) show that these emissions along the tracks can be substantial and should be considered in future estimates. Ongoing, more in-depth studies will provide better insights in the future.

Global warming: As in the case of air pollution, only the emissions emitted in the electricity production process are taken into account. The valuation is based on the shadow value of € 20 / tonne of CO_2 mentioned in the previous section. Because of the domination of hydro-electric and nuclear power stations in the electricity production mix, the contribution of the rail sector to global warming is negligible.

Noise: Similar to road transport, the availability of data about the current exposure of the population and buildings to noise emissions is rather limited. Calculations are based on information from the SBB for the mid-nineties. The valuation approach is the same as for road transport.

The results are lower than those estimated for the year 1995 in Maibach et al. (1999) and Infras/IWW (2000): In these studies the noise costs of rail transport in Switzerland is assessed at about € 100 million. A bonus of 5 dB(A) allowed for rail in the UNITE calculations but not in the other studies is probably the reason for the deviation. This bonus is based on the assumption that noise from railways is perceived to be less annoying than road noise (INFRAS/IWW 2000). Noise costs of rail are likely to decrease until 2005 because of large efforts to reduce noise emissions and exposure taken in Switzerland.

Nature, landscape and further environmental effects: The same approach as for road transport has been chosen. Since Switzerland has no high speed lines, nowhere does 100% separation and habitat loss occur. Compared to road, the share of rail costs is rather small.

Nuclear risks: The present annual overall consumption of nuclear power is negligible. For the 2005 forecast, a nuclear power share of almost 15% (based on rough estimations of the SBB considering scenario calculations) is taken into account. Since the hydro power supply – and therefore the "residual" consumption of nuclear power – differs strongly from year to year, the estimated nuclear power share for the year 2005 is vague. Nevertheless it is assumed to be much higher for the coming years because the overall electricity consumption for the SBB is estimated to increase substantially, and this increase cannot be covered with hydro power.

Taxes, charges and subsidies

On the infrastructure side, revenues result from track charges (€ 774 mill.), from the provision of infrastructure like stations, industrial areas etc. (€ 1 001 mill.) and from subsidies (€ 962 mill.). The subsidies for the operation of rail services amount to € 659 mill. which corresponds to 30% of revenues from user tariffs (see table 29).

As in the case of road transport, the following tables 28 and 29 show cost and revenue figures expressed in € per train-kilometre and contain more detailed information (i.e. separation between passenger and freight transport where possible).

Table 28
Average variable costs of rail transport per train-kilometre: Switzerland
€ / train-km, at prices 1998

	1998	
	Passenger	Freight
Core information		
Infrastructure costs		
Fixed	-	-
Variable	-	-
Supplier operating costs	15.17	30.31
External accident costs	0.02	0.02
Administrative	0.00	0.00
Health costs	0.00	0.00
Production loss	0.01	0.01
Environmental costs	0.39	0.43
Air pollution	0.02	0.06
Global warming	0.00	0.00
Noise	0.37	0.37
Total I		
Additional Information		
Delay costs	0.44	0.22
Internal accident costs	0.17	0.17
Administrative [1)]	0.02	0.02
Health costs [1)]	0.00	0.00
Material damages	0.03	0.03
Risk value	0.12	0.12
Environmental costs	0.01	0.03
Nature, landscape, soil and water pollution	0.01	0.03
Nuclear risk	0.02	0.04
Total II	**0.62**	**0.42**
Revenues		
User tariffs	10.93	26.13
Track charges	3.85	9.27
Non-transport-related revenues	4.98	11.99
VAT [2)]	-	-
Total (without track charges)	**15.91**	**38.12**
Subsidies	**9.24**	**14.07**
Infrastructure subsidies	4.79	11.53
Subsidies to operators for services	4.45	2.54
Basic data		
Train-kilometres (mill. train-km) [3)]	131.80	28.70
Passenger-kilometres (bill. pkm)	14.10	
Tonne-kilometres (bill. tkm)		9.26

[1)] The internal part of these costs, i.e. covered by payments of liability insurance companies. – [2)] VAT on fuel tax. However, diesel traction is not relevant in Switzerland. - [3)] Figures for 1997.

Source: Suter et al. (2002)

Table 29
Costs and revenues of rail transport in more detail: Switzerland
€ million, at prices 1998

	1998			
	Passenger	Freight	Others[1]	Total
Core information				
Infrastructure costs				2 762.0
Fixed				
Variable				
Supplier operating costs	1 999.0	870.0		2 869.0
Out of these: track charges	508.0	266.0		774.0
External accident costs	2.4	0.5	4.8	7.7
Administrative	0.4	0.1	0.2	0.7
Health costs	0.0	0.0	0.0	0.1
Production loss	1.9	0.4	4.5	6.9
Environmental costs	51.9	12.3		64.2
Air pollution	2.8	1.7		4.5
Global warming	0.1	0.0		0.1
Noise	49.0	10.6		59.6
Total I	**3 357.2**	**1 566.8**	**4.8**	**4 928.9**
Additional information				
Delay costs	58.20	6.40		64.6
Internal accident costs	21.77	4.74	41.28	67.79
Administrative[2]	2.00	0.43	1.40	3.83
Health costs[2]	0.07	0.02	0.13	0.21
Material damages	4.41	0.96		5.36
Risk value	15.30	3.33	39.75	58.38
Environmental costs	3.92	2.06		5.98
Nature, landscape, soil and water pollution	1.90	1.00		2.90
Nuclear risk	2.02	1.06		3.08
Total II	**83.89**	**13.20**	**41.28**	**138.37**
Revenues				
User tariffs	1 441.00	750.00		2 191.00
Track charges	508.00	266.00		774.00
Non-transport-related revenues	656.00	344.00		1 000.00
VAT[3]				
Total (without track charges)	**2 097.00**	**1 094.00**		**3 191.00**
Subsidies	**1 217.00**	**404.00**		**1 621.00**
Infrastructure subsidies	631.00	331.00		962.00
Subsidies to operators for services	586.00	73.00		659.00

[1] Rail accidents that cannot be attributed to passenger or freight transport (e.g. accidents of rail workers. – [2] The internal part of these costs, i.e. covered by payments of liability insurance companies. – [3] VAT on fuel tax. However, diesel traction is not relevant in Switzerland.

Source: Suter et al. (2002)

5.3 Public transport: Urban and regional bus, trolley bus and tram

Table 30
Swiss account for non-rail public transport for 1996, 1998 and 2005
€ million, at prices 1998

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs[1]			
Fixed			
Variable			
Services			
Supplier operating costs	1 436	1 270	*1 316*
Accident costs (external)[2]			
Environmental costs	47.2	45.1	*35.1*
Air pollution	31.8	28.5	*20.5*
Global warming	4.5	5.7	*5.2*
Noise	10.9	10.9	*9.4*
Total	**1'483.2**	**1'315.1**	***1'351.1***
Additional information			
Congestion costs	69	64	*68*
Accident costs (internal)[2]			
From this: risk value			
Environmental costs	1.4	1.3	*1.3*
Nature and landscape, soil and water pollution[3]			
Nuclear risk[3]	1.4	1.3	*1.3*
Revenues			
Directly related to a specific cost category			
Charges for infrastructure usage	0	0	*0*
Fixed			
Variable			
Subsidies for concessionary fares			
User Tariffs[4]	691	675	*692*
Other transport specific revenues	0	0	*0*
Fuel tax			
VAT			
Subsidies[5]	676	566	*625*
Non-transport related revenues of PT companies[6]			

[1] The infrastructure costs of urban and regional buses of € 57.5 mill. in 1998 are contained in the Swiss road account. The costs of special infrastructure for tramways and trolley buses are part of the supplier operating costs. - [2] Accident costs are included in road and rail transport accounts. Because of the problem of arbitrary cost allocation, only the figures for the total of transport system internal and external can be calculated for public transport: It amounts for buses, trolley buses and tramways to about € 49.2 million in 1998. - [3] Because there is no standardised methodology for the calculation of these costs, the figures are approximate indications. Nature, landscape and further environmental effects: Included in road and rail transport. - [4] Subsidies and VAT are excluded.- [5] Subsidies include the provision of infrastructure, for debt relief, for the provision of services etc. and are shown in monetary terms. - [6] No separation from 'other revenues' possible.

Source: Suter et al. (2002)

For public transport (excl. rail) it is not possible to draw a complete picture because some of its modes are also part of road transport. In order to avoid double counting, table 30 only contains cost and revenue figures which are not included in the Swiss road account (table 24).

As expected, the figures for a mode operating especially in urban areas show high congestion costs. Furthermore, the environmentally-friendly mode is supported substantially with public subsidies: For the regional and urban public transport services some € 566 million – or 35% of the subsidies for rail transport – are spent annually by the public. The consequence of these significant subsidies is that the share of the transport system external costs lie in the same order of magnitude as for rail transport.

There is only a limited change in total costs predicted for the future, namely a slight increase of about 3% from 1998 to 2005. Because this cost increase in absolute figures (about € 40 million) is assessed to be higher than the growth in revenues (some 2.4% in relative terms or € 17 million in absolute terms), an additional need for subsidies is forecasted for 2005 (approximately +10%).

Comments on specific cost categories

Infrastructure costs

The infrastructure costs for buses are considered in the Swiss road account, although only at national level. Detailed information for city related infrastructure (like tramways, infrastructure used by trolley buses etc.) is not fully available. For urban public transport therefore all business account information (i.e. infrastructure costs for trolley bus lines or tramways) is covered within the supplier operating costs.

Supplier operating costs

Financial data of urban and regional public transport services have been taken from official statistics (statistic of public transport by the Swiss Federal Statistical Office, BFS 1997, 1998, 2000, 2001).The data used is especially for 1998 provisional and partly incomplete. Supplier operating costs and related revenues have been calculated simultaneously, because official statistics contain cost as well as revenue and subsidy figures.

About 61% of total costs can be allocated to urban public transport (tramways and buses), and 39% to regional bus transport. There are significant changes between 1996 and 2005 due to the change of legislation and productivity increases.

Congestion costs

The focus has been set on delays of urban public transport services whereby a two-step approach has been used. In a first step user costs due to travel time differences of tramways, trolley- and diesel-buses in peak hours versus off-peak traffic conditions have been calculated. In a second step, the observed delays to the respective timetable of scheduled public transport services has to be considered. Since very few urban public transport companies collect delay data systematically, total congestion costs for Switzerland have to be extrapolated based on a detailed analysis of the urban public transport company in Zurich.

The share of small delays due to the increase in travel time in peak hour traffic conditions is responsible for about 83% of the total delay costs. The results are, as in rail transport, highly dependant on the chosen benchmark, from which heavy delays are taken into account. Based on the available data, delays in the delay-class of 4-6 minutes (with an average of 5 minutes) and higher have been used to calculate congestion costs for heavy delays.

Accident costs

The transport system internal and external accident costs of urban public transport and regional bus services are included in the figures for road transport (buses) and rail transport (urban railway lines). In the case of rail transport a separation is not possible because of a too low level of detail of the input data. For road based urban and regional public transport, the "monitoring" or "victims perspective" chosen within UNITE in view of the availability and expressiveness of accident data in most European countries prevents a separation of the external costs for different vehicle categories unless arbitrary cost allocation is accepted: in the UNITE perspective the accident costs are attributed to the vehicle categories of the accident victims and not – as usually made in Switzerland – of the accident perpetrators. Without knowing the latter it is not possible to allocate insurance payments which lead to an internalisation of the accident costs to the different vehicle categories. Only the total of the transport system internal and external costs, i.e. the total social costs can be estimated per vehicle category. These amount to about € 49.2 million for urban and regional buses, trolley buses and tramways. As mentioned above, the € 49.2 million are included in the figures for road transport.

Environmental costs

Air pollution: The costs of air pollution of urban diesel buses is derived from the total costs of air pollution of road transport using the share of urban buses on the emissions of the different air pollutants and their contribution to the costs. For trolley buses and tramways, the basic input data are the energy consumption and the average Swiss electricity production mix (56% hydro, 40% nuclear, 4% others). As expected, almost all of the total costs of € 28.5 million are caused by the diesel buses (99%). Trolley buses and tram are irrelevant.

Global warming: The basic input data are the same as for assessment of the costs of air pollution. Because of the Swiss "hydro- and nuclear-friendly" electricity production mix the contribution of trolley buses and tramways to the total costs of € 5.7 million is negligible.

Noise: The calculations are based on the same input data and methodology as in the case of road transport. The share of urban public transport on the total external noise costs has been derived by using the share of urban public transport on the total mileage of road transport whereby the mileages of heavy vehicles are weighted with a factor 10 to take into account the higher noise emissions per kilometre driven.

Nuclear risks: Due to the low share of nuclear power, the costs for urban public transport environmental costs due to nuclear risks play only a minor role. However the importance will increase in the future due to the liberalisation of the electricity markets.

Taxes, charges and subsidies

As in the case of rail transport, urban public transport is, by far, not in a situation where the total costs can be covered by tariff revenues: The subsidies of € 566 million correspond to about 84% of the revenues from the users of urban and regional public transport services. In the case of regional bus services this figure increases to more or less 100%. The subsidies for urban public transport services amount to 75% of the user tariffs (see table 32).

Table 31 presents the costs of non-rail public transport in € per vehicle-kilometre whereas table 32 shows in detail the differences in the total costs between regional and urban transport.

Table 31
Average variable costs of non-rail public transport per vehicle-kilometre: Switzerland
€ / vkm, at prices 1998

	1998		
	Regional Public Transport	Urban Public Transport	Total Non-Rail Public Transport
Core information			
Infrastructure Costs [1]		-	-
Fixed		-	-
Variable		-	-
Supplier operating costs	3.35	6.25	4.68
External accident costs [2]		-	-
Environmental costs	0.19	0.14	0.17
Air pollution [3]	0.14	0.14	0.14
Global warming [4]	0.03	0.03	0.03
Noise		0.07	0.04
Total I			
Additional information			
Delay costs [5]	0.00	0.51	0.24
Internal accident costs [2]		-	-
Environmental costs	0.0007	0.02	0.02
Nature, landscape, soil and water pollution	0.0007		- 0.0007
Nuclear risk		- 0.02	0.02
Total II	**0.0007**	**0.53**	**0.26**
Revenues			
User tariffs	1.65	3.47	5.13
Subsidies	1.64	2.61	4.25
Basic data			
Vehicle-kilometres (mill. vkm)	147.00	124.40	271.40
Passenger-kilometres (bill. pkm)	1.60	3.09	4.69

1) Infrastructure costs included in the road account. - 2) Accident costs included in road account. - 3) Only diesel buses. 4) Diesel buses and CO2-emissions from electricity production. 5) No delay information available for regional bus services.

Source: Suter et al. (2002)

Table 32
Costs and revenues of non-rail public transport in more detail: Switzerland
€ million, at prices 1998

	1998		
	Regional Public Transport	Urban Public Transport	Total Non-Rail Public Transport
Core information			
Infrastructure Costs [1]			0.00
Fixed			0.00
Variable			0.00
Supplier operating costs	492.00	778.00	1 270.00
External accident costs [2]			
Environmental costs	27.30	17.52	44.82
Air pollution [3]	21.15	7.05	28.20
Global warming [4]	4.25	1.47	5.72
Noise	1.90	9.00	10.90
Total I	**519.30**	**795.52**	**1 314.82**
Additional information			
Delay costs [5]		63.80	63.80
Internal accident costs [2]			
Environmental costs	0.10	1.30	1.40
Nature, landscape, soil and water pollution	0.10		0.10
Nuclear risk		1.30	1.30
Total II	**0.10**	**65.10**	**65.20**
Revenues			
User tariffs	243.00	432.00	675.00
Subsidies	241.00	325.00	566.00

[1] Infrastructure costs included in the road account. - [2] Accident costs included in road account. - [3] Only diesel buses. [4] Diesel buses and CO_2-emissions from electricity production. [5] No delay information available for regional bus services.

Source: Suter et al. (2002)

5.4 Aviation

Table 33
Swiss air transport account for 1996, 1998 and 2005
€ million, at prices 1998

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs			
Fixed			
Variable			
Airports	607	650	*899*
Air traffic management services			
Flight control	151	154	*147*
Accident costs (external)[1)]	10	10	*11*
Environmental costs	74	78	*73*
Air pollution[2)]	16	17	*24*
Global warming[3)]	31	34	*49*
Noise	27	27	*n.a.*
Total	**842**	**892**	***1 130***
Additional information			
Congestion costs	111	132	*280*
Accident costs (internal)	84	86	*90*
From this: risk value	52	54	*58*
Environmental costs	3.1	3.1	*2.6*
Nature and landscape, soil and water pollution[4)]	3.1	3.1	*2.6*
Nuclear risk[4)]			
Revenues			
Directly related to a specific cost category			
Charges for infrastructure usage	594	651	*881*
Airport revenues			
Revenues flight control	155	159	*151*
Total	**749**	**810**	***1 032***
Loss of revenues due to tax exemptions[5)]		-89.3	
Mineral oil tax	n.a.	-83.1	*n.a.*
VAT on mineral oil price	n.a.	-6.2	*n.a.*
Other transport specific revenues	0	0	*0*
Fuel tax			
VAT			
Subsidies			
Non-transport related revenues of airports[6)]			

[1)] Transport system external costs only: Included are those cost parts that are not borne by rail users and insurance companies of the rail sector but by the public sector and third parties. The transport system internal costs are given below under "Additional information". – [2)] Emissions of particles not included. [3)] Transit flights over Switzerland included. – [4)] Because there is no standardised methodology for the calculation of these costs, the figures are approximate indications. – [5)] Mineral oil tax and VAT on the mineral oil tax (negative entries because of zero taxes). – [6)] It was not possible to subdivide costs and revenues into flight related and non flight related parts.

Source: Suter et al. (2002)

The overall costs as assessed in this mode of transport amount to about € 1.1 billion. They are significantly lower than the costs of road and rail transport. By far the largest part of the costs is transport system internal. This is also a result of the fact that there are no "official" subsidies for aviation with the exception of the tax exemption of air transport fuel (see "losses of fiscal revenues ..." in the table above). Under the assumptions used in the calculations, congestion costs are higher than the environmental costs of aviation.

According to the estimates for the future the total costs of aviation as given in the table above tend to increase significantly between 1998 and 2005 (almost +35%). This increase is the consequence of the considerable growth of the airport infrastructure costs, congestion costs and environmental costs.

Comments on specific cost categories

Infrastructure costs

The basic information stems from the business accounts (annual reports) from the three national airports Zurich, Geneva, Basle-Mulhouse and from the air traffic control company Skyguide which is responsible for air traffic control over Switzerland. It is not possible to separate the information from the annual reports into flight related infrastructure and non-flight related infrastructure (on the cost side it is totally impossible, on the revenue side some parts would be applicable). Therefore the whole profit and loss account is used for this pilot account. Hidden subsidies on a federal level have been included within the cost calculation, but since 1994 no subsidies nor loans at reduced interest rates have been provided.

The national airports show a sharp increase of infrastructure costs from 1998 to 2005 (+38%). The main reason is the building of the fifth construction stage at Airport Zurich with construction costs of overall € 1.3 billion (1996 – 2005).

Congestion costs

Information stems from Federal Office for Civil Aviation which was able to supply detailed data on passenger delays for all three Swiss international airports (Zurich, Geneva and Basle) for the years 1997, 1998 and 1999. The number of delayed passengers for each delay class (e.g. 15-20 minutes) has been multiplied with the class centre and added, giving the delayed passenger-hours. A benchmark of 15 minutes has been applied according to common practice in air transport. To avoid double counting only departure delays have been taken into account (see Link et al. 2002). Due to lack of data, delay costs of air freight transport has not been calculated.

For 2005 an increase to around € 280 million has been estimated (+112%). Within the coming years a sharp increase in congestion costs of air transport is highly likely due to increasing passenger numbers and stricter rules regarding operation times of the Zurich airport. Again, congestion costs are highly sensitive in regard to the used benchmark of 15 minutes.

Accident costs

Each accident in air transport is recorded in detail at the Swiss Federal Office for Civil Aviation. Because the number of accidents with fatalities and injuries varies considerably between years, an eleven-year average (reflecting the maximum length of data availability) has been chosen to define the relevant number of accidents and victims for the UNITE base year 1998. The valuation of fatalities and injuries is based on the same assumptions for the VOSL and the relative values for injuries. Limited information on material damages has been gathered from national offices. Looking at the quality of the input data, the estimates of the accident costs of air transport show greater uncertainties than for road and rail transport.

The total accident costs amount to € 96 million per year. This figure is somewhat higher than the accident costs of rail transport – a relationship that can also be found in INFRAS/IWW (2000). Almost 90% of these costs are borne by users within the transport system.

Environmental costs

Air pollution: For the assessment of the costs of air pollution very detailed emission data was available from the Swiss Federal Office for Civil Aviation (BAZL 1999) for the three national airports. The emission refer to the landing and take off cycles (LTO cycles) on these airports. They served as inputs for the calculations with the ExternE model. The costs of air pollution from transit flights and the flight stretches over Switzerland before/after landing and starting in Zurich, Geneva or Basle couldn't be calculated.

The total annual costs of € 17.3 million are significantly lower than those stated in Infras/IWW (2000) of € 32 million. As in the case of road transport – but to a lesser extent – the ExternE model seems to produce relatively low estimates of the costs of air pollution. One reason for the difference is that the emissions of particles have not been included in the calculations because of missing data for Switzerland. In Germany, about 30% of the total costs of air pollution of aviation are caused by these emissions. Because of the strong traffic growth predicted for air transport in Switzerland, an increase of the costs of air pollution of more than 40% is forecast for the year 2005 compared to 1998.

Global warming: The basic input data are the same as for the assessment of air pollution costs. Again, the total costs of € 34.2 million are much lower than those stated in Infras/IWW (2000) of almost € 1 billion. These figures are however not directly comparable due to different shadow rates per tonne of CO_2 and other systems delimitation procedure. As in the case of air pollution, a significant increase in costs is predicted for the year 2005 (+44%).

Noise: In the case of noise, a detailed and comprehensive evaluation of the population and buildings exposed to different levels of noise from air transport has been carried out by the Eidgenössische Materialprüfungs- und Forschungsanstalt EMPA for the three national airports in Zurich, Geneva and Basle (only Swiss population).

The results calculated by the ExternE model of € 26.5 million for the three airports seem to be low though there are no in-depth estimates available for Switzerland for comparison. Nevertheless, a comparison with calculations made for the Dutch airport Schiphol gives evidence that the estimates for Switzerland should be interpreted as a low value. Morrel and Lu (2000) find in their analysis that the noise tax per landing should amount to about € 625 – and not to € 160 as in the late nineties, – if the tax level were to reflect the noise costs. If the Swiss figures is divided by the number of air craft movements, only a value of about € 60 results (see table 34).

Nature, landscape and further environmental effects: No compensation costs for habitat losses have been taken into account due to the fact that even the largest Swiss airport (Unique Airport of Zurich) covers valuable natural biotopes within its total area and provided several compensation measures. Thus there are only unsealing costs of runways and other airport infrastructure and the costs for decontaminating impaired soil. In comparison to road transport, the share of air transport is rather small.

Taxes, charges and subsidies

The directly allocatable infrastructure revenues of € 651 million are the sum of different transport-related and non-transport-related revenue sources (e.g. airport taxes, rents, user charges etc.).

There is no taxation of kerosene. Therefore, the losses in fiscal revenues are shown in table 33.

Table 34
Average variable costs of air transport per aircraft movement: Switzerland
€ / movement at the three national airports, at prices 1998

	1998		
	Passenger	Cargo	Total
Core information			
Infrastructure costs			
Fixed			
Variable			
External accident costs [1]	18.84		18.84
Administrative	2.99		2.99
Health costs	0.16		0.16
Production loss	15.69		15.69
Environmental costs [1]	125.34		125.34
Air pollution	39.50		39.50
Global warming [2]	25.34		25.34
Noise	60.50		60.50
Total I			
Additional information			
Delay costs [3]	300.92		300.92
Internal accident costs [1]	199.51		199.51
Administrative	17.08		
Health costs	0.30		
Material damages	59.30		59.30
Risk value	122.83		122.83
Environmental costs [1]	7.08		7.08
Nature, landscape, soil and water pollution [1]	7.08		7.08
Nuclear risk			0.00
Total II	**507.51**		**507.51**
Revenues [1]			
Charges for infrastructure usage	1 847.87		1 847.87
Airport revenues	1 486.88		1 486.88
flight control	360.99		360.99
Fuel tax			0.00
VAT [4]			0.00
Total	**1 847.87**		**1 847.87**
Subsidies			
Exemption for kerosene tax [5]	**203.89**		203.89
Total	**203.89**		**203.89**
Basic data			
Number of aircraft movements (3 national airports)	437 990		437 990
Passenger-kilometres (bill. pkm)	59.99	-	59.99
Tonne-kilometres (bill. tkm)	-	2.26	2.26

[1] No allocation to passenger/cargo possible. - [2] Only CO_2-emissions at the airports taken into account. - [3] Delay costs for cargo is not avialable. – [3] VAT on fuel tax. - [5] There is no tax on kerosene. The figures give the losses of fiscal revenues due to this tax exemption.

Source: Suter et al. (2002)

Table 35
Costs and revenues of air transport in more detail: Switzerland
€ million, at prices 1998

	1998		
	Passenger	Cargo	Total
Core information			
Infrastructure costs [1]	650.02		650.02
Fixed			
Variable			
External accident costs [1]	8.25		8.25
Administrative	1.31		1.31
Health costs	0.07		0.07
Production loss	6.87		6.87
Environmental costs [1]	77.90		77.90
Air pollution	17.30		17.30
Global warming [2]	34.10		34.10
Noise	26.50		26.50
Total I	**736.17**		**736.17**
Additional information			
Delay costs [3]	131.80		131.80
Internal accident costs [1]	87.38		87.38
Administrative	7.48		7.48
Health costs	0.13		0.13
Material damages	25.97		25.97
Risk value	53.80		53.80
Environmental costs [1]	3.10		3.10
Nature, landscape, soil and water pollution	3.10		3.10
Nuclear risk			0.00
Total II	**222.28**		**222.28**
Revenues [1]			
Charges for infrastructure usage	809.35		809.35
Airport revenues	651.24		651.24
flight control	158.11		158.11
Fuel tax			0.00
VAT [4]			0.00
Total	**809.35**		**809.35**
Subsidies			
Exemption for kerosene tax [1)5)]	89.30		89.30
Total	**89.30**		**89.30**

[1] No allocation to passenger/cargo possible. - [2] 11.1 € mill. costs attributable to LTO cycles at the three national airports, 23 € mill. to transit flight over Switzerland. - [3] Delay costs for cargo is not avialable. – [4] VAT on fuel tax. - [5] There is no tax on kerosene. The figures give the losses of fiscal revenues due to this tax exemption.

Source: Suter et al. (2002)

5.5 Inland waterways

Table 36
Swiss inland waterway account for 1996, 1998 and 2005
€ million, at prices 1998

Costs **Core information**	**1996**	**1998**	**2005**
Infrastructure costs – inland waterways			
Fixed			
Variable			
Infrastructure costs – inland waterway harbours	9.96	10.01	15.28
Fixed			
Variable			
Accident costs (external)			
Environmental costs			
Air pollution			
Global warming			
Noise			
Total	**9.96**	**10.01**	**15.28**
Additional information			
Congestion costs			
Accident costs (internal)			
From this: risk value			
Environmental costs			
Nature and landscape, soil and water pollution			
Nuclear risk			
Revenues			
Directly allocatable			
Charges for infrastructure usage			
Fixed			
Variable			
Inland waterway harbours[1)]	11.8	13.1	15.1
Total	**11.8**	**13.1**	**15.1**
Other transport specific revenues			
Fuel tax			
Eco tax			
VAT			
Subsidies[2)]	0.03	0.03	0.03
Non-transport related revenues of ports			

[1)] Subsidies and VAT are excluded. – [2)] Subsidies include the provision of infrastructure and are expressed in monetary terms.

Source: Suter et al. (2002)

The mode inland waterways only plays a very minor role if the territoriality principle is taken to assess costs - which is the case for UNITE. For Switzerland, this mode is limited to the harbours in the border town Basle. Therefore, the cost analysis concentrated on infrastructure costs and revenues of the two ports in Basle.

Infrastructure costs

Basic information stems from the annual reports from the two ports in Basle (Rhine). For 1998 both annual reports and the asset and depreciation account of one port was available. According to their information the ports did not receive any subsidies or loans at a reduced interest rate from the cantons. For the asset value of one port (missing asset and depreciation account), we assume that this port has the same structure of assets as the other Rhine port and therefore the same relationship between depreciation and asset value.

Between 1998 and 2005, a growth of the costs will take place due to infrastructure enlargements in the first year of the new millennium. This does not show in higher capital costs in 2005 because the ports have an unusual depreciation method: All investments are totally depreciated in the first year. Because of the infrastructure enlargement, the ports are able to have a higher turnover. Therefore, running costs increase significantly.

6 Conclusions

This report presents a summary of the first tranche of the pilot accounts: the country accounts for Germany and Switzerland. For the full country pilot account report see Link et al. (2002) and Suter et al. (2002). Summarising up, it was possible within the Tranche A accounts to estimate the majority of the categories described in Link et al. (2000).
For Germany, the following data is included within the account:

- Full infrastructure costs for road, national rail, airports and the inland waterway system were estimated. Figures for the capital stock and for the capital costs of transport infrastructure could be estimated for non-national rail, trams and metro systems and for inland waterway harbours and seaports.
- Supplier operating costs for national rail were estimated, however, data was not sufficient to estimate supplier operating costs for non national rail companies and public transport companies.
- Congestion costs (calculated as delay costs) could be calculated for all modes of transport studied.
- Accident costs were estimated for all transport modes except maritime shipping. The major parts of accident costs, namely the risk value, the costs due to production losses and the health costs were calculated for all transport modes (except maritime shipping as mentioned above). The further parts of accident costs, e. g. administrative costs of accidents and costs of material damages to vehicles were estimated for some of the transport modes depending on the data situation. Administrative costs, expressed as police costs were estimated for all categories other than shipping while material damages to vehicles were estimated for road and public transport only.
- Within the Environmental cost category air pollution costs and the costs of global warming were estimated for all transport modes except maritime shipping. Noise costs were calculated for road, rail, air and inland waterway transport. The cost associated with nuclear risk arising form electricity production was estimated for rail transport. Furthermore, it was also possible to compile figures for the costs associated with nature, landscape, soil and water pollution for road, rail and air transport.
- The taxes and charges for road, rail, public transport and air transport could be calculated. Subsidies for rail, public transport and aviation were documented. Partial revenues for

inland waterway shipping were estimated, but no actual data can be presented for maritime shipping.

The picture for Switzerland is similar:

- It was possible to estimate most of the cost and revenue categories for road and rail transport, the two most important modes.
- The calculations profited from the fact that the elaboration of transport accounts for these two modes is not a new issue for Switzerland. The assessment of infrastructure, accident and environmental costs has been subject of a number of studies or is even anchored in official annual statistics (Swiss road account). Nevertheless, the UNITE accounts provide new figures that will influence the transport policy discussion in Switzerland on subjects like the taxation and the financing of transport.
- This is the first time that congestion costs have been assessed in this detailed way for Switzerland.
- The figures given in the air transport account are new for Switzerland.
- For road and rail transport, the UNITE calculations for Switzerland give results that are different from previous figures, showing the large degree of uncertainty within these calculations. In the cases of large differences (for example the costs of air pollution) further analysis to explain these differences will be necessary.

Compared to existing transport accounts the pilot accounts presented in this annex report have achieved considerable progress in terms of methodologies used, consistency of both methodologies and data across modes of transport and types of costs and quality of data and empirical estimates. In the following we can draw conclusions with respect to two questions:

(1) How can the results be interpreted and used for transport policy?

(2) What are the future challenges to improve the pilot accounts?

6.1 The relevance of the pilot accounts for transport policy

Sansom et al. (2000) raises the question of how the estimation of total and average costs and revenues contribute to the priority areas of transport policy identified to be relevant for the UNITE project. Indeed, this question is important since first best pricing rules refer to marginal cost, not average cost. Sansom et al. (2000) identifies than three main areas to which the UNITE accounts contribute: (1) equity, (2) efficiency, (3) financial viability. In the light of the results obtained within tranche A and also considering the remaining gaps it is now possible to clarify more precisely how the accounting results can be used in these areas.

Equity: As stated in Sansom et al. (2000) there is no unique definition of equity, but equity quite obviously refers to the relation between the costs imposed by an economic subject and the charges paid. This relationship can have different dimensions: income classes or even individual transport users, vehicle classes (for example HGV versus passenger cars), regional differences or country differences (for example port charging, non-discriminatory road user charging in cross-country transport, international rail track access charging). The pilot accounts presented in this report give indications on equity between modes (intermodal comparisons), between types of transport (passenger versus freight transport) and between vehicle classes (see for example the road account).

Efficiency: If cost recovery is a binding constraint, second best pricing principles are relevant. This, however, requires information on the costs to be covered in order to guarantee that the mark-ups on marginal costs are sufficient to meet the cost-recovery goal. On the other hand, this information is essential in order to monitor that there is no overcharging. This again is an important issue with respect to planned HGV charging schemes, not only in a national context but also in the context of cross-border road traffic. The issue of avoiding overcharging is also dealt with in the directive on rail infrastructure charging which states that mark-ups over marginal costs must not exceed total costs. The UNITE pilot accounts provides this total cost information. Furthermore, with the (at least for some modes) estimated share of fixed costs, the results give an indication to what extent it would be worthwhile to subsidise parts of the fixed costs from tax revenues. This refers to the information which the pilot accounts provide both at the cost side and the revenue side.

Financial viability: Again, if cost recovery is a binding constraint, either since private operators have to recover their costs or due to political/budget reasons, it is necessary to have knowledge on the level of total costs as presented here in the pilot accounts. It is extremely important for an appropriate monitoring by governments and regulators. One example for this is the rail sector: if marginal cost pricing is introduced and the revenues from track access charges are not sufficient to recover total cost, the state has to subsidise the deficit. In this case where rail companies negotiate with the government on subsidies it is essential for the government and/or the regulator to know the total costs to be covered and the extent of subsidies really necessary for covering the deficit.

For all potential uses of the pilot accounts it should, however, be noted that they reflect the actual, rather than the ideal accounts and can not be considered to supply the absolute total of all transport related costs and revenues. Therefore a simple adding up and comparison of the costs and revenues within the modal accounts described in this report supplies the reader only with the specific costs and revenues found using the methodology described in Link (2000). Although the accounts are comprehensive they can not be considered to be all inclusive. This leads to the conclusion that, this area of research requires further work.

6.2 Open questions and future improvements

There are still gaps in the German and Swiss pilot accounts. For Germany, these gaps refer to non-DB railway companies, to public transport (tram, metro, trolley bus), to parts of the inland waterway account and to maritime shipping. Estimates for noise costs are missing for urban public transport. The data situation for inland waterways was not optimal for either tranche A country.

At this stage we can draw conclusions for future work:

- Data problems occurred for public transport with tram, metro and trolley buses. These refer mainly to infrastructure and supplier operating costs, e. g. those costs which are monetary costs (in contrast to environmental, accident and congestion costs which have to be monetarised). In many countries, these companies do not have a separate bookkeeping for infrastructure and operation and they usually do not provide separate figures for buses, trams, metros. It is expected that the reporting of these costs be problematic for other countries.

- It was not possible to consider bus transport in a systematic way for all cost categories. This results in a split between the road account (for example for infrastructure costs) and the public transport account (for example for supplier operating costs). This can cause confusion when researching and interpreting the accounts and must be documented clearly for transparency in the results.

- The development of the pilot accounts for Germany faced serious data problems for rail, both for DB but even more for non-DB companies. We see this as a specific German problem due to the market structure and due to the strong position of DB against the government not to provide statistics and information to the public.

- For countries with a high density of inland waterways, data problems preventing the estimation of infrastructure costs, infrastructure operating costs and the revenues of inland waterway harbours may be expected. The high number of harbours and the lack of central statistical data compound this problem. We are not sure to what extent this might also be a problem for the following country accounts.

- It was not at all possible to compile any estimate for the mode maritime shipping.

- It should be mentioned that the estimation of subsidies was not based on a systematic definition and analysis which would have been too time consuming. So far, figures refer to parts of subsidies only. Here clearly a potential for future improvement is given. Note, however, that depending on the administrative structure of a country this can consume considerable time expenses.

Finally it should be noted, that a direct comparison of the pilot accounts carried out for Germany and Switzerland does not seem to be practical or sensible. The size of the countries, the geographical situation, the methods used to calculate transport costs and allocate these costs to different transport user groups and the relative importance of the different transport modes unfortunately do not provide a basis for comparison. As more country accounts are completed a structure for comparison can be defined and utilised.

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Glossary

Accident Costs Costs caused by transport accidents. These costs are directly related to material damage costs and medical costs, the administrative costs of police and insurance companies, the costs associated with production loss through accident related illness and fatalities and the costs of "suffering" associated with accidents (risk value).

Capital costs The capital costs comprise the consumption of fixed capital and interest. Capital costs represent a high share of total infrastructure costs and are different to the annual capital expenditures.

Capital value The capital value is the value of fixed capital measured either as a gross or a net value. The gross value represents the capital value of all assets still physically existing in the capital stock. It can thus be considered as an equivalent of production capacity. The net value represents the value of assets minus the meanwhile consumed fixed capital. The difference to the gross value is thus the loss of value due to foreseen obsolence and the normal amount of accidental damage which is not made good by normal repair, as well as normal wear and tear. Methods for estimating capital values are the direct method (synthetic method) and the indirect method (perpetual inventory concept).

Congestion Congestion arises when traffic exceeds road capacity so that the travelling speed of vehicles is slowed down. It can be defined as a situation where traffic is slower than it would be if traffic flows were at low levels. The definition of these "low levels" (reference level) is complicated and varies from country to country (e.g. six service levels in the American HCM).

GDP	(= Gross Domestic Product). The GDP is the sum of all goods and services produced within a country and a year. GDP per capita can be regarded as the relative economic power of a country per inhabitant.
GVW	GVW is the gross vehicle weight and contains the weight of the vehicle itself and the weight of the payload.
HGV	HGV means heavy goods vehicles. Within this study they are defined as all goods vehicles with a maximum GVW equal or more than 3,5 tonnes.
Impact Pathway Approach (IPA)	Methodology for externality quantification developed in the ExternE project series. It follows the chain of causal relationships from pollutant emission via dispersion (including chemical transformation processes), leading to changes in ambient air concentrations from which impacts can be quantified using exposure-response functions. Damages are then calculated using monetary values based on the WTP approach.
Individual transport	Transport performed on the own account of users with their own vehicle for private reasons.
Infrastructure Cost	Cost category which comprises capital costs (depreciation and interests) and running costs for maintenance and repair, operation and administration, overheads and traffic police.
Infrastructure suppliers	are defined as the totality of public and private enterprises which are financing the provision and maintenance of the transport infrastructure for all modes (road, rail and water) within the urban area analysed.

Opportunity costs The expressions "opportunity costs" and "shadow prices" are used synonymously within the Real Cost Scheme. They determine the value added for an individual in the case a good would not have been bought or built or in case negative effects of transport would not be present. Opportunity values are used for the evaluation of investments (capital costs), lost lives (statistical value of human life) or for the assessment of noise nuisance.

Perpetual-inventory method Perpetual inventory model: This is a method to estimate the asset value from a time series of annual investment expenditures. Annual new investments are cumulated and – according to their remaining life time – depreciation will be calculated. The sum of these annual remaining asset values is equal to the total amount of the asset value.

PPP PPP means purchasing power parity. PPPs are the rates of currency conversions which equalise the purchasing power of different countries. This means that a given sum of money, when converted into different currencies at the PPP rates, will buy the same basket of goods and services in all countries. In particular, PPPs are applied if figures for specific products or branches shall be expressed in foreign currency (for example in ECU or in US $) because in these cases the use of official exchange rates is not appropriate.

Primary particles Particles, that are directly emitted.

Public Transport PT subsumes all services that are supplied according to a pre-defined timetable in passenger and freight transport. The final user here pays an average fare. Typical PT is rail, bus, air and ferry services. The transport of an additional person or unit of goods does not cause in the short run additional vehicle kilometres, as scheduled vehicles are used, which are running anyway. In the long run, due to increased capacity use, additional or larger vehicles have to be scheduled. In the former case the marginal costs are zero, in the latter case the marginal costs are the costs per vehicle kilometre divided by the capacity use.

Replacement value/cost The cost of replacing a particular asset of a particular quality with an asset of equivalent quality. Replacement cost may exceed the original purchase cost because of changes in the prices of the assets.

Risk value The risk value represents the society's willingness to pay for avoiding death casualties or injuries in transport. It reflects the decrease in social welfare due to the suffering and grief of the victims and their relatives and friends. The relevant cost elements are: Own risk value and suffering and grief of relatives and friends

Secondary particles Particles, such as nitrates and sulphates, that are formed in the atmosphere through atmospheric chemical reactions.

Supplier Operating Cost Costs mainly related to costs incurred by supplier in its operations.

Vehicle category Road: passenger car, motorcycle, bus, goods transport vehicles.

Public transport: bus, tram, trolley bus, metro.

Rail: electric passenger train, diesel passenger train, electric goods train, diesel goods train.

Inland Waterways / Marine: Goods transport.

	Air: passenger, goods transport
VOSL	Value of statistical life: An unit often used to express individuals´ willingness-to-pay (WTP) for safety. The individual states (or reveals) a WTP for a small reduction in risk (dz) for a fatal accident; he is never asked the question about the value of life per se. If this risk change is summed over (n) individuals so that statistically the risk reduction will save one life we can also sum their WTP; this sum of the WTP then becomes the Value of statistical life (VOSL). VOSL = WTP*n = WTP/dz if n*dz = 1
VOT	Value of time. The value of time is standardised for each country within the UNITE accounts.
WTP	Willingness to pay: The direct or indirect response to questionnaire about individuals willingness-to-pay for a good. For example the WTP for higher safety.

Abbreviations

ASTRA	Swiss Federal Office for Roads
BASt	German Highway Research Institute
BAV	Swiss Federal Office for Transport
BAZL	Swiss Federal Office for Civil Aviation
BFS	Swiss Federal Statistical Office
BMVBW	German Ministry of Transport, Construction and Housing
BUWAL	Swiss Federal Office for the Environment, Forests and Landscape
CO_2	Carbon dioxide
DB	German National Railways = Deutsche Bahn
FSO	Swiss federal statistical office
GDP	Gross Domestic Product
GDV	German Association of Insurance Companies
HGV	Heavy goods vehicles (goods vehicles with a maximum GVW equal or more than 3,5 tonnes)
LGV	Light goods vehicles (goods vehicles with a maximum GVW less than 3,5 tonnes)
LTO	Landing and take-off cycle
n.a.	No data available
PM_{10}	Fine particles with a diameter of 10 µm or less
$PM_{2.5}$	Fine particles with a diameter of 2.5 µm or less
PPP	Purchasing power parity

SBB	Swiss federal railway company
UPT	Urban public transport
VAT	Value added tax
VDV	German Association of Railways and Public Transport Operators
VOSL	Value of statistical life
VOT	Value of time
WTP	Willingness to pay
YOLL	Years of life lost

Abbreviations used in data tables

–	No existing data category (for example sea ports in Switzerland)
0	Zero or approximately zero when compared to other data entries
.	Not applicable (for example the length of a sea harbour)
:	No data available